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Environmental Approach to Assessment of Landfill Leachate Effect on Groundwater

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Mashhad landfill location on granitoid rocks has been covered by the alluvium by the present treaty and a height equivalent is 1080 meters. Granitoid basement rocks mix of granite, granodiorite and is pegmatite. Mashhad south Fault is the closest fault to this place where it passes through south. There are large cracks and joint in the rocks that play significant role in the leachate transfer due to landfill waste into the ground. In this study, the environmental impacts of Mashhad landfill was investigated, including land subsidence and pollution of soil and water resources. Also in this study to assess downstream pollution in landfill is done groundwater sampling and soil sampling standpoint of chemical and microbial analysis. Surveys implemented in the landfill clarify the concentration of metallic elements near the landfill are relatively high and amount of them is reduced with distance from the landfill. Also, nitrate and phosphate levels have been affected by landfills and agricultural activities.

Keywords: Leachate, Landfill, Environmental pollution.

INTRODUCTION

One of the important environmental issues and problems that the country's big cities are facing with them including urban, industrial, medical and dangerous solid waste management. Meanwhile, industrial and hazardous waste management or so-called special wastes is very important because the lack of proper planning and management that can cause pollution of surface and underground water resources, soil and air widely. According to the mentioned subjects above and the overall approach of waste management , one of the basic steps and the main axes in integrated waste management is special waste management, which special attention has demanded and it is necessary to be considered the management and control systems. Subjected records review of plans and structural projects implementation in developing countries shows that in the past program-the importance and values of natural resources and environmental is hidden from the perspective of decision makers and many of them have been designed and utilized, without regard to environmental considerations. The outcomes and consequences of such measures have been various pollution outbreak and degradation and severe depletion of environmental resource in countries.

Certainly the urban landfill sites can be considered also among the plans and constructional projects, having the short and long term effects of environment[1]. To solve the critical problems of environment basically must be designed macro views and development infrastructures comply with the rules of the environmental protection law. Any policy and economic development planning, social and culture of the future country on the foundation of Environment protection and Natural Resources and wisely productivity from these resources takes place with the attitude of balance and proportion between the rules of environmental law and sustainable development. Environmental impact. On land use as one of the environmental management tools. During the previous three decades in many developed and developing countries is normally; the obligation to use this approach is emphasized for large constructional projects such as municipal landfill sites. Environmental problems of urban landfill sites and their surrounding environments, long time have been considered the people and authorities. In recent decades, especially after the development of solid waste management knowledge, urban landfill sites was exploited in the form of the past few years; caused the issues related to environment to be considered more critical. Therefore, to reduce existing environmental problems, the first objective of environmental urban landfill sites assessment to ensure compliance of policies and guidelines set in the programs and activities of the plans or projects is discussed in regard to regulations, standards, state environmental laws and regulations. Hence providing an

assessment report includes identifying all the important effects of proposed projects or plans related to municipal landfill sites by providing a logical and acceptable options is created the least negative and dangerous effects with the maximum increasing of life quality for humans and the highest trust and confidence in decision makers and people levels[2,3].

EXPERIMENTAL

Landfill in every city is affected by urban development. Usually landfill near the city and where having the suitable conditions for landfill, is be selected.

Mashhad, as the second largest city of Iran with a population over 3 million people per year and attend the annual 16 million pilgrims, produce the average daily 2000 tons of waste. Average per capita production of waste household in the town of *ca.* 560 g and in time the presence of pilgrims increases to 720 g daily. Mashhad, according to its permanent expansion, have changed landfill sites and in some places where waste is buried now have been organized in the urban context by the parks and green spaces organization have been transformed into parks. Mainly have been in the eastern part of Mashhad. After closing these locations the landfill was set farthest from the city and 5 km the South East old road near Neyshabour-Mashhad (Fig. 1).

