Environmental Impact Assessment of Erbil Dumpsite area - West of Erbil City-Iraqi Kurdistan Region

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Abstract

During the last few years, the concern about the protection of the environment has largely increased due to the contaminants mainly with anthropogenic origin and have affected and continue to threaten human resources especially air quality, surface soil and groundwater. Solid wastes are produced every day in urban societies as a result of human activities and in an attempt to dispose of these materials; man has carelessly polluted the environment. Erbil City has experienced an economic development, intense urbanization and change in consumption patterns that have resulted in an increase of solid waste generation. The study area lies within Erbil plain, about 10 km west of Erbil City, covering about 7km^2 and located on a hill conjoined by two drainage valleys. The aim of the study is to provide prediction, detecting possible contamination and highlighting the repercussions of unprotected and uncontrolled waste disposal practices in Erbil dumpsite. The baseline environment has done which describes the existing environmental settings in the study area and is based upon the secondary information collected from the published sources, reconnaissance survey, primary socio-economic survey and environmental monitoring of air, noise, soil, ground water and surface water in the study area. Soil and water samples were collected nearby the Erbil dumpsite to assess the baseline data. The results of water sample analyzed are within the acceptable limits and they are suitable for drinking and irrigation. The results of soil sample analysis show that clays are of loam types with pH of strongly alkaline. The septic tank discharges valley has been contaminating the soil with two zones, the thickness of these zones is about (1.0- 1.5m) and (4m) show the impact of septic tanks to the near subsurface layers by its vicinity to the septic tank discharging valley. On the other hand, no adverse impact on ground water quality is anticipated in the present project. Generally, the Erbil waste dumpsite has negative impact on the geo-environmental parameters, social and cultural views, in addition to the direct impact on the human health and biodiversity. Evidence of lack of adherence to proper landfill structure, operation a management was recorded and recommendations were postulated for rectification. The Environmental Impacts Assessment (EIA) that was undertaking for this project has also postulated mitigate set simple measures. The assessment revealed lack of environmental awareness by public, workers, and personnel, which can be solved through regular environmental training programs.

Keywords: EIA; Dumpsite; Groundwater; Soil; Erbil; Iraq.

1- Introduction

Disposal of refuse occurs all over the world and proves to be a major problem. Kurdistan region, like a lot of parts of the world experiences problems in terms of shortage and degradation. A lot of factors affect environmental pollution such as industrial, agriculture and the wastes

and affluence released by human activity. They are generally classified into solid, liquid and gaseous. The means of waste disposal like that of many industrialized towns in developing countries is the use of open dump landfills. This is an improper solid waste management system which is globally accepted as the major cause of environmental pollution in the world (Ogungbe *et al*., 2012).

The major problem facing the construction of new communities or development is the source of water. Groundwater is considered as one of the main sources of water in a semi-arid and arid environment. Groundwater resources have been under rapidly increasing stress in large parts of the world due to pollution. Pollution is primarily the result of irrigated agriculture, industrialization, and urbanization, which generates diverse wastes, with the attendant impact on the ecosystem and groundwater. With a rapid increase in population and growth of industrialization, groundwater quality is being increasingly threatened by the disposal of urban and industrial solid waste (Raju *et al*., 2011; Singh *et al*., 2015).

Pollution from solid wastes always begins with precipitates carrying the leachates into land surface and ends with the water reaching surface water or groundwater. Solid waste projects are made to prevent the environment from the negative effects of solid wastes. The pollutant components of solid waste are: leachate, gas emission, odor, noise and bad view. These are the main pollutants that are expected from every kind of solid waste. The effects are generally the same but its level may be changed according to the region (Gulmez, 1999). Therefore, EIA of solid waste project is prepared in the aim of minimizing these effects. Careless dumping of refuse and poor management can greatly affect one's health. Poor management of solid waste materials leads to potentially disastrous environmental and health hazards. Among health hazards that have resulted from the lack of an effective disposal system are periodic epidemic and communicable diseases (Azeez and Eyinla, 2014).

Environmental Impact Assessment (EIA) is a formal study process used to predict the environmental consequences of a proposed major development project. An EIA identifies ways to minimize the problems and outlines ways to improve the project's suitability for its proposed environment. The (EIA) process, which originated in the United States in the late 1960s and early 1970s, has been adopted extensively in the rest of the world. The U.S. model and that of other developed countries share basic principles and reflects commonly agreed-upon approaches to similar problems (Jennifer, 2008). Open dumps are the oldest and most common way of disposing of solid wastes. The practice of landfill as a method of waste disposal in many developing countries is far from standard recommendations (Mull, 2005; Adewole, 2009).

2- Research objectives

Although EIA should have been carried out at the advent stages this EIA phase will address the existing current conditions and possible means for rectification. It aims to achieve the following:

1- The preventing and protecting of the public from the possible infections and contamination from the municipal waste.
2- Providing safe, clean and healthier environment to the local communities.
3- Protecting of the public health from the spread of potential infectious diseases.
4- Providing an overall assessment of the social and biophysical environments of the affected area by the proposed construction of the project.
5- Improving project acceptance.
6- Avoiding impacts and violations of laws and regulations.
7- Improving project performance.

Protecting the productivity and capacity of natural systems and the ecological processes which maintain their functions.

3- Site characterization

The Erbil dumpsite sit lies within Erbil plain, about 10 km west of Erbil City, covering about 7 km^2 with Latitude 36° 11' 40.60" N and Longitude 43° 53' 05.10" E (Fig. 1) and located on a hill conjoined by two drainage valleys. The elevation of this site is about 435m above sea level.

The Erbil dumpsite operation life since year 2001 (Municipal ministry), and currently receives all types of solid waste. Daily disposal is about one thousand ton (Dawd, 2009, Personal Communication) of solid waste of varied types.

