



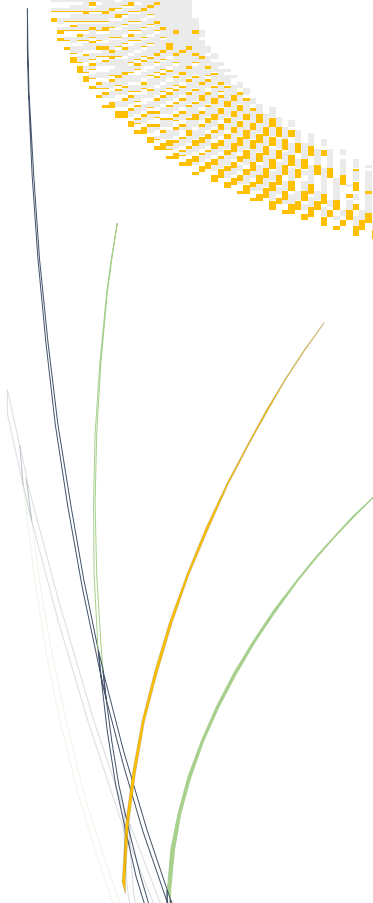
# SWACHH BHARAT



***A STEP-BY-STEP MANUAL TO CHANGE OUR HABITS AND CLEAN OUR HABITATS***



एक कदम स्वच्छता की ओर



**Dear Reader**

**Welcome to ways in which we can clean our country together and keep it clean for our children and grandchildren.**

**This is a guidebook for the cleanliness of our 6 lakh villages and 7935 towns.\* All these need Swachh Bharat plans and programs.**

**It provides proven, workable, commonsense and easy solutions to the Solid Waste Management problems faced everywhere.**

This booklet begins with **General Principles** for keeping our surroundings clean. The **Doorstep Collection and Micro planning** sections show how urban spaces can be rapidly cleaned up with just a month or two of effort.

Information follows for villages and the smallest towns, as **the same basic needs and solutions apply to all, big or small.**

Suggestions are added, in each chapter, for larger towns and cities. **So those covered by one chapter should also read all earlier ones.**

**Read through the Index fully first, so you can find what you need. The whole world is moving from waste to resource management. It is our resourcefulness that is going to make a difference and ideas do not work, we have to work on them.**

**If we are sincere 'Sach' in our efforts 'Swachh' is just an arm's distance away.** Let us not call our country dirty, just because we have forgotten to clean our glasses. **Happy cleaning.**



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**As per the 2011 census there are 7935 towns in India's 676 districts, of which 4041 are municipalities, corporations, cantonments or have notified area committees to be covered under the 'Swachh Bharat program'.**

**There are also 475 large Urban Agglomerations (of more than one city/ town) plus 981 "Outgrowths" of over 20,000 population like railway colonies, university campuses, port areas or military camps.**

**415 Class 1 Cities of 1 - 10 lakh population generate 30 to 550 TPD of Municipal Solid Waste and have a total population of 104 million which is 28% of our urban population.**

**53 Cities have million-plus populations and a combined population of 161 million (42% of our total urban population). 3 of these are Mega cities of over 10 million population; Greater Mumbai, Delhi and Kolkata.**

**The remaining 3894 are smaller "census towns", usually outside cities, with at least 5000 population and 75% of the male workforce not in agriculture.**

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# CHAPTER 1: GENERAL PRINCIPLES

**1.0 Swachh Bharat Abhiyan or Clean India Mission** for a clean and healthy India is to be our nation's gift to Mahatma Gandhi on his 150<sup>th</sup> birthday, 2<sup>nd</sup> October 2019. We need to have toilets for all, and manage our waste well. '3R's are Reduce waste (by refusing unnecessary packaging etc), Reuse what we can, and Recycle the rest to reduce the water, energy and pollution from making things from virgin materials.

This Guidebook explains practical steps for cleaning up India. It is written for all Stake-holders : the Secretaries and District Magistrates/Deputy Collectors of Central and State Governments, the Commissioners/Chief Officers and Mayors/Presidents and all elected Councillors of our cities and towns and all their staff, Pollution Control officers as well as citizens.

**Our Constitution of India** in Part A 42<sup>nd</sup> Amendment 1976 Article 51A is the only Article which spells out our duty to our country:

**"It shall be the duty of every citizen of India.... (g) to protect and improve the natural environment including forests, lakes, rivers and wildlife and have compassion for living creatures."**

This Guidebook shows us how we can do our duty to protect our environment by eco-friendly waste management. It also explains how to follow the Municipal Solid Waste (Management & Handling) Rules 2000.

## 1.1 UNDERSTANDING WASTE

Waste is unwanted material discarded by each of us. Most of it can be useful and valuable for others. There are two main kinds of waste discarded. Organic Waste from cooked and uncooked food, fruit and flowers are natural products which decompose quickly and are called '**Wet' waste**'. Other manmade or manufactured products which are discarded are called '**Dry' wastes**'. These include plastics, rubber, metal, glass, cloth, paper, and packaging.

If all these different types of discards are **kept unmixed**, each of them can be reused or recycled if they are collected and managed separately and not mixed with each other.

**Mixed waste = Garbage**  
**Unmixed waste = Useful Resources**

## 1.2 RESOURCE RECOVERY

'Wet' waste can be converted to **organic manure** which can make fields more fertile. (Compost standards apply when waste stabilising is followed by sieving and enrichment for sale as compost). Unmixed wet waste can also give biogas for cooking, plus slurry which is also a useful fertilizer. Different methods for processing wet waste are described in detail separately in this guidebook. Garden waste and tree trimmings can be converted to **compost or fuel pellets**.

'Dry' waste can be reused for different purposes, recycled into new products, or used for energy recovery as described in detail below. Some but not all of it is hand-picked out of dustbins and dump-sites because we throw it out mixed with food waste. Mixed waste needs to be spread on the road before waste-pickers can get what they need to feed their families. Such picking, sorting, baling and recycling is done by 1-2% of every city's population.

**If we keep our food waste separate from dry recyclables, all of this can cleanly support all these poorest of the poor, reduce waste volumes needing processing and disposal, and reduce the municipal taxes we pay for waste transport services.**

Some wastes are not easily processed, like e-waste (Electronic waste) which needs special safe recycling. Hazardous waste (Annexure 'A') is bad for the environment if thrown out with general daily waste and needs special safe disposal. So both these need separate collection days, maybe once in 1 to 3 months.

Besides separate collection of 'Wet' and 'Dry' waste, 'sani-waste' also needs to be collected separately and managed as described in Section 1.7.2 below. '**Sani-waste**' is domestic sanitary waste like used disposable sanitary napkins, diapers for babies, invalids or old persons, and used bandages or dressings.

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## 1.3 NO WASTE ON ROADS

Indian homes and workplaces are kept very clean, by rich and poor. But a Clean India means clean streets, lanes and public spaces. For a Swacha Bharat, waste should never touch the streets.

All waste should be collected at the doorstep and go straight from the home, office or shop to a pushcart or other 'primary collection' vehicle and from that,



for longer distances, directly into a waiting larger vehicle for 'secondary transport' to the place where it can be processed or recycled.

This will also keep our streets free of stray dogs searching for food. It will also reduce infectious diseases, as Surat statistics proved before and after the cleanup forced by the 'plague' in 1994.

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#### **1.4 CLEAN FRONTAGES : 'MERA AANGAN SAAF'**

A whole street can be always clean if every person along that street keeps just their own tiny part of it clean every day, like their homes.

All villages, towns and cities can be clean if they pass a resolution that every house, office and shop shall not only keep its inside spaces clean but also its road frontage, footpath and keep any open drain clean alongside their premises. '**Mera Aangan Saaf**' is what the residents of big cities like Chandigarh have done since over 20 years.

In most small villages even today, people voluntarily clean their frontage daily. Urban residents need to do the same. Then only public spaces like parks, gardens and roads without buildings need to be cleaned by public services.

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#### **1.5 WHY DOORSTEP COLLECTION**

All unwanted waste which cannot be managed at home must not be thrown outside onto the road or vacant plots. Keep it for pickup once a day by persons coming to the doorstep. This must be done even on holidays and especially on festival days.

Doorstep collectors should collect 'wet' and 'dry' (recyclable) waste separately in vehicles planned for this. While transporting it, they **MUST NOT MIX WASTE WHICH HAS BEEN GIVEN UNMIXED**. If mixed waste is given, **sort it at the doorstep collection point** (or at the gate of apartments and colonies). Explain and demonstrate the simple sorting process for the first 3 or 4 days.



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#### **1.6 DOORSTEP COLLECTION EXPLAINED**

Doorstep collection of waste is the best way to keep waste off the road, to provide waste pickup services to all and to keep Wet and Dry wastes unmixed. It is most effectively done in pushcarts with four 60-litre bins for wet waste and different large bags for different dry wastes. Four-bin pushcarts have proved

very successful in over 70 large and small towns to date. Their recommended specifications and operation are described in detail in Annexure 'B'.

Doorstep collection really means gate-to-gate collection at the main property entrance and not every door in every floor for every family.

**For ground-floor dwellings,** collection pushcarts move from one entrance to the next one.

**For colleges, office complexes, malls, multistory dwellings, gated communities,** the municipal pushcart collection team is not expected to enter private spaces or to climb several floors and knock at every door on every landing.

**The Building Society, Apartment Manager or Residents Welfare Association** has to provide, from its maintenance budget, cleanliness services and collection of Unmixed Waste within its private areas. Each apartment should keep two bins and a bag for easy pickup or emptying and return. One bin is for wet waste (food-fruit-flower-leaf) and one or more bags are for dry waste (recyclables without house-dust or garden sweepings). A second small bin is for sani-waste (used diapers and sanitary napkins and bandages etc). These three kinds of waste must be separately collected and taken downstairs unmixed to corresponding large bins provided INSIDE the apartment premises, separately for wet waste and sani-waste and bags of dry waste.

**A separate sani-waste bin** is needed for domestic sanitary waste / sani-waste like used sanitary napkins, baby and adult diapers to be taken separately by the collectors for drop-off at the nearest biomedical waste pickup facility.

**These private bins and bags** should be kept inside the main gate or side entrance for pushcart pickup, but in a place where passing public cannot throw in any mixed waste. The private management has to take full responsibility for this and be warned or penalized if waste is mixed. Mixed waste should not be picked up till separated by them on-site.

**For small towns with one or two storied houses,** daily wet-waste collectors stopping at the gate or street door is compulsory. Pushcart teams need not be discouraged from climbing up to one or more flats to pick it up from upstairs if it does not greatly slow down their normal collection duties. This optional private arrangement is usually in exchange for monthly or festival tips, clothes or snacks.

**Collection Targets:** Each municipality should **fix its own doorstep**

**collection target of 250 - 350 households per team** and strictly leave it to the collection teams to use or sell their separated inorganic wastes.

**Sale proceeds from collected wastes** is the team's pocket-money and is not to be factored into or deducted from their salaries. **If collection is outsourced, contractors are not to take away dry waste.** Allowing the doorstep collectors to benefit from segregation automatically promotes doorstep segregation without municipal effort. This should be strongly encouraged because that means huge savings at the waste-processing point and less waste to landfills.

In many towns, the authorized doorstep collectors allow one or two waste-pickers to follow them around, in exchange for a daily fee or spot sale of recyclables, or sometimes using them as free helpers. Do not discourage this voluntary arrangement unless the waste-pickers complain about it.

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## **1.7 COLLECTION FREQUENCY FOR DIFFERENT WASTES**

### **No collection: Manage food waste at home and on-site**

Every average family produces every day less than half a kilo of what it does not need or want. Slums waste much less, hardly 100 gm a day. Rich homes in big cities may throw away 1 kg a day of waste. But less than half of this is kitchen waste, and there is enough space for every home, big or small, to manage this waste at home.

It can be buried daily around a tree to fertilize it. It can be buried in a trench alongside a compound wall in large housing colonies to help the growth of flower borders.

In small apartments, it can be added, a little every day, to 7 or 10 flowerpots, one by one. It can help grow a terrace garden for healthy vegetables. Every one of us can help by not throwing biodegradable 'wet' waste away.

So only non-biodegradable waste needs to leave the home, say once a week.

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### **1.7.1 DAILY COLLECTION**

All waste does not need to be collected daily.

Only biodegradable 'wet' waste which cannot be managed on-site needs to be collected daily. It is good animal feed if collected every 12 hours. After 24 hours it begins to decompose and smell if kept closed without air or in large heaps.

**Wet waste must not be tied in plastic bags!** Clean containers can be washed daily like any cooking-pot. Or use a quarter-newspaper sheet as liner.

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### **1.7.2 'SANI-WASTE'**

Domestic sanitary waste ('sani-waste') like use-and-throw sanitary napkins, baby diapers or diapers for bedridden or older people should be wrapped in newspaper, marked with a cross and given separately to the doorstep collectors who should drop it off at the nearest municipal clinic or hospital or cooperating private hospital for pickup by bio-medical waste collection services where available.

If there is no bio-medical waste service provider, deep burial or autoclaving is allowed.

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### **1.7.3 WEEKLY COLLECTION**

'Dry' recyclables can be collected weekly or at longer intervals as they cause no smell or flies. Just as newspapers are regularly sold or given to charity, not thrown away, if all plastics of all kinds are rinsed and stored in one big plastic bag, they can also be sold or given away to waste-sorters for recycling.

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### **1.7.4 MONTHLY OR QUARTERLY COLLECTION OF SHARPS**

Broken glass should never be thrown away with any other waste, wet or dry, as it can cut and injure waste-collectors and waste-handlers. Quantities are small everywhere and low-value, Re 0.50 – 1.00/kg. So mix it with cement and use it for filling rat-holes made in walls. Or keep it in a tin or flowerpot for separate monthly collection.

Do not discard used razor blades or injection needles along with recyclable 'dry' waste. Store these 'sharps' safely in a tin or bottle and wait for monthly or quarterly days when they can be picked up and given to the nearest hospital for pickup with their biomedical waste.

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### **1.7.5 HAZARDOUS WASTES**

Some wastes are harmful to health and can pollute and spoil the environment if mixed with other waste. These should be stored for collection every 1-3 months: used tube-lights and CFLs (because they contain mercury), paint cans (which have oils and harmful lead, cadmium etc), torch cells, button cells and batteries. cosmetics and hair dyes (which contain lead), oily rags from cleaning vehicles, and many others listed in Annexure 'A'.

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## **1.8 MINIMISE WASTE BY CITY & CITIZENS WORKING TOGETHER**

**Any village, town or city can become litter-free, bin-free, dump-free and almost Zero-waste** if we do not throw it onto the road at any time of day and towns and cities do not dump useless mixed waste outside their boundaries onto village lands.

We must collect unmixed wastes at the doorstep so that every kind of waste becomes a useful resource if transported unmixed to different destinations. This will **Minimise Waste To Landfill**, leaving little for final disposal anywhere.

The Swachh Bharat initiative has come at the right time. We now have the know-why and know-how to manage waste as resources.

