Designing of Landfilling for Karad City: A Review

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Abstract - *Sanitary landfills are needed either as the only solution or as the final destination of the waste from other systems. This first step calls for the selection of appropriate sites to build sanitary landfills, from both the economic and social standpoints. It is important to stand in mind that the different components of the integrated management of MSW should be interlinked in any program or system and should therefore have been selected for their ability to counterpart each other. The sanitary landfill has the lowest rank in the integrated management of MSW because it represents the least appropriate option for handling wastes.*

***Key Words*: Sanitary Landfill, Designing, Planning and Designing Process Conclusion, Suggestions, etc.**

1. INTRODUCTION

A modern sanitary landfill can be defined as a facility designed and operated as a basic sanitation project that has sufficiently safe elements of control, and the success of which lies in the selection of the suitable site, its design, and of course, its effective and efficient operation and control. The ground water table in karad city finds at 8 to 10 ft. from ground level. So there are possibilities of water contamination due to less water depths. So sanitary landfill is suitable for this city. (Figure1).

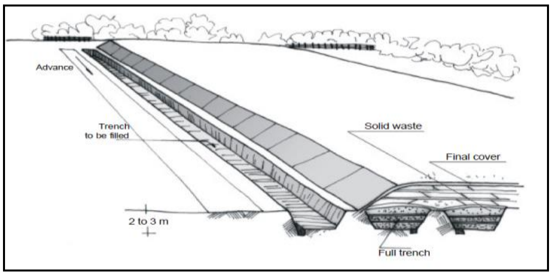

Fig.1 sanitary landfill

2. Planning Design and Infrastructure of sanitary landfill for Karad City:

Karad City Municipal Corporation is contemplating a comprehensive Municipal Solid Waste Management system to meet its ever growing MSW problem. MSW 2016 Rules amongst other issues dwells on an important issue of Source segregation of Municipal Solid Waste and stipulates that the landfill shall be restricted to biodegradable waste, residues of waste processing facilities and other waste that are not suitable either for recycling or for biological processing. The facility shall be developed in accordance with the guidelines as prescribed by MSW 2000 and will have all the support infrastructure facilities to ensure the sustained operation Sanitary Landfill.

2.1 Planning and design process

a) Waste volume and landfill capacity

The landfill site at Karad is proposed at Bara-Dabari area which is about 4 km from the city. The total land area is only 16 Acres. Further, waste is dumping presently at Bara-Dabari area in Karad city. And this was estimated to about 6.5 Hector (16 acre) of land with average height of 8.00 m of landfill and this dump needs to be cleared and landfilled in the proposed sanitary landfill. Considering about next 5 years for clearing the above dump the existing dumpsite once cleared of MSW shall be converted into new sanitary landfill site. The integrated plant needs to address the present mixed garbage quantity with an ability to undertake likely future increase in the tonnage due to population growth. The quantity to be handled in the mixed garbage scenario over a period of 5 years in the landfill.

Table -1: Waste volume generation per year

Years	Waste generated in per day MT	waste generated yearly in MT	20% rejected volume	Total volume m³	10% Increased
2016	38	13870	2774.0	3467.5	3814.25
2017	38.8	14147	2829.5	3537	3891
2018	39.5	14430	2886.1	3608	3968
2019	40.3	14719	2943.8	3679.74	4048
2020	41.1	15013	3002.7	3753	4129
			Total	**18045**	**19850**

b) Design life

Considering the above "active" design life of karad city is 5 years. Though, it does not meets the MSW 2016 Rules recommendation of 25 years of "active" life cycle, in the coming years the non-biodegradable volume will come down due to implementation of source segregation at household level and greater segregation of bio degradable waste at segregation platform of microbial bio-methantion facility.

c) Landfill Section & soil properties

Generally the profile of the soil plays a major role in the selection of the landfill site because of the following consideration:-

- Good quality suitable excavated earth can be used as cover soil, which has a direct bearing on the project cost.
- Low permeability of soil (1×10^{-7} cm/sec) to reduce the leachate seepage.
- Stability of the natural slopes.

Soil typically possesses a range of physical characteristics including particle size, gradation, plasticity that affect that affects their ability to achieve a hydraulic conductivity of 1×10^{-7} cm/sec or less.

d) Liner System below MSW

A composite liner comprises of two barriers, made of different materials, placed in intimate contact with each other to provide a beneficial combined effect of both the barriers. Usually a flexible geo-membrane is placed over a low-permeability clay or amended soil barrier.

As per Environment Protection Agency design criteria standard Type design shall be:

- Upper component of 60 mil (1.5 mm thick) HDPE liner
- Lower component of minimum of 600 mm thick compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec.
- Drainage layer of 15 cm thick granular soil material of permeability value of 1×10^{-2} cm/sec.
- A 1.5 mm thick HDPE liner.
- A 900 mm thick compacted soil of permeability value 1.0×10^{-6} m/sec amended with additives like Bentonite to reach the required permeability value.