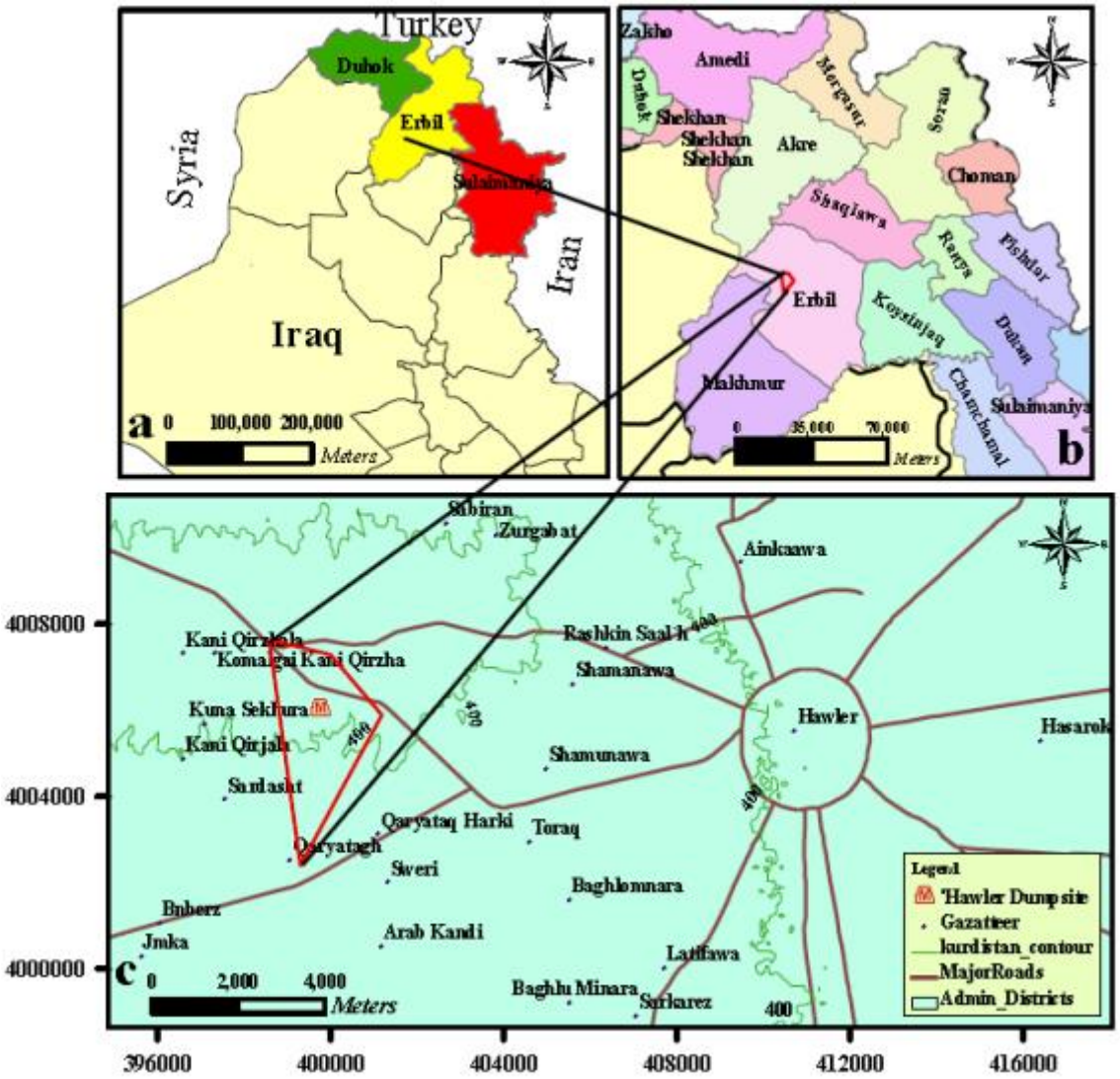

Figure 1) Maps show: a- Iraq, location of Erbil Province is indicated, b- Kurdistan Region of Iraq and c- Erbil City, location of the study area is indicated (Red line).

The location is generally used for any type of general household waste. The waste dumped at this site includes domestic waste, e.g. kitchen waste, food leftovers, paper, newspaper, metal and glass cans, packaging, plastic, glass, cartoon, wood, metals, ceramics, leather, cloths and batteries. These wastes can spontaneously ignite and produce noxious smoke smell and which varies according to waste composition with greater risk to the operating management staff. Construction and demolition waste, which consist of sand, bricks and concrete block are also dumped. Dumping activities started from

the top of the site by merely toppling the waste over the edge.

Some components of the waste are very hazardous or toxic such as liquid solvents seen along one of the valleys, north of the Erbil dumpsite ridge. Furthermore it was observed that black water from household septic tanks was also discharged nearby the site.

With an increasing population in Erbil City, as a capital of the Iraqi Kurdistan Region and changing production and consumption patterns in the last few years, levels of degrading waste is increasing at alarming rates.

Existing waste disposal sites are rapidly filling up and with the ever increasing costs for disposal of waste; it is becoming very difficult and expensive to dispose of food waste which is the main waste in the Erbil dumpsite. Therefore any sector that generates food waste is facing a potentially huge disposal problem, particularly those establishments catering on a large scale, such as hospitals, schools, universities, ministry of Defense sites, prisons, hotels, restaurants, and even shopping centers and parks, in addition to household food waste. The wastes in the Erbil dumpsite is decomposing continually and a sludge of decomposed soup known as leachate will develop. The age of a landfill significantly affects the quantity of leachate formed. Leachate generated in the initial period of waste deposition (up to 5 years) in landfills has pH value range of 3.7 to 6.5 indicating the presence of carboxylic acids and bicarbonate ions. With time, the pH of leachate becomes neutral or weakly alkaline ranging between 7.0 and 7.6. Landfills exploited for a long period of time give rise to alkaline leachate with a pH range of 8.0 to 8.5 (Słomczyńska and Słomczyński, 2004). It is therefore important that a systematic study on Environmental Impact Assessment (EIA) is carried out to assess the effects (both positive and negative) of dump siting on the environment, which may also include historical, cultural and social aspects.

4- Base line environment

The term "baseline" refers to the collection of background information on the biophysical, social and economic settings proposed project area. Normally, information is obtained from secondary sources or the acquisition of new information through field samplings, interviews, surveys and consultations with the public (Ogola, 2007).

This section describes the existing environmental settings in the study area and is based upon the secondary information collected from the published sources, reconnaissance survey, primary socio-economic survey and environmental monitoring of air, noise, soil, ground water and surface water in the study area.

The major purpose of describing the baseline environmental settings of the study area is:

_ To assess the existing environmental quality, as well as study the environmental impacts due to the proposed project.

_ To identify environmentally significant factors or geographical areas that could preclude any future development.

The baseline environmental conditions are established through literature survey and field works.

4.1- Geologic setting and structure

According to Jassim and Goff (2006), the study area lies within the Chemchamal- Butma Subzone of the Foothill Zone, which is the central unit of the Unstable Shelf. The zone was visibly affected by the Late Tertiary Phases of the Alpine orogeny. (Buday, 1980). Butma-Chemchemal subzone, however, has very conspicuous long and deep synclines with thick Pliocene molasses dominated by conglomerate and the strata are essentially horizontal (Jassim and Goff, 2006). Erbil plain is considered to be among these plains as a broad syncline between two main anticlinal structures, Pirmam from

east and Khurmala-Avana from west (Hassan, 1998). The inner parts of the synclines contain Quaternary deposits, referred to here as the polygenetic synclinal fill, (Jassim and Goff, 2006). The geological formations in the study area are described from the older to younger rock units as follows: Mukdadiya Formation (Pliocene) comprises of fining upwards cycles of gravely sandstone, sandstone and red mudstone, (Jassim and Goff, 2006). The depth of the upper boundary is not known. Bai Hassan Formation (Pliocene) consists of molasses sediments represented by alternation of claystones and conglomerates with some sandstones and siltstones, variations from one of the main constituents to the other, both laterally and vertically is very common (Hassan, 1998). The major part of the study area is covered by this formation (Fig. 2). No accurate information is present about the thickness of this formation, and Quaternary deposits (Pleistocene-Holocene), acording to Jassim and Goff (2006) Quaternary sedimentary veneer of polygenetic origin covers large areas in the synclines of the Foothill Zone. These synclines often have a central river system that cuts across, or flows parallel to their axes, the sediments filling the synclines consist mainly of a mixture of gravel and clay.

