

Landfill Cost Model for Disposal of MSW

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ABSTRACT

The study gives an overview of the Landfill Cost Model for disposal of Municipal Solid Waste. The objective of the work is to produce a flexible, user friendly computer model that predicts the capital and operating costs of new Landfills for disposal of Municipal Solid Waste generation in any city in India. The quantity of waste to be put in Landfill can be input by the user or allow the program to calculate the amount of waste material from the information of population of city, industries and other sources of waste generation. The model calculates the construction cost to build the Landfill (including cost of site selection), the operating costs to maintain it through the life of the Landfill, and post-closure expenses required to maintain it after it is closed. Operating costs include the cost to land, transport, fill and characterisation of waste as well as monitoring the general maintenance of the site. Post-Closure activities include a continued monitoring program and site maintenance. The model provides a total cost on a cost/unit wt. basis for all activities that are associated with Landfilling municipal solid waste, including a specified internal rate of return. The accurate cost information is needed by utilities to make the most economical and environmentally sound decision.

1. INTRODUCTION:

Engineered landfills are not common in cities and towns in India. There is a practice of disposing solid waste collected by municipality or local controlling agencies, in open low lying area around the periphery of city boundaries. In due course of time the waste become part of hydrological cycle and cause air pollution, surface water pollution, and sub surface water pollution etc. Since the towns and cities are expanding very rapidly the unsafe disposal is proving to be a critical problem.

The major causes behind the unsafe disposal of the waste in open surface or low lying area may be due to

- Lack of awareness of impact of unsafe disposal on environment
- Lack of availability of information for planning, designing and operation of Landfill facility at local level is limited.
- Lack of funds for planning, construction and operation of Landfill.
- Lack of socio-economic and political will of the administration.

The Landfill cost modeling is aimed to develop a methodology and provide sufficient information regarding Landfill planning, designing and operation, with nominal input data. It also provides information of design details, expenditure cost of the unit waste disposal, cash flow etc.

The work is divided in to the following major part

- a. Designing
- b. Detailing
- c. Estimation of cost for unit waste disposal
- d. Cash flow

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The activity of Landfill development is divided into following components

1. Site acquisition
2. Site assessment
3. Design and detailed engineering cost
4. Construction cost for site development
5. Operating costs
6. Closure cost
7. Post closure care cost including long term monitoring

To analyze the economy of Landfill the major expenditures are

1. Site assessment costs comprised of cost pertaining to
 - i. Site surveying
 - ii. Soil investigation
 - iii. Geological and hydrological investigation
 - iv. Reconnaissance and data collection
 - v. Environmental impact assessment
 - vi. Waste characterization
 - vii. Socio-economic impact assessment
2. Landfill design costs consist of cost for
 - i. Planning of landfill
 - ii. Design of components
 - iii. Testing relative to soil liner design, the leachate quality etc.
 - iv. Detailed engineering of each component including construction and drawings details
 - v. Phased operation planning
 - vi. The construction methodology, operational methodology, and the post closure methodology
 - vii. Quality control specification for the each stage of design and construction
3. Site development cost to include cost of
 - i. Site clearing operations
 - ii. earth work excavation and fill
 - iii. surface water drainage system
 - iv. Access roads
 - v. Site office and laboratory
 - vi. Fencing cost
 - vii. Weighbridge cost
 - viii. Store / workshop cost
 - ix. Site service cost
 - x. Environmental instrumentation
4. Liner and leachate collection system costs comprise the material cost and labour cost relating to
 - i. Clay/ amended soil
 - ii. Geomembrane
 - iii. Protective/Separation geotextile for both primary and secondary liners as well as material cost for
 - Drainage blanket
 - HDPE pipes
 - Manholes and sump
 - Pumps
 - Collection and delivery pipes

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5. Site operation cost include cost of
 - i. Waste handling and placement
 - ii. Daily cover and intermediate cover (material and laying)
 - iii. Temporary roads and surface water drains construction
 - iv. Wages and salaries for site maintenance
 - v. Leachate collection and removal
 - vi. Gas collection
 - vii. Environmental monitoring
 - viii. Equipment maintenance
6. Cost for closure comprises of
 - i. Cover system
 - ii. Landscaping
 - iii. Surface water drainage system
 - iv. Planting of cover vegetation including bed preparation and fertilizer etc,
7. Cover system cost includes cost of material and laying of
 - i. Surface layer (local soil)
 - ii. Protective layer
 - iii. Drainage layer(sand)
 - iv. Barrier layer(clay/geomembrane)
 - v. Transition layer
8. Post closure cost comprises of
 - i. General maintenance of vegetation cover
 - ii. Treatment of differential settlement of cover
 - iii. Wages and salaries for site maintenance, pertaining to operation of leachate collection and extraction system
 - iv. Periodic sampling and analysis of environmental parameters

