Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 4, Issue, 10, pp.252-256, October, 2012

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

# ENVIRONMENT ASSESSMENT OF INDUSTRIAL LANDFILL SITE IN TAMIL NADU

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ARTICLE INFO

*Article History:*
Received 19th July, 2012
Received in revised form
15thAugust, 2012
Accepted 10th September, 2012
Published online 30th October, 2012

*Key words:*
Hazardous waste,
landfill site, air pollution,
Soil quality and Water quality,
environmental assessment,
Effect of temperature.

ABSTRACT

Industrialization poses a great threat to human kind by the way of generating deleterious products followed through rapid urbanization and population growth activities. Different methods of waste management emit a large number of substances, most in small quantities and at extremely low levels. Land filling was the one of the method used for the discarding of industrial waste in Chennai, and the majority of the landfill sites are open dumping areas, which causes severe environmental and social threats. As a result, the hazardous waste generation has tremendously increased. Therefore an environmental assessment was the need of the hour. A field based study was taken up on five land fill sites namely the Madarpakkam, Sathyavedu village, Menallur village, Nemalur village, Pondavkkam village that were within the 10km buffer zone of the landfill site Gummidipoondi in Tamil Nadu, India and the sites were assessed for environmental parameters on air such as $SO_2$, $NO_x$ and SPM, ground water and soil on physical, chemical and associated factors. Overall results has showed that air, soil and water quality were within the prescribed limits of the International standards that could be due to buffer distance of 10km from the core region. A transect survey of environmental parameters would have been better to identify environmental impacts of disposal methods could be considered by decision makers in future to suggest the most environmentally and economic method to the policy planners.



## INTRODUCTION

Hazardous waste is a complex mixture of substances generated by industrial sectors. Hazardous waste generated by the industries can cause environmental pollution and adverse health effects, if not handled and managed properly. The generation of hazardous waste led to collection, processing, transport and disposal of waste at proper disposal site. In order to manage Hazardous Waste (HW) mainly solids, semisolids, solvents and other industrial wastes not covered by the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981, and to enable the authorities to control handling, treatment, transport and disposal of HW in an environmentally sound manner (Alshammari *et al*., 2008). Different methods of waste management emit a large number of substances, most in small quantities and at extremely low levels. A rapid growth of industries has entirely changed the hazardous waste generation scenario in the country. The quantity of hazardous wastes generated has increased appreciably and the nature of the waste generated has become complex. As regards (CPCB 2009), there are about 36,165 number of hazardous waste generating industries, generating about 6.2 million metric tons of hazardous wastes generated every year. The report revealed that the quantum of hazardous waste, which has to go for final disposal in secured land fill (SLF) was about 2.7 million metric tons (i.e. 44.30 %), disposal by incineration was about 0.4 million metric tons (i.e. 6.60 %) and recyclable waste was about 3.0 million metric tons (i.e. 49.10 %) of total hazardous waste generation in the Country. For disposal of wastes either captive facilities or common facilities of adequate capacities are required to be established, so as to dispose of such wastes without causing any harm to the public and the environment. Ministry of Environment & Forests (MoEF) promulgated Hazardous Waste (Management & Handling) Rules on 28 July 1989 under the provisions of the Environment (Protection) Act, 1986. In September 2008, the rules were replaced and new rules entitled "Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008" (here after referred as HW (M, H & TM) Rules) were notified. These rules were further amended in the year 2009. Common Hazardous Waste Management Facility (CHWMF) would facilitate operations like waste pre-treatment, storage of various hazardous wastes, stabilization, leachate treatment, incineration and final disposal.

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The open dump method is mainly practised by many countries to dispose the hazardous waste materials and therefore all these operations would release various pollutants into the environment, (Pandiyan et al., 2011) in turn may cause low to severe damages to the ecosystem, if not handled properly. In view of this, it is very important to site such facilities in systematic way through evaluating the environmental adequacy. Amended rules state that after preliminary impact assessment studies, for identification of possible sites for disposal facility, Environmental Assessment (EA) study should be undertaken to select appropriate site Guiqin *et al.* (2009).

Ten pollutants are considered to have the greatest potential impact on human health based on environmental persistence, bioaccumulation and amount emitted and/or on inherent toxicity were cadmium, mercury, arsenic, chromium, nickel, dioxins, PCBs, PAHs, $PM_{10}$ and $SO_2$ (Rushton, 2011). Incidence of low birth weight births and occurrence of various congenital malformations has been related to residence near landfill sites. Studies of cancer incidence and mortality in populations around landfill sites or incinerators have been equivocal, with varying results for different landfill sites. Hazardous waste can damage the environment by contaminating air, water and soil. Once in environment, hazardous waste can affect all life forms, whether through direct exposure or environmental damage, hazardous wastes present a risk to human health. (Grasso and Khan, Hazardous Waste, 2001). This study aims to study hazardous waste landfill site at Gummidipundi and explore environmental assessment relating to possible health hazards associated with environmental parameters and addresses management strategies.

