

# The Status of Solid Waste Disposal in RS & GIS Environment: A Case Study of Sonipat City

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## ABSTRACT

Most of cities and towns in the world are face solid waste disposal related problem. Fast increasing urbanization, industrialization, population growth and rural to urban migration created many problems related to solid waste management. Day by day per capita generation rate of solid waste has increased in urban areas. These increased rate create negative impact on human health and environment. Solid waste disposal is a serious problem in Sonipat city, because Sonipat is one of the fastest growing city, it generates solid waste is about 103.82 tons per day. The main purpose of this research work was to select potential sites for solid waste disposal. Medium resolution satellite data were used to prepared various thematic layers. The maps were prepared by overlay analysis using Geographic Information System (GIS) method, Remote Sensing (RS) and multi criteria analysis. Site aptness analysis for solid waste disposal consider the four criteria such as, road network, population density, underground water and land use / land cover. The final aptness map of the study area was prepared on Arc map and labeled as high, moderate, low aptness and inaptness sites. The high aptness area for solid waste disposal fall on the North and Southeast direction of the city where there are least environmental and health risk.

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## 1. Introduction

Solid waste material, including organic and inorganic waste matter, generated by the households, industrial, institutional, commercial activities, as a result, led to losing their values in the view point of first owner (Cointreau 1982). The solid waste which include the discarded and undesirable materials produced from the houses, commercial, industrial operations street sweeping, commercial and industrial operations. The haphazard growth of urbanization, and industrialization have given rise to the producing the solid waste (Basagaoglu et al., 1997). There has been a ample growth in the solid waste material in India. These rising trends of waste generation pressurized on all infrastructural, financial resources with adverse effects on human health and environment. It has been observed from various studies that an unscientific disposal site may prone to reduce the quality of ground water, purity of drinking water and lead to disease like jaundice, nausea, asthma etc (Bean et al., 1995).

In Sonipat city, there are three main sites for disposal. But all these three sites are not suitable from the view point of hygienic conditions. It is because of the reasons that these sites are located besides the high and moderate density of population areas. The solid waste management in medium-sized cities like Sonipat is generated in commercial, residential, educational institutions and industrial areas, hospitals and sweeping of roads and streets add to the generating in the total waste. In Sonipat city the per capita generation of waste of 0.343 kg/day was considered. The estimated amount of municipal solid waste generated is 103.82 tones/day in Sonipat city. As Sonipat is divided in two zone in terms of solid waste generation. The quantity of waste generated 63.43 and 40.39 tons per day (approximate generation per capita per day is 0.343 k.g) from zone one and zone two respectively.

This large amount of waste poorly disposed and untreated. Sonipat city does not have scientific disposable sites. It is a matter of serious thinking very to identify the suitable location for solid waste disposal. However, availability of the land resource is limited, as a result, the prices of the land is steady rising. Moreover the sight of garbage has lost the aesthetic value of the site of disposal and it becomes a cumbersome job for the civic bodies to chose suitable site for solid waste disposal. The present research work focused on to find out suitable disposable sites for urban solid waste of Sonipat city using Geoinformatics techniques like Geographical Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS) with the help of multi-criteria analysis to minimize adverse effects on environment.

## 2. Study Area

Sonipat district was carved out from Rohtak district on 22 December 1972. It came under hot and semi-arid South Eastern agro climatic zone. The city of Sonipat is located between 28°57'19" N to 29°01'29" N latitude and 76°58'27" E to 77°05'19" E longitude. Sonipat is the administrative headquarters of the division, district and tehsil of the same name. The district is surrounded by Panipat district in the North, Jind district in the West, Rohtak district in the South-West direction and Delhi in the South. The river Yamuna marks the eastern boundary of the district and across the river lies Bagpat district of Uttar Pradesh. The district headquarter, Sonipat is connected by metalled roads with important cities of the state and to Delhi. It is also connected by broad gouge railway line with Delhi and Chandigarh. The city is well linked with surrounding areas and other major city of the state by good network of roads.