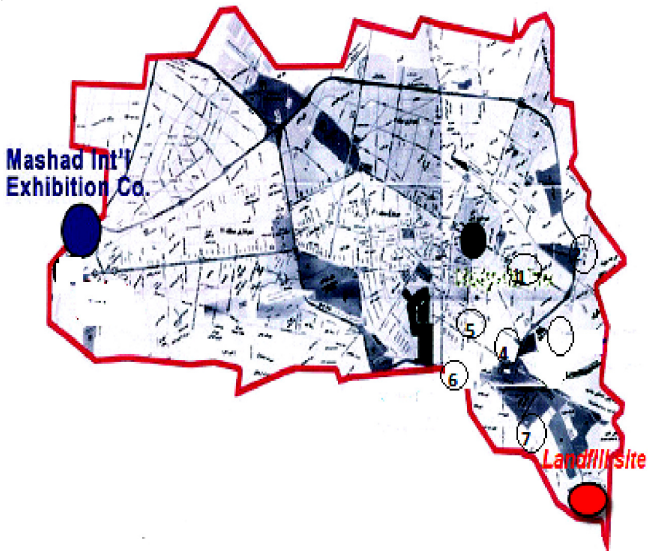

Fig. 1. Study area and location of sample wells

Mashhad current landfill site on the granitoid basement covered by alleviations testament now and have been height equivalent to the 1080 m granitoid basement is combination of granite, granodiorite and pegmatitic rocks. Mashhad south Fault is the closest fault to this place where it passes through south. There are large cracks and joint in the rocks that play significant role in the leachate transfer due to landfill waste into the ground. Soils formed in place are young soils that don't have evolved profiles and thus the low depth and are including much permeability and therefore play an important role in the transfer of leachate into the founded joints and cracks in aforementioned rocks.

It should be noted that the average annual rainfall in the study area is 270 mm. Small stream that are separates the landfill area will join the relatively large channel, this channel only when the heavy rainfall or long term may be current water inside. Nitrate including ions in the long-term its pollution effects become evident on the environment and also its pollution will remain until years after the closure of landfill site[4]. Previous researches clarify that the amount of ammonium in the leachate, even after 30 years of closing the landfill does not indicate significant reduction. Ammonium cause to attract released oxygen and will be converted to nitrogen which creating in eutrophication conditions has an important role[5].

Methodology: For investigated heavy metals density in region solids near to landfill and its downstream are excavated 6 samples numbers. For reducing surface impacts and also organic materials, sampling is done from 15-30 cm. from each point's 3.0-3.5 kg soil separate and put in plastic bags. About 1 kg soil is sent to laboratory for heavy metal analysis and left is used for identification soil structure and preparation extract saturation due to measure acidity (pH) and electrical conductivity (EC).

Samples of leachate were collected using up to two sample containers: one 500 mL amber glass bottle for the unfiltered sample and as necessary one quality control (QC) duplicate glass bottle. Duplicate sample bottles were labeled "FD". Each glass bottle was appropriately marked or labeled with the sample identification code and the analysis required. The sample containers did not contain a sample preservative (*e.g.*, nitric acid) because 3H adsorption onto container walls was deemed negligible and the 5 day holding time limit is therefore not applicable. Samples were not filtered because the laboratory analysis procedure utilizes evaporation during sample preparation.

According to the absence of surface water in area during sampling, sampling is limited to regional groundwater. So 6 sampling is done from groundwater. For sampling 250 mm poly ethylene bottles is using that have two caps, at the time of sampling 3 times rinsed with distilled water. Then sampling is done in the bottle with completely full of water and there is no air bubbles in sample bottle.

Measurement parameters for water can be divided two groups, such as acidity (pH) and electrical conductivity (EC), temperature (T) and sulphur hydrogen gases (H_2S) and carbon dioxide dissolved in water (CO_2) and measured parameters in laboratory including main density of anions and cations.