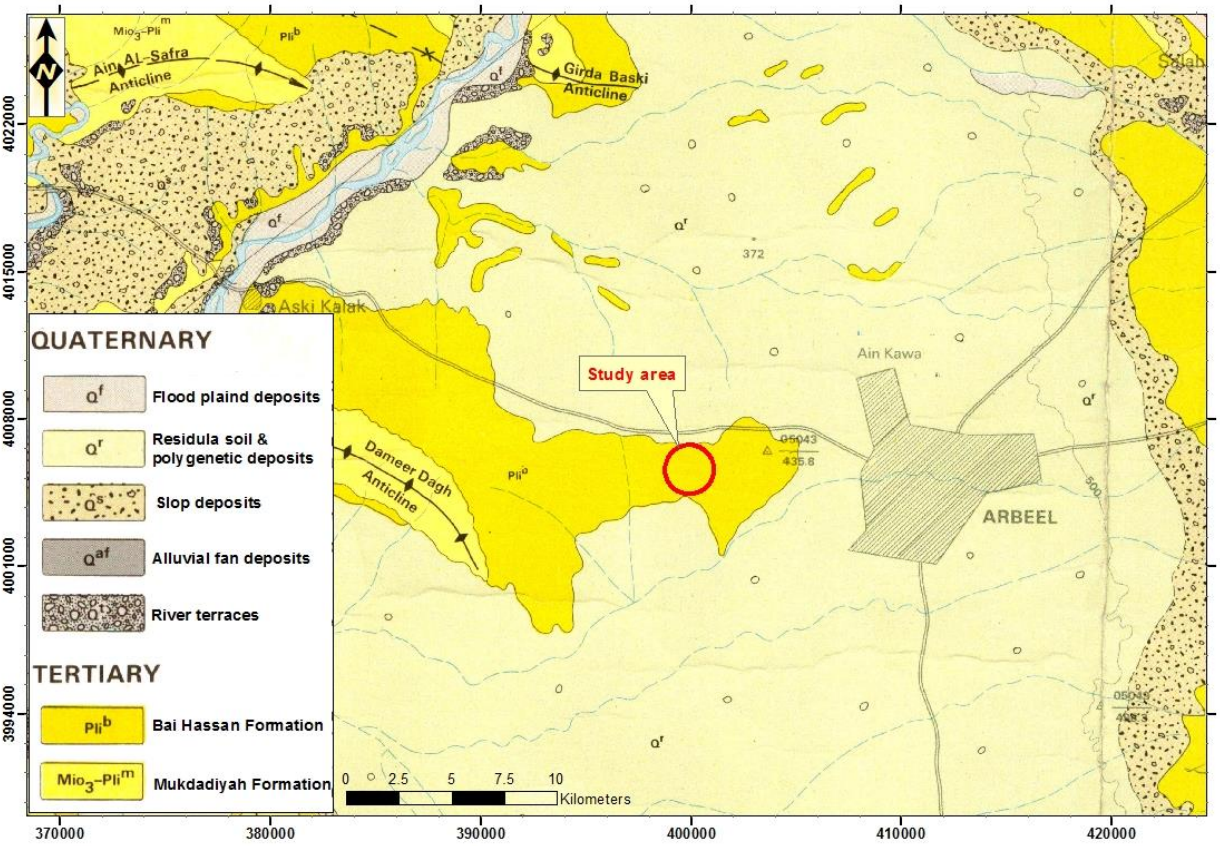

Figure 2) Geological map shows the study area (After Sissakian, 1997).

4.2- Geomorphology

There are no surface geological features in the studied area, except of some hills and valleys which are found controlled by the drainage pattern are reflection of the subsurface structures and rock unit nature. The Erbil area rises topographically from the flat plains in the west and southwest towards the hills in the north and northeast (i.e. towards the Pirmam Mountain). Erbil central plain slopes gradually from east to west (Fig. 3), its slope is less than 3°, and the local slopes do not exceed 8° (Hassan, 1998). In the Erbil areas, the drainage pattern falls into two subdivisions, the whole of the eastern part of the area drains from the east and the northeast with a parallel system of streams and valleys toward the central area just

west of Erbil city, this is consistent with the general slope of the area west and southwestwards from the Pirmam Anticline and the western part of the Erbil area on the other hand shows dendritic drainage pattern over gentle slopes of the ground (Ghaib, 2001).

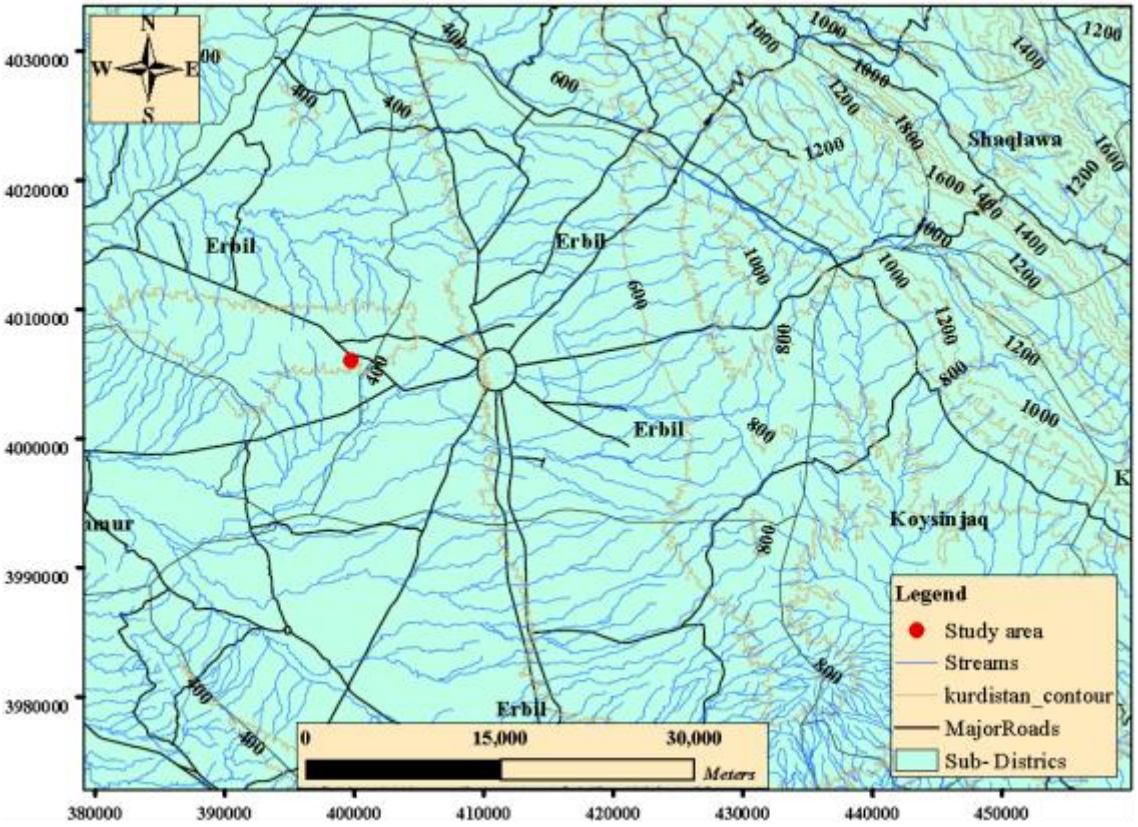

Figure 3) Topographic map of Erbil province shows the studied area.

4.3- Hydrogeological condition

Erbil hydrogeological basin is bounded by Greater zab from north and Lasser zab to the south. Erbil basin is a wide depression located between southern limb of Pirmam anticline and Dibaga hill zone (Zurgha Zraw Zurg) which gives a semicircular shape to Erbil basin. These two hill zones are consisting of Bakhtiari Formation (Majeed and Ahmad, 2002). The Erbil hydrogeological basin is a structural groundwater basin with at least three sub-basin units that are separated by minor surface and subsurface structures (Al- Jawad and Hussien, 1988 and Hassan, 1998).

The Pliocene Formations and especially the Bai Hassan is considered as a major aquifer in the Erbil basin, it is a continental deposit of gravel, conglomerate, sand and clay. The exposures of the Bakhtiari Formation are found in the higher lands of the basin (Al- Jawad and Hussien, 1988).

Depth of static water level is about (20-25) m, with good discharges water zone starts at depth after 25 m. with presence of surface water in some locations at depth of (10-15) m (Majeed and Ahmad, 2002). Depth to groundwater varies in short distances due to variable topography. According to Hassan (1998) the groundwater table depth ranges between 30- 50 m in Erbil City, and according to Al- Ansari *et.al.* (1981) the water table is usually 50 m deep. Hassan (1998) during his study noticed that the groundwater moves from east to west side of the Erbil city, so it flows in the same direction as regional groundwater flows.