**3. Objective**

To find out suitable solid waste disposable sites using multi-criteria analysis.

**4. Data Source and Research Methodology**

In the present study primary and secondary data are used. The primary data were collected from field surveys using GPS instrument to measure the coordinates of some location in the study area. Whereas, the secondary data for the study was acquired from governmental institutions, reports, books and journals. The main data used for this study guide map of Sonipat city and Landsat-8 image with spatial resolution of 30m

were used. Demographic data obtained from Census of India, which is useful for the creation of population density map. Ward maps and administrative boundaries of the study area were collected from Sonipat municipal council. Hence, in the present study various thematic maps are prepared by visual interpretation of the satellite imagery. The present research work used multi-criteria analysis technique to identify the most suitable solid waste disposal site (Bilgehan et al., 2010). The solid waste disposal site selection mapping was done using multi-criteria analysis and creating layers to yield a single output map or index of evaluation (Wiley and Sons, 2009).

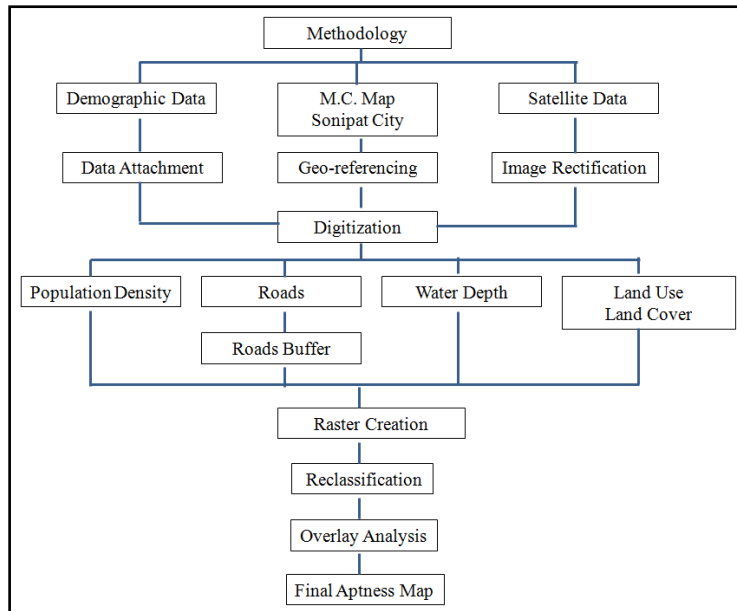


Fig. 1.1 (Flow chart of Methodology)

When potential sites were found in several locations, appropriate ranking techniques were applied to decide the best choices produce by Geoinformatics approach. The analysis has been used to find out potential sites for solid waste of Sonipat city.

been considered while selecting the site in *Sonipat* city. These factors are land use /land cover, far away from the networks of road, depth of ground water and the density of population with the help of cartographic model based technique.

**5. Criteria for selection of solid waste disposal site:**

Present study the criteria of evaluation were formed by referring to various sources such as Municipal Solid Waste (Handling and Management rules) 2000, Central Pollution Control Board (CPCB), and CPHEEO manual which have been using in accordance with a guideline which assists to determine the best location of the site situation. Subsequently, the criteria analyzed by making use of the analysis of the multi-criteria to make appraisal and to review the potentiality of prospective disposal locations of solid waste material. In order to disposing of the solid waste, as a result, four criteria have

**6. LULC based criteria for solid waste disposal site:**

The present study was evaluated in terms of coverage of land use/land with the help of Landsat-8, GeoEye image, and city guide map data for selecting the disposal of solid waste site. According to criteria, the disposal site is not supposed to very close to settlement to avoid adverse impact of land value and prospective development and to ensure to provide protection protect from environmental hazards created by the disposal sites (Clark and Gillean, 1974). It is therefore, there should be wisely selection of disposal sites which should be far away from the residential area. The fallow land and scrub land both are most suitable for disposal sites (table 1.1).