**Political and administrative will**, combined with public cooperation, can truly make our country a Swachh Bharat.

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## **1.9 PROVIDING PUNCTUAL DAILY SERVICE IS THE KEY**

Waste collection service must be totally dependable to earn the trust and cooperation of the public. People are willing to cooperate if they can be sure that this service will be daily, totally, unfailingly regular.

**Workers will cooperate to provide dependable services** if they are allowed to develop and maintain a **daily work rhythm** and are paid punctually and fully. Collection-worker discipline, administrative discipline and public discipline need to go hand in hand. One without the others is like a bird without a wing.

**Success depends chiefly on the field waste-collector** (service provider, Public Health worker, PH). Address worker grievances promptly and very fairly and impartially, with respect for their needs, problems and the vital service they provide. Citizens receiving this service must also treat their PH workers with gratitude and respect.

Punctual and dependable service is not costlier than neglect, which requires mass cleanup and costlier processing before disposal.

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## **1.10 MICRO-PLANNING LEADS TO PROMPT SERVICE**

**Attention to detail** is most important while planning for cleanliness.

**100% coverage of all households / units needs a two-person team** of PH workers with a push-cart covering a daily compact route. It needs enough backup workers to ensure unfailing reliability. See 1.12 below for key steps.

**Micro-planning is necessary in the smallest towns and also in the largest metro cities.** It brings in job clarity and fixed responsibility. Supervisors must become effective Route Managers.

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### **1.11 ADVANCE PLANNING IS VITAL FOR SUCCESS:**

- Decision-making by Council and leadership support
- Collect and analyse wardwise data
- Estimate manpower and material needs
- Estimate costs and budgets for one-time and recurring expenses
- Mobilise funds including from sponsors
- Procure and provide materials, pushcarts and vehicles
- Train manpower for field, supervisory and executive staff and elected reps
- Design and prepare materials and activities for community awareness
- Find locations for decentralized Wardwise management of 'Wet' waste
- Tie up with Farm Producer Organisations (FPOs) for supply of compost
- Tie up buyers for 'Dry' wastes
- Arrange EPR (Extended Producer Responsibility) for no-value wastes
- Plan separately for construction and demolition (C&D) waste and debris
- Plan for disposal of hazardous and special wastes

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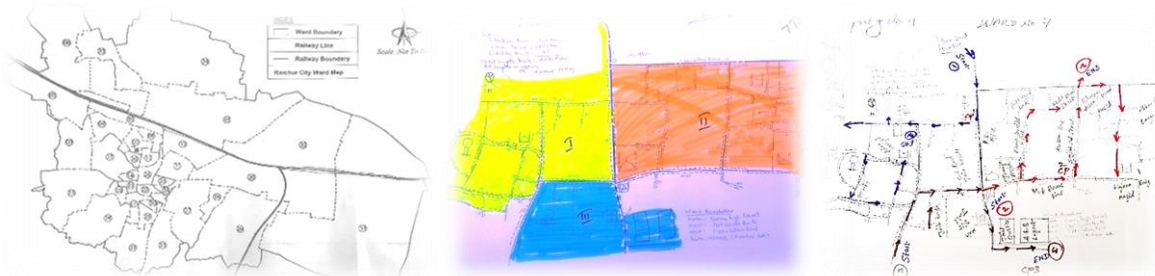
### **1.12 KEY STEPS TO IMPLEMENT 100% DOORSTEP COLLECTION IN MICRO-POCKETS IN SMALLEST TO LARGEST URBAN AREAS**

**A, Subdivide every Ward**, from Nagar Panchayats to the largest cities, **into compact areas or micro-pockets** which can be covered by one daily route for upto 350 households/units per 2-person team, using existing manpower.

**B, Two persons** should be allocated per daily-collection route. They should not be changed frequently and should never be deputed for any other work.

**C, Use Election Ward Maps** on which local mukadams or field supervisors, working now as Route Managers, can plan the direction, timing and number of trips (maximum three) to complete the coverage of their 350 doorstep pickups.

**D, Route :** For every collection trip, define and indicate on a micro-pocket map, with landmarks the **starting, ending and transfer (unloading) points** for every individual collection route and arrow marks for direction of pushcart movement. End points may be the same as starting points for convenience.



**E, Timings :** Estimated pushcart start time, average trip time and punctual break times (say 30 minutes about two hours after starting) and end times must be fixed and strictly enforced.

**F, Pushcart Design:** Pushcarts must be easy to use and maintenance free. (See Annexure B for the most successful design recommended). It should have 4 unbreakable 60-litre plastic bins for wet (food) waste.

**G, Unloading :** After every trip, pushcarts will keep their full bins of Wet waste at a pickup point and exchange them for empty bins to use for their second trip.

**H, Waste Transfer:** Ward Sanitary Inspectors must carefully do **one-time planning of timings and routes** for pickup of the full wet-waste bins from the 3-4 pickup points within their Ward. Tractors with two loaders are preferred pickup vehicles to load the full bins into their trailers and drive them to the decentralized wet-waste management point within the Ward. Fixed-body goods autos or trucks may be used in larger towns. In the largest towns, bins may be emptied into tipper trucks. But everywhere, **MATCH THE TIMINGS OF PICK-UP TRUCKS TO UNLOADING TIMES OF PUSHCARTS** to prevent the bins lying for long at the pickup point.

**I, Plan for maximum one hour** gap between unloading time of full pushcart bins and their pickup by tractors (in small and medium towns) or trucks in large and very large cities. The tractors or trucks after emptying their bins into biogas units or composting stacks (see below) should bring the empty bins back to the pickup points for timely use next day.

**J, See micro-pocket map** and sample time schedule under 1.12.D above as an example.

**K, Bins should be washed** before pushcarts are parked at the end of their last trip, either at the starting/muster point or some convenient location per micro-pocket. If wet waste goes into a biogas unit, this washing-water is also useful for generating gas.

**L, Takeaway bin liners :** In larger metros where distances are larger, bins for wet waste may be provided with takeaway HDPE sack liners which can be unloaded at the pickup points, so that the same bins can be used for the next pushcart trip. The bags after emptying can be rinsed in wash-water which can be usefully used on compost stacks or windrows.

**M, Sale of collected items:** At the end of the pickup service, workers will either take their different kinds of dry waste to waste-buyers (kabadiwalas) for sale or the waste-buyers will come to the pushcarts. This incentive to the pushcart workers effectively reduces absenteeism and motivates punctual daily separated collection. Prices range from Rs 25/kg for PET and Rs 15/kg for milk sachets down to Rs 5-6/kg for other plastics.

**N, Low-value or no-value packaging** like mixed carry-bags (Rs 2-3/kg) metallised multifilm snackfood sachets (no value) or thermocole (EPS Expanded Polystyrene) for which transport to recyclers is too costly, needs to be shredded and used in “plastic roads” or taken back or managed by the supplier of such unwanted waste as their Extended Producer Responsibility (EPR) required in the Plastic Wastes (Mgt & handling) Rules 2011. See Section 5.3 below.

**O, Share Auction proceeds :** Income from composted organics (Rs 2-3/kg) should be shared by all field level and supervisory level staff with some portion to the tractor / truck drivers and Public Health workers. This nicely keeps inorganic dry waste out of the wet waste.

**P, Remove old street dustbins** and also clean traditional dirty locations ('black spots') a day or two after doorstep collection has begun. Clean that area well, decorate the spot with rangoli / kolam designs in chalk powder and keep one or more potted plants in the centre. Public will not dirty a clean place.

**Q, Mass cleaning** of an area just after doorstep collection is started, makes a very good impression and helps the public continue to cooperate with doorstep collection. Do this only with Reserve Teams without disturbing regularity of doorstep services. Remove old piles of debris and construction material which tempt the public to dump mixed garbage onto it. Clear weeds and bushes into which garbage is often thrown.

**R, Commercial Areas :** Plan special timings for streets with shops and offices after discussing their preferred pickup timings, say 9am and 8pm. Strictly disallow and after warnings penalize throwing of any waste outside their premises. Pickup of trade waste and cost of an evening pickup trip may be charged on cost basis as part of their cost of doing business in the town or city.

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### **1.13 DO NOT DISTURB WASTE-COLLECTION SERVICES**

Allot 2 persons per push-cart to cover about 350 homes (in areas of average density) during 5 morning hours and collect unmixed waste.

If mixed waste is given initially, separate and sort it at the doorstep, explaining what should go where, and why. Collect a token daily penalty of one rupee for repeated non-cooperation.

The same doorstep collection team should preferably clean their stretch of streets in the afternoon. Then they generally keep it clean and daily sweeping of every meter of road or lane may not be needed. This will save the cost of a separate sweeping team which results in blaming of others for unclean streets.

**Doorstep collection teams should not be diverted** to any other general work. That is preferably done by separate Reserve Teams.

But Reserve Team members (see 1.15 below) can be utilized for doorstep collection which is an absolutely vital function which must never be interrupted.

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### **1.14 PROVIDE FOR ABSENTEEISM**

Keep 5% extra staff for absenteeism. If each person needs one holiday every 7 days, in theory one needs 8 persons for 7 jobs, that is 15% extra persons. But once the collection workers are allowed to keep and sell their dry waste and start earning well from it, absenteeism comes down drastically as none wish to lose their share of daily sales. This saves funds for the city and taxpayers.

**IMPORTANT: Arrange waste-buyer tie-ups** for waste collectors in advance.

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### **1.15 RESERVE TEAMS FOR SPECIAL TASKS**

Festivals and VIP events must not be allowed to disturb the unfailing punctuality of the regular doorstep collectors, or the public will lose faith and start random dumping which is hard to clean up.

Keep a separate standby team for VIP events and extra festival work. Even if these occur on average for only 5 days in a month, use the reserve force on the other 20 days for mass cleaning especially of debris and drain cleaning and many other tasks to keep the city spotless at all times. Clean areas never attract dirt, only dirty areas become dirtier. The Reserve Teams may occasionally supplement doorstep teams.

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## 1.16 PLAN UNLOADING POINTS FOR COLLECTED WASTE

Ideally, push-carts (primary doorstep-collection vehicles) should unload their bins directly into biogas units or compost stacks or vermi-beds at any decentralized waste-processing point.

If not, the full wet-waste bins need to go into a secondary-transport vehicle and taken to a further unloading and processing point (not an open dump).

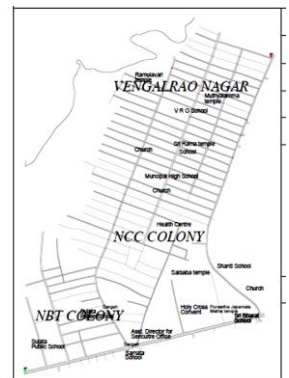
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## 1.17 CAREFULLY MATCHED ROUTE PLANNING IS MOST IMPORTANT

Careful and detailed advance planning is the secret to keeping towns clean by keeping waste off the roads. Well in advance, there must be very detailed planning of how a secondary vehicle like a tractor or lorry, which can collect and transport the bins of say 3-5 pushcart routes, will travel to their 3-5 pick-up points one by one, every day at about the same time. That way, waste bins need not remain at any street-corner for long, and must never remain uncollected the same day.

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## 1.18 ENSURE PUNCTUALITY OF SECONDARY VEHICLES

A tractor or goods lorry must be punctually present every day without fail at the time that push-carts or primary vehicles bring their doorstep-collected waste to the meeting-point, or very soon after that. Push-carts can keep their full bins of wet waste at a pre-decided corner for secondary transport vehicles to pick them up with no more than one hour's time gap between drop-off and pick-up.

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## 1.19 KEEP SPARE VEHICLES

There must always be one or two spare vehicles available to step in if there are breakdowns. These can be the town's own vehicles or hired vehicles which can be 100% depended on to be immediately available when needed. But carefully track breakdowns to avoid deliberate vehicle-hiring scams.

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## **1.20 MAINTENANCE-FREE NON-MOTORISED VEHICLES ARE BEST**

Double-handled pushcarts have everywhere proved to be the best possible option to help hang bags for doorstep-sorting of Dry wastes. The most user-friendly design for Indian road conditions is a pushcart with two fixed wheels at the front and one single fully-rotating guide wheel at the back (near the handle) for easy turning. See Annexure B.

For durability (12-18 months), top quality wheels are the most important. They should have heavy duty steel rims with solid nylon rubber tyres on a 25mm rod axle and a heavy duty bracket for the fully rotating wheel with double ball-bearings. The pushcart frame can be of 25 x 25 x 2.5mm square pipe, with handles of 25mm dia medium class MS pipe. Bins should be of unbreakable plastic, 60-80 litres capacity for ease of lifting and loading. See Chapter 8 Learnings from Failures.” Procure one proven design, then carefully copy it locally if required without compromising on wheel quality.

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## **1.21 AVOID COMPLICATED AND HIGH MAINTENANCE VEHICLES**

It is impossible to stock and maintain spares for every part that is not readily available, especially for imported vehicles or different local models. This leads to long repair times which breaks the daily collection routine and also breaks the trust and faith of the public in the town's services and officers.

All secondary vehicles like tractors or trucks should preferably be of maximum two makes or models so that spares are always available.

Except perhaps in metro cities, it is better not to transfer loose waste from pushcarts into secondary transport but to move the filled bins from the pushcarts into secondary vehicles, which need not be tipper-trucks or tipper-tractors. The filled doorstep-collection-bins can be lifted from push-carts or their temporary drop-off points into fixed-body secondary-transport trucks and then manually unloaded at the processing point into bio-methanization hoppers or onto stacks or windrows for composting or into vermi-bins. This modular movement of waste makes handling clean and easy.

If bins are emptied into tipper-vehicles, these only unload onto the ground at the processing-point and so the waste will need slow manual handling, which is unpleasant, unhygienic and leads to absenteeism and waste pile-up which creates daily crises. Mechanical handling is expensive, underutilized, unreliable.

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## **1.22 AVOID TRANSFER STATIONS WITH LONG RAMPS & COMPLEX EQUIPMENT**

Most towns do not need transfer stations because distances to their unloading points are not far away. The largest cities try to save transport costs by moving waste from medium-tonnage secondary vehicles into high-tonnage tertiary vehicles at complicated structures called transfer stations.

These should only be considered for Metro cities (over 10 million population) which have very distant waste-processing points. They are mostly advocated by consultants wishing to impose the costliest solutions.

Transfer stations should not be planned for in 95% of cities because any interruption in their functioning, like power cuts or breakdowns of large stationary compactors etc. causes a backup of loaded trucks and total disruption of punctuality in grassroots doorstep collection.

The ramps often planned for transfer stations occupy needlessly huge public space and make waste-collection services high maintenance and very inflexible.

If at all necessary, the best model is one which can be easily accommodated, as at Chennai, in a vehicle-maintenance workshop. Primary collection vehicles empty waste into troughs from which a rail-mounted travelling crane lifts out waste into large trucks waiting on the other side of it. Thus even if there is a temporary breakdown of this swiveling crane, the unloading of primary collections is not interrupted at all, nor the doorstep collection timings it needs to adhere to.

