

Municipal Solid Waste Management in Bhopal city Madhya Pradesh India

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Abstract

The management of Solid waste is one of the earliest of man's branches of knowledge. In some ways it is also one of the latest. This was particularly so during the latter part of the last century, when the study and practice of public health grew up to ameliorate, in the particular the housing and living condition of the working poor in India cities. The public health movement spread rapidly to our country, where the need for improvement was not as strong as in our societies but where danger signs were visible in the increasingly crowded conditions of the India cities. The new problems included fundamental changes in the nature of domestic refuse which in the days of wood has consisted pre dominantly of ashes and food wastes and which became increasingly composed of large quantities of paper, plastic and glass packaging materials. The problems also included changes in industrial wastes, which began to incorporate as previously unknown variety of substances with in many cases, still unknown properties and hazardous our previous complacency resulted in our being caught virtually unawares by these new problems. The last two decades have seen an increasingly rapid growth in first concern and later, action which has transformed the whole field of solid waste management.

1. Solid waste management rule 2016

Whereas the draft of the solid waste management rules, 2015 were published under the notification of the government of India in the Ministry of Environment, Forest and Climate Change number G.S.R. 451 (E) dated the 3rd June, 2015 in the Gazette of India, part II, Section 3, sub0section (i) of the same date inviting objections or suggestions form the publication of the said notification on the Solid Waste Management Rules, 2015 in supersession of the Municipal Solid Waste (Management and Handling) Rules, 2000; And Whereas, copies of the said Gazette were made available to the public on the 3rd June, 2015: And Whereas, the objections or comments received within the stipulated period were duly considered by the Central Government; Now, Therefore, in exercise of the powers conferred by section 3,6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) and in supersession of the Municipal Solid Waste (Management and Handling)Rules, 2000 except as respect things done or omitted to be done before such supersession, the Central Government herby makes the following rules for management of Solid Waste, Namely Solid waste management rule 2016.

2. Application

These rules shall apply to every urban local body, outgrowths in urban agglomerations, census towns as declared by the Registrar General and Census Commissioner of India, notified areas, notified industrial townships, areas under the control of India Railways, airports, airbases, Ports and harbours, defence establishments, special economic zones, State and Central government organisations, places of pilgrims, religious and historical importance as may be notified by

respective State government from time to time and to every domestic, institutional, commercial and any other non-residential solid waste generator situated in the areas except industrial waste hazardous waste hazardous chemicals, bio-medical wastes, e-waste, lead acid batteries and radio-active waste, that are covered under separate rules framed under the Environment (Protection) Act, 1986.

3. Definitions

1. “aerobic composting” means a controlled process involving microbial decomposition of organic matter in the presence of oxygen;
2. “anaerobic digestion” means a controlled process involving microbial decomposition of organic matter in absence of oxygen;
3. “biodegradable waste” means any organic material that can be degraded by micro-organisms into simpler stable compounds;
4. “bio-methanation” means a process which entails enzymatic decompositions of the organic matter by microbial action to produce methane rich biogas;
5. “combustible waste” means non-biodegradable, non-recyclable, non-reusable, non-hazardous solid waste having minimum calorific value exceeding 1500 kcal/kg and excluding chlorinated materials like plastic, wood pulp, etc;
6. “composting” means a controlled process involving microbial decomposition of organic matter;
7. “co-processing” means use of non-biodegradable and non-recyclable solid waste having calorific value exceeding 1500 kcal/kg as raw material or as a source of energy or both to replace or supplement the natural mineral resources and fossil fuels in industrial processes;
8. “door to door collection” means collection of solid waste from the door step of households, shops, commercial establishments, offices, institutional or any other non-residential premises and includes collection of such waste from entry gate or a designated location on the ground floor in a housing society, multi storied building or apartments, large residential, commercial or institutional complex or premises;
9. “dry waste” means waste other than bio-degradable waste and inert street sweepings and includes recyclable and non-recyclable waste, combustible waste and sanitary napkin and diapers, etc;
10. “dump sites” means a land utilized by local body for disposal of solid waste without following the principles of sanitary land filling;
11. “facility” means any establishment wherein the solid waste management processes namely segregation, recovery, storage, collection, recycling, processing, treatment or safe disposal are carried out;
12. “inerts” means wastes which are not bio-degradable, recyclable or combustible street sweeping or dust and silt removed from the surface drains;
13. “incineration” means an engineered process involving burning or combustion of solid waste to thermally degrade waste materials at high temperatures;
14. “materials recovery facility” (MRF) means a facility where non-compostable solid waste can be temporarily stored by the local body or any other entity mentioned in rule 2 or any person or agency authorized by any of them to facilitate segregation, sorting and recovery of recyclables from various components of waste by authorized informal sector of waste pickers, informal recyclers or any other work force engaged by the local body or entity mentioned in rule 2 for the purpose before the waste is delivered or taken up for its processing or disposal;