Table 1.1: LULC based ranking for solid waste disposal sites

Criteria	Sub criteria	Ranking	Level of aptness
Land Use/ Land Cover	Water Body	4	Inaptness
	Built-up Area	3	Less aptness
	Vegetation	2	Moderate aptness
	Scrub / Fallow Land	1	Highly aptness

Source: Compiled by Researcher

Built-up, open land/vegetation, fallow land, and the water bodies are major land use/land cover classes in context to the

present study. It is therefore, ranking were assigned of each class of land use and land cover (fig. 1.2).

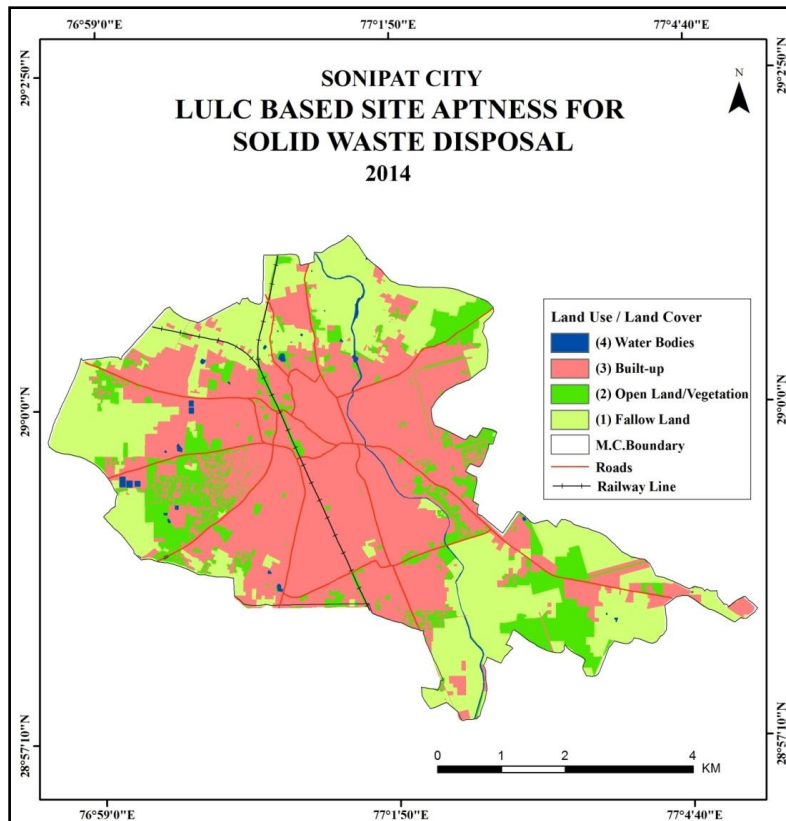


Fig. 1.2 (LULC based site aptness)

On the bases of LULC North, Northwest and Southeast part are suitable for solid waste disposal site. Fallow land, open land and vegetation area are high and moderate aptness for solid waste disposal site. Built-up and water bodies are less aptness and inaptness area for solid waste disposal site.

**7. Distance from road network for solid waste disposal site:**

The site for waste disposal is not supposed to be located within the distance of 250m which is distance from network of transportation (Bhambulkar, 2011). This site must be located at some convenient distance from network of road to cost-effective transportation. Distance of 250m, 500m, 750m and over 750m, with multiple ring buffer have developed around the road network and assigning the ranks of each buffer zone in accordance with the site criteria (table 1.2).

Table 1.2: Criteria wise Multiple ring Buffer along the Road network

Criteria	Sub criteria	Ranking	Level of aptness
Distance from Roads	< 250m	4	Inaptness
	250m – 500m	3	Less aptness
	500m – 750m	2	Moderate aptness
	750m <	1	Highly aptness

Source: Compiled by Researcher

The distance which is less than 250m from road is inaptness for the site for disposal; distance from 250m to 500m is less aptness. Similarly, the distance from 500m to 750m is

falls in moderately aptness and distance over the 750m, indicates the most aptness for solid waste disposal site in the urban areas. (fig. 1.3).