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## **1.23 DAY VS NIGHT TRANSPORT**

One very serious mistake made by cities like Trivandrum and Bangalore which eventually cost them the use of existing waste-management spaces outside the city, is to thoughtlessly agree to local demands for only night unloading as a traffic-reduction measure. Waste must be transported away immediately after doorstep collection. If collection is done in the morning and waste is left in closed vehicles till night-unloading, all the waste becomes airless and stinking and causes more problems to those along the route and near the destination. It also becomes very difficult to compost, just as it is not possible to make good curd/yogurt out of spoilt milk.

Where night unloading is unavoidable, door-to-door collection will have to be switched to evenings, to move waste for processing as promptly as possible.

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### **1.24 UNLOAD WASTE ONLY IN WIND-ROWS, NOT HEAPS**

Where there is no decentralized waste management like biogas units or stack composting, waste must compulsorily be stabilized by unloading it in wind-rows and turning these promptly every week for 4-5 weeks. Waste must not be unloaded in huge heaps and then leveled or covered as this makes it airless, generating smell and leachate.



No soil layers must be placed over wet waste in either heaps or wind-rows. This is not allowed as per MSW Rules. Use stabilized waste as cover.



Enforce unloading of waste in windrows only, for stabilizing by weekly turnings. Circulate the waste stabilizing guidelines endorsed by hon. Supreme Court on 28 July 1997 in WP (C ) 888/96 (**Annexure C**). Such 'Biological stabilization of wet waste' is mandated in MSW Rules (Sch 2 (5)). Only unloading discipline (like parking-lot management) is necessary for compliance. Upgrading the stabilized waste to FCO-grade compost is optional. Stop all open dumping in unturned high heaps which release smell and leachate without access to air.

Windrows need watering in dry weather to keep them moist and their decomposing bacteria active. They may need 100 litres water per ton of waste. Use surface water from ponds or open drains rather than wasting clean groundwater from borewells.

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### **1.25 ON-JOB TRAINING FOR DOORSTEP COLLECTION & TRANSPORT**

Training for good collection, transport and processing systems must be cost-effective and have visible results at the end of training.

Training needs to break old habits and bring in good new ones.

So all should focus on the good results that have to be achieved.

Awareness lectures and workshops for the public are useful only IMMEDIATELY AFTER good systems are ready and put in place for people to be enabled to

adopt such advice. Even for them, two-minute individual doorstep training for each family works best, to get them to keep kitchen wastes unmixed with any other wastes.

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## **1.26 TRAINING OF FIELD STAFF & ACTUAL WASTE-COLLECTION TEAMS IS MOST IMPORTANT**

Lowest level health workers may not all be literate and may not all be comfortable with spoken or written teaching. But all are intelligent and are quick learners if their job is treated with respect, and they learn best by doing hands-on work.

Their training works best if broken up into at least two rounds, maybe three. The total training time spent in these rounds should be broken up into 70% on-job learning time, only 10% total theory time, and 20% total time spent learning from each other by sharing their field experiences on what works best, what to avoid and what problems need more explanations.

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## **1.27 70% ON-JOB TRAINING**

Good collection systems can only be achieved by actual on-job training. Then the field workers can learn in just 3-4 days of showing how to do things right. A master trainer should accompany each team and actually demonstrate how to receive waste in basins and remove any unwanted items mixed into the food wastes before emptying the sorting basin into the four pushcart bins.

The trainer should actually demonstrate what dry waste to put separately into each of the hanging bags: paper, thin plastics, snackfood packs and sachets, coconut shells, sani-waste.

In the field, one trainer can cover four micro-pocket teams of two persons every day, spending half an hour with each team. Or on the first day, 5-6 pushcarts can all follow each other on one street, the first one being taught how to receive household waste first in a sorting basin while the others watch how only organic waste should go into the 60-litre bins, and different other items in different bags hanging from the vehicle. Then after 2-3 houses the second pushcart begins actual taking of waste from the house while the first pushcart goes off on its own route.

But daily repetition for the first four days is a must, with weekly follow-up and corrective action to explain the handling of any unexpected wastes. Repetition works wonders. Field training should total 70% of total training time.

**10% classroom training and theory time** in the afternoons is to explain why they need to do what they were shown in the field as a workable model,

and why it is better than earlier systems. It gives them a chance to clarify doubts, get answers to questions, share suggestions for improvement and fill gaps in their knowledge, improve their skills on their respective jobs and especially to create a positive attitude for change.

These classroom sessions are held separately for different groups like field workers, their supervisors and their executive staff.

It is where they are given both short-term and long-term motivation for change and continuing with the new systems.

**20% Learning From Each Other (Peer learning) Workshops**, also in the afternoons, are for sharing experiences. They are always for mixed groups of field level functionaries, supervisors and executive staff of the ULB, where they can understand the challenges faced by each other and the solutions offered. These brainstorming sessions can share best practices from within their town or city and also from elsewhere. It is important to explain in these sessions “what is in it for me” such as easier working, less street sweeping, shorter work hours, and inculcate team bonding and team working habits. This prevents fault-finding and encourages fact-finding and solutions thinking.

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## **1.28 RECYCLING DIFFERENT WASTE STREAMS**

**Recycling at Home:** All wastes are useful if they are not mixed up. All we need to do is to keep our kitchen wastes (food, fruit, flowers) unmixed with other waste. Then it can be used to make biogas for cooking, or organic manure for our home gardens, farms and fields.

Other waste can be reused or recycled. 1-2% of India’s urban population earns its living by recycling waste. If we keep it clean and unmixed with food waste, and give it to waste-pickers, it will fetch them better value, like old newspapers sold from homes and offices. Waste-pickers will then become waste-sorters and it will improve their incomes and help their children go to school.

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## **1.29 RECYCLING OF SPECIAL WASTES NOT COLLECTED AT DOORSTEP**

Doorstep collectors will pick up all unwanted discards and sort them into different categories on their pushcart itself for sale to recyclers.

But there are other types of municipal wastes other than those captured by doorstep collection. All of these other kinds of waste can also be usefully managed within a town. Examples:

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**1.30 DRY LEAVES AND GARDEN WASTES** can be collected weekly for compost in nearby parks for use as organic manure costing Rs 1.50 -2 per kg to replace or reduce synthetic fertilizers. Burning leaves is banned by law. Both citizens and doorstep collectors and their superiors should work together to stop atmospheric pollution, asthma and global warming caused by burning.

**1.31 TENDER-COCONUT SHELLS AND SUGARCANE JUICE WASTE** bagasse can be made into fuel pellets by separate collection, shredding, drying and briquetting. These sell (in 2015) at Rs 4.50 per kg for 2-3' diameter briquettes and upto Rs 10/kg for cigarette-size pellets. Power costs for drying and compacting are fairly high. Doorstep collected coconut shells can be stored at processing point until a truckload can be moved to briquetting unit.

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### **1.32 PREVENT LITTERING OF FOOD WASTES**

The sale of peanuts in shells or green-gram on their stalks or sugarcane chewing-bits can be allowed in markets to take home, but not at bus-stands or railway stations or outside public parks. Persons love to buy this "time-pass" food and throw all the shells etc onto the floors of buses, trains, waiting-rooms and pathways. Peanuts and gram which cause no litter may be allowed.

**1.33 THIN-FILM PLASTICS, MULTIFILM SACHETS AND EXPANDED POLYSTYRENE** (Thermocole, Styrofoam) can be finely shredded and used to double the life of bitumen (tar) roads as described in Section 5.3. They can also be converted to diesel-like fuel in P2F (polymer to fuel) units (Section 1.44).

**1.34 TAILORING WASTES** are used for pillow stuffing. If pure cotton waste is collected separately it fetches good value from paper mills (Rs 6-8/kg).

**1.35 OLD CLOTHES** can be collected periodically for donation to the needy.

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**1.36 E-WASTES LIKE CELL-PHONES AND COMPUTERS,** can be refurbished and donated, or recycled. E-waste can be collected at doorstep once in three months on pre-announced dates at no cost. Or drop-off centres can be designated where e-waste buyers will perhaps purchase items on fixed dates as they do from businesses.

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**1.37 DISPOSABLE DOMESTIC SANITARY WASTES (SANI-WASTE)** like used sanitary napkins, baby diapers and adult diapers must not be mixed with 'wet' food wastes or 'dry' recyclables. In villages and small towns they can be buried, if their State supplies fully-compostable sanitary napkins. They can also be sterilized by autoclaving or microwaving. In towns having biomedical waste pickup, sani-waste should be dropped off at the nearest pickup point like a



hospital or primary health centre. Biomedical waste service providers will charge something extra for this pickup.

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**1.38 ASH FROM WOOD-BURNING** is consumed in villages and is a useful soil enricher for farms. In small towns it is used for washing vessels. If unwanted in larger towns, cold ash can be added to the wet waste collection bins going for composting but not to biogas units. Hot ash must never be accepted for doorstep collection, it will burn the plastic bins and bags. It must be kept indoors or wetted till cooled.

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**1.39 BANNERS, HOARDINGS AND VINYL** are a tremendous non-recyclable nuisance waste because they are now made of non-recyclable PVC which releases dangerous dioxin when burnt. 80% of India's total usage is imported from China, which has banned PVC banners in its own country.

The solution for this is city Resolutions permitting only PVC-free Flex and Vinyl, which are now made in India from fully recyclable polythene and have a recycling value of Rs 15/kg.

If you have queries about management of any special wastes, go to [www.wasteguide.in](http://www.wasteguide.in) for advice.

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## **1.40 INCOME FROM WASTE**

Most small towns can also manage their wet waste within their boundaries. As early as 2003, Suryapet in Andhra Pradesh managed all the unmixed wastes from their 1 lakh population in a half-acre plot of municipal land within city limits. They earned Rs 45,000 every month from sale of organic manure and vermicompost.

They also earned Rs 55,000 a month from sale of all their dry wastes which was sorted by hired waste-pickers into different items for recycling: paper and cardboard, thin-film and hard plastics, rubber, metals, glass and wood. Scrap dealers were happy to buy these sorted bulk resources for recycler customers.

## **1.41 INERTS**

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House sweepings in tiny quantities may go into the ground around a house, or into wet waste if there are no ground around, but road sweepings, dust, drain silt, called 'inerts', should not be collected with 'wet' or 'dry' waste. It can go along with debris and construction or demolition waste to be recycled into building products or used to improve road sides or raised plinths for buildings. It should not go into low-lying areas which are needed as collection-space during heavy rainfall and thus prevent flooding.

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## 1.42 CONSTRUCTION WASTES ON ROADS:

Building sand is often unloaded onto roadsides and even spills onto the carriageway (tarred or concreted portion) making the city look untidy and obstructing traffic.



Though this is not yet a “waste” material, it needs to be managed neatly, by enclosing the sand in a spill-proof border of bricks, blocks or simply filled sandbags as shown in the photo. This will prevent spillage of sand onto



the road which is dangerous for two-wheelers. Also such spilled sand often gets into open drains, costing the city a lot in drain desilting and also flood damage.

Municipal officials must insist on such spill-proof management of piles of sand and stone aggregate (jalli, gitti).

Monthly cleanup drives on pre-informed dates can be arranged to separately collect leftover sand or bricks or stones as free raw material for repair works.

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## 1.43 FINAL DISPOSAL OF REJECTS

**NEVER DUMP MIXED WASTE BELOW GROUND! Avoid using quarry-pits** (except for inert debris) because polluting leachate will never be seen as it flows into groundwater and nearby wells and water-bodies, ruining them permanently for many many years. Quarries should first be filled with non-recyclable construction or demolition waste and only then can the ground-level space be used for waste management.

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## 1.44 CALCULATE ENERGY BALANCE FOR ALL NEW TECHNOLOGIES

Energy in the form of heat or electricity can only be obtained from waste if there is enough energy in the waste in the first place to take care of plant operations and leave a surplus. That is why Energy Balance to calculate ‘Energy In and Out’ is so important before selecting a particular technology.

For wet waste for example, in bio-methanation (see 4.2) no moisture needs to be evaporated out of it and pumping energy consumption is minimal. The biogas produced can be directly used for cooking in the hotel kitchen that produced the wet waste, with no deduction of energy required for transport.

Production of electricity from biogas engines attains 40% efficiency at best and so is not a technically preferred option.

Direct incineration of wet waste has been wisely stopped in the National Green Tribunal Order dt 20.3.15 in OA 199/2015 because it takes a huge amount of external energy to evaporate its initial moisture content, dry it, shred and convey it, burn it to produce steam and then convert steam calorific energy into electrical energy with current maximum 25% efficiency only. So no surplus energy is available from it, rather the reverse.

Waste in the West is 80% packaging and 20% 'wet' waste, so it has 5500 kilocalories of energy per kg of waste. Indian waste has exactly the opposite ratio and hence has only 1800-2200 kcal/kg. So there is not enough energy left over to produce any power from it, after deducting the power needs for plant operations and the 75% conversion losses for heat-to-electricity. In fact Energy Balance calculations require all attempts at waste incineration in India to add external calories in the form of diesel or paddy-husk or peanut shells etc to produce any power at all from MSW (Municipal Solid Waste).

Water Balance (how much water does a process need and where does it go, after internal recirculation if possible) and Mass Balance (how many tons input of raw waste comes out as how many tons of usable products and what weight of unusable waste rejects) should also be always calculated and submitted for all waste-processing projects.

In the P2F, Polymer To Fuel process (see 1.46), plastics etc are heated below 450°C to convert polymers to solid, liquid and gas fractions. As the gas is usually consumed for heating the next batch, its Energy Out cannot be counted. Only the calorific value of energy in the form of diesel-like liquid and in the solid char (useful as fuel briquettes) can be counted. No water is required.

When combustible fractions of waste are co-processed in cement kilns as AFR (Alternate Fuel Resources) to replace coal, Energy Balance calculations must deduct from the "Energy Out", the diesel fuel energy required for transport of waste over long distances to the cement plant, and add in the calorific value of the amount of coal substituted by AFR. (see 6.9 g). [Back to Top ^](#)

## **1.45 INCINERATION IS A LAST RESORT**

Waste To Energy (WTE) is best obtained from Biomethanation as explained above in 4.2 Biogas and in 1.44. High-temperature "mass-burn" technologies like incineration, pyrolysis, plasma, gasification etc are not economically viable because of the low calorific value of Indian mixed waste.

Incinerators in the West use the waste heat for heating their buildings, thus

making incineration affordable there. The capital cost of ‘mass-burn’ power is 3-6 times more per megawatt than conventional thermal or hydel power plants and requires States to buy such power at very high rates per unit, which raises power tariffs to consumers.

That is why the Planning Commission’s (Kasturirangan) May 2014 Report on WTE recommends that burn technologies should be considered only for metro cities and only for the combustible and unwanted dry waste fraction wherever good separation practices are in place.

Many cities look to incineration for waste volume reduction because its promoters promise “only 5% ash” coming out of the process. This may be true in disciplined Western cities where there is no road dust, drain silt or debris at all in their waste. Indian waste has upto 30% of such “inerts” in its mixed waste, which of course will not burn but come out along with the ash from combustible fractions, totaling upto 35% residue. All this residual ash needs very expensive disposal in Hazardous Waste Landfills. The cost of such disposal plus the cost of transport to a distant HazWaste Landfill if available needs to be added to the cost of operation of incinerator operations.