### Study Area

Gummidipoondi the waste disposal site is surrounded by three lakes namely Poondi, Red Hills and Sholavaram reservoir. All three lakes are sources of drinking water for Chennai city and also a rechargeable source of groundwater in that area. The hazardous landfill in Gummidipoondi is approachable by a road by about 16 kms from Gummidipundi village in the south eastern direction. Approximately 390 industries comprising districts of Chennai, Thiruvallur, Kanchipuram are covered in this landfill site. Among hazardous waste, incinerable waste accounted for 3,364 tonnes, including spent solvents, waste oils, pesticide wastes, capacitors containing polychlorinated biphenyls and organic waste etc., Annual rainfall for the past 10 years ranged between 1160.4 mm and 1427.6mm and the average rainfall in the Gummidipundi area was around 1000mm. The highest precipitation occurs normally from middle of August to first week of December. Summer temperature varies from 30ºC to 36 ºC and reaches a maximum of 40ºC in summer. However, winter temperature varies from 20 ºC to 22 ºC and reaches a minimum of 18ºC in winter. An approximate area of hazardous landfill study site is of 60 acres of land, where total waste buried, burnt or stored was 35,618 tonnes/year lead to 136 tonnes/day classified as small category waste landfill, whereas its actual capacity was 12,000 tonnes/year. Alstom Power Systems has supplied incinerator with chimney height 30 metres and incineration capacity of 1 tonne/hour and the life span of landfill was 25 years.

**Table 1: General waste landfill classes.**

| Landfill Size Class | | Maximum Rate of Deposition (MRD) (Tones per day) |
|---|---|---|
| Communal | C | <25 |
| Small | S | >25 - <150 |
| Medium | M | >150 - < 500 |
| Large | L | >500 |

The maximum rate of deposition (MRD) describes by weight (expressed in T/day, for a 260 day year) (Guidelines for Hazardous Waste Landfill, 2005).

## METHODOLOGY

Field sampling activities must be coordinated between sample collection for chemical analysis, laboratory toxicity testing, and field survey activities. Sample collection and field survey activities should be coordinated in space and time (William *et al.,* 1991). The total study area comprises 34 rural villages within the buffer zone covering an area of 10 km radius. Among 22,918.45 ha of comprising the breakup for different classes area as follows a) forest land: 909.14ha (3.97%) b) irrigated land: 7126.27ha (31.09%), c) unirrigated land: 7325.27ha (31.96%) d) cultivable waste land: 3,222.21ha (14.06%) and e) area not available for cultivation: 4335.64ha (18.92%). Wetland cultivation was predominant in most of the rural villages crops like rice, ragi and cumbu are grown in the area due to adequate irrigation water available in the tanks. The existing hazardous landfill was almost barren except for few planted fruit bearing trees such as mango and coconut that are available within the landfill site. Environmental Assessment (EA) has become one of the most effective tools for incorporating environmental consequences into decision-making. EA assists, but does not control project planning and implementation; ensuring that environmental considerations are incorporated into decision-making, along with technical and economic factors. Public participation has become an integral part of EA that are aid in making decisions, which are informed and environmentally sound decisions could be taken for sustainability. Environmental quality studies in the area with respect to air, water; soil and noise have been studied during the course of investigation.

### Air Quality Monitoring

#### *Air quality and Climate*

The atmosphere provides an excellent medium through which pollutants can be transported. Pollutant release to atmosphere can occur during the construction, operation and post-closure phases of a facility. The impact of air pollution release to atmosphere can be of two types:

#### *Direct*

Direct contact with the chemical in the air results in an adverse effect. Examples include health effects caused by inhalation (e.g. asthma), nuisance effects from odours, and the effects of acid deposition on vegetation.

#### *Indirect*

Higher-order effects in which the receptor is in contact with environmental media (e.g. soil or water) or materials, which have been contaminated by chemicals in the air.

