

# BIO-MINING OF OLD WASTE-DUMPS

Mrs Almitra H Patel, Member Supreme Court Committee for SWM  
50 Kothnur, Bagalur Road, Bangalore 560077 . Cell: 98443 02914  
[almitrapatel@rediffmail.com](mailto:almitrapatel@rediffmail.com), [www.almitrapatel.com](http://www.almitrapatel.com) March 2016

**ABSTRACT:** India has pioneered a very simple, low-tech, low-cost, quick and eco-friendly method of remediating old open waste dumps to permanently achieve near-zero emission of landfill gases and leachate. Loosened layers of old waste are sprayed with composting bio-cultures and then formed into conventional aerobic wind-rows above-ground, on-site. The waste is thus sterilized, stabilized and its volume is minimized. This eco-friendly on-site treatment above ground, called “bio-mining” of old waste, is described below with examples and costs, explaining its financial and environmental advantages over conventional capping of unlined waste heaps. It is now a decade-old well-accepted technology.

## HISTORY OF LANDFILL CLOSURE

Worldwide, open dumps initially were covered with a layer of soil or capped (with a waterproof cover and gas extraction systems) to prevent contamination of groundwater and air. When it was found that such covered waste dumps, though protected from percolating rain or snow, still generated polluting leachate internally by anaerobic decomposition of the covered waste, new landfills began to be lined at the bottom and sides also, and later covered with an impervious cap, to form “dry tombs”. Since even these may leak after 30 years, the EU has now banned all below-ground landfills, is prohibiting landfilling of organic matter which can self-generate any leachate and methane during anaerobic decomposition, and is going for above-ground composting of food wastes instead. India banned landfilling of organics in 2000!

India has wisely learnt from this historical sequence and has very progressive laws, which require “**appropriate biological processing for stabilization of wastes**”, whether subsequently used or sold as compost or not. Landfilling is restricted to non-biodegradable inert wastes or pre- and post-processing rejects. Closed landfill sites can be considered for human habitation only after fifteen years of post-closure monitoring.

India’s innovative approach to closure of old waste dumps by garbage bio-mining eliminates leachate and landfill gases by shaving off old waste from the top down, or from one side in cliffs, and forming the loosened waste into bio-treated aerobic windrows for almost total recovery of waste. This has many win-win benefits, described below, to:

- \* Increase available post-closure area for a new scientific landfill or alternate use.
- \* Achieve near-zero emissions of methane and leachate.
- \* Clear the site of old waste at less than one-tenth the cost of conventional capping and totally avoid the high annual costs of landfill management, leachate treatment and gas monitoring.

\* Drastically minimize the volume of old waste needing permanent burial and the requirement of scarce land for this.

\* Recycle both organics and buried recyclables. Organics become converted to soil-enriching bio-earth.

\* Achieve all this in one year or less, compared to 30-year closure management of old landfills. Site clearance by bio-mining can commence at many points simultaneously if closure is very urgent.

\* Avoid the insurance costs and potential liabilities for explosion-prone capped sites

\* Leave no pollution problems or environmental time-bombs for future generations.

Table 1 below lists, yearwise, thirteen sites already bio-remediated to date, two planned, with site-wise details and cost comparisons with the exorbitant option of capping (at Gorai, No 9):

