International Journal of Pure and Applied Mathematics
Volume 120 No. 5 2018, 793-801
ISSN: 1314-3395 (on-line version)
url: http://www.acadpubl.eu/hub/
Special Issue

http://www.acadpubl.eu/hub/

SELECTION, DESIGN AND MANAGEMENT OF SANITARY LANDFILL SITE FOR AL-DIWANIYA CITY

Dr.suad alfatlawi[1], Noora Ali Obaid[2]
1 Environmental engineering department, Babylon University, Hila, Iraq
2 Environmental engineering department, Babylon University, Hila, Iraq
[1]noora_ali22@yahoo.com
[2]suadalfatlawi@gmail.com

ABSTRACT

The present paper compares, assesses and designates new and old landfill disposal sites proposed by the Diwaniya municipality. For the comparison, forty chosen parameters suitable for the landfill site were employed. Classifications for the site relevance were either poor, fair, good or excellent, based on the feasibility of parameter according to the guidelines and landfill criteria. It was found that the proposed site met most of the criteria needed for similar facilities. However, the soil characteristics, area capacity, groundwater quality, area capacity all exhibited superior traits for the new landfill compared to the old landfill site. The findings also show that soil cover is ample for both old and new sites. Calculations were conducted as per Iraqi experience in landfill construction, showing that the old landfill site may be operational for 25 years with 1 m high of waste, whereas the new landfill may be operational for 10 years, with 1 m high of waste. Significantly, the results are able to act as a guide for potential groundwater pollution. Thus, it was concluded that construction of an effective sanitary landfill site for integrated solid waste management is a much needed and should be prioritized for Al-Diwaniya city, Iraq.

Keywords: Evaluation, (ISWM), landfill, site criteria, solid waste disposal, AL-Diwaniya.

INTRODUCTION

Currently, no control system for solid waste disposal exists for the city of Al-Diwaniya. The traditional waste management system entails that waste be either dumped in random locations, disposed in uncontrolled dumps without treatment or burned in pits. These traditional practices have a negative impact on aesthetics while also being harmful to public health and not being eco-friendly. Furthermore, Al-Diwaniya city does not possess an integrated solid waste management (ISWM) policy as well as an effective reuse and recovery plan. This leads to an approximated 900 to 1000 tons of solid waste generated every day by

the city. Presently, the city dumps the major generated solid waste within an open dump in the south part of the city. The dumps need to be improved and engineered to be more sanitary. In order to achieve this, the choice of landfill site should be duly considered to upgrade the existing waste management program. From an environmental engineering perspective, the available land resources should be properly utilized in order to choose a site that will be robust in protecting the environment and public health if the landfill were to be contaminated [1]. Choosing the appropriate landfill sites, especially for a developing country like Iraq, has been viewed as quite difficult [2]. This is due to the limitations on financial, technical, institutional awareness and human resources which are all required to ensure proper environmental standards.

Even if all requirements are not up to standard, a landfill site may still be proposed. Generally, engineering design could make up for an inconvenient landfill site, but these adjustments could often be costly. Numerous criteria should be imposed for landfill sites, which are environmental, sociopolitical and economic requirements, which may often be contrary to one another. The rise of new legislations, environmental awareness and improvement of procedures and tools, landfill site selection has become a more sophisticated process. Thus, the present paper considers the landfill site selection of two proposed sites located in the city of Al-Diwaniya, Iraq. The two sites are compared using relevant criteria given the region's conditions.

Materials and Methods

A potential landfill site in the Southern part of the city was suggested by the city municipality. This particular site already utilized an open dump and were the only available solid waste disposal options for the city. The new and old sites spanned 100 ha and 161 ha, respectively [3]. The locations and features of the sites relative to the city centre are shown in Figures 1 and 2, for the new and old sites, respectively. A careful consideration was given to the present literature for the city's solid waste and characteristics [4]. Other studies related to landfill sites were also consulted [5]. The sites proposed were also visited, with soil and water samples being taken for purposes of quality assurance. Guidelines and standards were also followed or recommended by the appropriate authorities [6]. Furthermore, applicable and extensive criteria were chosen to evaluate the landslides, tabulated in table (1) [7]. These criteria were also categorized into five groups, with each group being divided according to site-specific and characteristic factors. A total of 40 specific site properties were chosen as the site evaluation criteria. The site soil was ensured to be feasible for implementation of landfill site, also being tested using physical and chemical testing.