All “burn” plants are also dangerous because of the emission of dioxins from chlorine-containing waste like bleached paper and sanitary waste and PVC. India has only two test locations for dioxins, let alone means to monitor or control it. Each dioxin test takes a few weeks and costs upto Rs 1 lakh per test. Indian combustible waste has a high content of PVC from packaging, toys, footwear, stationery, banners and hoardings, unlike countries abroad where short-life PVC and PVC banners etc are banned.

The cost of dioxin and emission control equipment exceeds the cost of the waste-burning and power-producing unit. Strict enforcement of enviro-norms abroad and the high cost of compliance is the reason why almost no new incinerators are coming up in the West and many old ones are being closed down because of high cancer and other risks around such installations.

## **1.46 P2F**

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**Polymer To Fuel (P2F)** is a low-temperature depolymerisation process (below 450°C) which breaks down rubber and all plastics to charcoal and liquid fuel which can be purified and used like diesel, plus gas which is reused as fuel for the heating process. Heating of polymers at such low temperatures does not form dioxins and if carefully done is a safe process, recommended in the Kasturirangan Report for general use and disposal of nonrecyclable wastes. This should ideally be invested in and managed by the producers and users of non-recyclables as their Extended Producer Responsibility (EPR).

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## **CHAPTER 2: VILLAGES, SPECIAL AREAS & CENSUS TOWNS**

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### **2.1 VILLAGES**

India's 6 lakh villages and small hamlets are definitely cleaner than urban areas and are also the easiest to keep clean. They have 67% of India's population, so Swachha Grams will lead to a Swachha Bharat.

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**2.2 PIT COMPOSTING:** Every home has animals to which leftover food waste can be given. What is wasted by them is used even today to make organic manure for farms and fields. It is usually stored in a pit until it is needed before the next planting season. Because it is mixed with cowdung and is added to the pit in small daily quantities, the waste does not smell. These pits should be only in private plots or farms, not in public spaces or roadsides, where passers-by may throw in plastics or other non-biodegradable wastes.

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**2.3 EATERIES:** Village anganwadis and schools serving midday meals, roadside eateries and shops must arrange to add only their unmixed food wastes to a nearby compost-pit by arrangement.

They must be required by panchayat resolution to use only washable plates, or leaf-plates and cups which can be added to compost-pits. **They should not be allowed to use disposable paper or plastic plates.** If they do discard plastic ice-cream cups etc these should be washed and given as recyclable waste at drop-off points or kept until weekly doorstep collection is done. **NO WASTE SHOULD BE THROWN BEHIND SHOPS OR ALONG THE ROAD** and offenders should be penalized.

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**2.4 PACKAGING WASTE:** Shops should be encouraged to use paper or leaf wrapping and not plastic. However nowadays many pre-packed foods come in plastic which needs to be well-managed. Panchayats should provide a drop-off point for all such non-biodegradables.

**2.5 WEEKLY PICKUP SERVICE:** If panchayats choose to provide a weekly (not daily) doorstep pickup of plastics and other recyclables, it should preferably be done not in a wheelbarrow where everything will get mixed, but in a local handcart with 4-6 plastic bins of 60-80 litres and lots of hooks to hang different sacks on the sides (used cement or



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grain sacks).

They can also get a double-handled pushcart with jumbo sacks as shown in Annexure B which is ideal for doorstep collection in the smallest to the largest cities and metros. Waste must first go into a sorting basin, then into 'wet' bins.

Many large sacks can be hung open for separately filling with paper, plastic and 'other' non-food waste, so that sorting gets done during collection itself for added recycling value and does not require an additional space for sorting. Such push-carts should also have a 20-litre shallow basin in which waste is received at the doorstep and non-biodegradables picked out of wet waste before adding it into the bins.

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**2.6 TEMPORARY STORAGE :** Only a small room or covered space is needed for temporary storage of collected sacks. Panchayats need to tie up with a waste-buyer or have monthly auctions to dispose of the collected material, even at nominal cost. Most of the unwanted non-recyclable waste in villages is snack-food packs or tiny pouches and sachets. These are very bulky when loose and costly to transport away. So these should be foot-compacted in large sacks (used for maize, sugar etc) or foot-compacted in a wooden baling crate and then tied tightly with plastic twine in bundles which are economical to transport.



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**2.7 RESIDUAL WASTES** may also be there in very small quantities, about 5-10% of total waste of all kinds. The District Collector should innovate some locally suitable solution for yearly removal of residual wastes to keep the villages clean.

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**2.8 STREET SWEEPING** is traditionally done by occupants of street-facing buildings who sweep and keep clean their half of the road in front of their properties, including keeping drains clean and free-flowing to minimize mosquitoes and malaria, flies and diarrhoea. This good Mera Aangan Saaf policy needs to be encouraged everywhere with gram sabha support. Then no separate sweeping staff are needed. Heaps of dust can be used for pothole filling or road-widening at the nearest point.

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**2.9 BURNING WASTE ON ROADSIDES IS BANNED BY LAW.**

Leaf sweepings should be added to compost pits or composted in the nearest parks by sprinkling with a dilute solution of 5% cowdung in water.

**2.10 SUB-POST OFFICES AND BANKS MUST NOT BURN** their waste papers. These can be shredded or packed in sacks and sent to their head offices if not taken to the panchayat drop-off point for auctioning. State Postmasters-General and Zonal Bank managers should enforce this.

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**2.11 BUS-STANDS** should have litter-bins and throwing waste on the ground by both locals and visitors should be discouraged. Litter-bins are not preferred in many areas for fear of fires from discarded cigarettes and antisocial elements. Disallow sale of peanuts in shells and green gram on stalk etc.

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**2.12 MONTHLY CLEANING DRIVES** should be arranged by Panchayats to clear away building debris and unused construction material on the roadside like leftover stones and bricks or blocks and use them for road improvement or take them to a planned disposal point. This should not be beside a lake or river or low-lying depression as these spaces are needed for ground-water recharge.

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**2.13 FESTIVAL WASTE MANAGEMENT** should be planned by Panchayats or gram sabhas in advance and provided for, to prevent waste from annual temple events and national festivals or crackers from lying around for long and spoiling the cleanliness of the village. Keep a 'nirmalya-kalash' for collecting all flower-offerings free of plastics.

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**2.14 CLEANLINESS AWARDS BY THE DISTRICT COLLECTOR** are very useful for building local pride in keeping their environment clean.

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**2.15 SPECIAL AREAS** of different types are described below.

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**2.16 DEFENCE CANTONMENTS** are very clean but must manage all their wet and dry waste entirely within their areas and not depend on nearby civil towns to take away their waste to places they have no control over. The General Principles of waste management in Chapter 1 apply to all of them. In addition, depending on their size and population density, they can follow the additional advice that follows for towns and cities described below.

A special recommendation for military areas is to have small biogas units attached to each mess to handle its kitchen and food waste and supply some hours of cooking gas as a bonus.

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**2.17 RAILWAY COLONIES, INDUSTRIAL TOWNSHIPS** and large institutions must also process all their biodegradable and food wastes on-site or within their areas, sending out only saleable recyclables.

Catering services in trains must not throw waste on the tracks. If needed they can hang large bags between carriages for separate wet and dry wastes to be unloaded and managed at subsequent railway stations.

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## **2.18 CENSUS TOWNS:**

Census towns will have just 1000 or more families with just 1-2 tons per day (TPD) of waste, which can be easily managed in a decentralized location as described for villages or small towns.

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## **2.19 Hilly Areas and Tourist Towns**

Hill towns rarely have any uninhabited level space for waste processing. They usually throw all their mixed waste downhill into one valley or another, from a point reachable by some pushcart or vehicle. They are also tourist towns with a floating population and many lodges and eateries. It is absolutely vital for them to collect biodegradable food wastes separately.

There is always enough level space near the valley head for stack composting. (See Section 3.5 below). One stack of 1m x 2m can accept 400 kg waste a day in 0.2m (8") layers , from 400 homes or 100 eateries. The stack can accept 14 days' waste, so space for only 2-4 stacks is needed, more in winter. This is near-zero-cost waste stabilizing. The stacks can be auctioned after 1-2 months to farmers at very nominal cost (say Rs 100/stack), to clear the space for the next month's stacks.

When there is no demand from farmers, the waste must be stabilized for at least two months. Then it can be thrown down to thinly cover denuded slopes, or to cover existing valleys full of old mixed waste, to heal the hillsides. But there must be NO DRY WASTE in these stacks. Unstabilised wet waste must never be thrown onto slopes or valleys.

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## 2.20 Islands

Lakshadweep settlements depend solely on gen-sets for power. Spilled and waste oil from these gensets seeps through the porous limestone soil, killing corals and marine life. This is totally avoidable.

For lighting, extremely affordable off-grid solar lighting is now available for individuals and homes, approved by MNRE. Both portable lights and mini home-lighting systems can also charge cell-phones. Payback is in 1-2 months, as these lights last over 10 years, with low-cost battery replacement every 5 years.

For cooking, kerosene or hard-to-transport gas cylinders can be easily and very profitably replaced by individual or group biogas units. 4 kg food waste (if available and not used as animal feed) can give 1.5 hours of cooking gas a day. Small affordable home biogas units are also available from CREDAI at Kochi for biogas from sewage-plus-food-waste.

Tuna-processing waste and wash-water can be profitably used in slightly larger biomethanation units to provide the heat needed for the fish-processing.

Dry waste needs to be collected and stored separately for once-a-month transport to the capital or the mainland, to feed a P2F unit (see section 1.46 above). If installed on an island, the fuel oil can be directly used in gensets, and the char sold for fuel.

In Andamans, shiploads of dry waste are carried at huge annual Central Govt expense to be dumped on the mainland at Chennai's already overloaded dumpsites. This avoided cost can easily fund plastic-shredders on one or more islands for improving the life of tar roads (See Section 5.2 below) or for P2F units (see Section 1.46). Plastic recycling units and handmade paper units can provide both income and meaningful employment to prisoners in the Cellular Jail and also those idling in internment camps for those caught in our territorial waters.

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## 2.21 Riverside towns

These can and must become zero-waste towns through strictly separate collection of wet and dry waste and windrow-stabilising or stack-composting of wet food wastes. The compost can be profitably auctioned to fund cleanup of storm-water drains emptying waste-water into rivers.

Waste water can be easily and very affordably treated in-situ in Nala Gardens like the 244 km of beautiful linear lung spaces along ten stretches in Pune. All these are zero-cost natural rootzone treatment solutions, done by Pune municipality's horticulture dept. Maintenance costs are recovered through low-cost entrance fees and monthly family passes for enjoyment of these lovely linear recreational spaces which have walking/cycling/jogging paths, herbal gardens, a butterfly park and even a laser light show.

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## **CHAPTER 3: SMALL TOWNS 20,000 TO 50,000 POPULATION**

Small towns normally have 5-10,000 houses which each have some small space around them, where their daily 100-200 grams of food waste can be managed on-site.

### **3.1 HOME COMPOSTING**

A small town near Pune decided not to have any waste-collection service. Instead they trained every school and college teacher to convert their food wastes to compost at home, do it themselves and then teach all their students to do the same. Their home-garden competitions were a huge success.

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### **3.2 COLLECTING WASTES UNMIXED**

If food waste is not managed on-site, it should be collected unmixed with plastic or other waste in pushcarts with plastic bins as shown in Annexure B. It will not be more than 1-3 tons wet waste a day. If a bullock-cart is used, it should have bins for easy unloading with lots of hanging bags for spot-sorting. In some cases, instead of stopping at each and every doorstep, it can go around, stopping at every few houses, **COLLECTING UNMIXED WASTE & TRANSPORTING IT UNMIXED.**

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### **3.3 TRACTORS OR GOODS AUTOS**

These are sometimes used to stop at every 5-6 homes for waste to be brought to them, but with such start-stop primary collection, idling consumes too much diesel, causes too much smoke pollution, and vehicle breakdowns can disturb the smooth collection routine which no-maintenance push-carts can establish. If used for primary collection and direct transport to a waste-processing site, keep a partition in the tractor body for dry waste behind the driver with high weld-mesh sides to increase capacity and let all citizens see that their dry waste is kept unmixed with the wet waste in the rear portion of the tipper-trailer.

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### **3.4 WET WASTE DIRECTLY TO FARMERS**

On-farm composting is the most efficient way of returning nutrients to the land for revitalizing the soil, improving water retention, and developing strong root systems to withstand changing rainfall patterns. There is a huge shortage of organic manures for agriculture as farm animals are replaced by tractors.

Farmers will gladly take fresh waste and compost it on their own lands for use when needed. But they will not come daily with vehicles and labor to collect it.

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The town must deliver pure wet waste to the farm gate, preferably to different farmers in pre-fixed rotation, for which farmers may be invited to bid nominal amounts. Ideally, not more than 20 tons per acre per year should be given to one farm.

The best option is to **COLLECT ONLY FOOD WASTES DAILY** and other waste once a week in a separate trip or in bags hanging on the outside of the tractor.

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### **3.5 STACK COMPOSTING:**

Unload the wet waste onto wooden frames for "Stack Composting". This is done in the same way that farmers store their harvest, straw or hay for feeding their animals. Wooden or bamboo poles are tied together with 0.3-meter spacing into frames of 1 meter x 2 meter. These are placed on supporting stones or blocks to keep them 0.2-0.4 meter off the ground. Old bamboo baskets or matting is placed on these frames. Then fresh food waste can be directly unloaded onto these platforms in thin layers (max 20 cm) for good aeration.



Thus each frame can accept about 400 kg waste daily. Start a second or third frame for extra 'wet' waste, do not overload in thicker layers. Build up the stack till 2.5 meter height or so, then leave for 1-3 months before giving or selling it to farmers. Do not try for a high price, try to make space on the stack frames for fresh waste. A plastic sheet covering the top may be needed only in coastal and high-rainfall areas.



As there is no labour, power or fuel required for such passive composting, production cost is very low, Rs 50/t, sales are profitable.

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### **3.6 WIND-ROW STABILIZING WITH OPTIONAL COMPOSTING:**

This can be done where there is enough space. Unload waste in long heaps, two meters high and as long as required to hold one day's waste. Make each day's heap parallel to the previous day's heap (called wind-row). Keep heaps moist (but not wet) preferably using waste-water or surface water, with addition of 5% fresh cowdung to speed up microbial decomposition of waste.

Turn each heap promptly at 5 day intervals to allow every part of the heap to get enough air and oxygen. This waste stabilizing is sufficient to comply with the MSW Rules. After a month, auction these heaps to nearby farmers to recover fuel cost for turning the heaps by Bobcats or JCBs.

In low-demand seasons between crops, auction them even at nominal rates to clear the site for more wind-rows.

**3.7 VERMI-COMPOSTING** can be done as a business by farmers or others as it is a form of animal-husbandry operation where the earthworms need to be kept warm, moist and healthy. For this, 15-day old stack waste or wind-row waste can be spread for cooling before feeding to earthworms. Do not add fresh waste directly onto earthworm beds except in very thin layers, as the heat of decomposition can kill the worms. Vermicompost sells at higher rates of Rs 5-10/kg because of its rich microbial and enzyme content and earthworm eggs.