4.4- Sample analysis

Soil and water samples were collected nearby the Erbil dumpsite to assess the baseline data (Table 1). Soil samples were collected from

different locations (Fig. 4) at about 25cm depth within the activity area including three samples (Table 2) to establish the baseline data at this time. The pH of soil samples was measured by pH meter equipment and electrical conductivity (EC) by EC equipment in the Chemistry Department laboratory in Science College-Salahaddin University. The soil class is clay loam in two first samples and silty clay loam in sample three. The pH of soil is strongly alkaline based on the classification of Al- agidi (1989).

Water samples were collected from three water wells at different locations above and behind the Erbil dumpsite. The pH measurements show that all water samples are of basic type. The chemical composition of the water wells compared with the WHO (2003) is given in (Table 3). All water analyzed samples are suitable for drinking and irrigation.

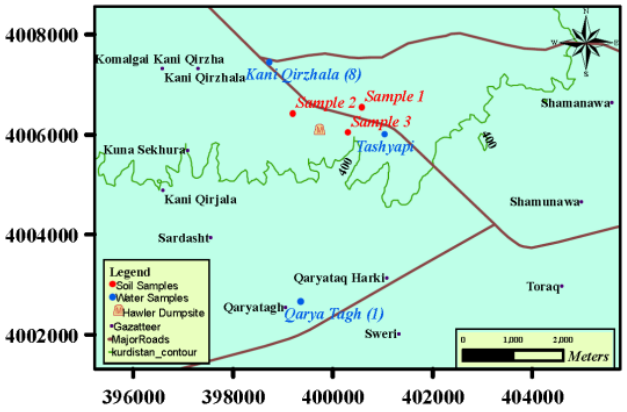

Figure 4) Map shows water and soil samples locations.

4.5- Biological data

The biological data was carried out by field observation and collection of secondary data.

Table 1) Location of the samples analysis.

Soil Sample Coordination				Water Sample Coordination			
Sample No.	Lat. (UTM)	Long. (UTM)	Elev. (m)	Well Location	Lat. (UTM)	Lon. (UTM)	Elev. (m)
1	400597	4006541	426	KaniQirzhala (8)	398747	4007442	429
2	399210	4006419	436	Tashyapi	401053	4005990	436
3	400318	4006035	412	QaryaTagh (1)	399363	4002660	337

Table 2) Soil sample analysis.

Sample No.	**Class** ***(Mirsal, 2008)***	**Texture** ***(Al- agidi, 1989)***	**Color** ***(Munsell Book of Color, 1975)***	**Moisture Content%**	**pH**	**EC (mS/cm)**
1	Clay loam	Moderately to medium	Very dark brown	16.96	8.7	8.25
2	Clay loam	Moderately to medium	Dark yellowish brown	13.25	8.7	13
3	Silty clay loam	Moderately to medium	Dark yellowish brown	15.61	8.6	9.95

4.5.1- Flora

The Flora is the presence of plants in a particular area or habitat at a particular time. Most of the landscape is used as wheat and/or barley pastors and heavily dependent on rainfall frequency for several decades ago. This means that the natural flora was replaced by cultivated plants in most of the study area, but still few common herbaceous species and few tree plants are present. All classified plant species are common and widely distributed in Kurdistan Region. Almost all plants were familiar and usually treated as weeds in cultivated area. Most cultivated trees were cut as fuel or been used in furniture or construction of houses by making roofs from tree trunks and covered by branches and leaves. The vegetations all were present in moderate to high vegetation, while in some places were naked and bare off vegetations (Al-Mousawi, 1987; Townsend *et al.*, 1965; Al-Rawi and Guest, 1966).

Table 3) Water sample analysis (mg/L).

Parameters	Tashyapi	Kani Qirzhala	QaryaTagh	WHO (2003)
Turbidity (NTU)	0.6	0.4	0.4	5
pH	7.6	7.4	7.1	8
EC (mmho/cm)	1062	703	516	1530
T.D.S.	680	450	330	1000
Hardness (as mg($caco_3$)/l)	340	232	286	500
Ca	44	47	49	200
Mg	39	43	38	150
Na	16	9	12	200
K	0.51	0.65	0.59	3
HCO_3	20	31	37	200
SO_4	47	41	44	250
Cl	29	21	11	250
NO_3	5	8	8	50

The plants in the area were collected and identified by experts of taxonomy in the herbarium of Salahaddin University in college of Science using volumes 2, 3, 4, 8 and 9 of Flora of Iraqi and volumes 1, 2, 3, 4 and 5 of Flora of Europea. The vegetation in and around the study area could be divided into the following regions:

(1)- Man cultivated vegetation: This can be summarized as:

a- Livestock vegetation which are cultivated nearby houses in the villages.

b- Trees which are cultivated near cultivation areas where farmers cultivate to be used as shading and resting places such as *Morus alba*, *Morus nigra*,*Ficus carica* and *Salix acmophylla* when sun rises at noon time or to be used commercially by cultivating *Populus euphratica*, especially in well watered area, which is used usually in construction houses.

(2)- Wild vegetation: This kind of vegetation usually differs in their presence according to rainfall season weather high or low, where all plants that present in the field are ephemeral plants and grow in rain fall season during winter and spring. The vegetations which were noticed in the field are classified and listed in (Tables 4 and 5).

4.5.2- Fauna

They are present in a particular area or habitat at a particular time. As has been mentioned in flora of study area that this area has been used for cultivation by man for several centuries and the natural vegetation is already replaced by agricultural fields, this has forced natural animals to leave the area (Dost and Dandelot, 1993; Salem *et al.*, 2006). Wild life is almost represented by very few numbers of worms, Jackals, Rabbits, Foxes, and Hyenas and etc.

The fauna in the area were collected and identified by experts of taxonomy of Salahaddin University in college of Science which using volume 25 of Common and scientific names of amphibians, domestic animals, birds, invertebrates, mammals, reptiles and aquaculture.

The presence of birds inside study area and around is connected directly or indirectly with existence of food and water so as for mammals (Table 6). The mammals inside study area that had been noticed also included domestic animals such as dogs, cats as well as rodents (rats and mice) (Table 7). Also some of the reptiles and amphibians are present in study area (Table 8).

4.6- Climatic and meteorology

The climatic condition in the study area is characterized by hot summers, and cold winters. Rainfall is seasonal occurs during late autumn, winter, and early spring months, and there is no rainfall during summer.

Table 4) List of herbaceous plants present in study area.

Scientific name	Family	Kurdish name
Chenopodium album	Chenopodiaceae	**Simrka**
Cadaria draba	Asteraceae	**Dow Basara**
Raphanus raphinestrum	Brassicaceae	**Toorowka**
Capsella bursa-pastoris	Brassicaceae	**Shelima**
Convolvulus arvensis	Convolvulaceae	**Lawlaw**
Avena fatua	Poaceae	**Paraspeelka**
Centaurea bruguierana	Asteraceae	**Drkaspeelka**
Aegilops columnaisi	Poaceae	**Kutka**
Aegilops eudata	Poaceae	**Kutka**
Urtica dioica	Urticaceae	**Gazgazok**
Malva parviflora	Malvaceae	**Tolka**
Matricari chamomilla	Asteraceae	**Bayboon**
Achilla millefolium	Asteraceae	**Bezhan**
Anchusa italica	Boraginaceae	**Golmiza**
Alhagi graecorum	Fabaceae	**Hushtraluk**
Prosopis farcta	Fabaceae	**Khrnook**
Allium ampeloprasum	Liliaceae	**Qurada**
Anchusa orientalis	Boraginaceae	**Gormiza**
Euphorbia regelii	Euphorbiaceae	**Khushilk**
Anemon coronria	Ranunculaceae	**Guladar**
Bellevalia ciliata	Liliaceae	**Glekha**
Bougardia crypostigma	Leonticaceae	**Tirshoka**
Brassica santheniae	Brassicaceae	**Turoka**
Bromus danthoniae	Poaceae	**Ganmoka**
Ceutaurea solstitiales	Asteraceae	**Dirkazarda**
Cephalaria syriaca	Dipsacaceae	**Zewan**
Cyperus rotundus	Cyperaceae	**Sutka**
Galium coronatum	Rubiaceae	**Nooska**
Gundelia tournefortii	Asteraceae	**Kangir**
Glaucium grandiflorum	Papaveraceae	**Gulalaynisan**
Lolium rigidum	Poaceae	**Giaganma**
Medicago hispida	Fabaceae	**Separa**
Papaver bornumelleri	Papaveraceae	**Gulalasura**
Muscari neglectum	Liliaceae	**Piazoka**
Plantago ovata	**Plantaginaceae**	**Bznagui**