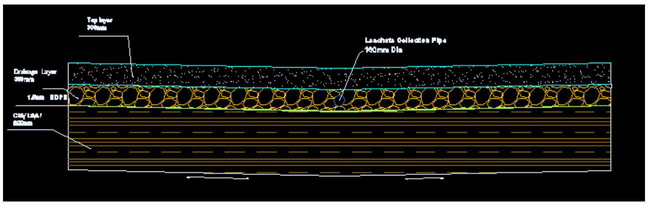

Fig -2: Cross- Section of liner system

e) Daily Cell Cover

The purpose of daily cover is to control the blowing of waste materials; to prevent rats, flies and other disease vectors from entering or exiting the landfill; and to control the entry of water into the landfill during operation. A daily cell covers of 15 cm thick of locally available compacted soil of permeability coefficient of 1.6×10^{-3} cm/sec provided.

f) Leachate Volume Calculation during Active Period of Landfill

Table No.2: Leachate Calculation during Active Period due to Rain

No of uncovered days	Area under landfill in ha	Run-off co-efficient	Rainfall Intensity in mm	Quantity cum/sec	Quantity cum/hr.	Quantity cum/day
	A	C	I	Q=CIA/360		
10	0.06	0.95	25.00	0.004	13.74	329.70
15	0.09	0.95	25.00	0.006	20.61	494.55
30	0.17	0.95	25.00	0.011	41.21	989.10
45	0.26	0.95	25.00	0.017	61.82	1,483.65

g) Final Cover system

- Vegetative Layer of 450m thick with good clay soil
- Drainage Layer of 300mm thick granular soil material of permeability value of 1×10^{-2} cm/sec.
- Geo-membrane layer of 1.5mm thick HDPE liner with hydraulic conductivity of 7×10^{-15}m/sec.
- Barrier Soil layer of 600mm thick compacted soil amended with additives like Bentonite to achieve a permeability value of 1×10^{-7} cm/sec.
- Gas venting Layer of 200mm thick granular soil material of permeability value of 1×10^{-2} cm/sec.

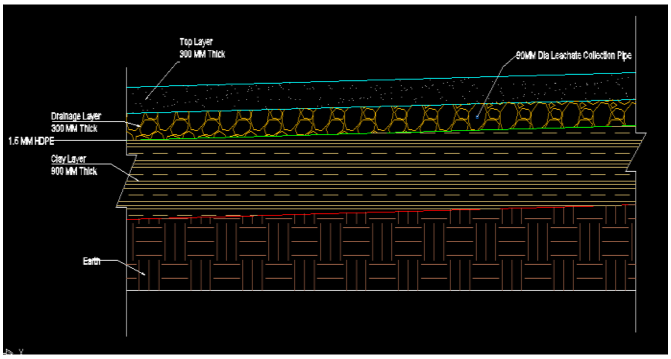

Fig-3: Cross section of final cover system

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h) Site infrastructure

The Bara-Dabari site is will be developed as an integral plant; the most of the infrastructure for engineered sanitary landfill site. The following are infrastructure points.

1) Office
2) Internal Roads
3) Leachate Collection day Sump
4) Leachate Collection Sump
5) Waste Inspection and Sampling Facility
6) Water Supply
7) Street Lighting
8) Cover material Storage area
9) Temporary garbage storage area
10) Compound wall and Security
11) Buffer Zone

i) Material Handling Equipment

For daily cell operation:-

Vibro- compacter = 1 No
JCB/ front end loader = 1 No
For Excavation of landfill area
JCB/ front end loader = 1 No
Tipper Lorries = 3 Nos.
For transport of daily cover material
Tractor with trailer = 2 No.

j) Environmental Monitoring system

Monitoring at a landfill site is carried out in four zones:-

(a) On and within the landfill
(b) In the unsaturated sub-surface zone (vadose zone) beneath and around the landfill.
(c) In the ground water (saturated) zone beneath and around the landfill.
(d) In the atmosphere/ local air above and around the landfill.

The parameters to be monitored regularly are:-

i. Leachate head within the landfill.
ii. Leachate and gas quality within the landfill.
iii. Long term movements of the landfill cover.
iv. Quality of proper fluid and pore gas in the vadose zone.
v. Quality of ground water in the saturated zones and
vi. Air quality above the landfill, at the gas control facilities, at buildings on or near the landfill and along any preferential migration paths.