2. INCOME SOURCES

Incomes from the landfill, or various components of the waste management system, may be included in the analysis. Income can arise from the following sources and activities:

1. Landfill user charges
2. Uniform annual charges for waste management services from city dwellers
3. Lease of land not used for land filling purposes
4. Sale of trees or crops
5. Sale of landfill gas (this income may continue after landfill closure)
6. Sale of excavated material
7. Sale of rubbish bags
8. Sale of recyclables
9. Sale of compost

To operate landfill a tax structure for charging can also be proposed:

- i. The taxes should be some percentage of property tax for all inhabitants in the municipality area.
- ii. Illegal dumping of waste should be prohibited and there should be punishment or penalty for illegal dumping

- iii. Nominal charges be levied for industrial waste and for the waste segregated for recyclable and non recyclable a subsidy can also be given
- iv. Construction and demolition waste may be accepted at free of charge supplied at site of landfill

3. BASIS FOR CHARGING

In general, those who generate waste do not shoulder any responsibility for its disposal. Most of landfill site are run by municipality, the charges for running the facility is not collected directly, but applied as uniform service charge as a part of municipal tax.

To consider commercial return on Landfill investment the disposal charge should reflect the commercial cost of providing service. So setting nominal waste disposal charge will be helpful in following way:

To meet full-cost for providing Landfill facility.

To meet waste reduction target, to encourage separation and recycling of waste.
Ability to accommodate changes.

The current charges are not sufficient for development of new facilities and to meet actual full cost of waste disposal. High charges may lead to illegal dumping and politico-economic problems.

4. COMPUTER PROGRAM OVERVIEW

The Landfill design and cost model estimates quantity, provide geometric and other design details of landfill to satisfy given input. It predict cost for site selection, cost for site development, cost of linear and leachate collection system, cost of operation including cost of waste handling, daily, intermediate cover temporary roads, surface water drains, wages and salaries for site maintenance, leachate collection and removal, gas collection and environmental monitoring , cost of closure, cost of final cover system and post closure cost.

It provides solution for three types of landfill geometry i.e. Flat, valley, and sloped. It provides predefined lining system, or user may provide his own lining material with specifications, and rates. For income resources user can enter charging structure for different type of waste.

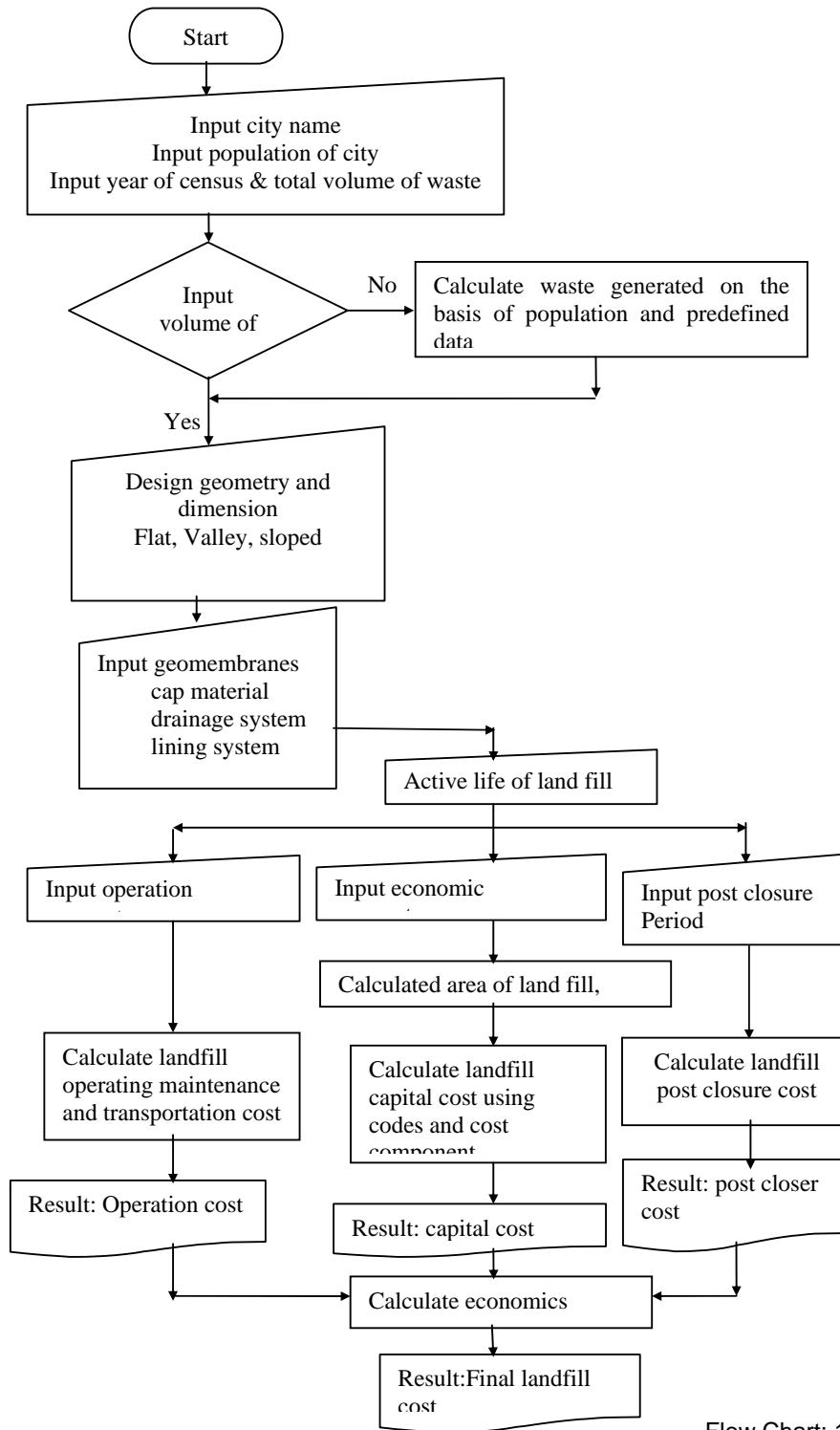
Each input value has suggested ranges, default values and helpful comments. To provide easy user interface critical values are on Visual Basic form with default values and useful tool tips. This help for new users. For expert user and to have more control, detailed Data are available on different EXCEL worksheets, can be suitably changed to satisfy user requirements.