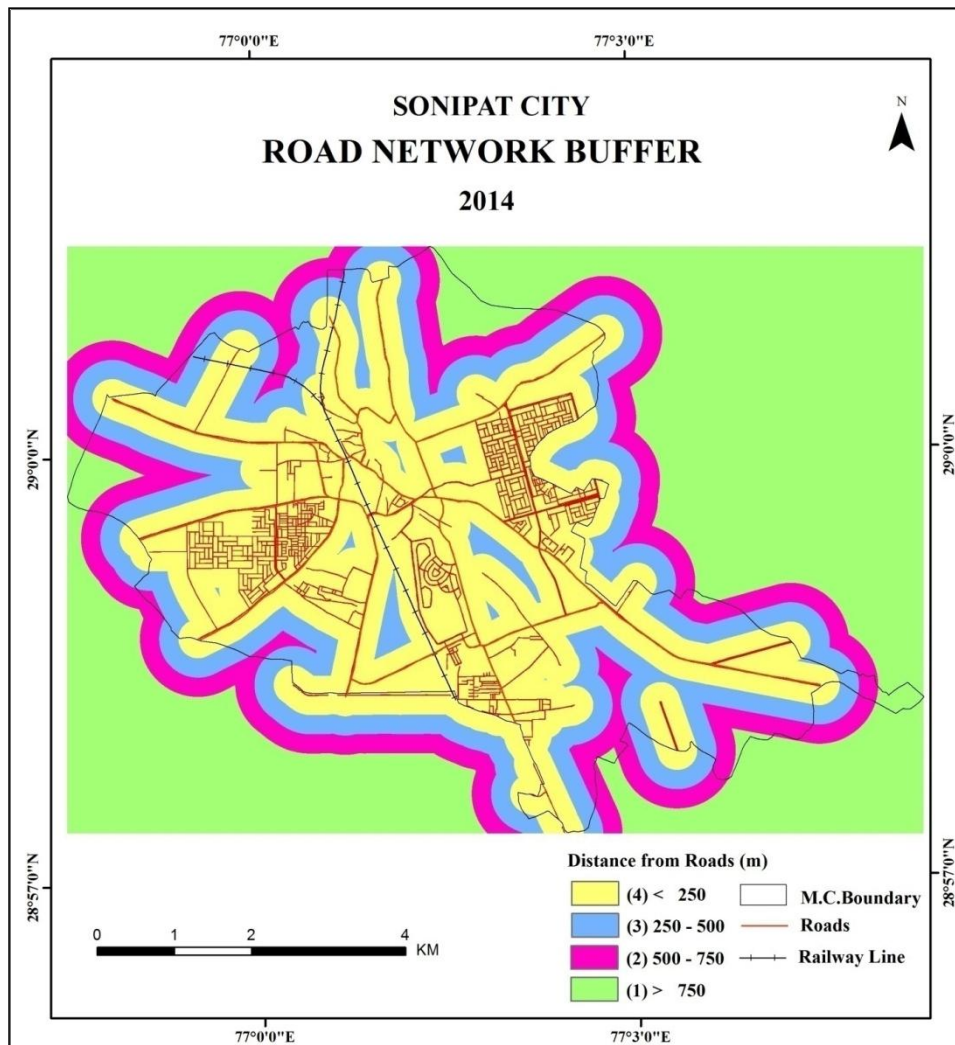


Fig. 1.3 (Buffer on road network of Sonipat city)

Solid waste site would not situated near the road. It would be situated at suitable distance. For this purpose multiple ring buffer have been created along the road network. Distance more than 750m is high aptness, distance between 500m to 700m is moderate aptness, distance between 250m to 500m is less aptness and distance less than 250m is inaptness for solid waste disposal site.