In summer, Erbil is under influence of Mediterranean anticyclones and Subtropical high- pressure belts which is moving from west, southwest to north, and northeast. Southerly winds blow carrying sand to the Erbil Governorate raising daily temperature to a maximum value of more than 50°C. In winter Mediterranean cyclones take over moving east to northeast over the Erbil Governorate and the entire region. The site and topography of the location has a significant effect on the amount of rainfall, precipitation increase from the southwest to the northeast (Stevanovic *et al.*, 2001).

The climatic condition is important for waste disposal site, because the wind direction and wind speed have a considerable role to generate storms at these sites. Also the rate of the rainfall is one of the most important factor that runoff on the surface of waste disposal sites which seeping as a leachate through it according to the rate of precipitation, finally contact with the groundwater as a contaminant material.

The study area is located within the Erbil City. The measured data were taken from Erbil Station (Latitude: 36 12 N, Longitude: 44 02 E, Altitude: 470 m above sea level) (Agro-Meteorological Monthly Bulletin, 2009).

4.6.1- Ambient temperature

Monthly average ambient air temperatures recorded in Erbil are given in (Table 9).

4.6.2- Precipitation

Annual average total precipitation in Erbil was measured as (150.1 mm) where the maximum monthly rainfall was measured as (88.7mm) in March, (Table 10).

4.6.3- Humidity

Annual average relative humidity in Erbil was 46.7 %, the minimum relative humidity was 8 %, and the maximum relative humidity was 100 %, (Table 11).

4.6.4- Wind

The annual average wind speed in Erbil was 2.21 m/s. The maximum average wind speed is 3.0 m/s of the SE direction in both months February and June, (Table 12).

4.7- Air quality

There were not available ambient air quality baselines in the study period to be dumped on neither sufficient equipment nor instrument to be used in measuring the air analysis of the studied area.

Table 5) Trees and shrubs that are present as natural flora or cultivated plants in the study area.

Scientific name	Family	Kurdish name	Plant case
Nerium oleander	Apocynaceae	Zhala	**Wild**
Melia azedarach	Meliaceae	Tasbeeh	**Cultivated**
Ficus carica	Moraceae	Hanjeer	**Cultivated**
Eucalyptus camaldulensis	Myrtaceae	Eucalyptos	**Cultivated**
Eucalyptus glauca	Myrtaceae	Qalamtuz	**Cultivated**
Callistemon lensiolata	Myrtaceae	Filcha	**Cultivated**
Myrtus communis	Myrtaceae	Murtik	**Cultivated**
Platanus orientalis	Platanaceae	Chinar	**Cultivated**
Populus euphratica	Salicaceae	Speedar	**Cultivated**
Salix babylonica	Salicaceae	Shorabi	**Wild**
Salix acmophylla	Salicaceae	Darabi	**Wild**
Tamarix pentandra	Tamaricaceae	Daragaz	**Wild**
Morus alba	Moraceae	Tooyspi	**Wiled and cultivated**
Morus nigra	**Moraceae**	**Tooyrash**	**Wild and cultivated**

4.8- Noise

In an urban environment, noise levels change from moment to moment. Any project normally has a significant impact on noise levels until it complete. No monitored noise data was available for the study area and noise pollution has not been considered as an issue with regard to the dumping of solid waste.

Table 6) Showing birds that are present in study area.

Scientific Name	English Name	Kurdish Name
Buteo buteo	Buzzard	Saqr
Streptopelia decaocto	Collard dove	Kokokhti
Corvus splendens	Common crow	Qala rash
Tringa hypoleocus	Common sandpiper	Titerwaska
Hirundo rustica	Common swallow	Paraselka
Galerida critala	Crested lark	Sofaqita
Sternus roseus	Starling	Reshola
Passer domesticus	House sparrow	Cholaka

5- Environmental Impacts and Mitigation Measures

For each potential adverse impact the plan for its mitigation at each stage of the project should be documented, as this is very important in the selection of the preferred alternative. The objectives of mitigation therefore are to: find better alternatives and ways of doing things; enhance the environmental and social benefits of a project avoid, minimise or remedy adverse impacts; and ensure that residual adverse impacts are kept within acceptable levels. The potential environmental impacts associated with the project are summarized in the following sections.

Table 7) Showing mammals fauna in study area.

Scientific Name	English Name	Kurdish Name
Cannis familaris	House dog	**Sag**
Felis domesticus	House cat	**Pisheela**
Rattus rattus	House rat	**Girj**
Mus musculus	House mouse	**Mishk**
Canis aureus	Jackal	**Torek**
Hystrix indica	Porcupine	**Seekhur**
Vulpes vulpes	Fox	**Rewi**
Leprus nigricollis	Hare	**Karweshk**
Hemiechinus auritus	Hedgehog	**Zhuzhik**
Crocuta crocuta	**Spotted hyena**	**Kamtyar**

Table 8) Showing the reptiles and amphibians that are present in study area.

Scientific Name	English Name	Kurdish Name
Hemidactylus flaviviridis	House gecko	**Marmelka**
Varanus flavescens	Monitor lizard	**Marmelkay Deshti**
Bufo surdus	Toad	**Boqi Sarzawi**
Rana previceps	**Frog**	**Boqi Aw**

Figure 5) Industrial wastes in the study area (agricultural plots).

5.1- Potential negative impacts

5.1.1- Impacts on physical environment

The potential impacts and mitigation measures on the geology, soil and water resources are as follows:

A- Impacts on soil and groundwater

Areas near waste disposal sites have greater possibility of groundwater and soil contamination because of the potential pollution source of leachate and septic tanks discharge area originating from the nearby site. Such contamination of groundwater resource poses a substantial risk to local resource user and to the natural environment.

Table 9) Monthly temperature variations in Erbil (after Agro-Meteorological Monthly Bulletin, 2009).

Months	Maximum Temperature C°	Minimum Temperature C°
January	18.5	-3.2
February	20.4	3.6
March	17.2	9.6
April	29.7	7.5
May	39.2	15.3
June	42.1	20.4
July	40.0	27.6
August	39.5	26.3
September	39.7	12.2
October	34.2	15.0
November	27.1	5.6
December	20.2	5.5

Leachate is the liquid generated at the bottom of the waste disposal site is considered one of the most potentially significant sources of groundwater pollution for waters (Lee and Jones- Lee, 1993). Leachate contains inorganic and organic elements (Slack *et al.*, 2005). Leachate migration from landfills and the release of pollutants from sediment (under certain conditions) pose a high risk to groundwater resource if not adequately managed (Venkatesan and Swaminathan, 2009).

Water is one of the most important commodities which man has exploited than any other resource for the substances of his life. Many parts of Erbil Plain rely on reserves of groundwater for their drinking water.