Non-food wastes can be managed as described above for Villages. It will be about 10% by weight (or upto 50% by volume) of the total waste

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### **3.8 Ferti-composting**

This is a near-zero-cost method by which raw food waste is filled to ground level in shallow trenches or pits between rows of trees in an orchard or plantation and covered with a heap of the excavated soil, which will sink down over time. It decomposes in-situ and becomes natural fertilizer for the trees nearby. The trench should be about 40cm (1.5') wide and 40 cm deep so that the heat and leachate from small quantities of wet waste do not burn the roots. Place a thin layer of dry leaves or agro-waste at the bottom of the trench and sprinkle some bioculture or 5% dilute fresh cowdung on the bottom leaves and then also on top of the waste, or place one-week-old composted or fermented wet waste in the pit. In dry weather, some watering of the pit may be needed. Give one year rest before returning to the same spot for ferti-composting. The only cost is labour for digging trenches.

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### **3.9 Bio-mechanical Composting**

This is a step which follows wind-row stabilizing, to make this material conform to FCO (Fertiliser Control Order) standards for bagging, branding and marketing as organic manure of certified quality. It helps to do pre-screening of incoming waste through an 80-mesh or 100-mesh trommel (cylindrical rotary screen) and forming windrows for turning and stabilizing from the screened material.

After 4-5 turnings, the stabilized organic waste is again screened through trommels with screens of 35-40 mesh, then 16 and finally 4 mesh to remove bits of glass or plastic and make the compost easy to spread in fields. The finest 4-mesh fraction is blended with micronutrients and supplements to reach FCO standards, and bagged shortly before dispatch. The already-stabilised medium fractions (4-14 mesh or 4-40 mesh) are used as cover material on new wind-rows to give more yield and time for decomposition. They can also be sold at a low price (upto Re 1/kg) for placing as slow-release organic manure in pits for horticulture or tree-planting. The coarsest fractions (plus-40 mesh) and the initial plus-80 or 100 mesh material can be compacted for use as RDF (refuse Derived Fuel) as a substitute for coal in the nearest power plant or cement plant.

Compost yields are about 20-25% of well-segregated incoming wet waste and compost production cost is Rs 2.50/kg. If waste is not well-segregated, even mixed waste is compostable but at higher cost and much lower yields.

So far cities have tried to get private parties to set up compost plants to handle their mixed waste, often with drain silt, debris and inerts mixed along with the wet and dry waste. This requires additional capital and operating cost to separate out unwanted material from the compost, making its price unaffordable to farmers who are reluctant to pay more than Rs 3/kg for delivery at farm gate and definitely do not want inerts.

In SAARC countries where there is no urea subsidy, there is high demand for city compost and good profits. In India, urea costing Rs 25/kg is given to farmers at Rs 5.50/kg, which suppresses city compost prices. Subsidy goes to fertilizer companies not farmers. There is about 50% loss of urea applied as it goes as polluting runoff into water-bodies. City compost used along with urea absorbs this wasted urea and gives it back as slow-release nutrient. Farmers can get the same yields with less water and no extra cost if they cut their chemical fertilizer use by half and use the money saved to buy city compost.

So fertilizer companies have been advised by Fertiliser Ministry circular No 12012/15/2007-FPP dt 2.6.2008 to co-market 3 or 4 bags of compost along with 7 or 6 bags of chemical fertilizer in a basket approach. As soon as this co-marketing is made mandatory, city compost prices will rise to Rs 5/kg, making all compost plants profitable.

Meanwhile, to cover the gap between prices paid by farmers and the production cost, the private operators of compost plants demand “tipping fees” (see Section 6.8 below) to cover their costs of handling the mixed waste of cities too lazy to collect and transport wet waste unmixed. This tipping fee on raw waste intake tempts operators to accept waste but not to stabilize or compost it but just dump it.

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### **3.10 Green Belt around Compost Plants**

A very dense plantation of 3-6 staggered rows of different tall trees (about 3 trees per square meter) needs to be planted all around the boundary of a windrow-stabilising site or compost plant, to prevent flying dust and minimize odours nearby.

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### **3.11 Catch net to prevent wind-blown plastic**

Until the trees grow tall enough, use a ‘catch-net’ to prevent wind-blown plastic flying into surrounding fields or areas. A catch-net is a wall of netting or fishnet, tied to movable bamboo poles to a height of about 3 meters, which is placed around the down-wind side of a waste-processing site. Wind-blown plastic will collect against this netting and can be collected periodically for recycling. The wall of netting can be moved to the opposite side of the windrows when the wind direction changes.

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### **3.12 Landfills**

When wet and dry wastes are collected and transported separately, very little remains after waste stabilizing. If stabilized waste is sieved before supplying to farmers, the coarse fraction can be used for erosion control on slopes.

Not more than 10% will be unusable rejects that need permanent disposal. This can be landfilled as described in detail in the MSW Rules 2000.

If waste-processing is privatized, payment should be only a support price on products produced (no “tipping fee” on raw waste intake) and payment for landfill operations should never be for more than 10% of raw waste intake (or maximum 15% for metro cities only).

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### **3.13 Buffer Zone around Compost Plants and Landfills**

Waste-stabilising or composting sites and landfills receiving rejects (never raw waste) will always have some dust and odour problems. So except for small decentralized waste-management units within urban limits, it is necessary to prevent new residential and commercial development in a buffer zone around such locations. This should be 100 meters for sites accepting 50 tons waste per day, upto 500 meters for large sites. State land-use Development Plans should automatically provide for Bufffer Zones wherever they provide for waste processing and disposal sites. Otherwise there is always pressure for closure of facilities from surrounding land developers even around well-managed sites.

States/U.Ts should immediately declare buffer zones around all existing waste-management sites including open dumps in use.

Property owners within the buffer zone should be compensated for lowered land values through TDRs or other compensatory measures.

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## **CHAPTER 4: MEDIUM TOWNS 50,000 TO 1,00,000 POPULATION**

As always, **keep 'wet' kitchen wastes unmixed with any other waste so that it can be well managed.** This biodegradable waste will be 12-30 tons a day in medium towns.

It can be collected in push-carts and the bins full of wet waste should be immediately picked up by tractors or small trucks and taken to places where stack composting or wind-row composting (described above) can be done. Wet waste should never be unloaded on the roadside or ground for pickup as this will require manual handling again, which is undesirable and not allowed.

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### **4.1 COUNCILLORS' DUTIES**

Every single councillor or elected member must very strictly ensure that mixed waste collection must be refused or penalized, and that transport arrangements ensure that waste is collected and also transported unmixed to separate destinations (dry waste for recycling). There must be zero tolerance for mixed waste transport in both primary and secondary routes. Give monetary or political rewards and recognition to councillors of wards with maximum unmixed waste collection.

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### **4.2 BIOGAS**

Medium towns will usually have a hotel serving many meals a day. Their food waste can be best managed by themselves in a small low-cost decentralised bio-gas (bio-methanation) unit so that the bio-gas can be used directly for cooking in the same kitchen. If a larger unit is installed, the hotel can take in wet waste from nearby eateries or homes to get more hours of biogas for its kitchen. Four kg of biogas can give at least one hour of cooking gas. If waste rice-water or plate-washing water or whey is added instead of plain water, almost double the gas is produced. Decentralised biomethanation works best, is eco-friendly and capital costs could be funded from waste-transport savings.



For say 1 ton/day food waste, high-tech compact units need 20-40 sq m area and cost about Rs 40 lac, with 3 years' payback to replace commercial LPG. 1 ton wet waste can give 100 cubic meters or 50 kg LPG equivalent gas but only 150 units power/day.

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**4.3 AVOID PRODUCING ELECTRICITY FROM THE BIOGAS** as this wastes 75% of its energy content. Biogas can be scrubbed (purified) and compressed for transport and used as CBG (Compressed BioGas) for cooking or in motorised vehicles. Bottling is only economically viable where over 100 tons of wet waste is fed to biomethanation units.

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#### **4.4 TRADE WASTES MANAGEMENT AT COST**

It is the duty of all municipal councils and municipalities to manage the waste of its residents. But their tax-payers are not required to subsidise the cost of managing commercial waste produced in hotels, hostels, shops and offices. So towns should charge them the full cost of managing such “trade waste” as that is also part of their cost of doing business.

Medium town councils should **pass ‘Mera Aangan Saaf’ resolutions** to require all residential, commercial and industrial properties to be responsible for the cleanliness of their property frontages, including drains, upto the middle of their road. Corner plots must keep their half-roads clean on both sides.

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#### **4.5 CLEANING ROADS AND DRAINS :**

Where door-to-door collection is being done, usually from 6:30 am to 11 am, the same team of workers should do periodic street sweeping and drain cleaning in their own assigned area. Instead of group cleaning work, it is best to **give ‘pin-point beats’** with each worker responsible for a definite 0.5 or 1 km of drain. Only major storm-drains deeper than 0.6 meters need a separate cleaning team.

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#### **4.6 DRAIN SILT**

This should never be left on the roadside to dry out even for a day as passing traffic and delays in lifting it make the silt go back into the drain. Each beat worker should be given a “wheely-bin” (a large 100-litre bin with wheels and handle) into which even **wet silt is immediately and directly filled for immediate loading** into a leak-proof lorry before the end of the day. The lorry must be given a designated unloading-point for each ward.

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#### **4.7 MANAGING DIFFERENT WASTES**

Sections 4.8 to 4.14 describe the management of many specific wastes.

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#### 4.8 FALLEN LEAVES, PARK AND GARDEN WASTES

must all be composted in the nearest park. It can be a simple heap on the ground, sprinkled with a 5% dilution of Fresh Cowdung in water. If space is a problem, a cylinder of weldmesh can be formed to hold the leaf waste. When it is composted (quite slowly, after 4-5 months) the mesh can be lifted to remove compost from the bottom, or the mesh cylinder can be relocated to an adjoining spot.



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**4.9 TREE TRIMMING** is periodically done by Electricity Boards to roadside trees, usually rather thoughtlessly. If power-lines are exactly above a row of too-tall trees, or passing near a beautiful large old heritage tree, these bare wires can be replaced by an **insulated ABC cable** (Air Bunched Cable) so that no tree trimming is ever needed even if branches touch the ABC wire.

**Large Branches** from fallen trees can be cut up by diesel-powered or hand saws and sent to crematoriums for free use by the poor.

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**4.10 TEMPLE FLOWER WASTES** can be composted onsite and distributed to devotees or sent to 'temple-lands' nearby for on-farm composting. Or they can be given to farmers supplying flowers or cattle-fodder. Plastic packaging for prasad must be avoided, also disposable plates and cups. Disposable leaf-plates can be shredded and make a nice addition to composting food-wastes. Used banana-leaves used for serving food are welcomed as food by buffaloes, but not if they are piled too high for too long and turn black and charred with self-generated heat. These leaves and also banana-stems may also require shredding before composting.

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**4.11 FESTIVAL BIODEGRADABLE WASTE** can be collected free of plastic wrappings and decorations and farmers may be invited to take it away free. They will gladly do this if it is not mixed with non-biodegradable waste.

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#### 4.12 IDOL IMMERSIONS

They were always traditionally done with clay for hidden environmental benefits. Nowadays idols get larger and larger and are made of wire and Plaster-of-Paris (P.O.P.). A town resolution is required well in advance to inform the public that worship of non-clay idols will not be disallowed, but **immersion of non-clay idols in any public water-body will be banned**. Encourage natural colours.

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#### **4.13 WATER-WEEDS CLEARANCE**

Annual cleaning of storm-water channels and lakes are a major expense for municipalities, creating huge quantities of solid waste which are never considered a municipal waste or separately-categorised solid waste.

**A preventive approach** is two-fold. Divert all sewage inflows away from storm-drains and water-bodies, into mandatory septic-tanks or to small decentralized sewage treatment plants. Anaerobic UASB-type systems require little expensive electricity to run them.

Another preventive measure is, by a town resolution, to restrict the commercial sale and use of detergents with high free-phosphate content as that is what fertilizes the growth of water-hyacinth etc.

A study tour to Kolar, pop. 1.5 lac, is worthwhile. By adopting the Clean Cities model it achieved, in just one month, ongoing 100% doorstep collection, 70% segregation and 100% decentralized waste stabilization by Stack Composting. If they can do it, so can hundreds of other medium towns.

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#### **4.14 CONSTRUCTION AND DEMOLITION WASTE AND DEBRIS**

This is a major problem for large and very large cities. But it should not be allowed to become a problem for medium towns which will soon grow into larger ones. When houses are expanded or demolished there will be a lot of construction and demolition waste (called C & D waste) which will come onto the road. This must be stopped at the earliest, because once there are uncleared piles of such inert waste on the road, people consider it a dirty spot and soon start dumping wet waste, dry waste and all other unwanted items including industrial or trade waste onto these heaps, making it useless.

At the earliest, identify places where this waste can be usefully utilized, such as for raising the plinth of new buildings. Good soil from foundation excavations can go for pot-hole filling and widening or improving road shoulders, or be used in nearby brick kilns.

If waste stones and waste concrete or concrete blocks can be unloaded in separate heaps, rock-crushing units can recycle these into aggregate and “manufactured sand” for concrete block making and construction.

**Identify destinations, publicise them and insist that all such inert waste goes directly from building plots to the destinations without coming onto the road at all.**

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## CHAPTER 5 : CLASS 1 CITIES WITH 1 TO 10 LAKH POPULATION

These 415 million-plus cities with a total population of 104 million in 2011 census accounted for 28% of our total urban population. All of the above guidelines are useful for them also.

They also have their own very detailed guidelines since March 1999, in the form of a Report on Solid Waste Management in Class 1 Cities of India by an Expert Committee appointed by the hon. Supreme Court. See References on last page. This needs to be **translated into regional languages** in every State and Union Territory. Its **Chapter 3 - Recommendations and Technical Aspects** need to be translated and distributed down the line to the supervisors / mukadams / maistries, each of whom supervise about 20 safai karmacharies or ground-level workers. Its Chapters 4 onwards are guidelines for top-level city managers and councillors.

However, **all Class 1 Cities must remember that they are made up of Wards which each have the population of 25-50,000 like the Small Towns above.**

**So decentralized waste management as described for these Small Towns is also relevant even for the largest cities.**

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### 5.1 MANDATORY RESOLUTIONS

Make it mandatory for citizens to keep Wet and Dry waste unmixed. After three warnings, either refuse to collect mixed waste or charge a daily fee for sorting it at their doorstep.

**Make it mandatory for ULBs to ensure Separate Collection and Separate Transport of Wet and Dry Wastes.** This is a prerequisite for citizen cooperation and waste minimisation. See Contract Management in Section 6.6 below in case any outsourcing is done in the largest cities.

**Daily Collection of Wet Waste** (food, fruit flowers) is necessary, even on holidays.

**Weekly Collection of Dry Waste** may need a municipal resolution. The sale proceeds of dry recyclables should go only to the primary waste-collection team to incentivize unmixed collection and thereby waste reduction.

**Unwanted unsaleable** non-compostables should have a separate destination from wet waste. Baling is necessary to transport them economically.