15. “non-biodegradable waste” means any waste that cannot be degraded by micro organisms into simpler stable compounds;
16. “processing” means any scientific process by which segregated solid waste is handled for the purpose of reuse, recycling or transformation into new products;
17. “recycling” means the process of transforming segregated non-biodegradable solid waste into new material or product or as raw material for producing new products which may or may not be similar to the original products;
18. “refused derived fuel” (RDF) means fuel derived from combustible waste fraction of solid waste like plastic, wood, pulp or organic waste, other than chlorinated materials, in the form of pellets or fluff produced by drying, shredding, dehydrating and compacting of solid;
19. “sanitary land filling” means the final and safe disposal of residual solid waste and inert wastes on land in a facility designed with protective measures against pollution of ground water, surface water and fugitive air dust, wind-blown litter, bad odour, fire hazard, animal menace, bird menace, pests or rodents, greenhouse gas emissions, persistent organic pollutants slope instability and erosion;
20. “waste hierarchy means the priority order in which the solid waste is to should be managed by giving emphasis to prevention, reduction, reuse, recycling, recovery and disposal, with prevention being the most preferred option and the disposal at the landfill being the least;
21. “waste picker” means a person or groups of persons informally engaged in collection and recovery of reusable and recyclable solid waste from the source of waste generation the streets, bins, material recovery facilities, processing and waste disposal facilities for sale to recyclers directly or through intermediaries to earn their livelihood.

4. Criteria for water quality monitoring

1. Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 meter of the periphery of landfill site shall be periodically monitored covering different seasons in a year that is, summer, monsoon and post-monsoon period to ensure that the ground water is not contaminated.
2. Usage of ground water in and around landfill sites for any purpose (including drinking and irrigation) shall be considered only after ensuring its quality. The following specifications for drinking water quality shall apply for monitoring purpose, namely:-

Sl.No.	Parameters	IS10500:2012, Edition 2.2 (2003-09) Desirable limit (mg/l except for pH)
(1)	(2)	(3)
	Arsenic	0.01
	Cadmium	0.01
	Chromium (as Cr ⁶⁺)	0.05
	Copper	0.05
	Cyanide	0.05
	Lead	0.05
	Mercury	0.001
	Nickel	-
	Nitrate as NO ₃	45.0
	pH	6.8-8.5

	Iron	0.3
	Total hardness (as CaCO ₃)	300.0
	Chlorides	250
	Dissolved solids	500
	Phenolic compounds (as C ₆ H ₅ OH	0.001
	Zinc	5.0
	Sulphate (as SO ₄)	200

5. Criteria for ambient air quality monitoring

1. Landfill gas control system including gas collection system shall be installed at landfill site to minimize odour, prevent off-site migration of gases, to protect vegetation planted on the rehabilitated landfill surface. For enhancing landfill gas recovery, use of geomembranes in cover systems along with gas collection wells should be considered.
2. The concentration of methane gas generated at landfill site shall not exceed 25 percent of the lower explosive limit (LEL).
3. The landfill gas from the collection facility at a landfill site shall be utilized for either direct thermal applications or power generation, as per viability. Otherwise, landfill gas shall be burnt (flared) and shall not be allowed to escape directly to the atmosphere or for illegal tapping. Passive venting shall be allowed in case if its utilization or flaring is not possible.
4. Ambient air quality at the landfill site and at the vicinity shall be regularly monitored. Ambient air quality shall meet the standards prescribed by the Central Pollution Control Board for Industrial area.