Table (1) Categories of landfill site criteria

Water Protection Aquifer Flood plain Ground water Proximity to drinking water source Surface hydrology Wetlands Water quality **Transportation** Access Haul route Proximity to water source Traffic congestion Traffic safety **Land Use** Aesthetics Acreage available	Airport safety Buffer area available Existing land use Adjacent land use Mitigation issues Noise Property acquisition Property devaluation Sensitive receptors Utility availability Zoning **Geology** Bedrock Cover soil availability Fault areas Hydrogeology Soils	Seismic impact zones Topography Unstable areas **On-Site Environment** Air quality Wildlife resource Archaeological /historic resources Biological resources Support infrastructure Threatened species Wind direction

Results

- **Old landfill site**

  Regarding the old site (A1), the location is in an agricultural area, within 6.9 km to the south of city centre, and 560 km from the Al-Diwaniya-Basrah highway connecting to the city. An automatic oil plant also lies close to the site, as well as a few small villages lying about. The site itself lies about flat clay soil, is on relatively flat ground and is inhabited by a small community roughly 1 km eastwards. There are no wells near the site, and groundwater table is salty and lies within the range of 1.25 m to 1.50 m. The site area is roughly 161 ha and is already employed as a landfill area. Preliminary calculations show that the old landfill could contain up to 25 years worth of solid waste, with 1m in height as shown in figure 1. It may be also noted that the site may be vulnerable to self-combustion. Currently, there doesn't exist an appropriate landfill because of the presence of large quantities of waste and the lack of feasible equipment.

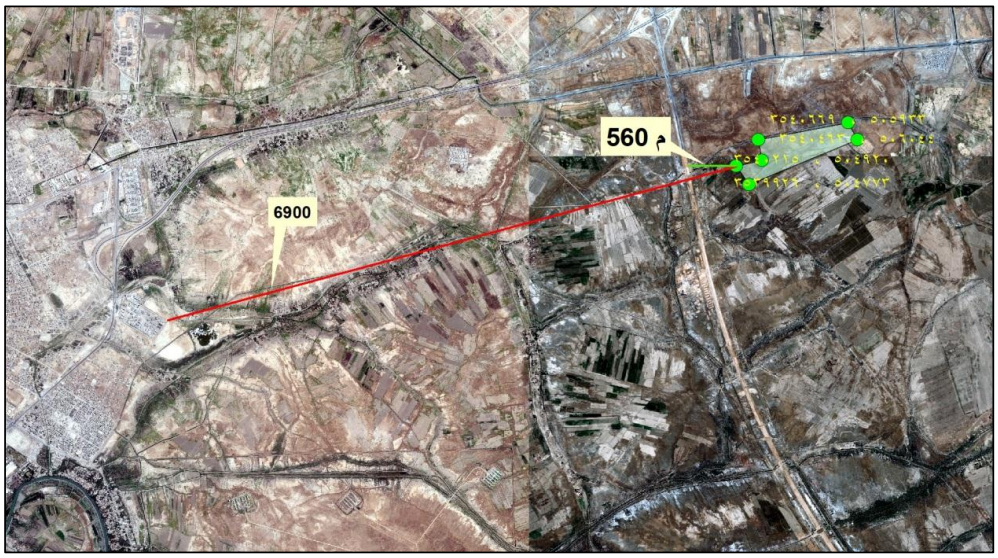

Figure (1) old landfill site and its surroundings.

- **New landfill site**

The new site (A2) is roughly 100 ha and lies within 7 km to the south of the city, as well as 690 m from the nearest highway connecting to the city. The land area is relatively flat with no nearby quarries as shown in Figure 2. This site lies within natural depression, with groundwater table approximately 1.5 m to 2 m from ground level, containing a poor quality of water. Nearby area (roughly 1 km) lies on clay soil which may be advantageous for lining the landfill. Preliminary calculations have shown that up to 10 years' worth of slid waste may be held by the new site, with solid waste reaching a height of 1 m. This particular site was suggested for landfill because the old site is about to meet its end period. Furthermore, the site is located to the south of the city opposite to the prevailing wind direction of Al-Diwaniyah, which possess northwest wind. The site was approved by both the Municipality and Environment Departments.