The following instruments/ equipment have been preceded for periodical monitoring system:-

(a) Ground water samplers for ground water monitoring wells
(b) Leachate samplers for leachate monitoring within the landfill and at the leachate tank.
(c) Vacuum lysimeters, filter tip samplers, free drainage samplers for leakage detection beneath landfill liners.
(d) The surface water samplers for collection of sample from sedimentation basin.
(e) Downhole water quality sensors for measuring of conductivity, P^H, DO, temperature in leachate wells, ground water wells and sedimentation basin.
(f) Landfill gas monitors (portable) for onsite monitoring of landfill gases.
(g) Active and passive air samplers for monitoring ambient air quality.

k) Closure and post-closure maintance plan:-

The criteria for landfill closure focus on two central things

1) The need to establish low maintance cover systems
2) The need to design a final cover that minimizes the infiltration of precipitation into the waste. Landfill closure technology, design, maintance procedures continue to evolve as new geosynthetic materials become available, as performance requirements become more specific, and as limited performance history becomes available for the relatively small number of landfills that have been closed using current procedures and materials. Critical technical issues faced by the designer are:-

(a) Degree and rate of post –closure settlement stresses imposed on soil liner components.
(b) Long term durability survivability of cover system.
(c) Long term waste decomposition and management of landfill leachate and gases.
(d) Environmental performance of the combined bottom liner and final cover system.

Once a landfill reaches its capacity, it must be managed to limit any potential adverse environmental effects. Closure involves capping the landfill with a excavated soil amended with additives like Bentonite to achieve a permeability value of 1×10^{-7} cm/sec to minimize moisture infiltration.

3. Estimation of Landfill Cost Based On Preliminary Design

Table No. 3: Site Selection and Site Characterization Cost

Sr.No.	Item	Cost Rs x 10^3
1	Data Collection	0.5 -0.7
2.	Geotechnical Investigation for Design , Borrow Material,	5-7

	Ground Water Investigation	
3.	Topographical Investigation	1-2
4.	Hydrological Investigation	2-3
5.	Geological Investigation	2-3
	Total	**10.5-15.7**
	Average	13.1

Note: This estimate is lumpsum and approximate. The values are indicative. However, actual costs will vary from site to site and should not be restricted by the range indicated in the table

Table No. 4: Design and Detailed Engineering Cost

Sr. No.	**Item**	**Cost Rs x 10^3**
1.	Design and Detailed Engineering	15.00-20.00
	Average	17.50

Table No. 5: Site Development Cost

Sr.No.	**Item**	**Cost Rs x 10^3**	**Cost Rs x 10^3**
1.	Land Acquisition*	830.00	
2.	Cost of Infrastructure		102.70
3.	Equipment for Landfill Construction/Operation**	359.00	
4.	Surface Water Drainage System		30.75
5.	Leachate Management Facility		23.85
6.	Environmental Monitoring Facility		8.00
7.	Gas Collection Facility***		
	Total	**1189.00**	**165.3**

Land acquisition cost will vary drastically from location to location; market value indicated but not included in costing.

** Equipment cost indicated but not included in costing since all earthwork / waste placement work are computed on job basis.

*** Not included in the example but to be taken into account whenever gas is collected for energy recovery / flaring.

Table No. 6: Phase Development Cost (Yearly)

Sr.No.	**Item**	**Cost Rs x 10^3**
1.	Up-dated Design of Phase	20.00
2.	Preliminary Operation	11.10
3.	Temporary Surface Water Drains	5.00
4.	Monitoring Facility Below Liner	20.00
5.	Liner System	60.85
6.	Leachate Collection and Removal System	84.5
7.	Maintenance of Existing Facility	50.05
	Total	**251.5**

4. Conclusion

Following conclusions are drawn from the analysis of present study.

1. In Karad city collected solid waste separated at regular intervals. organic waste is processing on Biogas plant.There is no any treatment or disposal method for Inorganic or non-biodegradable waste. So proper treatment and disposal method is necessary for this waste. Hence Integrated SWM involving sanitary landfilling technology should be adopted over open disposal.
2. The environmental & climatic conditions are suitable for sanitary landfilling.
3. It is now time to seriously consider acceptance and adoption of the sanitary landfill as a key strategy for deriving short and long-term environmental, regulatory, monetary and societal benefits. The option is a direct result of engineering and building a new generation of environmentally sound landfills.
4. It provides environmental security while permitting and encouraging rapid stabilization of the readily and moderately decomposable organic waste components. It is hoped that the emerging sanitary landfill technology will point our solid waste industry towards taking a new look at a very effective option to manage our waste disposal.
5. Rapid population growth rate, increased urbanization rate and current changing lifestyles of the Karad residents result to the increase in waste generation rates as well as characterization of the wastes generated.

Recommendations:-

1. Public awareness is necessary at the generators level so as to minimize waste generation, to reduce the undesirable adverse impacts of overflowing of waste bins and accumulated wastes on roadsides, strict rules must be applied on the management related activities and the level of public awareness should be increased.

2. It is recommended to minimize the volume of waste through effective waste minimization techniques which involves reuse, recycling and recovery. An effective waste minimization can reduce the costs, liabilities and regulatory burdens.
3. Private sector involvement as well as other actors in SWM should be increased so as to improve the efficiency of SWM.
4. SWM monitoring system should be put in place to ensure adherence to SWM regulations/laws. Sanctions and penalties of waste mismanagement should be put in place and strictly followed.
5. Required non-development zone around the landfill site must be provided.

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