6. Town-wise update of the model towns

On the lines of Indore, Bhopal has deployed 713 vehicles for collection and transportation. All the vehicles have partitions for dry, wet and domestic hazardous waste, filled with GPS and are connected with integrated command and control center (ICCC).

Bhopal has setup various standalone processing facilities to treat municipal waste. This includes:

- 7 transfer stations (on the lines of Indore Model)
- 5 Fully functional MRF to process 435 TPD of dry waste (including plastic waste)
- Centralized Waste to Compost Facilities of 400 TPD capacity in total
- 05 bio-methanation plants to process wet waste

7. C&D Waste Management

The city is also setting up a 100 TPD C&D Waste Processing Plant in Bhanpur which is under construction. The ULB has 19 dedicated vehicles for C&D waste collection and transportation. They have already established four locations for C&D waste storage. Bhopal has tied up with Tiles and Paver Blocks companies for selling 35 TPD of waste.

8. Dumpsite remediation

Bhopal has already remediated 100% of legacy waste at bhanpur khanti.

9. Scientific Landfill

Bhopal has a scientific landfill in operation.

Bhopal has secured rank 7 in the > 10 lakh category in the “Swachh Survekshan 2020” and has also been awarded as the Best Self Sustainable State Capital in the 2020. The City has also been awarded 3-Star under GFC Star Rating Protocol. This was a Progress over last year when Bhopal was given 2 Star status. Bhopal has significantly improved its solid waste management condition this year.

Name of cluster	Town	Population (2015)	MSW Generation in TPD (2015)
Bhopal Cluster	Ashta	57,433	27
	Berasia	33,424	16
	Bhopal	1,941,873	907
	Ichhawar	16,437	8
	Kothri	11,367	5
	Mandideep	64,420	30
	Obedullaganj	24,670	12
	Sehore	117,835	55
	Total	2,267,459	1,060

9.1 Integrated solid waste management project Bhopal

9.1.1 Name of Project: Development of an Integrated MSW Processing and Disposal Facility at Adampur Chhavni, Bhopal by M/s. Green Resources Solid Waste Management Pvt. Ltd.

9.1.2 Location of Project: Adampur Chhavni, Raisen road - Bhopal (M.P.)

9.1.3 Google map of project site:



Fig. 9.1.3 Google map/ Satellite view of Project Site

9.1.3 Latitude and Longitude: (23°15'55.6"N 77°33'33.3"E)

9.1.4 Site Layout :



Fig. 9.1.5 Site layout plan of Integrated Solid Waste Management Facility, Bhopal