**Table 1. Locations details of the study area with reference to core zone**

| Code | Locations | Distance From Core Zone (km) | Direction |
|---|---|---|---|
| BA1 | Project area | - | - |
| BA2 | Sathyavedu village | 6.0 | NW |
| BA3 | Menallur village | 1.7 | NE |
| BA4 | Nemalur village | 1.8 | SW |
| BA5 | Pondavkkam village | 2 | N |

The ambient air quality has been assessed with respect to SPM, $SO_2$, NOx, and CO the sampling stations were carefully chosen based on the prevailing meteorological conditions during the study period using synoptic scale climatological normal and with the help of available screening air quality

**Table 2. Methods used for analysis of ambient air pollutants**

| Pollutant | Method |
|---|---|
| SPM | HVS with filter |
| SO2 | Pros aniline method |
| NOx | Sulphaniliamide method |
| CO | Co direct reading detector |

**Table 3. Locations details of the ground water collection points with reference to core zone**

| Code | Locations | Direction |
|---|---|---|
| BW1 | Ground water from madarpakkam village | - |
| BW2 | Bore well water from sathyavedu village | NW |
| BW3 | Well water from menallur village | NE |
| BW4 | Well water from nemallur village | SW |
| BW5 | Well water from pondavakkam village | N |

**Table 4. Observed air quality values of the landfill site**

| Sl No | Village | SPM µgm/m$^3$ | $SO_2$ µgm/m$^3$ | NOx µgm/m$^3$ |
|---|---|---|---|---|
| 1 | Core zone | 75 to 95 | 6 to 8 | 6 to11 |
| 2 | Sathyavedu village | 64 to 94 | 6 to 9 | 6 to 9 |
| 3 | Menallur village | 59 to 94 | 6 to 9 | 6 to 8 |
| 4 | Nemallur village | 60 to 93 | 6 to 9 | 6 to 9 |
| 5 | Pondavkkam village | 62 to 102 | 6 to 10 | 7 to 11 |

**Table 5. CPCB Limits of Ambient Air Quality Limits**

| Sl No | ZONE | SPM | $SO_2$ | $NO_X$ | CO |
|---|---|---|---|---|---|
| | | µgm/m3 | | | |
| 1 | Industrial mixed use | 500 | 120 | 120 | 5000 |
| 2 | Residential and rural areas | 200 | 80 | 80 | 2000 |
| 3 | Sensitive zones | 100 | 30 | 30 | 3000 |

**Table 6. CPCB Limits of Ambient Air Quality Limits with respect to Core and Buffer Zone**

| CORE ZONE | | | BUFFER ZONE | |
|---|---|---|---|---|
| | MAX | MIN | MAX | MIN |
| SPM | 95 | 75 | 102 | 59 |
| $SO_2$ | 11 | 6 | 10 | 6 |
| $NO_X$ | 8 | 6 | 11 | 6 |

models like PTMAX, PTPLU PTDIS. The ambient air quality locations were tabulated in table 1 and the methods used for pollutant analysis were listed in table 2. The ambient air quality parameters were monitored at these locations twice a week on 24 hrs basis and analyzed for SPM, NOx and $SO_2$.

**Water Quality Monitoring**

The water samples were collected from five ground water sources from the project area including the buffer zone that was mostly land locked and no major waters bodies were located within the buffer zone. Water quality has been assessed at five locations and the details are described in table 3. The characteristics of water such as colour, odour, temperature, pH and electrical conductivity were monitored.

**Soil Quality Monitoring**

Soil is considered as important component of the eco system. Soil samples were collected from the following locations namely

BS – Madarpakkam agricultural soil
BS- Study area
Approximately 2 kg of samples from each site were collected using auger/core cutter in polythene bags, scaled well and transported to laboratory for analysis for its physicochemical characteristics.

**Noise Quality Monitoring**

The primary sources of noise impact on waste disposal and treatment facilities are a) mobile plant used in construction, operation and restoration phases b) fixed plant, primarily related to the operational period. c) Heavy Good Vehicles (HGVs) movement for delivering and unloading waste and removing residues make noise from bearable to unbearable extent. Noise impact on environmental receptors will be influenced by a number of site-specific factors relating to site operations and location of the site. Operational factors include size and type of plant and location factors include proximity to sensitive receptors, the existing ambient noise levels and other noise sources in the locality, local meteorological conditions particularly wind direction, etc.