**Table 1. Open Dumps Bio-remediated By Bio-mining, May 2010:**

	Year	Location	Area cleared, hectare	Waste Height meters	Time taken, months	Total cost, Rs. millions	Cost per cubic meter, Rs	Final use
1	1997-98	Hyd, Yusufguda	2 ha	3	3.M	0.70	Rs 12	Public garden
2	2002-03	Nasik	11.6	5 mtr	3 mo	6.4 mn	Rs 15	Stadium
3	2003-04	Madurai	12	2 mtr	1 mo	0.75 mn	Rs 3	Vegetables + Fodder Grass
4	2003-04	Mumbai, Gorai	1	10mtr	3 mo	1.0 mn	Rs 16	Creation of extra landfill space
5	2003-04	Hyderabad, Autonagar	3	20mtr	2 yrs	NIL	NIL	Garbage overflow on forest land removed
6	2007	Hyderabad	19	20 mtr	< 5 yrs	NIL	NIL	Agreement signed EPTRI Phani kr gandamguda
7	2006	Pune demo,	1	10 mtr	NA	NIL	NIL	For waste dumping
8	2007	Pune	N A	15 mtr	< 5 yrs	NIL	NIL	Agreement signed
9	2007	Gorai Capping	<b>16</b>	<b>17</b> mtr	<b>24</b> mo from April 2007	<b>Rs430</b> mil annual operating costs for 30 yrs	<b>Rs 210</b> excl leachate transport & treatmt offsite	No Pollution-abatement, no gas capture. Mumbai Corp repaid Rs 15cr advance Carbon Credits recd. Land-grab move
10	2008-09	Faridabad:Dabva near Grain mkt	3.00	2.5	4	2.4	32	Public utility garden
		milk dairy site	2.00	4.0	4	2.8	35	Hanjer Rs 260/t Housing Project planned
11	2009-10	Nagpur: Bhandewadi	8.00	12	8	45.00	48	GEPIL cleared for Hanjer's MSW plant
12	2008-09	Alappuzha: Kavaloor	2	3	6	2.5	33	3a cleared by APTDC and HydroAir for MSW platform run by
13	2008-09	Kanpur:, Panki	14	3	9	4.2	30	20ft x 34 ha 6m 3.5 cr
14	2009-10	Bharatpur	2	2	4	1.0	25	Setting up of MSW processing facility
15	2010-11	Amritsar Bhagatwalansite	10	5	1Yr	28.50	57	Setting up of MSW processing facility. Rs

		Agreemt signed						260/t
16	2010-11	Pondicherry, Karuvadikuppam STP, nr runway, Agrmt signed	16a	Avg 2	2 yrs	NIL	NIL	Sewage grass farm
17	2014	Raichur	35 a	2.5	11 m			CASHUTEC bearing all capital + operation cost
18	2015	Kumbakonam	6.5 a	1.5	8 mths			Rs 300/cu.m for 1.3 lac cu. m paid every 5000 cu. m.
19	2015	Pahalgam	2 a	3	6 mths			Cost-plus paymt
20	2016	Bidar	22 a	2.5 m	6 mths			Nirmiti Kendra mgt, starting May 2016
21	2016	Kalyan- Dombivli	15 a	22 m	24 m			Rs 200/cu m starting May 2016

## NASIK

The first well-documented bio-mining experiment was in 2002-03 at Panchvati in Nasik city, where a 28 acre site under average 4-7 meters depth of garbage was engulfed by the expanding city and the dumping of 260 tons per day over a twelve-year period needed to stop. The site was cleared of all old waste in just 120 days by a Bombay firm at a cost of Rs 6.4 million. Garbage was loosened by tractor-cultivator in six-inch layers and bulky waste removed by hand. Then the old rotted garbage (quite smelly) was sprayed with another Bombay firm's Bio-sanitiser (for almost instant odour control and no nuisance to neighbours) plus their composting bioculture which then cost Rs 28 per kg and was used at an application rate of 250 grams per cubic meter of old waste. Using a JCB (front-end loader), the loosened old waste (picked over by ragpickers for recyclables) was heaped into 2-meter-high aerobic wind-rows which were turned weekly, just as for fresh garbage windrows. This was the major cost element and the result was the same as with fresh waste: high heap temperatures attained in 2-3 days, and visible volume reduction within a week. This high reactivity of old waste seems surprising but should not be, since anaerobic landfills are known to retain their biological activity over a 15 to 25 year period, releasing measurable quantities of landfill gases in the process.

At Nasik, the soil below the old waste was excavated upto a depth of 1 meter and found to be mostly silt. So the site was closed after levelling it to a height of 1 meter above surrounding ground level to keep out flood-water, and observed for a year. Strong growth of natural vegetation on the site confirmed that there were no remaining gases or underground heat of reaction, which normally kills off the roots of plants. (Normally, nothing grows on untreated uncovered dumps, however old they are). Soon thereafter, a temporary tent-camp was erected on the site for over 100,000 pilgrims to a once-in-twelve-years festival, with no ill effects or odour. Then an outdoor stadium was constructed over the well-settled site and there have been no problems whatsoever till date (2010).

## **MADURAI**

Next in 2003-04 , the same firm cleared a 30-acre city dumpsite at Avaniapuram, Madurai. Old waste here was at an average height of 2 meters, and was cleared to ground level within one month, by similar bio-treatment and windrowing. The clearing cost of Rs 7-800,000 was borne by the firm which was to be allotted a compost-plant site at that location, which did not materialise. Currently the site is used to grow flourishing vegetables like egg-plant (brinjals). Incidentally, an uncultivated brinjal used for medicinal purposes is found to naturally thrive upon uncleared old waste at Nagpur, and could be usefully and economically used as pioneer vegetation to colonise freshly cleared waste dumps.