9.1.4 Site map :

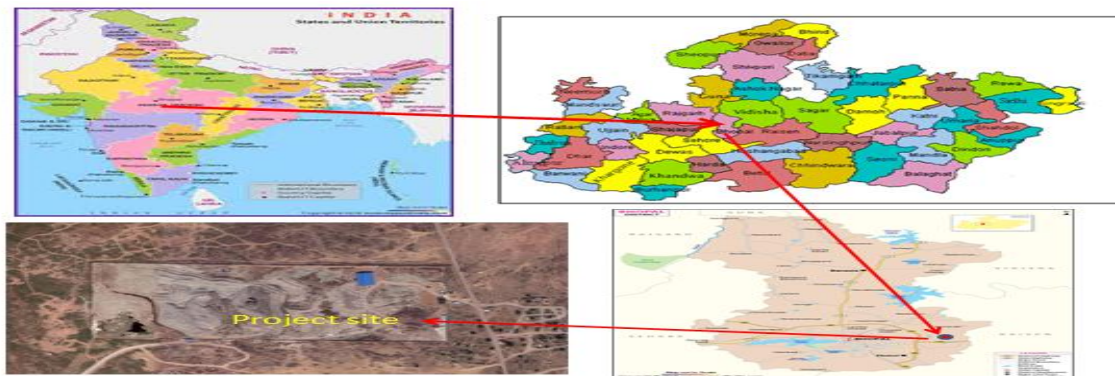


Fig. 9.1.5 Site map showing location of Project site in India

9.1.5 Feasibility of Project (why this technology is adopted): Safe disposal of municipal solid waste being generated in the ULBs is necessary as per SWM rules 2016. The project aims to manage the solid waste of Bhopal Municipal Corporation in integrated manner so as to minimize the likely environmental impact and efficiently utilize the waste as a resource wherever it may be possible. The project helps in generating RDF (Refuse Derived Fuel) which is to be used for energy recovery and organic fraction is being converted into compost by windrow composting which is further utilized /sold to farmers for horticulture / agriculture purposes. Thus such a facility is beneficial for handling MSW in efficient manner following 4R principal (Reduce, Reuse, Recycle & Recover) and hence it is cost effective/economical as well.

9.1.6 Area covered by ISWM Facility: The ISWM facility is handling MSW of Bhopal Municipal Corporation only. An indicative Google map of Bhopal city is given below:

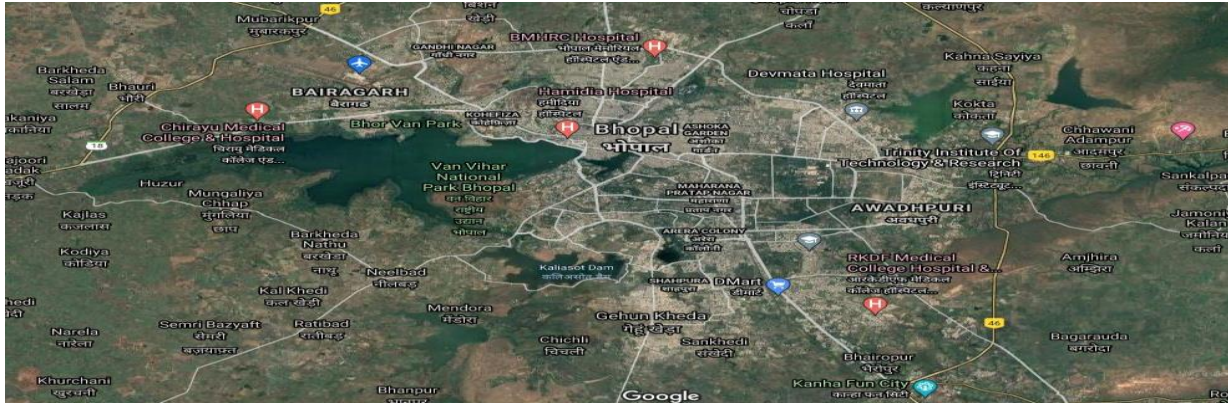


Fig. 9.1.7 Indicative Google map of Bhopal City of Madhya Pradesh

9.1.7 Quantity of solid waste: At present the daily amount of MSW being collected is approximately 800 TPD however the plant capacity for projected population is about 1000 TPD. Out of this collected MSW the daily amount of RDF being generated is about 200 TPD and finished compost of good/desirable quality is about 100 TPD. Apart from this recyclables obtained in the range of 7 TPD whereas inert material quantity going to landfill is approximately 50 TPD.

9.1.8 Characteristics of solid waste: Mixed type of waste is being sent to the facility which contains food waste, vegetable waste, fruit peels, plastic waste, metals and inert waste etc. Approximate physical composition of waste is given below:

Table No. 1.1.9

Waste Component	% share
Food, vegetable& other organic waste	54
Textile	6
Paper, cardboard	7
Plastic and Polythene	13
Glass & Ceramic	2.5
Rubber & Leather	3.5
Wood	2
Stones & Bricks	11
Metal	1
Total	100%

9.1.9 Details of installed units

Table No. 9.1.10

Sr. no.	Name of unit	Capacity	Purpose	Water pollution control arrangement	Air pollution control arrangement
1	Compost plant (windrow)	500 TPD	To produce compost of good quality from organic fraction of	The processing of waste is done under shade and leachate	The processing of waste is being done under covered