A sound level meter, an instrument which has a microphone amplifier and weighting networks and an indicating meter that gives a reading in dB relative to 2 * 10-5 N/M2

**Table 7. Observed Water quality values of the landfill site**

| Sl. No. | Parameters | BW1 | BW2 | BW3 | BW4 | BW5 |
|---|---|---|---|---|---|---|
| 1 | pH | 7.3 | 6.8 | 6.9 | 8.0 | 7.9 |
| 2 | Colour (visual) | colourless | colourless | colourless | colourless | colourless |
| 3 | Total Suspended Solids (TSS) | 10 | 12 | 8 | 14 | 9 |
| 4 | Total Volatile Solids (TVS) | 22 | 41 | 68 | 20 | 32 |
| 5 | Dissolved Oxygen (DO) | 2.8 | 3 | 2.9 | 2.4 | 3 |
| 6 | BOD | 2 | 3 | 4 | 2 | 2 |
| 7 | COD | 10 | 9 | 12 | 14 | 11 |
| 8 | Calcium (Ca) | 38 | 41 | 55 | 68 | 42 |
| 9 | Magnesium (Mg) | 22 | 29 | 22 | 21 | 19 |
| 10 | Iron (Fe) | 0.2 | 0.1 | BDL | 0.1 | 0.2 |
| 11 | Chlorides (Cl) | 98 | 103 | 114 | 95 | 122 |
| 12 | Sulphates ($SO_4$) | 22 | 1.8 | 43 | 16 | 42 |
| 13 | Fluorides (F) | 0.7 | 0.6 | 0.8 | 0.7 | 0.8 |
| 14 | Total Nitrogen | 28.6 | 13.2 | 14.8 | 28 | 14.2 |
| 15 | Total dissolved solids (TDS) | 355 | 412 | 600 | 310 | 398 |

*BDL Below Detectable Limit

The microphone responds directly to the pressure variations and its output was amplified to give a reading of sound pressure level directly on the meter. The weighting networks superimpose a frequency response on the amplifier similar to right of the human ear density.

## RESULTS AND DISCUSSION

particularly of hazardous wastes. export from industrialized countries to low-income countries circumvents strict waste disposal regulations implemented in the country generating these wastes. Often this is highly organized, as informal, though illegal, transactions between an exporter and importer using false documentation (Mackenzie, 1989) lead to accumulation of waste disposal. Quantity of waste having considerable effect on life of site in turn it affects the economic viability of the site. The landfill site should be selected in the area where large number of industries available. The hazardous waste generating industries such as electroplating, chemical, petrochemical, service stations, textile processing and engineering type of industries are located around the sites. Gummidipoondi landfill site of waste management quantity lies between 250-500 tons/day.

**Table 8. Tolerance Limits for Water as per IS Standards**

| Sl No | Parameters | Limits IS :10500 |
|---|---|---|
| 1 | pH | 6.5-8.5 |
| 2 | Colour | Colorless |
| 3 | TDS | 500 |
| 4 | Chlorides | 250 |
| 5 | Sulphates | 150 |
| 6 | Total residual Chlorine | 0.2 |
| 7 | Fluorides | 0.6-1.2 |
| 8 | Arsenic | 0.05 |
| 9 | Copper | 0.05 |
| 10 | Lead | 0.1 |
| 11 | Magnesium | 30 |
| 12 | Calcium | 75 |
| 13 | Iron | 0.3 |
| 14 | Mercury | 0.001 |
| 15 | Zinc | 5 |

**Table 9. Soil physical and chemical characteristics of Landfill site**

| Sl.No. | Parameters | Madarpakkam | Landfill Site |
|---|---|---|---|
| 1 | pH | 8.2 | 7.5 |
| 2 | Electrical conductivity ($dsm^{-1}$) | 0.09 | 0.07 |
| 3 | Total Nitrogen (%) | 0.05 | 0.03 |
| 4 | Total Phosphorous (%) | 0.032 | 0.009 |
| 5 | Total Potassium (%) | 0.024 | 0.022 |
| 6 | Natural moisture content (%) | 5.0 | 7.0 |
| 7 | Gravel (%) | - | 8.1 |
| 8 | Sand (%) | 12.6 | 23.2 |
| 9 | Silt (%) | 53.2 | 46.4 |
| 10 | Clay (%) | 34.20 | 22.30 |
| 11 | Textural class | Silty Clay | Red Loam |
| 12 | Bulk density Mgm | 1.98 | 2.45 |
| 13 | Liquid limit (%) | 9.85 | 12.10 |
| 14 | Plastic limit (%) | 5.62 | 3.80 |
| 15 | Infiltration rate (cm/hr) | 21.2 | 12.40 |
| 16 | Field capacity (v/v)% | 19 | 25 |
| 17 | Wilting coefficient (v/v)% | 10 | 15 |
| 18 | Available water storage capacity (v/v)% | 9 | 10 |