Due to pollution identification of leachate in Mashhad landfill site, two samples of 250 mL of produced leachate from landfill that gathered in leachate stabilization pound, then gathered samples mixed together and passed through Whatmann 42 filter paper to obtain relatively homogeneous solution and without suspended particles. Then for solution obtained density of Pb, Zn, Ni, Cu, Fe, Na, Mg and Ca with atomic absorption is measured by Mashhad municipality health unit in chemistry laboratory of Firdausi Mashhad University[6,7].

In all cases due to acquire density at first prepare 5 standards and for all standards read by absorption atomic system. Then for desired sample is read by atomic absorption method, having prepared standards density and read related system for standards. Prepare density diagram and according to system reading for desired sample is calculated its density.

RESULTS AND DISCUSSION

The adverse effects of various contaminants on human health have drawn attention during the past decades. In this regard, different standards have been established to protect human health. The different approaches stand for defining a scientific data base for the maximum exposure levels of a specific chemical compound.

Measured parameters in sampling location: In order to investigate the downstream water quality of landfill is done six water samples of downstream wells. The characteristics of the various wells including their depth are shown in Table-1.

TABLE-1
CHARACTERISTIC OF SAMPLING WELLS

Well No.	Distance from landfill (m)	Depth (m)	Aquifer type
W1	7.3	210	B2/A5
W2	6.8	234	B2/A5
W3	3.9	320	B2/A5
W4	4.2	215	B2/A5
W5	5.2	175	B2/A5
W6	4.1	258	B2/A5
W7	2.8	320	B2/A5

The typical characteristics of landfill leachate and standard discharge limit set by Institute of Standards and Industrial Research of Iran (ISIRI) are given in Table-2.

TABLE-2
CHARACTERISTIC OF LANDFILL LEACHATE AND ISIRI DISCHARGE LIMITATION

Parameter	Range	ISIR discharge limitation to surface water[8]
pH	Neutral	5.5-9
BOD_3 (mg/L)	2000-30000	30
COD (mg/L)	3000-60000	250
Dissolved solids (mg/L)	–	2100
Suspended solids (mg/L)	200-2000	100
Total nitrogen (mg/L)	10-800	100
Pb (mg/L)	0.05-0.1	0.1
Cd (mg/L)	0.005-0.01	200
Ni (mg/L)	0.1-0.2	3
Zn (mg/L)	0.5-2	5
Cu (mg/L)	0.05-0.1	3

The measured parameters were temperature, acidity (pH), electrical conductivity (EC), Gas carbonic acid (CO_2) and hydrogen sulfide (H_2S). The results are presented in Table-3.

According to the results contained Table-1 can be made such comments:

Groundwater temperature in the study area exception of No. 3 sample from 8/19 to 8/21 are varies that this little difference is concerned to the depth of the water table and the measurement time. For No. 3 sample the water temperature equal to 25 ± 2 ºC despite the difference in time measurement and water table depth probably groundwater stems from the other table.

The amount of electrical conductivity in samples change from 505-1585 micro mouse/centimeters. 1, 2, 4 and 5 samples are deep wells in the downstream channel of the landfill area, respectively. The electrical conductivity has increased from the upstream to down that is quite normal and its reason is increasing water perdurable time in aquifer groundwater. For No. 3 sample the electrical conductivity is 919 micro mouse/cm, as the water temperature of this well is different with other wells, probably it is related to the another aquifer. For No. 6 well this instance in the city (Ummat Park, previous location of Mashhad landfill site) is located, affected by the groundwater flow; enter to Mashhad plain from remote area and groundwater contact time with components of hydrated layer has been relatively long.

About acidity are observed its amount is variable about 2-7 to 3-8, which is standing in the range of natural waters.

Amount of dissolved carbon dioxide varied in the study area water and is different from between 1-5 mg/L.