Erbil dumpsite, agricultural and industrial activities (Fig. 5) has been identified as the main pollution sources to groundwater and soil in the study area. The main flows of heavy metals to the environment are from industrial and municipal wastes, both of which contained a variety of toxic heavy metals (Chaungcham *et al*., 2008). This problem is important especially when industrial wastes are involved because many of these substances are resistant to biological or chemical degradation and, thus, are expected to persist in their original form for many years, perhaps even for centuries (Fatta *et al.*, 1999).

Groundwater from the Quaternary aquifer is suitable for use as a source of drinking water

and for industrial uses. However, development of the contaminated sources in the study area is threatening the quality of the groundwater.

Table 10) Precipitation in Erbil (after Agro-Meteorological Monthly Bulletin, 2009).

Months	Average Total Precipitation (mm)	Months	Average Total Precipitation (mm)
January	1.6	July	0
February	29	August	0
March	88.7	September	10.1
April	28.6	October	5.3
May	0	November	2.3
June	5.4	December	8.1

Table 11) Monthly relative humidity in Erbil (after Agro- Meteorological Monthly Bulletin, 2009).

Months	Average Humidity (%)	Max. Average Humidity (%)	Min. Average Humidity (%)
January	58.2	77.5	38.9
February	56.6	73.6	39.6
March	61.7	80.2	43.6
April	51.4	71.7	31.3
May	33	45.8	20.4
June	26.6	37	16.1
July	28.4	38.9	17.9
August	25.9	36	15.8
September	34.1	46.3	22
October	36.6	47.9	25.3
November	61	75.9	46.1
December	71.9	84.6	59.2

Table 12) Wind conditions in Erbil (after Agro-Meteorological Monthly Bulletin, 2009).

Months	Average Wind Speed (m/s)	Wind Direction (Degree)
January	1.6	117.4
February	3	117.9
March	2.7	147.1
April	2.5	149.7
May	2.4	190.3
June	3	187.3
July	1.7	200.3
August	2	166.8
September	2	167
October	2	161.6
November	1.6	146.7
December	2	119

Contamination of ground water can take place, if the waste disposal site containing above substances gets leached and percolates into the ground water table. Hence, no adverse impact on ground water quality is anticipated in the present project. Even in the very long term (on a timescale of several hundred years), when these sources are continued, the potential impacts on groundwater quality are predicted to be slight.

The kind of geologic material underlying the site is the most important factor, if it is sediment (gravel, sand, silt, clay), it needs to be impermeable to limit the migration of leachate, the only sediment that meets that criterion is clay, which makes an ideal landfill substrate because it has low permeability (Coch, 1995). The results of the geophysical investigation by the geo-electrical survey for geological condition obtained by Gardi (2017) that this site was composed of alternation of these clastic sediments. From the results of geo-electrical resistivity indicates two zones of contaminated has been detected. The thickness of these zones is about (1.0- 1.5m) and (4m) show the impact of septic tanks to the near subsurface layers by its vicinity to the septic tank discharging valley. It can flow by infiltration from the surface to the downward due to the high porosity and permeability of the lithology. If this process is continued it may contact with groundwater surface and finally contamination the groundwater. The depth that subject to contaminate from the surface is about (1.0- 18.0m).

The soil at the study area was found to be incapable of preventing the migration of contaminants, vertically and/or horizontally from the source point. Hence this illustrate that the septic tank discharge valley has been contaminating the soil as well as increasing its vulnerability not only to the soil and groundwater as it is also capable to effect on the fauna and flora. The short pathway needed for these contaminants before reaching groundwater was enhanced by periodic water table fluctuations and infiltrating water during the rainy season. These metals accumulate near the

soil surface and decrease with depth due to adsorption to soil particles. Adsorption occurs on surfaces of clay minerals, hydrous oxides or iron and aluminum, and organic matter (GWMAP, 1999). Also the nature of geology has important rule to infiltrate the pollutants through it, as the geological composition of the study area is of clastic materials have higher effect to infiltrate. This with time may reach to the groundwater and can contaminate it.

According to Shyler *et al*. (2009) important soil characteristics that may affect the behavior of contaminants include: soil mineralogy and clay content (soil texture); pH of the soil; amount of organic matter in the soil; moisture levels; temperature; and presence of other chemicals.

Septic waste discharged to coarse-textured soils proceeds vertically through the unsaturated zone and into ground water (Fig. 6). Once in ground water, a septic plume develops and moves with ground water flow. Approximate times for septic effluent to passes through the unsaturated zone to ground water range from a few hours to fifty days, depending on the volume of effluent and the distance to ground water (Robertson *et al*., 1991; Robertson, 1994; Robertson and Cherry, 1995). Nitrate is the primary chemical of concern in most septic plumes. Nitrate plumes slowly attenuate as a result of dilution from recharge water and dispersion within the aquifer. Nitrate concentrations can exceed drinking water criteria at distances of 100 meters or more from the drain field (GWMAP, 1999). Factors that may affect an aquifer's susceptibility to nitrates and the concentration of nitrates in groundwater include land-use, climate, topography, groundwater flow, infiltration rates, subsurface biogeochemical conditions, bedrock types, and soil characteristics (Lindsey *et al*., 1997; Nolan and Hitt, 2003).

Figure 6) a- Convoy of waste loading tankers heading towards the site. b- Sewage is discharged at one point and c- Developing little stream as consequence to continued discharge.

Mitigation measures

- It is recommended conducting a water quality monitoring program to ensure the identification of any possible contamination and immediately address the problem.
- Use the liner and collection system.
- Maintaining the cover to ensure little or no water will enter.
- Remove the leachate from the liner system.
- Septic tanks should be treated.
- Treatment of leachate: the treatment unit of leachate should be provided with proper lining system such as high density polyethylene (HDPE) supported by a homogenous sub- base material.
- Periodical inspections of leachate system should be implemented.

B- Water resources

The use of quantities of water resources are depending on the project requirements during the activity in a day.

The extraction of water from the vicinity wells for project activities can affect groundwater availability in the long term and drop the groundwater level. It can affect the quantity and quality of groundwater refers to time period of the project activity. The water from the Bai Hassan aquifer and recent deposits are generally also of good quality, with the exception of the waters from shallow wells, located near cities and villages, which are often contaminated, mainly as a result of the free seepage of sewage water (Stevanovic and Iurkiewicz, 2009).

Mitigation measures

Groundwater should be used carefully during the project activity.

5.1.2 Air quality impact

Here discuss some potential air quality impacts associated with the Erbil dumpsite to address these impacts.

A- Gas emissions

Once solid waste dumped will be responsible for a series of reactions. Gasses are generated by degradation of biodegradable fraction and are influenced by physico-chemical composition of waste and environmental variables (pH, temperature, moisture, nutrient, etc) (Kumar *et al.*, 2004).

The main constituents of solid waste gas are methane and carbon dioxide; also contain a wide variety of contaminants such as volatile organic compounds, and particular chemicals may be present if they have been disposed of at the site (Fig. 7). If the methane reaches a concentration of over 15 percent it becomes explosive (FELCG, 1997). The gas composition varies greatly depending on the waste composition and burial conditions (Abu Qdais, 2007). Carbon dioxide and methane are greenhouse gases, which do not cause harmful effects to the local environment, but rather affects global warming (Anon, 2005).

Figure 7) Exposed gas emission from Erbil dumpsite.

These gases can move underground away from the site and appear at the surface more than half a kilometer away from where it started (FELCG, 1997). Due to long residence times in the atmosphere, some airborne pollutants travel hundreds of miles from the source before deposition on land, soil or waterways (Davis *et al.*, 1994). As well as posing a risk of explosion, also it damages vegetation by displacing oxygen from around the roots of plants, also gas lead to explosion which have damaged property and injured people (FELCG, 1997).

Mitigation measures

A production gas wells must be used in the site. The main purpose of the collection system is to minimize explosion risk from methane emissions.