## Air quality

Air quality in Chennai and pollutant dispersion was relatively good. Nitrogen Oxide ($NO_x$) $SO_2$ and fine particulate matter (SPM) are now the threat to the quality of air in Chennai. A major source of these pollutants is transport, however the relative contribution of transporting hazardous waste is not known but heavy vehicles contribute to ambient NOx concentrations through exhaust emissions and SPM concentrations through exhaust emissions. Air pollution data collected from the high volume sampler for SPM, $SO_2$ and $NO_x$ were reported in table 4. The ambient air quality data at five for all the locations below detectable levels. The levels of SPM, $SO_2$ and $NO_x$ are extremely low due to absence of industrial activity in the core and buffer zone areas. Quantity of waste having considerable effect on life of site in turn it affects the economic viability of the site. The landfill site should be selected in the area where large number of industries available. Then only the revenue to the landfill operator will be good. The hazardous waste generating industries such as electroplating, chemical, petrochemical, service stations, textile processing and engineering type of industries are located around the sites. The distance between collection point and landfill site is having direct impact on transportation cost. The transportation cost of hazardous waste should be paid by waste generating industry, which is included with the treatment cost. In addition, the spillage risk will be reduced if the distance is less. The distance from Gummidipoondi site to the collection point is greater than 50 km. Emissions of NOx, SPM and $SO_2$ pollutants from waste incineration are relatively small. The most prominent pollutants from thermal treatment in the public consciousness are dioxins and furans, which are extremely harmful to human health.

## Water Quality

Pollution may also occur from unauthorized waste sites, illegal dumping, inappropriate disposal of hazardous wastes and other activities such as diesel laundering wastes. Hazardous waste and hazardous waste management are currently having a relatively low level of impact on groundwater quality. Hazardous waste management may impact directly on groundwater quality through active facilities or closed waste disposal facilities. Water quality pollution potential can be cleaned from amounts and types of wastes deposited, site management and site location in relation to aquifer vulnerability. Aquifers are underground layers of rock which contain water and which are capable of yielding it to surface waters such as streams and rivers. In this study, hydrogeological understanding was poor and means to improve the understanding of hydrogeology were limited, a default approach for assessing pollution potential from wastes was to investigate distances between waste disposal and drinking-water abstraction. The TSS values at the five sampling stations were 10 mg/l, 8 mg/l, 14 mg/l and 9 mg/l while TDS were 35.5 mg/l, 412 mg/l, 600 mg/l, 310 mg/l and 398 mg/l. The average chloride values at the five sampling stations are 98 mg/l, important in considering the groundwater resource of an

**Table 10. Noise observations recorded from the landfill site**

| Sl no | Code | Location | Noise Level in dB(A) |
|---|---|---|---|
| 1 | BN1 | Landfill site | 36 |
| 2 | BN2 | Sathyavedu village | 34 |
| 3 | BN3 | Menallur village | 45 |
| 4 | BN4 | Nemalur village | 36 |
| 5 | BN5 | Pondavakkam village | 40 |

**Table 11. Tolerance Limits for Noise Level Measurement**

| Area Code | Category of Area / Zone | Limits in dB(A) Leq* | |
|---|---|---|---|
| | | Day Time | Night Time |
| (A) | Industrial area | 75 | 70 |
| (B) | Commercial area | 65 | 55 |
| (C) | Residential area | 55 | 45 |
| (D) | Silence Zone | 50 | 40 |

aquifer: the scale of the aquifer and the vulnerability of the aquifer to pollution. However, there was an increasing trend in the number of groundwater samples showing no contamination.

### Soil Quality

Currently hazardous waste management was having low impacts on study site soil quality. However certain hazardous waste activities have a relatively high impact in some other areas, such activities include inappropriate disposal of certain hazardous wastes and Illegal disposal activities. Overall the quality of soils in Chennai was good. However, there is increasing pressure on soils resulting in their physical, biological or chemical degradation. Analyzed results of these soil samples indicate that red loam in and salty clay in nature. The pH values of these two soil samples are 7.5 and 8.2. By suitable selection of species for plantation, proper toning, timely seeding, watering and continuous monitoring of the soil nutrients and micro nutrients. It would be possible to maintain a very good forestry and green belt which are ideal for maintaining the ecosystem.

### Noise Measurement

Noise levels in the area range from 30 db(A) to 59 db(A) which are within prescribed limits There are several noise measurement scales that are used to describe noise at a particular location. The most common is the A-weighted sound level or decibel (dBA). This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive.

### Conclusion

Environment assessment of landfill study site is located in a SIPCOT complex. The same site was used as agriculture land for the past few decades. Hazardous landfill site was seem to be a secured landfill site considering the prevailing environment observations on air, soil, water and noise has been within permissible limits during the course of this investigations. Wider use of alternative technologies was likely, including advanced thermal treatment, such as gasification and pyrolysis, mechanical and biological processes should be through to treat waste before disposal in the near future.

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