The following is the flow chart representation for complete design and cost modeling.

Flow Chart 1 represents complete process of landfill development, cost modeling, and closure and post-closure activities.

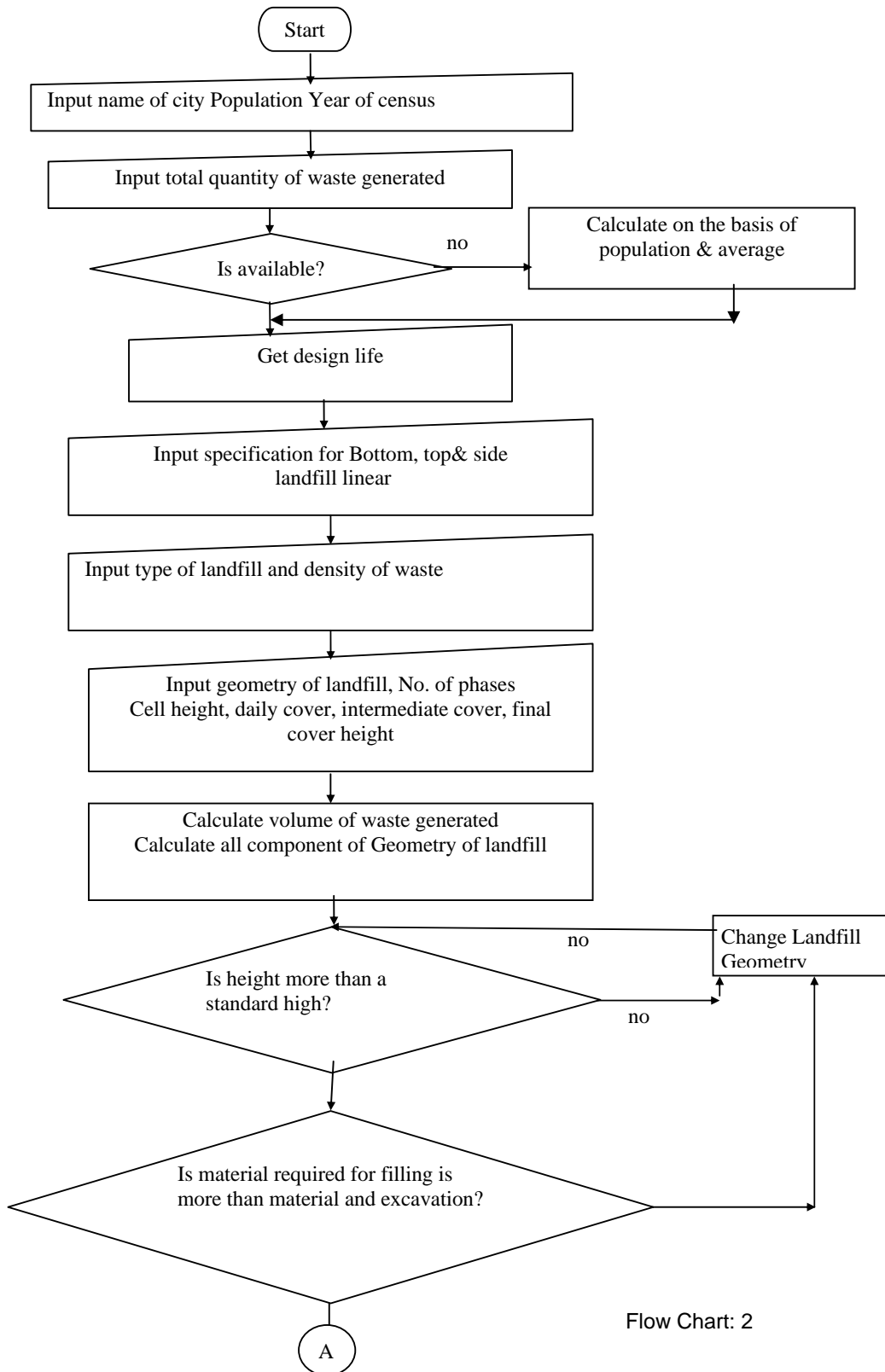
Flow Chart 2 represents steps methodology adopted for design of landfill components