	composting)		municipal solid waste	collection system is provided. Leachate treatment plant (LTP) will be installed soon to treat excess amount of leachate.	shade and to mitigate the odour problem organic chemicals are sprayed over the waste daily.
2	RDF Processing unit	500 TPD	To produce RDF which may utilized further for energy recovery	Leachate collection system is provided.	The processing /sorting is done under covered shade.
3	Recyclables	20 TPD	To recycle the plastic, metal, wood, glass and other recyclable fraction of the waste.	Recyclable fraction will be given to recyclers for processing.	Recyclable fraction will be given /sold to recyclers for processing and reuse.
4	Sanitary landfill	50 TPD (Area of landfill is 5 acres)	To dispose off leftover waste in secured manner, which cannot be reused or further processed.	HDPE liners are provided on the base and daily cover is applied in secured manner. Leachate collection system is also there.	Daily cover is applied.
5	Bio-mining	2000 TPD	To handle the legacy waste already dumped at the site	Leachate collection system is provided.	Covered boundary is there along with green belt.

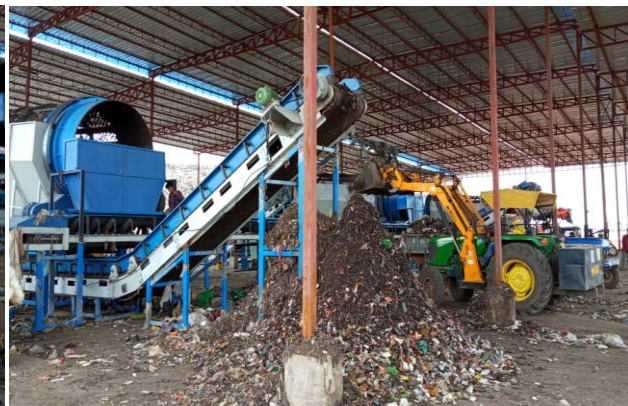
Photographs of installed units are given below:

9.1.10 (a) Compost Plant:





\ (b) RDF Processing unit:



(c) Recyclables/ Material Recovery Facility:



(d) Sanitary Landfill:



(e) Green belt development with internal paved roads:



(f) Other relevant photographs



(g) Bio-mining Facility for legacy waste treatment



9.2 Ambient Air Quality at ISWM facility, Village- Admapur Chhavni, Bhopal

Monitoring location 1- Within plant premises

Monitoring location 2- At plant Boundary main gate

Monitoring location 3- plant upwind at vill. Adampur Chhavni

Monitoring location 4- plant downwind at vill. Kolua Khurd

Date: 23.11.21

Table – 9.2

Sr. No.	Parameter	Unit	Value				Standards (as per NAAQS 2009)
			Location1	Location 2	Location3	Location4	
1	PM ₁₀	µg/m ³	62	65	43	48	100
2	PM _{2.5}	µg/m ³	35	34	22	23	60
3	SO ₂	µg/m ³	40	41	30	28	80
4	NO ₂	µg/m ³	38	40	23	22	80

Note - NAAQS standards values are given for 24 hours weighted average.

Graphical representation of above ambient air quality data is shown below:

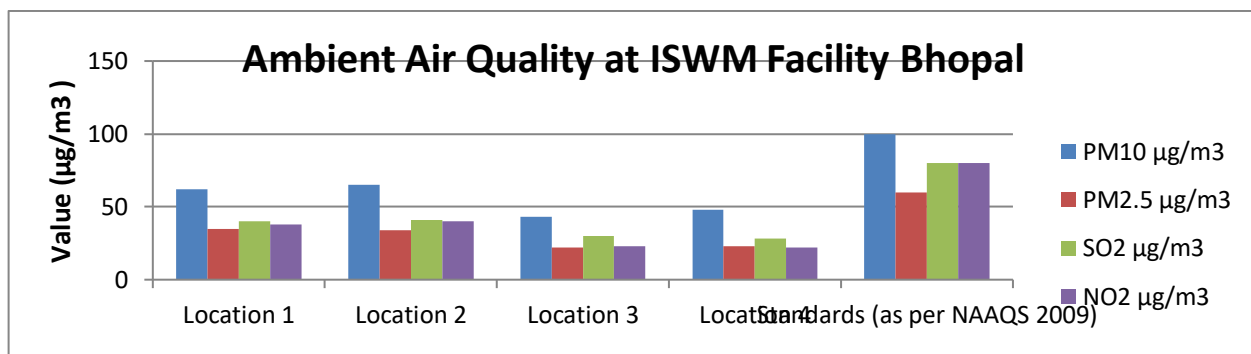


Fig. 9.2 Graph showing Ambient Air Quality at four locations of ISWM Bhopal.