**Ban PVC Banners, Hoardings and Vinyl** as they are unrecyclable.

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## **5.2 'PLASTIC ROADS'**

**These polymer-modified bitumen roads should be mandatory** and specified in municipal road tenders. All cities must use unrecyclable plastics (like snackfood sachets and thermocole) either as cement-kiln fuel or in P2F plants where available (see 1.46) or in hot-mix asphalt plants so as to consume all remaining non-recyclables in 'Plastic Roads' within the city. This will give 2-3 times the normal life of bitumen roads. It is approved by Indian Roads Congress. Refer to CPCB's guidelines PROBES/101/2005-06 on how to use waste plastics and PROBES/122/2008-09 for data on improved tar road quality. No non-recyclable plastics should end up in landfills.

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## **5.3 ENFORCE EXTENDED PRODUCER RESPONSIBILITY (EPR)**

Extended Producer Responsibility (EPR) is defined in the **Plastic Waste (Management and Handling) Rules 2011 Section 3 (g)** as "the responsibility of a manufacturer of plastic carry bags and multilayered plastic pouches and sachets and the brand owners using such carry bags and multilayered plastic pouches and sachets for the environmentally sound management of the product until the end of its life." In Plastic Waste Management Rules **Section 6 (d)**, cities are responsible for collection of such carrybags, pouches and sachets, but may **seek the assistance of their manufacturers or brand owners**, particularly those with factories or registered offices within the city.

This wonderfully useful EPR clause is rarely availed of by cities, though they are drowning under such trade waste. Vigorous efforts must be made by each and every Class 1 city and larger, to enforce this clause. Cities must insist that producers and users of these wastes shall take them back and/or pay for or organize their collection, recycling and processing facilities. Or producers and users must themselves set up such end-of-life services for all their packaging wastes products. They must and should do this, individually or collectively.

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## **5.4 STREET FOOD WASTE MANAGEMENT**

Medium and large cities have numerous pushcart vendors moving along streets as mobile shops for the great convenience of residents.

But they must be required to have a dustbin as well on the lower shelf of their handcarts. Ideally, each pushcart should go to its night destination along with its waste and give that to the doorstep pushcart collectors in the morning. Otherwise, each Ward will have to individually decide when and where these hand-cart emptied wastes must be unloaded at the end of the working day and how they will be removed for processing and disposal.

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## **5.5 MARKET WASTE MANAGEMENT**

The door-to-door pickup becomes here a stall-to-stall pickup service, every hour or two-hourly or 3-4 times a day as needed, by the existing market-cleaning staff, preferably paid by stall-owners. Every vegetable-fruit-flower stall must keep a small basket within their stall space for wet waste only. A pushcart continuously moves up and down along the rows of shops so that the baskets can be quickly emptied into it without overflowing.

The pushcart unloads its wet waste collection directly into a waiting trailer or tractor or lorry to be taken away at the end of day. If this vehicle fills up within 3-4 hours, it can go straight to the city's cattle-pound as feed, or to farmers. Otherwise it needs decentralized biomethanation or stack composting or goes directly to a centralized site for wind-row stabilization.

The same stall-to-stall frequent pickup service for emptying waste-containers is a must in fish-markets so that nothing is thrown on the floor or shop platform. It helps to spray on odor-control or composting biocultures at the market itself so that transport through the streets is odour-free and composting begins before the waste can rot. The cost should be borne by all the stall-owners on polluter-pay basis.

Market stalls also have a lot of dry waste like the newspapers wrapped around papayas, or plastic wastes. These must be collected in separate jumbo bags hung behind or under the stalls, and a waste-picker or kabadi service arranged to collect or buy it at the end of day.

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## **5.6 WHOLESALE MARKET PACKAGING WASTES**

Packing straw around fruits etc coming into wholesale markets **MUST NOT BE ALLOWED TO BE UNLOADED ON THE ROAD**. The trucks must take all this out of the crowded market area and unload it at a nearby waiting truck before they proceed to another transport job. This straw can be taken to a cattle pound or goshala or any cattle-owner who asks for it. Or it can be used as cover for windrows. It is not advisable to add it into biogas units.

Wholesalers sell the produce in cartons or baskets to the retailers having stalls or pushcarts. There must be **a take-back policy for such packaging**. For every box or basket the wholesaler gives a retailer, he must take back a box or basket and load all these empty returns into any just-unloaded truck leaving the market, for sale or disposal outside the markets. Interested buyers may be allowed to come and collect such packaging waste at end of day, or waste-pickers with identity cards may take it away. Both should pay some nominal cost or they will be irregular and not value what they can collect for free.

Use secondary transport garbage vehicles in the early mornings for a wholesale-market-waste trip before they are needed later in the day for pickup of pushcart bins from micro-planned doorstep-collection routes.

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## **5.7 MARKET CLEANING CONTRACTORS**

In many towns and cities, contractors bid in auctions and pay fixed fees to the city in exchange for the right to charge a daily fee for temporary stalls or spaces, especially in farmer markets along roadsides in the evenings or at annual fairs and exhibitions. **'No-waste-on-road at any time' must be a compulsory clause** in such contracts.

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## **5.8 MARKET WASTE TO CATTLE POUNDS AND FARMERS**

Unmixed market waste is useful feed for large and small animals if delivered within 12 hours and becomes useful manure in a day. It is also wonderful for composting in farmers' fields. Farmers should be encouraged and helped to **bid for and take away the market waste to their fields** on a regular or seasonal basis as organic fertiliser.

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## **5.9 SLAUGHTER WASTE MANAGEMENT AND HOUSEKEEPING**

Farmers should also be encourage to bid for (at very nominal cost) and take away daily the undigested grass-like stomach contents (**rumen waste**) of slaughtered buffaloes or cattle. This is a very smelly material but very rich in nitrogen, so it should also be linked to prompt pickup by farmers bidding for it,



or bidding to have it delivered to their fields. Sprinkling it frequently with a 5% solution of fresh fully-digested cowdung may help control smell. It is wonderful how little gets wasted in slaughter-houses.

Almost nothing is wasted, except blood nowadays. Blood used to be collected in pans for sale until 2000, when its use for pharma products was banned by the Supreme Court. After that butchers became careless and allow blood to flow on the floor, washing it into drains which end up in urban lakes or streams.

This must not be allowed at all. **All blood must be collected as before in pans** below the necks of both large and small animals. This blood must be collected in separate bins and allowed to solidify for eventual on-farm composting with undigested rumen waste, or collected in a way suitable to animal-feed processors as they desire. Blood-processing may be encouraged next-door to larger slaughter-houses.

The walls of slaughter-sheds must be tiled, preferably with polished stone. Throwing water on them for cleaning does not help. They should be brushed down with stiff hand-brushes after pouring hydrogen peroxide in a thin film over the wall surface to loosen dried blood. Chandigarh's slaughterhouse is perhaps India's best, as a model unit.

Rumen contents means the smelly undigested stomach contents of large animals, looking like chopped hay. It is the only item which is often not recycled, though it is rich in nitrogen and can be easily composted, but with soil cover and interlayers. It can be sprinkled with 5% solution of fully-digested fresh cowdung to control odour during transport.

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## **5.10 MEAT, CHICKEN AND FISH WASTE FROM SHOPS**

Much non-veg shop waste finds direct buyers for fertilizer and other uses, except for chicken feathers and fish-bones and fish scales.

Poultry waste from retail chicken shops is very useful if rotting and spoilage is prevented. It is processed in many Indian cities. In Hyderabad, it is collected in tubs filled with ice tied in plastic bags to keep the waste unspoiled. This is then promptly processed within a few hours by steam-cooking and drying, then ground for pet food or animal feed. So such processing plants, which are very costly to set up, are best located within the city or close to the outskirts. They can be located within sewage-treatment plants which have lots of space.

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## 5.11 CO-DIGESTION WITH SEWAGE SLUDGE

Most large sewage treatment plants (STPs) have been designed with big digesters to produce biogas from the sewage sludge, as drying beds take too much space and time. Surat has a very successful gas-generation unit in one STP which runs on the power it generates. Most of these units are no longer functional, or produce very little biogas.

In the West, STPs try to be 'carbon-neutral' by **generating on-site their own power requirement for operations**. To increase gas yield, they purchase and add to the STP some Fat, Oil or Grease (F O G). This is so successful that they earn income from exporting surplus power to the grid.

In cities wishing to manage their unmixed wet waste in a decentralized way, shredding and adding it to sewage sludge in existing STP biodigesters is a very cost-effective option and will also increase gas yield. Non-veg waste free of feathers and fish-scales can also go into biogas digesters.

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## 5.12 HOTEL AND EATERY WASTE MANAGEMENT

Hotels, party halls and eateries need to sort their waste into three categories.

Kitchen and food waste (before and after cooking) is good biodegradable wet waste. It is best fed into a biogas unit onsite to produce cooking-gas for their own kitchen. Adding kitchen-vessel and plate wash-water into the biogas unit helps produce more gas. Or it can be sent to piggeries (if tea leaves and coffee grounds and lemon peels are kept out of it). Or it can be collected by a central biogas-bottling plant.

Clean dry recyclable waste (packaging, rinsed PET bottles and Tetrapaks etc) can be sold to waste-buyers or given away to waste-pickers.

**Soiled recyclables like disposable** plastic plates and paper tea-cups are a problem and must not be mixed with the clean dry recyclables. Disposables must be avoided and washable items used instead. Some items like soiled ice-cream and yogurt cups and plastic spoons etc can be thrown directly into a mesh basket immersed in water with a little detergent. The mesh basket can be lifted up for drip-drying so that the items become saleable and recyclable like other dry waste. Plastic film table-cloths must be banned by the city, as these are often rolled up along with disposables and leftover food and cause cattle deaths when eaten.

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### 5.13 TENDER COCONUT SHELLS AND BAGASSE MANAGEMENT

These are a very bulky problem, hard to compost and a breeding point for mosquitos carrying dengue, chikungunya etc.

The simplest solution is to require coconut vendors to have trade licences on nominal charge but subject to the condition that they **cut every tender-coconut shell into four quarters** before discarding it, whether there is edible solid (malai) in it or not. Cutting it in half will not do as even halves can hold the spoonful of water that a mosquito requires to breed in. The quartered coconuts dry faster and hence have some sale value rather than a disposal cost. They can be used in brick kilns etc.

In Bangalore, they are being collected at source by dedicated vehicles for shredding, drying and **converting to fuel briquettes and pellets** for value addition. Such units are financially viable without city support beyond land, shed and access to 30HP power. They can also collect and briquette the bulky bagasse waste from inner-city sugarcane-juice stalls. Briquetting banana-stalks is being tried also.

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### 5.14 NEW WASTE-MANAGEMENT DEVELOPMENTS

Some new waste-processing developments have not been mentioned in the MSW Rules 2000 but are worth considering and are given below.

1, Tender coconut shells and sugarcane-juice waste bagasse are bulky trade wastes which are difficult to compost. These can now be shredded, dried and extruded into **fuel briquettes or fuel pellets**.

2, Wet waste is also being squeezed, dried and converted to fuel briquettes. The squeezed liquid is converted to biogas and used to heat the dryer. The clear biogas slurry is a useful **liquid fertilizer**.

3, Largescale biomethanation is becoming sophisticated, with remote monitoring and control with the **bottled biogas** supplied as LPG substitute in the hotel or community kitchen producing bulk food waste. For larger quantities of waste, scrubbing and bottling of biogas as an LPG gas substitute is now becoming more and more economically viable.

4, '**Plastic Roads**' can consume waste carrybags, non-recyclable shredded snack-food sachets, thermocole and soiled thin-film waste to produce bitumen (asphalt, tar) roads with more than double normal life. See Section 5.2. The shredded plastic is added to the fully-hot stones and mixed for 30 seconds to soften and stick onto the stones like a baked-on primer coat. When molten tar is poured on for a further 3-4 minutes of mixing, it binds much more firmly to the coated stones. PET and PVC cannot be used for Plastic Roads.

Plastic Roads have become State policy for all roads in Himachal Pradesh and was pioneered and promoted widely in Tamil Nadu. It has been approved by the Indian Roads Congress so all cities should immediately include it in their road tenders.

5, **P2F or Polymer To Fuel** (see Section 1.45) is a low-temperature depolymerisation (below 450°C) process to convert unwanted plastics to a diesel substitute, gas (used on-site for the heating process) and char. This process is recommended as a part of Integrated Solid Waste Management in the Planning Commissions 'Kasturirangan Report' on WTE dated May 2014. Build-own-operate facilities are now more viable as diesel price is decontrolled.

6, High-calorie hard-to-recycle wastes like vehicle tyres and unwanted plastic packaging of all kinds can be compacted and baled and shipped to the nearest cement plant for use as **AFR = Alternate Fuel** resources instead of coal in cement-making. Plastics require mechanical/hydraulic compacting into bales to make the waste transport cost-effective.

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## **5.15 Handling emergency situations**

There will sometimes be emergencies like waste-worker strikes, road-blockages to badly-managed dumpsites, or even earthquakes, floods or storms which may require several days or weeks for life to return to normal. Two emergency responses are immediately necessary. First, ask all citizens to stop throwing out any dry waste and bury their wet waste within their premises where space permits. Secondly, treat any wet waste piles decomposing on city streets with composting biocultures or a 5% dilution of fresh cowdung to control smell. Citronella / lemon-grass oil can be diluted 1:100 and sprayed on waste heaps to mask the smell.

When normalcy returns, waste must always be unloaded in wind-rows which can be turned weekly for aeration and stabilising, and not dumped in huge piles or compacted by bulldozers.

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## **CHAPTER 6: MILLION PLUS CITIES, POPULATION OVER 10 LAKH**

In 2011 these 53 cities, including 3 Mega cities over 10 million (Greater Mumbai, Delhi, Kolkata) had a combined population of 161 million or 42% of our total urban population.

All million-plus cities are growing fast and so need long-term planning and a city-specific **Waste Management Plan**. All of the suggestions given above and in the Supreme Court Committee Report can form part of the customized plan.

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### **6.1 STATE WASTE MANAGEMENT AUTHORITY**

An autonomous body like a Water Supply Board or ESCOM should be created to provide vision, a long-term Waste Management Plan and continuity of policy, strategies and decisions. This is necessary to insulate city management practices from the changeable decisions of new Commissioners, new mayors and elected councillors (many of whom have a conflict of interest with waste-management contracts) and changing political majorities which may or may not match the ruling parties at State or Centre.

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### **6.2 CONSUME STABILIZED WASTE WITHIN THE CITY**

The main difference between large cities below and above 1 million is that in million-plus and mega-cities, farmlands are much farther away from city limits. These are also sprawling cities where decentralized Ward-wise or at least Zone-wise waste management is very necessary for both cleanliness and cost-effectiveness and transport savings and decongestion of traffic.

Here, the stabilized wet waste needs to be consumed within the city's parks, roadside plantings, road dividers and traffic islands for use as organic manure. The surplus may need to be given away at nominal cost, or delivered at the city's cost to farms or to compost plants outside the city where the stabilized

waste can be sieved, enriched and bagged for sale as compost meeting FCO standards.

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### **6.3 WASTE COLLECTION IN SLUMS**

Slums are 'authorized' or 'unauthorized' unplanned areas of our largest cities where there are poor or no civic services like power, water supply, drainage or sewage management and waste collection. In the largest cities, only pedestrian movement is possible within some slums and even bicycles cannot enter.