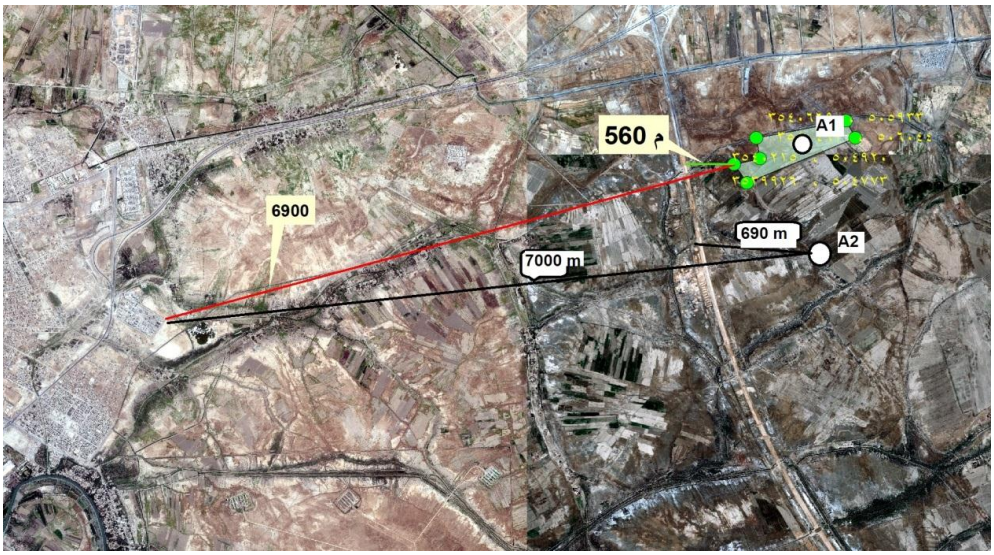

Figure (2) new landfill site and its surroundings.

Overall site characteristics

Both sites are not located near any prominent locations, such as an airport. There are also no rivers of any size or water bodies within the site's vicinity. Various soil properties (i.e. water contents, organic matter content, gypsum, etc.) as well as hydraulic conductivity have both been identified to be evaluated.

Site comparison

Two sites were compared in the final step, using the chosen evaluation criteria. The data collected as well as concept designs generated were employed to assess the performance for each site with respect to the criteria. The ratings for the site were either poor (score of 40-49), fair (score of 50-74), good (score of 75-89) or excellent (score of 90-100) for each of the criteria shown in Table 2. Even though both of the sites were feasible given the weightage of the criterion.

Discussion

From the findings, it was concluded that the site visit and investigation showed promise, in that the sites satisfied the criteria required for overall land-use plan. Sites were easy to access via public or major roads, and selected sites for landfills are not expected to pose any hazards or inconvenience to public health for inhabitants nearby. The landfill site is expected to not harmfully deplete the environmentally sensitive resources. The sites are also able to accommodate 10 – 25 years' worth of solid waste, which is a reasonably long time.

Table (2) Landfill site comparison

Criteria	Old site (A1)	New site (A2)
Aquifer	excellent	excellent
Flood plain	Good	Good
Ground water	poor	poor
Proximity to drinking water source	Good	excellent
Surface hydrology	Good	excellent
Wetlands	Good	Good
Water quality	Good	excellent
Access	Fair	Good
Haul route	Fair	Fair
Proximity to water source	Good	Good
Traffic congestion	Good	Good
Traffic safety	Good	Good
Air quality	poor	Good
Wildlife resource	poor	poor
Archaeological /historic resources	excellent	excellent
Biological resources	excellent	excellent
Support infrastructure	poor	Fair
Threatened species	Fair	Fair
Wind direction	excellent	excellent
Bedrock	poor	poor
Cover soil availability	Good	excellent
Fault areas	excellent	excellent
Hydrogeology	Good	excellent
Seismic impact zones	excellent	excellent
Soils	excellent	excellent
Topography	excellent	excellent
Unstable areas	excellent	excellent
Aesthetics	Good	Good
Acreage available	Good	Good
Airport safety	excellent	excellent
Buffer area available	Good	Good
Existing land use	excellent	Good
Adjacent land use	Fair	Good
Mitigation issues	Good	Good
Noise	Fair	poor
Property acquisition	poor	poor
Property devaluation	poor	poor
Sensitive receptors	Good	Good