## **MUMBAI (BOMBAY)**

A third project was in Mumbai, at Gorai, where waste dumping began many years ago in marshy land just beside a wide tidal creek. Here in 2003-04, the BMP (Bombay Municipal Corporation) paid Rs 1 million for a pilot project to clear down to ground level, one hectare of land under about 10 meters of old waste. This was done within budget in just 3 months, by a firm with compost-plant experience, again using the same biocultures, leaving a considerable amount of “bio-earth” soil conditioner for the city to use in its parks and gardens. Here too, despite the close proximity of multistory buildings which had sprung up adjacent to the Gorai dumping ground, there was no complaint of nuisance during the bio-mining operation.

This extremely quick and eco-friendly technology could have cleared the entire 17-hectare site (upto 33 meters high) to 3 meters above ground level for a cost-effective Rs 50 million at most and no off-site movement of solids or liquids. Instead, BMP engaged at a cost of Rs 170 million a quasi-Government consultancy firm which is now earning itself a bad name countrywide for its over-costly, unproven and unviable waste-management advice (see Capping Disasters at Mumbai below). Based on their recommendations, BMP awarded a tender to cap the site to a 1-in-3 slope and a 30-meter-high top of only 6.3 usable hectares instead of 17 hectares! The awarded cost of Rs 370 million excludes the cost of transporting and treating leachate at distant sewage-treatment plants not designed for such high levels of BOD, COD and contaminants, and the horrendous environmental consequences explained below.

## **HYDERABAD**

The same year, 2003-04, an almost identical project was begun in Hyderabad by a compost-marketing entrepreneur, though both parties came to know of the others’ activities only through my site visits. The firm began clearing the fringes of a huge hill of old garbage at Autonagar which received 800 tons a day of waste for decades, and in 2007 signed a five-year contract with the Municipal Corporation of Hyderabad for “bio-mining” the entire 47-acre site on no-payment-either-side basis. Excavating the waste in vertical layers from a garbage ‘cliff’, and using their own biocultures on aerobic windrows along with upto 25% of fresh garbage, their bio-mining costs are covered by enriching, blending and selling the recovered organics as a compost much appreciated by farmers and flower nurseries.

## **PUNE**

The Hyderabad firm, after a year-long demonstration and product test-marketing in nearby farmlands, signed a similar long-term contract in 2007 with Pune Municipal Corporation for no-payment-either-side levelling of their extensive hill of garbage at Urali-Devachi within five years. They have applied for renewal of the lease.

## **FUTURE PROJECTS**

Convinced by the tremendous proven benefits of bio-mining old waste dumps, the Government of India through its JNN Urban Renewal Mission cleared funding for similar landfill bio-remediation projects at Chennai, Madurai, Kochi and Faridabad, with more to follow. The technology is no longer experimental, but mainstream now.

## **CARBON CREDITS**

Historically, landfill-gas capture has been tried in fully bottom-and-side-lined and capped landfills. To date, at best only 55% of the landfill gas from these gets extracted for flaring or for power generation, with the rest leaking slowly into the atmosphere or causing landfill explosions.

Electricity from extracted landfill gas is everywhere financially unviable and has always needed Govt subsidy even in the US, given for environmental reasons. Since landfill-gas capture has been adopted at several locations now, the calculations for earning Carbon Credits from such reduction of methane release are well established. Calculations extend at most from 15 to 25 years, ignoring the fact that gases continue to be released to the atmosphere thereafter in annually decreasing amounts, after extraction even for flaring is abandoned.

Bio-mining or bio-remediation of waste dumps to produce ZERO emissions and ZERO leachate by totally recovering and recycling all the waste from the levelled site, leaves only limited inerts and no problems for future generations, with maximum recovery of usable space. This is a recent cost-effective technology fine-tuned in a hitherto developing country and it has not been tried in the West yet, where use of bio-cultures for composting is uncommon. So the initial investment, time and effort needed to make this very eco-friendly option eligible for Carbon Credits has not yet been undertaken by any of the firms who have developed and used the technique so far, though the potential fiscal benefits could exceed those from the landfill-gas-capture route.

It is now necessary for all the biomining operators along with the Govt of India to take the lead in ensuring that this fully well-proven bio-mining option becomes eligible for Carbon Credits, which is what is driving disastrous decisions like capping and cosmetic gas-tapping of the creek-side Gorai dump, where waste piled above an old quarry continues to be waterlogged to a depth of 12 meters..