**8. Groundwater depth based criteria for solid waste disposal site:**

There are numerous of studies which show that an adverse impact of solid waste at disposal site on the quality of

the ground water at different disposal sites in the Sonipat city. The water has already been presented in the waste or due to the infiltration of water by rainfall. This water which occurs or generates because of the process pours in the soil and led to contaminating the ground water. Ground water depths with its coordinates locations have collect by ground water cell department. By interpolation method, intermediate water depth has calculated in GIS software with the help of these nearby values. Depth of less than 16m, 21m, 26m and more than 26m zone were created by interpolation method in GIS and ranked were assigned of each zone based on site criteria are shown in (table 1.3)

Table: 1.3: Ground water depth level for sit aptness of solid waste disposal

Criteria	Sub criteria	Ranking	Level of aptness
Groundwater depth	< 16m	4	Inaptness
	16m - 21m	3	Less aptness
	21m - 26m	2	Moderate aptness
	26m <	1	Highly aptness

Source: Compiled by author

Distance less than 16m is inaptness for disposal site, depth from 16m to 21m is less aptness, depth from 21m to 26m

is moderately aptness and depth more than 26m is highly aptness for solid waste disposal site (fig. 1.4).

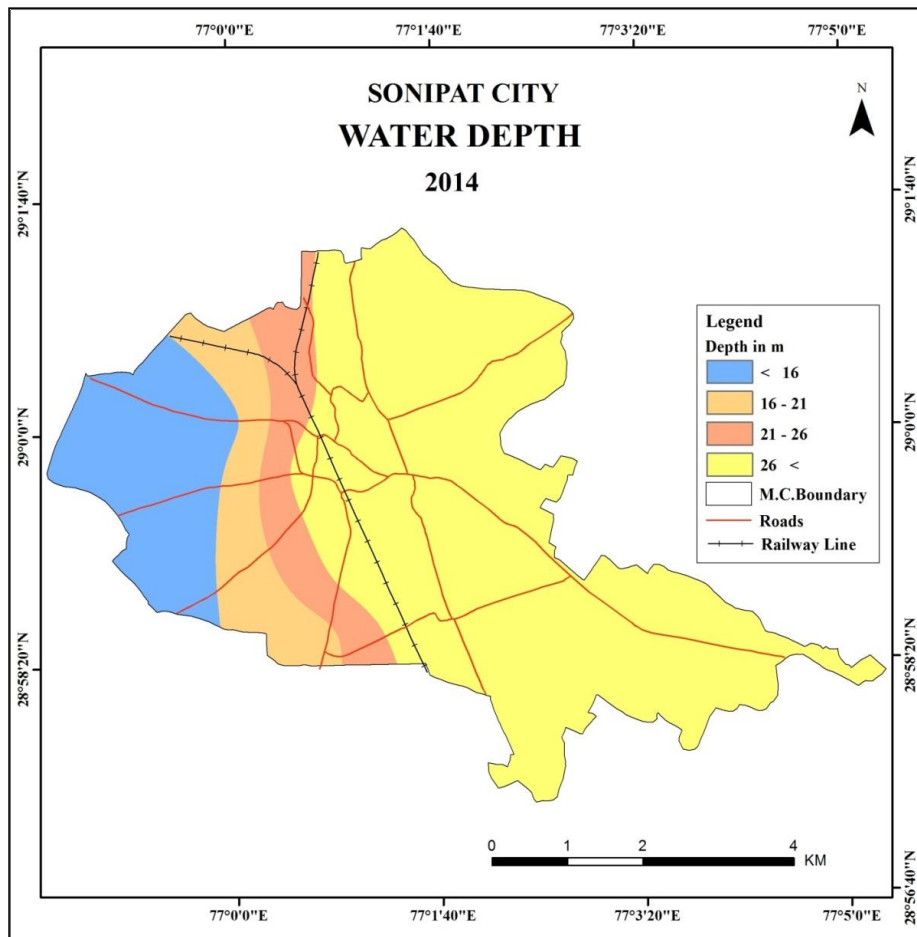


Fig. 1.4 (Ground water depth calculated by interpolation method)

After interpolation method four category has found. Less than 16m is inaptness, 16m to 21mm is less aptness, 21m to 26m is moderate aptness and more than 26m depth is high aptness for solid waste disposal site.