Cities are only as clean as their dirtiest areas, so city managers must give their poorest the priority that Gandhiji always kept in mind. Only political and administrative will is needed to keep slums clean.

Waste collection is easiest in slums, because slum dwellers are always the most neglected sector for waste collection. They desire and understand the need for a clean environment and the costs of ill health, so they are the most willing to cooperate in improved waste management efforts. Slum dwellers are also the most willing to pay for regular and dependable good waste management despite lower incomes. But no user fees are needed if on-site composting can save transport costs for the city.

There are several easy proven methods for slum wet waste collection and treatment :

- 1, Shared bins for on-site composting
- 2, Shared biogas units to produce cooking gas for community kitchens
- 3, Door-to-door collection in handcarts
- 4, A lorry at the slum entrance
- 5, Community bio-bins
- 6, Exchangeable bins at the slum entrance
- 7, Take-away bins in narrow lanes

**The slum-dwellers need to be consulted** on which system they would prefer.

1, **Shared Bins for on-site composting** are large barrels raised slightly off the ground on bricks, with a perforated bottom and sides, into which 4-5 self-selected families deposit their unmixed wet waste daily. These thin layers are self-aerating and do not smell. The drum has a small door near the bottom to remove the fully matured compost. NGOs regularly purchase this compost from them to motivate careful use of drums and addition of plastics-free waste.

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2, **Shared biogas units** receiving wet waste from a group of families can provide cooking gas to one or more of them or to a community kitchen where residents bring their own vessels and food ingredients for cooking. Gas production is very much more if the biogas unit of a community toilet is used for both sewage treatment and wet waste treatment. Prior social acceptability is necessary but possible.

3, If lanes are wide enough, the usual **pushcarts** may be used for doorstep collection of wet waste which is brought out of the slum.

4, where lanes are too narrow, residents walk to slum entrance and dump their waste just outside the slum. It takes a half-hour to clear this heap. Instead, an **empty truck can wait at that spot punctually for a half-hour** while the cleaner walks through the slum whistling to invite residents to come deposit their waste directly into the waiting truck and NOT on the road at any time.

5, **Community bio-bins** can be placed at the same slum entrance or earlier dump for wet waste to be deposited into a biobin (one pair for 40 kg per day). Residents can be paid for the compost thus produced.

6, In smaller unrecognized clusters, or where workers leave before dawn, if one family or shop near the entrance will take the responsibility for it, a bin is kept at the former 'black spot' location to receive only wet waste : a 50 litre bin for every 50 houses. At the transporter's convenient time, the **filled bin is taken away and replaced by an empty one** for next morning, which the in-charge resident or shop keeps safely indoors until it is put out early the next morning.

7, In a huge slum in Mumbai, the slum association appointed youths for cleaning work and **take-away bins**, before they go to college or jobs, paid for by resident contributions of Rs 5-10 per family per month. Road-facing shops pay more.

A mass clean-up drive is a must, immediately before the new system is started:

7-8am : narrow open drains beside internal paths are swept clean.

8am : 50-litre bins given by the city are **placed at internal path crossings**, one per 25 homes or so.

8-10 am : waste is carried from each home to nearest bin at residents' convenient time, often by tiny tots.

10-11 am : All bins are removed and unloaded directly into a waiting truck outside the slum. Daily punctuality by the city truck is vital !!

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11-11:30 am: Bins are stacked till next day in a protected open space (timber-yard etc). Youths leave for college or jobs.

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## 6.4 MANPOWER MANAGEMENT

It is very important to keep permanent workers contented by prompt payment in exchange for work performance upto pre-set norms and targets. Avoid 'group work' and instead allocate 'pin-point beats' such as cleaning a specific assigned half-kilometer of roadside drain or stretch of storm-drain to one specific person. This improves work accountability.

Discontinue unproductive work like sprinkling lime powder as 'VIP Rangoli' which requires time to both spread on one day and remove the next day. Instead, paint permanent white lines along road edges which will show equally well whether the road has been properly swept or not.

Strictly control the tendency of councillors to demand the free and unauthorised services of cleanliness workers as their gardeners, car cleaners, house help etc. Also strictly discourage the tendency of councillors to demand attendance of supervisory staff and lower-level officers at their residences in the mornings. These persons are needed all morning in the field for effective supervision. They should report to councillors' homes not more than once a week, only in the afternoons, or to attend monthly Ward Committee meetings.

## 6.5 OUTSOURCING WASTE MANAGEMENT SERVICES

This is recommended **only for the largest cities**, especially in **unserved areas** where the cities have expanded by absorbing surrounding villages without earlier waste-collection services.

**Never outsource more than 50%** of total waste-collection operations to one or more service providers, to keep a balance between permanent employees' labour unions and private companies which badly exploit cities where they control the full operations.

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## 6.6 CONTRACT MANAGEMENT

When cleaning work is outsourced to private parties, the contract should never be given only on a per-ton-payment basis or per-trip distance-based basis. This encourages a countrywide malpractice of resisting waste minimization and falsifying bills for trips made. Per-ton payment also encourages the mixing of heavy debris into mixed waste or even wet waste. So payment should be based



on a maximum allowed weight per vehicle volume, as one cubic meter of wet waste should weigh only about half a ton. (density 0.5 to 0.6 kg per cubic meter).

**Contracts can preferably be given on a per-capita or per-household basis** depending on the population of the area to be covered. This will encourage contractors to find ways to minimize the waste they have to transport over long distances. Instead they will make the same money as before by unloading dry waste within the ward and preferring decentralized waste-management points like bio-methanation units or stack composting.

It is easy to calculate say the per-household rate by dividing the cost of an earlier tender amount by the number of census households in the given area. The city can then fix the same per-household rate as the base price (or with slight escalation) and invite tenderers to bid at or below that indicated per-household rate to win contracts.

Tender renewals or fresh tenders become very easy by just adjusting for the number of households added in the meantime.

There should be minimum insistence on expensive vehicles like compactors. Contractors should be urged to adopt micro-pocket push-cart collection which enables doorstep sorting and sub-sorting of wastes. They should be left free to opt for the most cost-effective and convenient secondary-transport methods they choose, provided there are no citizen complaints of poor service and no spillage of waste or dripping of leachate on the roads they pass through.

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## **6.7 RECOGNIZING THE INFORMAL SECTOR**

For decades, waste-pickers, 'kabadiwalas' and scrap buyers have provided free services to cities in minimizing their waste quantities by collection and recycling. So far this has been done in the most inhuman conditions, and with police harassment and denial of access to waste. With doorstep collection of unmixed waste, the doorstep collectors themselves should be allowed to sell their sorted recyclables and retain the earnings from it. Waste-pickers may also be permitted to voluntarily follow the 2-man pushcart collection teams if it suits both parties.

Some cities are preferentially awarding some percentage of their outsourced contracts to Self-Help Groups of waste-pickers or giving them **Identity Cards to avoid police harassment**. This has greatly benefited cities who are sincere about their upliftment by prompt payment for services rendered.

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## 6.8 NO TIPPING FEE, ONLY SUPPORT PRICE PAYMENTS

If outsourcing is done for processing and disposal activities, **payment should never be on the basis of waste tonnage** or volume received at the site. This encourages acceptance of waste without doing any processing. This leads to enormous concentrated pollution, local unrest, loss of a potential waste-processing site and resistance to opening of new sites.

Instead, **payment should only be an output-based support price**, based on quantity of compost or biogas or briquettes or P2F fuel produced. Only this can ensure that contractors will try to maximize actual processing into such products.

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## 6.9 CLEANUP OF OLD OPEN DUMPS BY 'BIO-MINING'

Until 1960s, all urban households threw out only kitchen waste and some paper and leaves. Farmers eagerly emptied urban dustbins to take the pure wet waste in them back to their farms for composting.

Two things changed in the sixties: plastic waste began to be thrown out along with kitchen waste, making it unusable for farmers. Secondly, massive subsidies on urea killed the composting habit.

So mixed waste began to be dumped in the open outside towns and along highways, breeding huge numbers of aggressive stray dogs as well as flies, mosquitoes, rats and other pests. The MSW Rules 2000, forty years later, tried to correct this by requiring hygienic ecofriendly composting in special sites.

All Indian villages, towns and cities today, from the smallest to the largest, have open dumps where waste has been deposited at least from the sixties. As building activity increased, debris also began to be collected and dumped along with mixed waste. Some cities wrongly cover the open dumps of mixed waste with layers of debris or soil, making everything even more unusable.

These **old dumps need to be cleared** for many reasons: to reduce the methane and leachate still coming out of them for years to come, to remove such dumps as towns and cities grow, and to clear these spaces to ground level for re-use as waste-processing sites.

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We have many successful examples of clearing all existing dumps of untreated garbage by 'Biomining', which can remove and usefully re-use upto 90% of the old dump, without moving it to another place. Steps are:

a, **Sprinkle** the surface with a composting bioculture solution or a dilute solution of 5% fresh cowdung in water. This will control smell and speed up decomposition.

b, **Loosen** the surface to a depth of 200 to 400 cm with a tractor-mounted cultivator (harrow).

c, Hire wastepickers or labour to **manually pick out bulky waste** like coconut shells, banana stems, tyres and rocks. Store in separate heaps for sale or use.

d, With a JCB or earthmover, form the loosened top material into long heaps (**wind-rows**) 2m to 2.5 meters high.

e, **Turn** these windrow heaps once a week for 4 weeks as is done for fresh waste. The volume will reduce by 40% and the waste will be fully stabilized, meaning that there will be no smell or leachate formation and the material will be dry enough for sieving.

f, **Screen** the stabilized waste in a rotary screen or gravity screens of different size openings, preferably 100 mm, 35mm and 8mm. A fan can blow out the plastic fraction for use by recyclers.

g, **Use the different fractions** for different purposes. The finest fraction will be organic matter plus fine soil, called 'bio-earth', which can be used as soil improver, especially for restoring alkaline or saline soils to fertility. The next coarser fraction will be gravel and coarse organics, which can be used on road and railway embankments to grow some vegetation for erosion control. It is also useful as a lawn subgrade cum drainage layer, or it can be used as organic manure in tree pits. The next coarser fraction may have a lot of combustibles (cloth etc) which can be baled and supplied as AFR (Alternate Fuel Resources) in cement kilns or boilers.

h, The heavy fractions may be sand and gravel usable for **road shoulders** or soil/earth for **plinth filling**. Stones and concrete if any can be used for **road sub-grade**, or crushing for **recycling and reuse** in the construction industry.

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i, **About 10%** will be unwanted and can be **leveled on site** to raise the ground level slightly for future use. Reclaimed space can be reused for waste processing or alternate non-habitation uses .

## **6.10 SOLID WASTE MANAGEMENT MISSION**

To achieve all of the above, India needs a dedicated **National Urban Solid Waste Management Mission (NUSWAM) to meet 2019 deadlines** for clean cities in focused mission mode.

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## CHAPTER 7: COMMUNICATING & SHARING – IEC

### 7.1 CHANGING ATTITUDES, BEHAVIOR AND HABITS

This is necessary if we want a 'Swachh Bharat'.

Everything written above is Information. It needs to be used to Educate all and to Communicate it effectively to change the behavior of everyone : those who provide waste management services and those who receive them.

It is important to share all the above information and ideas with everyone concerned with managing waste, from State policymakers, elected and appointed city officers, implementing officials, field supervisors and waste-collection workers and to every citizen, including those who throw out waste from homes, offices and shops and institutions and those like waste-pickers and recyclers who serve the city for free, as well as those who create the use-and-throw packaging waste covered by EPR laws. All of these are collectively called stake-holders.

The different stake-holders need to be addressed in single groups of single types for some tasks, and in mixed groups to help them understand each other. For example :

Municipal staff and field workers all feel that though they are engaged round the clock in sweeping, cleaning drains and lifting waste regularly, **'It is the People who have to be blamed'** : they are apathetic, do not segregate and throw waste anywhere, everywhere and at any time. They feel unempowered and unable to collect user charges or enforce discipline through penalties.

Citizens everywhere complain that even when they make an effort to give wastes separately, workers take what they want, **mix all waste together "in front of our eyes"** and simply dump it outside the town or burn it. They complain of irregular and unpunctual service and resent paying more for their waste to be simply dumped on others when they already pay taxes.

Both service providers and service receivers yearn for better management.

Both of them can get this with the proven and successful common-sense approach described above, of micro-planning in both small and large cities to ensure punctual regular service with effective means of collecting as well as transporting wastes in separate segregated streams to convert waste to resources and leave nothing for dumping.

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## 7.2 SET QUICK DEADLINES TO ENSURE SUCCESS

Very many towns and cities have achieved 100% doorstep collection, 70% receipt of unmixed wet-dry wastes, transport of wet and dry to different destinations for 90% processing in just one to three months. Long-term targets rarely work, as both service providers and service receivers will wait till the last minute to do the right thing. Just provide adequate micro-planning and sufficient pushcarts and manpower and start at once with on-job training. Then use IEC alongside this effort.

## 7.3 IEC = INFORMATION, EDUCATION AND COMMUNICATION

This uses standard methods and tools, described below to help both sides understand each other and change behavior for the good of all.

It is always vital to first address the question of **What Is In It For Me?**

**People** will get better service, a cleaner environment, health benefits and decreased absenteeism from school and work.

**Municipal Workers** can get work done smarter and more hygienically with a chance to earn additional income from clean dry waste.

**Urban Local Bodies** will see cost reduction, monetary benefits and positive environmental impacts and a sense of self-confidence in achieving common-sense solutions based on practical success stories. Councillors will be appreciated.

Next give all a clear **Vision**, mutual understanding and appreciation of each others' roles and responsibilities and the way forward. This will generate not only cooperative behavior on both sides but also bring in donations of pushcarts and other items from an enthusiastic appreciative public in towns with tight budgets or slow and cumbersome tender and procurement procedures.

Create, explain and persist with **sustainable set procedures** for Collection, Transportation, Processing, Worker Benefits and also user-friendly ways to receive and promptly solve complaints.

## 7.4 PASSIVE AND INTERACTIVE IEC

Conventional ways of information-sharing are posters, banners (PVC-free please!) with simple messages, pamphlets and flyers (which often end up as more waste), catchy call-answering slogans and radio or audio announcements, street plays, rallies and events.

Teachers, religious and political leaders, sports or film stars can help convey messages to change attitudes and behavior.

Use available technology like cellphones, SMS, Facebook and Whatsapp etc to rapidly spread simple messages.

## 7.5 INTERACTIVE IEC IS MORE EFFECTIVE

**Make behavioral change fun and memorable** through contests, quizzes and prizes for school kids, housewives, self-help groups and workers who achieve their targets for waste separation, punctuality, income from recycling and composting etc.

## 7.6 USE BOTH INTENSE AND SUSTAINED IEC

A **Blitz** is where you create a impact, hype and a festive atmosphere for a short-term effort

Use the **Rainfall Drizzle** approach to plan year-long continuous activities to ensure long-term retention of the message of doorstep collection and unmixed transportation of wet and dry wastes. This prolonged exposure to the same message provides the motivation to bring about long-term behavioral change.