PM₁₀ and PM_{2.5} values in and around ISWM facility Bhopal are found well within the permissible limits as per NAAQS 2009 (i.e. 100 µg/m³ and 60 µg/m³ respectively). Similarly SO₂ and NO₂ are also found within the acceptable range (i.e. 80 µg/m³ and 80 µg/m³ both respectively). This is achieved because of pucca/Cement concrete road construction within plant premises and covered shade for processing/sorting/screening of waste and compost. At the same time proper care and maintenance of vehicles employed is also taken care of regularly which may otherwise deteriorate air quality in the plant vicinity. Apart from that for odour control organic chemicals are sprayed over waste piles/windrows daily.

9.2.1 Surface water Quality near ISWM facility Village- Admapur Chhavni, Bhopal

Sampling location S1 - Ghodapachhad Dam – Class A

Sampling location S2 – Ajnal Dam near Village Sankalpdariya – Class A

Sampling location S3 - Stream near LNCT bridge – Class B

Sampling location S4 – Pond in Village Bilkhiriya Kala- Class C

Date of sampling- 24.11.2021

Table – 9.2.1

Sr. No.	Parameter	Unit	Value				Standards (IS 2296 class A)	Standards (IS 2296 class B)	Standards (IS 2296 class C)	Standards (IS 2296 class D)	Standards (IS 2296 class E)
			Location S1	Location S2	Location S3	Location S4					
1	pH	-	7.2	7.3	7.6	7.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
2	Taste	-	Tasteless	Tasteless	Tasteless	Bitter taste	None	---	---	---	---
3	Odour	-	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	---	---	---	---
4	Colour	Hazen	6	8	35	140	10	300	300	---	---
5	TDS	Mg/l	400	435	660	615	500	---	1500	---	2100
6	DO(min.)	Mg/l	6.3	6.1	5.2	4.0	6	5	4	4	---
7	BOD (3 day at 27 °C)	Mg/l	1.1	1.5	2.8	4.1	2	3	3	---	---
8	Total Coliforms	MPN/100ml	20	40	220	840	50	500	5000	---	---
9	Oil & grease	Mg/l	0	0	0	0	---	---	0.1	0.1	---
10	Total Hardness	Mg/l as CaCO ₃	250	275	280	340	300	---	---	---	---
11	Chlorides	Mg/l as Cl	140	190	210	750	250	---	600	---	600
12	Sulfates	Mg/l as SO ₄	120	135	170	185	400	---	400	---	1000
13	Nitrate	Mg/l as NO ₃	12	16	22	32	20	---	50	---	---
14	Fluorides	Mg/l as F	0.1	0.12	0.12	0.1	1.5	1.5	1.5	---	---
15	Copper	Mg/l as Cu	0	0	0	0	1.5	---	1.5	---	---
16	Iron	Mg/l as Fe	0.1	0.08	0.08	0.03	0.3	---	50	---	---
17	Manganese	Mg/l	0	0	0	0	0.5	---	---	---	---
18	Zinc	Mg/l	2	1.7	1.7	1.1	15	---	15	---	---
19	Boron	Mg/l as B	0	0	0	0	---	---	---	---	2
20	Barium	Mg/l	0	0	0	0	1	---	---	---	---
21	Total Arsenic	Mg/l	0	0	0	0	0.05	0.2	0.2	---	---
22	Mercury	Mg/l	0	0	0	0	0.001	---	---	---	---

23	Lead	Mg/l	0	0	0	0	0.1	---	0.1	---	---
24	Cadmium	Mg/l	0	0	0	0	0.01	---	0.01	---	---
25	Chromium (VI)	Mg/l	0	0	0	0	0.05	0.05	0.05	---	---

Note- Class A surface water source may be utilized for drinking water source without conventional treatment but after disinfection.

Class B surface water source is acceptable for outdoor bathing.

Class C surface water may be used as source for drinking water with conventional treatment followed by disinfection.