More importantly, should carbon credits be earned at the cost of public safety, as BMP seeks to do at Gorai?

## **CAPPING DISASTERS AT MUMBAI**

### **Waterlogging of the waste**

The purpose of “capping” the existing 17-hectare dump at Gorai, upto 33 meters high, is presumably to keep out water, which accelerates decomposition and methane production, and produces leachate which permanently contaminates the groundwater. Capping is a common technology, but not where garbage is bounded on one side by a tidal creek, daily lapping against the garbage heap. It is like laying a large sheet of plastic over wet sea-sand on a beach to keep the area below it dry. Of course water finds its own level, so sand beneath the plastic will remain as wet as the sea-sand around it.

That is the problem at Gorai. The bottom of the garbage heap is in some places several meters below creek level, so moisture will continuously rise up into the garbage hillock. This permanently waterlogged base of the garbage hill will accelerate methane generation and leakage from the unlined side walls.

### **Curtain wall**

The capping plan aimed to keep water out of the heap by erecting, only on the creek side, a waterproof barrier wall of pre-cast concrete slabs going 7-8 meters down into the garbage. Since there will be massive settlement over time (especially if the intention is to extract methane for flaring or for power-generation), there will naturally be movement of the slabs and opening of the joints between them, letting in creek water and defeating the purpose. Even before that there will be water entry, because the capping contractor’s deepest (43 meter) geotechnical test bore went only upto “completely weathered rock” which is quite porous, and stopped drilling 11 meters below ground level, before finding out where bedrock is found. Keeping water out and gases in would require a deep wall around the entire garbage hillock, going right down to hard bedrock, and even that would not guarantee that there will be no leakage. Constructing such a wall is technically very difficult and needlessly wasteful of time and money. Bio-mining, instead, removes the problem instead of hiding it.

### **Fire and flies**

Work began at Gorai in late April 2007, using excavators to move waste around and level the 33-meter-high top to a uniform 30 meter height and to shape the steep sides to a one-in-three slope. Within a week of commencement, this opening-up of the heap released large quantities of methane which fed huge continuous fires and smoke. Fire-brigade efforts to douse the flames with copious water in fact aggravated the problem and generated more uncollected methane by introducing water deep into the airless mass which one wants to keep dry, apart from generating more leachate to pollute the groundwater. This vicious cycle of methane – fire – water-dousing – more methane – and - leachate will persist daily unless there is a change in practices. Instead, if

the topmost garbage had been levelled and removed by ‘bio-mining’ as described above, there would have been no generation of methane or leachate and no fires.

### **Landfill Capping Risks Exposed at Mumbai**

The MSW Rules, poorly enforced, state that “Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis comply with the specified standards.” Germany, Holland, Turkey and elsewhere have experienced the catastrophic consequences of building upon or very near to old landfills, even those closed in a state-of-the-art manner. Now India has its own horror story to add to this list.

The press in March 2007 exposed the disastrous consequences for the IT industry of a premier Mumbai builders’ flaunting of the MSW Rules, with official apathy, to construct the pricey Mindspace complex on a former dumpsite at Malad. All electronic equipment has been failing with such regularity, due to corrosive landfill gases in the atmosphere, that Annual Maintenance Contracts are unobtainable. Residents are moving away because of almost monthly failures of their air-conditioners, washing-machines, electric irons or mixers. Human health effects have also been highlighted. So it is clear that “capping” the Gorai dump, which is so very near to residences, will merely convert it to an environmental time-bomb for them in a few years, for which no-one will later take responsibility, as at Malad.

It would have been far better to remove the root of the problem by converting all the waste to a useful bio-earth via bio-mining. This can still be done, though at a needlessly huge cost of removing the soil and plastic cover.

### **Monitoring**

Despite the recent shocking Mindspace experience at Malad, there has been no move by the State Pollution Control Board to monitor air, soil and water quality at Malad or at any other waste dumps in Mumbai or Maharashtra State, although six-monthly monitoring by them is mandatory. They are evading this responsibility Statewide by claiming that open dumps are not “disposal facilities”, though that has been India’s only disposal method since Independence and even in 2010 in 94% of our 4378 urban Local Bodies. At Mumbai, they are not even monitoring the leachate brought to sewage treatment plants not designed for it, nor the ecological damage of releasing inadequately-treated leachate into the sea.