Utility availability	excellent	excellent
Zoning	Fair	Fair

Grade range (%): excellent (90-100), good (75-89), fair (50-74), and poor (40-49)

The groundwater tables lie near the landfill bases, which is not ideal for circumventing the groundwater contamination due to construction. Proposed landfill sites are within areas lacking karst topography, fractured bedrock and so on. This does not aid in guaranteeing groundwater protection. Nevertheless, the quality of water was very salty at both sites, which is not suitable for usage by any living creature. Both of the sites do not possess any water bodies nearby, such as streams, lakes or wetlands.

The nature of sites, groundwater tables, soils and area methods are suggested for the old landfill site. Two important factors which should also be considered for the selection are topographical and geological factors. Findings from the study showed that soil cover was ample for both old and new sites. These sites were not both owned by municipality. Elimination of the issues arising from private land ownership and site ownership could lead to the reduction of total landfill operational cost.

The obtained data shows that the site proposed by the municipality fulfil the analysed criteria. The old landfill site area was expected to hold 25 years' worth of solid waste, up to a total height of 1 m; on the other hand, the new site was expected to operate for 10 years with a solid waste up to a height of 1 m. The calculations were conducted by considering the limited resources within the local region for executing the project.

Table 2 shows the relative scores which were employed to appropriately rate the sites as either poor, fair, good or excellent. These scores stand for the degree of validity for each of the parameters according to the criterion. By way of an example, the criterion "proximity to water sources" entails that a site within 400 m would be scored "excellent", and a site within 200 m would be scored "good". In a similar way, the water quality is considered bad and graded "fair", thus indicating that the quality is worse at other sites, which would otherwise have received a "good" or "excellent" grade based on the quality. A higher score would also be given to specific parameters at sites which were low.

For landfill regulations in Iraq, systematic landfill siting processes should be employed and researched. The present paper may be considered a start, whereby parallel processes and further work is required to explore other features of landfill siting, such as consideration of public involvement and societal problems. This is so due to public

environmental awareness being a key element regarding landfill implementation. Iraqi constraints and criteria should be improved in terms of detailed, such as the work conducted in the present study. Furthermore, guidelines and regulations should be included for landfills in order to foster in proper leachate management strategies which address contamination issues which may arise as well as effective leachate treatment choices undertaken by local authorities.

In conclusion, the municipality in Al-Diwaniya ought to implement ISWM tool in order to identify solid wastes as proper economic resources. These practices augment the economy with benefits for landfill construction while also increasing the period of time a landfill may be in service.

REFERENCES

[1] Asfari A, and Mishaan M." Solid waste management in some Arabic countries (With modifications to comply with Iraq conditions)" A project financed by Arabic Fund for economic and social development. 134pp, 2007, Kuwait (Arabic text).

[2] Environmental Protection Agency, "Guidance for landfilling waste in economically developed countries "(EPA/600/SR-98/040). Retrieved from http://nepis. EPA .gov /Adobe/PDF/P1000IA1.pdf, 2011, USA.

[3] Municipality of Mosul "Personal Communication" July 2006, (Mosul, Iraq)

[4] United Nations of Public Services (UNOPS) "Enhancement of solid waste management capacity and facilities in Mosul city". (2007), Amman, Jordan.

[5] Government of Western Australia, Department of Environment "Siting, Design, Operation and Rehabilitation of Landfills" (Perth, WA, Australia) Retrieved from http://portal.environment.wa.gov.au/pls/portal/docs/PAGE/DOE_ADMIN/GUIDELINE_REPOSITORY/BPEM.PDF, (2005).

[6]Environmental Protection Agency, Ireland (2005" Landfill Manuals: Landfill Monitoring" (Johnstown Castle Estate Co., Wexford, Ireland) second Ed. Retrieved fromhttp://www.epa.ie/downloads/advice/waste/waste/EPA%20Landfill%20Monitoring.pd, (2005).

[7] Guam Department of Public Works" Preliminary Site Selection Report" (Guam, 2005, USA).