**9. Population density based criteria for solid waste disposal site:**

One of the important indices of population concentration is the density of population. It is per sq km or per hectare. In the year 2014, the population of Sonipat city is 302671 . Population density of *Sonipat* city is 184 persons per hectare in 2014. Solid waste disposal site would not be dense populated area. The population density of *Sonipat* city has categorized into four group (table 1.4).

Table 1.4: Category of density of population for site aptness of solid waste disposal

Criteria	Sub Criteria	Ranking	Level of aptness
Population Density	300ha <	4	Inaptness
	200ha – 300ha	3	Less aptness
	100ha – 200ha	2	Moderate aptness
	< 100ha	1	Highly aptness

Source: Compiled by author

Population less than 100 P/ha is high aptness, population within 100 P/ha to 200 P/ha is recorded in ward no 3, 4, 8, 12, 19, 22, 25, and 26 moderately aptness, population between 200 P/Ha to 300 P/ha is found in ward no 2,6,16,18, 20, 27 and

28 less aptness and more than 300 persons per hectare in central part (ward no. 5, 7, 14, 15 and 24) of city is inaptness for waste disposal site (fig. 1.5).

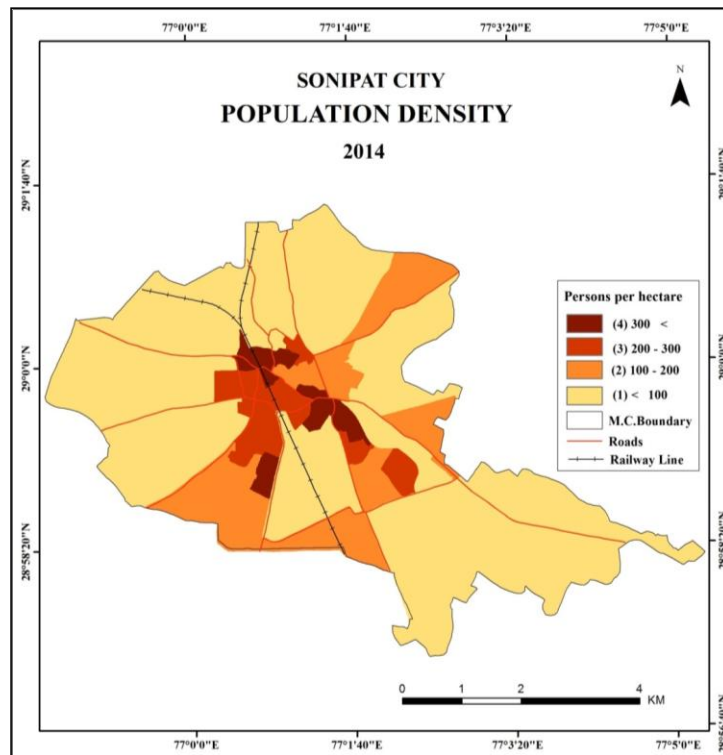


Fig. 1.5 (Population density of Sonipat city)

The study shows that the most dense population is found in the ward no 24 and as well as ward no 7 which has 605 and 515 persons per hectare density of population in city and lowest density of population was worked out in ward no 13 and ward no 30 that is 16 and 38 persons per hectare respectively. Population less than 100 persons per hectare is found in North West and Southeast direction (ward no. 1, 9, 10, 11, 13, 17, 21, 23, 29, 30 and 31).