Class D surface water may be utilized as a water source for fish culture and wildlife propagation.

Class E surface water may be fit for irrigation, industrial cooling, and controlled waste disposal.

9.2.2 Ground Water Quality near ISWM facility Village- Admapur Chhavni, Bhopal

Sampling location G1 - Borewell in the plant premises.

Sampling location G2 - Borewell in the Vill Kolua Khurd

Sampling location G3 - Borewell in the Vill Adampur Chhavni

Sampling location G4 - Borewell in the Vill Bilkhiriya kalan

Date of sampling – 24.11.2021

Table – 9.2.2

Sr. No.	Parameter	Unit	Value				Standards (as per IS 10500)
			Location G1	Location G2	Location G3	Location G4	
1	pH	-	7.1	7.2	7.2	7.3	6.5-8.5
2	Color	Hazen	2	1.5	1.3	1.3	5
3	Odour	-	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
4	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Turbidity	NTU	1	1.2	1.5	1.4	5
6	TDS	Mg/l	240	225	250	230	500
7	Alkalinity	Mg/l as CaCO ₃	95	90	92	105	200
8	Hardness	Mg/l as CaCO ₃	130	122	125	110	300
9	Total Coliforms	MPN/100 ml	0	0	0	0	0 (Nil)
10	Chlorides	Mg/l as Cl	140	150	155	135	250
11	Sulfates	Mg/l as SO ₄	105	95	98	92	200
12	Nitrate	Mg/l as NO ₃	10	12	17	15	45
13	Fluoride	Mg/l as F	0.15	0.18	0.18	0.19	1
14	Calcium	Mg/l as Ca	45	38	33	39	75
15	Copper	Mg/l as Cu	0	0	0	0	0.05
16	Iron	Mg/l as Fe	0.12	0.09	0.08	0.08	0.3
17	Manganese	Mg/l	0	0	0	0	0.1

18	Zinc	Mg/l as Zn	0.3	0.3	0.3	0.3	5
19	Boron	Mg/l as B	0	0	0	0	1
20	Aluminum	Mg/l as Al	0	0	0	0	0.03
21	Total Arsenic	Mg/l as As	0	0	0	0	0.05
22	Mercury	Mg/l as Hg	0	0	0	0	0.001
23	Lead	Mg/l as Pb	0	0	0	0	0.05
24	Cadmium	Mg/l as Cd	0	0	0	0	0.01
25	Chromium	Mg/l as Cr	0	0	0	0	0.05

The surface water quality as well as ground water quality was found well within the standards. Now no sign was found that any water body & underground water was found contaminated during studies.

Conclusion

The MSW management in the state is not on the priority of the local bodies at present. The waste collected from the community dust bins and road sweeping is transported and dumped on the outskirts if the town is considered as its management. The availability of the waste land in the out-skirts facilitates the unscientific method of disposal. The environmental impact factor is being ignored.

According the current legislative provisions, every local body required to obtain authorization under the Municipal Solid Waste (Management and handling) Rules, 2000 from the State Pollution Control Board. The prior environmental clearance is also required under Environmental clearance is also required under Environmental Impact Assessment Notification, 2006 for the development of the new disposal sites. Through introducing the provision of making improvement in the existing landfill site, the ministry of Environment & Forest envisaged to give some lead time to the local bodies before they set up full-fledged MSW disposal facilities. By improving the existing dumpsite and operating it, as per the provisions of the rules, the concerned personnel at the local bodies would also get insight of operation and maintenance of land facility. This provision will also enable the local bodies to comply with the rules even during the selection and development of new scientific facilities.

In fact, the selection of any new site for the development of a waste management facility is very difficult and it is a multi disciplinary issue and involves various environmental, economic and community aspects. The logical algorithm perceived was followed before earmarking a full-fledged waste management facility.

The analysis result of the surface water quality and ground water quality indicates that is a no contamination of water bodies. The presence of the coliform and faecal coliform is a direct indication of the pollution. After details studies no contamination was found therefore presently all water sources near by landfill site is fit for use after primary treatment ,

Monitoring result for the assessment of suitability of the existing landfill sites are classified within the desirable limits as specified in Municipal Solid Waste Management Rules 2016 .