### **Energy and pollution costs of capping waste**

Bio-mining requires one-time energy (diesel) for four weekly turnings of waste in aerobic wind-rows, which is then stabilized and releases no leachate, just like a sun-dried tomato. Capping makes the whole hillock anaerobic, so that all the waste in it will liquefy like a rotten tomato inside a plastic bag. All this leachate will eventually find its way into groundwater through the unlined bottom and sides of Gorai’s garbage hill. So far, all this was oozing into the creek and getting washed away by daily tides. Instead of standard leachate capture and treatment,

the promoters, over 15 years of site maintenance, plan to collect and send the leachate in tankers to Mumbai's existing municipal sewage treatment plants and "pay for its treatment". These are already massively overburdened by increasing population and wastewater release, and mainly dispose of the city's liquid waste by sending it through ever-longer pipes into the sea. What will happen when leachate which has already "killed" the Gorai creek, is now let out through pipes to distant new areas? Which unfortunate fishermen, near which sewage outfall in the sea, will have to bear the brunt of the discharge of concentrated 15,000-plus-BOD leachate compared to the 250-BOD average concentration of sewage? Which Mumbaikars will get sick eating fish exposed to such leachate discharges? This will happen regardless of whether the promoters construct a leachate-treatment plant near Gorai, or add to Mumbai's daily traffic congestion and vehicular pollution load by shipping it elsewhere. It is far better to Prevent leachate formation through bio-mining instead.

### **Methane Generation**

Flaring of methane and monitoring it is costlier than permanently avoiding its generation through bio-mining. All "waste-to-energy" plants are heavily subsidised in the US and elsewhere, all eventually at public expense. So as methane production gradually tapers off over time, the production of energy is no longer worthwhile and is abandoned after a few years, leaving the methane to be flared, and later released to the atmosphere when levels fall below that needed to feed a flame. It is far better instead to Prevent methane generation altogether through useful conversion and removal of all the waste through bio-mining.

### **Capping Failure and Explosion**

As waste decomposes, even under a capping, its volume decreases and the heap settles, leaving a dangerous vacant pocket near the top. A leading waste-management journal<sup>3</sup> (Waste Management World) quotes experts as saying that "a landfill's top cover and leachate collection system will 'undoubtedly' fail. The malfunctioning of the leachate collection system (such as due to clogging) will cause the site to overflow; this would allow fluids to infiltrate and trigger a 'second wave of landfill gas generation' which could blow out the cover". Another expert claims "all liners will fail no matter how well constructed they are". That is why "Europe is phasing out organics as required by the Landfill directive, while some Member States have even banned biodegradable waste from landfill completely". Even US experts are quoted as saying what India has wisely mandated in 2000: 'If organics are separated for composting, then we can convert a problem into a solution by restoring fertility to our depleted soils.'

### **Pollution Risks and Insurance**

The same article points out that most US regulations "do not require landfills to have assured mechanisms for post-closure funding for monitoring, maintenance and pollution clean-up, 'for as long as the wastes in the landfill will be a threat to cause groundwater pollution'. Therefore the current minimum 30-year post-closure funding period is insufficient ...this is especially a problem for privately developed landfills, where the ability of private companies to provide funding, 'effectively forever', is of concern." They also point out that "since 1996 the Netherlands has mandated 'eternal' after-care" after capping. Since Mumbai's landfill operator



has a Dutch technical partner, its citizens need to inquire, in their own interest, whether “eternal aftercare” liability and insurance and disaster-management provisions have been built into the contract terms for Gorai. It is in the Government’s long-term interest to make public, on its website or by other means, the complete terms and responsibilities of the persons assigned the present and future care of the Gorai landfill closure. The public today are very well informed and can bring improved solutions to the attention of the Government.

### **Bio-mining as a Safe Alternative to Capping**

Given all the advantages listed above, it is not too late for the BMP and State Govt, to abandon all thought of capping Deonar and other open dumps and adopt bio-mining instead. Hopefully within a year some progressive Carbon Credit trader may complete the arithmetic and paperwork for claiming global Carbon Credits via the eco-friendly bio-mining route, based on the Total Avoidance of potential methane generation from the entire volumes of waste in landfills which will be stabilized by bio-mining. The Central Govt, Maharashtra State and Mumbai civic authorities should go all out to help speed up this process of accreditation, based on the same data and assumptions used for carbon credits via capping. All that is needed is political support for this progressive alternative.

**Key words:** Bio-mining, landfill closure, waste recovery, aerobic windrows, leachate, carbon credits.

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#### References:

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- 3, Waste Management World, March-April 2007, page 94-100 :  
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