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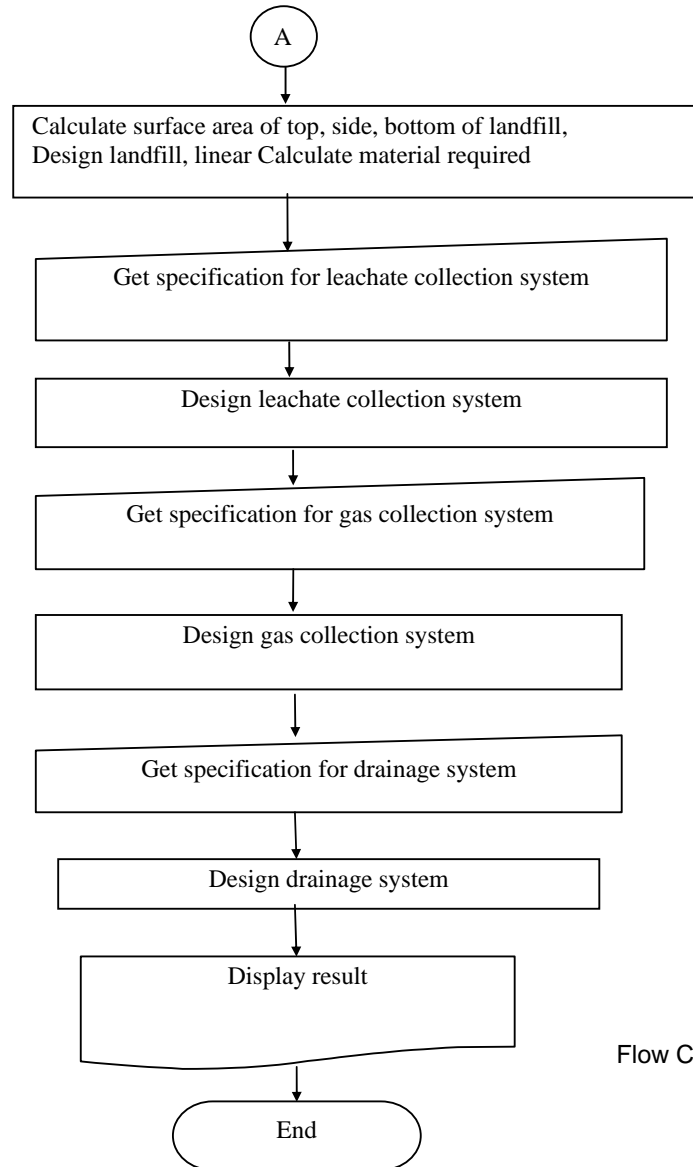
Flow Chart: 1

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Flow Chart: 2

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Flow Chart: 2

5. CONCLUSIONS

The proposed model gives cost of disposal of unit quantity of waste and estimates capital cost for landfill, so it may be useful to local bodies to assess amount of money required to initiate, and run such project. By calculating cost of disposal of unit weight of waste on land, for zero benefit, nominal charging structure or taxation scheme may be decided. Such charging structure will ensure running of landfill, for more hygienic environment, and with safe and secure closure and post closure maintenance and monitoring programme. The landfill may analyse on the commercial basis, to meet specified return on the investment to establish it. The user may specify project life, inflation rate, tax rate, and desired internal rate of return. The landfill charges for disposal of unit weight of waste required to collect this investment objective, can be calculated.

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