B- Odor impacts

Waste disposal sites often generate objectionable smells due to the decomposition of waste (Fig. 8). The odor potential at the site and the surrounding area was assessed by level of smelling at various distances from the working face on the site at various intervals during the day. The Wind direction has an important role to transport this noxious odor to the surrounding sites. It has been reported in studies that the offensive odor can reach for a distance of one mile or more from the waste disposal site (Abu Qdais, 2007).

Figure 8) Household septic tanks at the Erbil dumpsite.

In the Erbil dumpsite, odors may be generated from:

- Improper and incomplete waste separation;

- Improvised and uncovered trucks transporting the waste to the facility;

- Piled wastes for long periods of time before their processing;

- Maturating compost piles;

- Emission of gases;

- Decomposition of waste; and

- Septic tanks household waste discharge.

There are villages at the nearest Erbil dumpsite; they are far away about 2.5- 6.0 km from the surrounding villages, and some of them are located downwind from the site such as Sardasht, Qaryatagh, Jimka, and Binberz. Therefore, odor impact will not affect the closest residential to the site, it has adverse impact (health impact) on the workers in the waste disposal site.

Mitigation measures

The key mitigation measure is to ensure the implementation of best practices with special focus on prohibiting waste burning. The proposed mitigation measures include landfilling the waste using the cell phase approach, daily covering of the incoming wastes with sand, capping the cell following completion.

C- Dust impacts

Main sources of dust are excavation work, bulldozers and trucks movements over unpaved roads closure activities at the dumpsite (Fig. 9). This factor is classified to be short-term, reversible and limited as it will only occur during excavation activities. Increased traffic will also increase dust emissions both on-site and off- site.

Figure 9) Dust generation during construction phase.

Airborne pollution, in particular dust resulting from clearing of the land may further stress the local flora and fauna, and may also pose a health risk to construction workers and residents in the vicinity who suffer from asthma or other respiratory ailments (TEMN- LTD, 2006).

Mitigation measures

Dust from construction activities will be minimized by adopting cell approach. The purpose of adopting such practice is to minimize the environmental impact of the construction and operation of the dumpsite. During operation phase, dust impacts can be minimized through good site practices, as follows:

- Use of waste compaction and daily cover;
- Construction of paved site roads throughout the site and;
- Ensuring that wheels of all vehicles are washed before departure from the site.

D- Vehicle exhaust emissions

As municipal solid waste is collected and transported to a disposal or recycling facility, hauling vehicles emit gaseous pollutants. Few

traffic movement and air pollution sources exist near the waste disposal site.

However, since baseline levels of pollutants are low, emissions from these vehicles are unlikely to raise the level of air pollutants to hazardous levels (Anon, 2005).

Therefore, the potential impacts of vehicle emissions resulting from vehicles are likely to be minimal and contained within the site boundaries.

Mitigation measures

As the air quality of the site is bad and the impacts from the vehicles emissions are likely to be minimal, no specific measures are required. However, it is highly recommended that maintenance of vehicles be done on regular basis and according to a preset maintenance plan. Also, it is recommended that vehicles emissions testing to be performed on yearly basis.

5.1.3- Noise impact

The source of noise and vibrations will appear while using equipments such as shredders, boilers, generator, vehicular movement, and heavy mechanization, during the construction and operation phases of the dumpsite. The noise that originates from the trucks and other heavy vehicles and mechanization during the construction becomes neglectable at distance of 100m from each side of the route of movement and working, so that it should not be a subject of separate observation from aspect of negative impact (Anon, 2005). Having in mind that the closest settlements from the Erbil dumpsite are located at distance bigger than mentioned above, it can be concluded that the noise will have no negative impact on the population. But it affecting the workers that will work on the dumpsite will be solved by implementing ordinary measures for protection at work such as ear plugs.

The Erbil dumpsite is located in an uninhabited area and no sensitive receivers such as hospitals, mosques, churches, schools, or residential areas exist in the vicinity of the project site.

Mitigation measures

No specific mitigation measures are required. However, it is recommended to plant a green belt of beautification trees around the site to act as a noise shelter.

5.1.4 Impacts on ecological environment

Possible environmental impacts to the area include:

A- Impact on flora and fauna

Operations in dumpsite can have substantial impacts on terrestrial wildlife, ranging from temporary noise disturbances to destruction of food resources and breeding habitat.

The most obvious impact to biodiversity from the waste disposal site preparation is the removal of vegetation, which in turn alters the availability of food and shelter for wildlife. Loss of flora may result due to vegetation clearing activities for construction purposes and site preparation of the project components (Anon, 2005).

Mitigation measures

However due to the stated importance of vegetation for livelihood activities, the area should be preserved from damaging activities useless for the project implementation such as clearance for trucks' circulation or cut-off for charcoal or other uses. Besides, trucks' circulation should use the designated roads and trucks and drivers should avoid driving off road.

B- Displacement of fauna

Noise, vibrations, artificial lights and emissions resulting from the project activities will lead to additional migration of fauna from the project's neighboring areas. Although some wildlife may become accustomed to noise, others will move from the area, potentially reducing the population of those species in the immediate proximity of the site (Anon, 2005).

Mitigation measures

Faunal disturbance should be minimized from sunset to sunrise, as during this interval fauna is more active in performing its natural necessities. Most operations should not be carried out during this period of time. Self-monitoring activities should be carried out to reduce disturbance.

C- Increase of pest species

Worms may increase as a result of the waste presence in the area. In addition, dumpsites can attract a large variety and number of animals such as feral dogs and cats, rodents, birds, and insects. These animals, especially pests, are of concern because of their potential to spread disease and to adversely affect the aesthetic quality of the properties near the waste disposal site (Anon, 2005).

Mitigation measures

A fence should be constructed around the site to limit the entrance of larger animals. Besides, Waste should be compacted and covered daily to prevent the procreation of vermin and attraction of birds and other opportunistic species to the site.

D- Impacts of leachate ponds on biodiversity

The presence of leachate ponds may enhance the growth of marginal vegetation and the establishment of fly and mosquito populations that are sources of nuisance and public health threat (Anon, 2005).

Mammals and migrating birds are likely to be attracted by the ponds to food. Accordingly, these animals may be exposed to the risk of toxic substances, which might lead to their death.

Mitigation measures

It is recommended to fence the perimeter of the leachate ponds to prevent access to large animals. Moreover, the fence should have nettings to keep out small animals. Biocides which are safe to man and environment may be added to the leachate ponds to control mosquitoes and flies. Moreover, marginal vegetation, if any, should be regularly removed.

5.1.5- Impact on social and cultural environment

A- Socio- economic impacts

This dumpsite is expected to contribute in generating more positive social and other effects because of the organized collecting and taking care of municipal waste and improving the quality of life. Employment and income would be impacted both negatively and positively by the proposed development. The positive impact is represented by the creation of jobs during the construction phase of the development. However the operations are a source of concern to the local community because of issues such as water pollution, litter, vermin, flies, dust, odor, fire, traffic and noise, each of these should, however, be controlled and their effect minimized by modern engineering design, good operating practices and effective management.

Mitigation measures

The project would have major positive impacts on the locals. The project will increase the economic activities of the locals in different sectors, such as transportation, commerce, repair maintenance and etc.

B- Land use

The land of Erbil dumpsite is a public property and is not used for any commercial purpose. It is already utilized for dumpsiting waste and there are no houses located within the site boundaries. However future expansion of the city needs to be examined as part of EIA also, no inhabitants are present in informal dwellings on-site. Therefore, the project will not involve displacement of population now. The region of Erbil lies in a fertile agricultural land (Fig. 10).

Mitigation measures

References should be made to the development plan in relation to the zoning of the land use and

objectives, which include agricultural class type, industrial or others and existing master plans for the area should be consulted.