**10. Suggestions for solid waste disposal sites:**

In order to identify the site for urban solid waste disposal, as a result, four aptness sites are found, in accordance with various sitting criteria; different referenced materials and sources which are used. On the basis of “overlay analysis” of the under given factors; with the help of using raster calculator in the “Arc GIS software” generated the aptness solid waste disposal site. Finally, the map for solid waste disposal site aptness; was divided into four categories, including inaptness, less aptness, moderate aptness, high aptness which have been shown in fig 1.6 as follows:

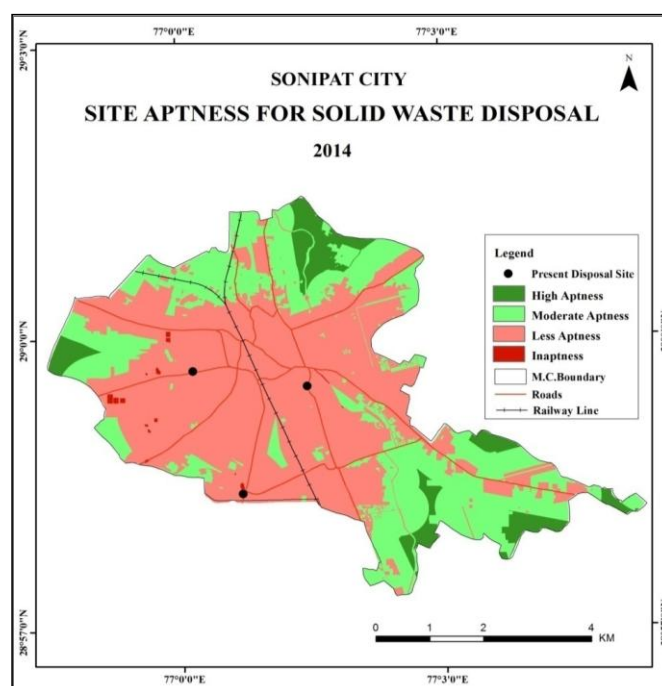


Fig. 1.6 (Overlay analysis of fig. 1.2, 1.3, 1.4 and 1.5)

Keeping in view the stated criteria of the areas of the aptness for disposal of solid waste site fall in the direction of the North, West and Southeast from the town (fig. 1.6). The areas have been identified as disposal site for highly aptness for solid waste which is suggested that selection of the site for solid waste disposal is to be chosen as 'optimum site' which may facilitate the transport and may also prove cost effective.

The total area of the most suitable disposal six sites is 2.95 Sq. Km out of a total area of 40.75 sq. km. The most suitable area ( the direction of North, West and Southeast) for disposal site for solid waste which is situated at distant location from any resources of economical/ environmental value, considered as one of the most appropriate site; which are tabulated as follows:

Table 1.5: Aptness class wise distribution with percent of covered total area

Aptness Classes	Area Sq. Km	Area (%)
Inaptness	0.11	0.26
Less aptness	23.90	58.65
Moderate aptness	13.79	33.84
Highly aptness	2.95	7.23
Total	40.75	99.98

Source: Compiled by Researcher

On the basis of tabulated figures, which shows that 0.26 per cent of the study area is inaptness, 58.65 per cent area, falls in less aptness category, whereas, there were 33.84 per cent of area is falls in moderate aptness category. Similarly, 7.23 per cent of the study area found highly aptness for the disposal site. Out of total study area, there were 7.23 per cent; meaning thereby that the 2.95 Sq. km area is suitable for highly aptness for disposal purposes. Thus, there are six potential sites are identify in the study area. All these are sites are located in North, West and South and Eastern direction.

## 11. Conclusion:

The study took population depth, land use/land cover, distance from road network and ground water depth as deciding factor to find aptness site for solid waste disposal. Results shows that six aptness sites have found for solid waste disposal. These sites are far away from any variables put into analysis. These sites reduce any type of risk and show the capacity to use GIS and remote sensing technology to efficiently locate high aptness site for solid waste. It highlights the requirement of solid waste management system. This study is useful for future planning of Sonipat city.

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