In 1, 2 and 3 samples deficiency reason of solution carbon dioxide because of carbonic gas consumption during component fundamental dissolution of ground water aquifer and in 4, 5 and 6 samples the amount of carbon dioxide is relatively high because of this reason that the wells are located in the plains. Because of high carbon dioxide of air trapped in the soil (due to microorganisms and plant roots activity) have been caused higher concentrations of carbon dioxide of the influenced waters into groundwater aquifer.

Table-1 showed that in all the samples there are more or less hydrogen gas that it indicates groundwater contamination by waste. It is interesting about the 6 sample, there is highest concentration of hydrogen sulfide gas, which is due to the sewage wells is the vicinity of this well within the city (parks Ummat). About other wells, concentration of hydrogen sulfide gas in Num 1 sample is very close to the current landfill was higher than all cases that seem to be quite reasonable.

Measured parameters in the laboratory: Besides the parameters directly were measured at the sampling site, the main anions and cations were measured in the Laboratory, Ferdousi University of Mashhad, results are presented in Table-4:

Table-2 showed that the significant concentrations of the main anions and cations *i.e.*, sodium, magnesium, calcium, chloride and bicarbonate with levels associated to electrical conductivity is quite conformed and agreed. The reason of difference between the main elements are the same comments about

TABLE-3
PARAMETERS MEASURED AT SAMPLING SITES

Number of sample		Geographical site	EC (µS/cm)	pH	T (ºC)	CO_2 (mg/L)	H_2S (mg/L)	Distance from landfill site (m)
Current landfill site	1	59°39′55″, 36°10′53″	505	8.18	21	0.9	2.4	2500
	2	59°40′54″, 36°10′40″	694	8.22	20.8	0.4	1.2	3700
	3	59°41′57″, 36°10′11″	919	8.25	25/2	0.1	1.4	5450
	4	59°43′2″, 36°10′41″	780	8.32	21.7	3.1	1.5	6500
	5	59°42′10″, 36°12′1″	811	7.7	21.8	3.2	1.5	6000
Old landfill location	6	59°38′38″, 36°17′6″	1585	7.19	19.8	5.2	16.2	–
	7	59°36′56″, 36°19′12″	2020	7.35	20.1	5.7	14.5	–

TABLE-4
MEASURED PARAMETERS IN LABORATORY

Sample number	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	PO_4^{3-}	Ca^{2+}	Mg^{2+}	Na^+
1	5	195	34	65	9.6	0.08	32	9	98.8
2	5	185	68	110	17.6	0.18	44	12	112
3	10	255	110	170	16.8	0.43	36	7	188
4	10	218	70	121	12.9	0.31	19.5	9.8	142.3
5	0	240	73	124	12.8	0.29	20	10	144.5
6	0	350	230	165	180	0.21	35	48	194.2

electrical conductivity. It is also considered that the nitrate ion concentration for all samples is more than 5 mg/ mL (threshold of water pollution[9]). This represents water pollution in these areas. Especially regarding the number of 6 samples due to the household sewage wells in the vicinity of this well; nitrate concentration has reached to180 mg/L. In case of the phosphate ions, it is observed that the ion concentration is different between 0.08-0.043 mg/L and its concentration is relatively high.

Conclusion

According to the subjects, it was observed that the downstream region groundwater of Mashhad landfill have been contaminated to some extent. As the concentration of hydrogen sulfide gas in them is relatively high and also the amount of nitrate in all cases is more than the standard limits (5 mg/L).

In terms of getting rich elements in the soil near the landfill place to the downward the amount of the elements is reduced that the reason is with increasing distance from the origin, absorption and deposition processes are more increase and elements exit from its surrounding environment.

Study results show that leachate produced and subsidence according to the performed calculations continues by more than 30 years after the closure landfill site that cause to be continued contamination.

It is necessary to mention here that sampling is done at the end of the dry season and probably at the end of the wet season more due to the penetration of leachate into the groundwater aquifer, contaminant concentrations will be higher in groundwater.

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