Figure 10) Agricultural lands near Erbil dumpsite.

C- Transportation

Transportation impacts are having impacts to the lack of access routes to the waste disposal site. As major roads within the community will be affected, the impact is short-term and significant.

Traffic flow on the street comprises a mixture of personal and commercial vehicles. Also due to rise of noise, vibration, exhaust emissions, dust, dirt and visual intrusion, heavy vehicles on narrow roads may create traffic management issues including delays to other traffic, damage to roads and can be a source of complaint. The Lorries will vary; there will often be problems of traffic congestion and an increase in the likelihood of accidents.

Mitigation measures

No specific mitigation measures are required. However, it is recommended to follow good maintenance practices and conduct annual emissions testing for the fleet to ensure low emission levels from vehicles.

D- Impact on settlements and surrounding landscape

The assessment was based on a qualitative evaluation of the land use and landscape character in the vicinity of Erbil dumpsite and an appreciation of the size and nature of the proposed development.

Mitigation measures

An awareness program aiming at providing landfill workers with basic knowledge on local natural resources is suggested to avoid unnecessary disturbing activities to neighboring areas.

E- Health and safety impacts

This aspect discusses the range of the potential health and safety impacts associated with the project activity.

Human wastes require care in their disposal because they carry diseases from pathogenic as mitts and ticks, worms, protozoa, bacteria and viruses. Workers (Fig. 11) in the vicinity of solid waste processing and disposal facilities also are exposed to environmental health and accident risks. Diseases can be transferred from the waste disposal site to the local community through animal vectors, water, and air. Public safety risks are mainly posed by the increased traffic caused by the waste collection vehicles.

Figure 11) Workers during sewage dumping at the Erbil dumpsite.

Environmental and human health risks arise from exposure to hazardous substances in groundwater, surface water, gaseous emissions and dust evolution as a result of leakage (Slack *et. al.*, 2005).

The current lack of proper solid waste management is surely having a negative impact on human health and the environment. Current and historical dumping of wastes, whether in open dumps, is directly polluting the environment and water resources of the area, and is furnishing breeding habitats for rodents and diseases to flourish (MEEA- Ltd., 2005).

A high number of children and adolescents working on the dumping site had illnesses related to the respiratory (Fig. 12), gastrointestinal and respiratory systems such as upper respiratory tract infections, chronic bronchitis, asthma, fungal infections, allergic and unspecified dermatitis/ pruritis – inflammation and itchiness of the skin (Cointreau, 2006).

Health risks from waste are caused by many factors, including:

- The nature of raw waste, its composition (e.g., toxic, allergenic and infectious substances), and its components (e.g., gases, dusts and leachates);
- The nature of waste as it decomposes (e.g., gases, dusts, leachates, particle sizes) and their change in ability to cause a toxic, allergenic or infectious health response;
- Manual handling of waste this is carried out without appropriate safety precautions leading to occupational hazards.
- The processing of wastes (e.g., odor, noise, vibration, accidents, air emissions, residuals, explosions, fires) and
- The disposal of wastes (e.g., odor, noise, vibration, stability of waste piles, air and water emissions, explosions, fires).

Figure 12) Children working in the Erbil dumpsite.

These risks relate to the emissions from the solid wastes, the pollution control measures used to manage these emissions, and the overall safety of the facility (Cointreau, 2006). Furthermore, sudden peaks in exposure are likely to occur when the lids of waste containers are opened (Ditto).

Domestic animals (e.g., cows, goats, chickens, and horses) are present at most open dumps and animal infection is likely (Fig. 13). Wastes from slaughterhouses are often indiscriminately discharged to the same open dumps as municipal solid wastes, raising concern about diseases (such as Bovine Spongiform Encephalophy, 'mad cow disease', which necessitated the selective slaughter of hundreds of thousands of cattle in 1996) being spread when animals eat the infected flesh of other animals (Cointreau, 2006). It may appear in our country in the future if the open dumps are not controlled. Vectors which may transfer diseases from the waste disposal site to local communities include worms, insects, birds and humans. Nitrate is the major contaminate from septic tanks which discharges along the valley. Nitrate can have serious and potentially fatal effects for infants that ingest water with high nitrate levels (drinking water standard is 10 parts per million) (Souder *et al.*, 2007).

Mitigation measures

Therefore, in order to minimize health impacts, operational practices already include the following:

Figure 13) Cattle watering from the running septic tank stream.

–Control of entry and exit to the site;

– Control of vermin, insects and birds by compaction of waste and use of daily cover;

– Control of birds through use of bird scaring methods and fences around the leachate collection ponds;

– Prohibit manual handling of the waste and use of mechanical equipment;

– Providing protective clothing to personnel working on site;

– Providing first aid facilities; and

Regular health checks for personnel.

5.2- Assessing current location

Does not apply with the standard, and as such it is being appropriated disposal process.

6- Conclusions

Erbil dumpsite is the major site for collecting manucipal waste in Ebil City. Due to increasing population rapidly, increases the volume of the waste consequently it has always been associated with negative impacts on environment. Based on fieldwork and the sample analysis, the following points are concluded:

1- The results of water sample analysis at three different locations shows that they are within the acceptable limits WHO (2003). All water analyzed samples are suitable for drinking and irrigation uses.

2- The results of soil sample analysis at three different locations at far distances away from the dumpsite shows that they are clay loam types with pH of strongly alkaline with electrical conductivity of (8.0- 13.0 ms/cm).

3- The septic tank discharges valley has been contaminating the soil. Two zones of contaminated has been detected. The thickness of these zones is about (1.0- 1.5m) and (4m) show the impact of septic tanks to the near subsurface layers by its vicinity to the septic tank discharging valley. It can flow by infiltration from the surface to the downward due to the high porosity and permeability of the lithology. While, no adverse impact on ground water quality is anticipated in the present project. If this process is continued it may contact with groundwater surface and finally contamination the groundwater. The depth that subject to contaminate from the surface is about (1.0- 18.0m).

4- Geo-environmental parameters such as air, odor, soil, agricultural land, vegetation, ecological impacts and landforms are affected directly by dumpsite activities.

5- The population living close to the Erbil dumpsite areas are the worst affected.

6- Workers in the vicinity of solid waste processing and disposal facilities also are exposed to environmental health and accident risks. Diseases can be transferred from the waste disposal site to the local community through animal vectors, water, and air. Public safety risks are mainly posed by the increased traffic caused by the waste collection vehicles.

7- Mammals and migrating birds are likely to be attracted by the ponds to food. Accordingly, these animals may be exposed to the risk of toxic substances, which might lead to their death.

8- Employment and income would be impacted both negatively and positively by the proposed development. The positive impact is

represented by the creation of jobs during the construction phase of the development. However the operations are a source of concern to the local community because of issues such as water pollution, litter, vermin, flies, dust, odor, fire, traffic and noise, each of these should, however, be controlled and their effect minimized by modern engineering design, good operating practices and effective management.

9- The Environmental Impacts Assessment that was undertaking for this project has also postulated mitigate set simple measures. The assessment revealed lack of environmental awareness by public, workers, and personnel, which can be solved through regular environmental training programs.

7- Recommendations

The geophysical and environmental studies of the Erbil dumpsite have led to the following recommendations:

1- Design of sanitary landfill to prevent or decrease any possible negative effects on the environment, particularly the pollution of groundwater, soil and air, also the resulting risks to human health arising from landfilling of waste.

2- Trace element analysis for water wells around the Erbil dumpsite to establish the baseline environment.

3- Soil analysis along the household septic tank discharges to detect the level of pollution.

4- Training environmental program for all public to elevate environmental awareness and reducing waste production.

Use of electrical resistivity tomography on future landfill for monitoring purposes.

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