## 7.7 MANDATORY MESSAGES IN ALL MEDIA

The hon. Supreme Court on 22/11/1991 in M.C.Mehta v. Union of India suggested to Doordarshan and All India Radio to broadcast daily interesting programmes on environment. The Karnataka High Court on 10 July 2015 cited this binding apex court order and requested Doordarshan and other TV channels to "telecast programs or slides or short films with regard to segregation of waste at source, transporting the segregated waste from the houses to the collection point and from collection point to the processing unit, so that people are educated as also about the nuisance created by littering in public places, so that the future generation would understand the importance of solid waste Management and altogether a new culture would be developed in the society."

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We have had several failures and success stories and learnt a lot from both, in the fourteen years since the Municipal Solid Waste Rules 2000 gave the country a unified road map for waste management: minimize waste to landfill through recycling of dry wastes and biological stabilization of wet wastes to return them to the soil for revitalizing farmland.

1, No-maintenance or low maintenance vehicles work best. Push-carts work better than tricycles. Use double-ball-bearing wheels with solid tyres. (See Annexure B for the most successful model)

2, Unbreakable 60-litre plastic bins work best for wet waste collection.

3, Four-bin push-carts are the most worker-friendly

4, Push-carts with one fully-swivelling rear wheel and two fixed front wheels are easiest to push and turn.

5, Goods autos with bins work better than tipper-autos where waste has to be unloaded on the ground.

6, Highly mechanised consultant-driven solutions are a costly failure, especially when copied from the West where high capital cost to reduce costly labour is their objective. Simple scaling-up of micro-planning from smallest towns to largest works the best and increases employment opportunities.

7, Dumper-placers and containers fail because Indian road surfaces and slow traffic are much worse here than in the West.

8, Street bins, containers, dalaos etc are a failure everywhere. Waste is thrown all around but not inside them and no wet-dry separation of waste is possible to make both wastes usable.

9, Waste decomposes faster in tropical climates so corrosion of metal containers and of sophisticated vehicles is much faster. Cities are not allowed to scrap anything till it is five years old, leading to junkyards of useless equipment.

10, Poor preventive-maintenance habits in India and shortage of spares for imported equipment leads to long down time, disruption of service and resulting loss of trust and cooperation from the public.



11, Compactors make sense in the West where waste is mostly packaging, there is no recycling and volume reductions of 5:1 are possible and required for dumping waste forever in landfills. In India, wet waste cannot be compressed more than 1.5:1 or 2:1 and compressing of dry waste makes its sorting and recycling impossible.

12, Waste stabilizing by unloading in windrows and turning 4-5 times weekly is sufficient to comply with MSW Rules and to directly use it as soil enricher if it is well-segregated wet waste.

13, Leachate recirculation by pumping it from the bottom of a windrow back into the top is the best practice. Its microbial content speeds up composting, and the internal heat of the heap evaporates leachate and reduces its volume.

14, Capping of India's largest waste dumps which do not have bottom or side liners or built-in gas-capture pipes is costly, meaningless and even dangerous as it drives landfill gases into nearby basements.

15, Biomining by scraping, inoculating, heaping, turning and screening yields maximum useful fractions and hardly 10% waste. No methane-generating waste is left onsite for decades for future generations.

16, Dumping mixed waste into quarry-pits or low-lying areas causes rapid, permanent and irreversible pollution of nearby ground-water through cracks in the rocks and the higher pressure of accumulated leachate.

17, Covering mixed-waste heaps with layers of soil ruins nearby hillocks and makes bio-mining difficult and unprofitable.

18, Biomethanation is costlier than composting and requires strictly-segregated wet waste only, but needs far less space and is mostly odour-free and more profitable. It is most useful when it is decentralized and the biogas is used on-site for cooking. Increasing prices of LPG now are making biomethanation more cost-effective.

19, Increasing diesel prices are making P2F (plastics to fuel) more and more attractive a solution for non-recyclable combustibles. [\*\*Back to Top ^\*\*](#)

20, Capping of unlined dumps is dangerous (e.g. Malad in Mumbai). Biomining is easy, far more affordable, eco-friendly and leaves no problems for the future.

## **ANNEXURE A : HAZARDOUS WASTES NEEDING SPECIAL DISPOSAL**

### **A LIST OF SOME DOMESTIC HAZARDOUS WASTES**

Aerosol cans

Batteries from flashlights and button cells

Bleaches and household kitchen and drain cleaning agents

Car batteries, oil filters and car care products and consumables

Chemicals and solvents and their empty containers

Cosmetic items, chemical-based

Injection needles and syringes after destroying them both

Insecticides and their empty containers

Light bulbs, tube-lights and compact fluorescent lamps (CFL) Medicines, discarded

Paints, oils, lubricants, glues, thinners, and their empty containers

Pesticides and herbicides and their empty containers

Photographic chemicals

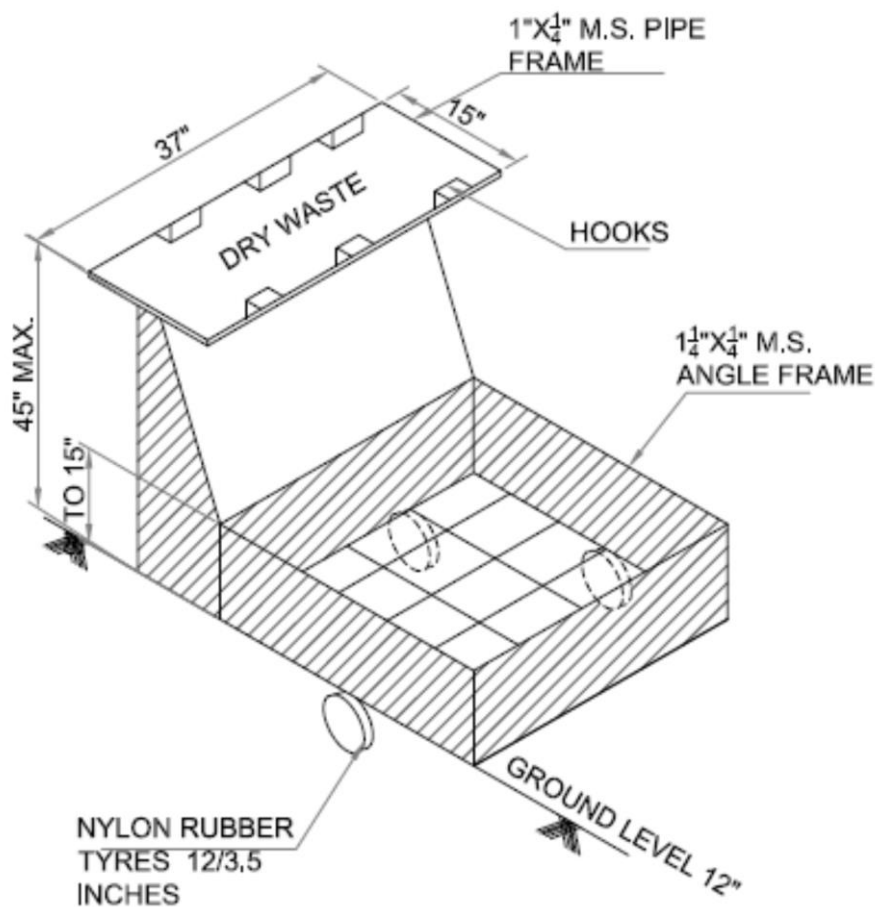
Styrofoam and soft foam packaging from new equipment

Thermometers and mercury-containing products

**NOTE:** Domestic sanitary wastes like used sanitary napkins, used baby or adult diapers, used bandages and dressings are not “Hazardous wastes” but need separate collection to a separate destination, preferably a Biomedical waste management facility. These should not be mixed with ‘wet’ food waste or ‘dry’ recyclables or the above hazardous wastes.

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## ANNEXURE B : RECOMMENDED PROVEN PUSH-CART DESIGN



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## Model Primary Collection Push Cart

- MS is Economical / SS is rust-proof but costly
- Capable of holding 4 bins with lids  
Either 60 Litres / 80 Litre capacity
- Every PC to have 1 or 2 Separation Tubs of 20 Ltrs for source separation of resources
- Handle frame suitable to tie 2/4/6/8 Dry resource bags (HDPE)
- Workers need to be supplied full personnel protective gear; Caps, Masks, Aprons, Gloves



## Dry Resource Bags at the back of cart

The handle is designed as a frame to suit both navigation purpose and tie bags.

Gap in handle frames: 15" to tie dry resource bags

The size of bags can vary as per the types of waste streams workers separate at Push-Cart level.

Minium 4 recommended:

1. Paper Recyclable
2. Plastic Recyclable
3. Mixed low valve recyclable /non-recyclable
4. Household bio hazards like sanitary napkins and diapers

HDPE Bags are recommended to last 1 year



The 2 front wheels and 1 at the back of the Push-Cart are called SRT (Steel Rim Tyres) with double ball bearings and nylon rubber tyres. The bracket at the back should be heavy duty with bearing movable bracket as shown, for easy guiding.



## **ANNEXURE C : NOTE TO SUPREME COURT ON WASTE STABILIZING AND ORDER DATED 28.7.1997 IN WP (C ) 888/96**

### **Note dt 28.7.1997: Immediate Low-Cost Garbage-Sanitization Option**

For the sake of convenience the method described below may be called "biotreatment" [*called waste stabilization in MSW Rules 2000*]. This method can be immediately started at all the existing locations where city garbage is currently dumped. Since no leachate is generated during aerobic composting no site preparation is required and the process is pollution-free. It makes the garbage free of smell and germs and pests, and involves the following steps:

1, Organic garbage should be collected and transported separately from debris or construction and demolition wastes<sup>1</sup>. Plastics should be removed for better results.

2, Garbage collected as at present should not be thrown in pits or deep depressions. It needs to be placed on level or open ground in long high heaps called wind-rows, parallel to each other with working space between for people or machinery to turn and aerate it at intervals<sup>2</sup>. Heaps or rows should be minimum 4-10 ft high for best results.

3, During unloading and placement of garbage in such wind-rows, it should be moistened (by splashing, sprinkling or spraying) at every 6-inch layer or so with any one or more of the following bio-treatment starter solutions<sup>3</sup> to trigger the aerobic composting process and give it a direction that prevents formation of foul smell and methane gas. The choice depends on local availability, transport costs, convenience and the result of successful practical field trials, judged by rapid reduction of foul smell in the garbage.<sup>1</sup>

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<sup>1</sup> House-to-house garbage collection by bell-system in mobile dustbins is the most effective means of segregated garbage collection and need not entail additional cost in most Municipalities. A separate Note on this will be filed later.

<sup>2</sup> Turning garbage heaps at intervals is necessary to allow air to reach the compost-forming microbes. Garbage piles without air will stink as they rot.

<sup>3</sup> Cowdung, village compost and commercial bio cultures all contain aerobic (air-needing) microbes that can digest cellulose. Most organic garbage is vegetable matter which is mostly cellulose.

Some bio-treatment solutions are:

- i) 5-10 percent-by-weight solution of fresh cow dung (preferably only 1-3 days old)
- ii) 10-15 percent by weight suspension in water of good<sup>4</sup> recent compost from a rural village compost-heap (where cattle-shed sweepings, farm and kitchen wastes etc are stock-piled together as fertilizer for agriculture).
- iii) 5-10 percent by weight suspension in water of commercially-available compost (from garbage or agro-wastes) sold in bags at plant nurseries or fertilizer shops.
- iv) 0.5-2% solution of Composting Bio-cultures specifically produced for the purpose by reputed or certified firms. Only Indian bio-cultures should be used.
- v) After bio-treatment with any of the above wetting-solutions has produced a good compost at the dumpsite, found useful by farmers, then that compost itself can be used in solution as 'starter' and outside material needs to be used only occasionally to keep the process going well. Pesticides or chemicals must NOT be used.

4, within 5-15 days, if the garbage has been well-moistened and kept moist, the heap will become quite hot inside. This heat of fermentation is necessary to kill off germs and pathogens and weed-seeds, but the heap should not be allowed to become so hot that it starts to dry out and smoke or burn.

5, As soon as (but not before) the heap of garbage becomes too hot to push one's hand inside, the heap should be turned (manually or by JCB or loader) to form a parallel new heap, in which the outer layer of undecomposed garbage forms the centre of the new heap, and the partly-rotted central portion of the old heap covers this up.

6, while forming this new heap, the partly-rotted garbage should again be moistened in layers with one of the above compost-starters (cowdung etc).

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<sup>4</sup> "good" compost looks like crumbly moist dark soil and has an 'earthy' smell like that after rain.

7, Repeat steps 5 and 6 once or twice more. The garbage in 1 or 2 month's time will have reduced in volume to about one-third of original, and decomposed into dark semi-dry soil-like matter which is an ideal bio-fertilizer for farm use that increases crop productivity. Farmers may need or want it only prior to monsoons in rain-fed areas. It will not deteriorate on storage for a season. The heaps can be sold or auctioned, or initially farmers can even be encouraged to collect it free to minimize the area of land needed annually for garbage treatment.

8, In order to encourage farmer use of decomposed garbage which is free from smell and germs, and to promote public health, it is absolutely necessary to immediately ban the lifting of raw garbage directly from markets and dustbins for dumping uncovered and untreated on farmland outside the town or city. This is a common practice which breeds flies and mosquitoes and rats, attracts dogs that live on rubbish-heaps and pose a rabies threat, pollutes groundwater and is an offensive nuisance to villagers living near the fields where raw garbage is open-dumped.

9, These bio-treatment operations are best managed by farmers co-ops or other beneficiaries of the end-product. Where there is little farmer demand, after the raw garbage is made inoffensive and disease-free by bio-treatment, it can safely be used for landfill, or levelled for developing a lush park, or the site can be leased at a good price for growing crops in situ for a couple of seasons before that part of the site is reused.

10, This well-decomposed stabilized garbage is the first stage of any compost-plant operations. It is not commercially marketable unless it has been sieved to remove glass and plastic, stones and metal, undecomposed tender-coconut-shells and branches, and bagged and labelled after proper quality-control. The major capital expenditure for compost plants is for equipment and operating cost for sieving, testing, blending, packing etc, which can be added in stages as funds permit.

Entrepreneurs can be encouraged to invest in full compost plants by offering them, at nominal cost on a long-term basis, the land and garbage presently being used for open- dumping. Compost-plants run by Municipalities usually fail because their marketing skills are poor, so sales do not cover compost-plant costs. Inventory costs are also high if compost needs to be stockpiled till the next planting season. Yet bio-treatment of raw garbage to produce germ-free compost in a non-polluting ways needs to be done for its own sake on health grounds alone.

**Supreme Court Order dt 28.7.14 in WP (C ) 888/96:**

"The respondents are directed to consider low cost waste sanitization option. They may be required to file an affidavit in reply within four weeks, stating whether this Bio-treatment methods can be implemented. In the event that the answering respondents find that the proposed Bio-treatment method is unfeasible or other scientific waste disposal method is more appropriate then the answering respondent is directed to set out reason and conclusion for the same.

The respondents are directed to include in their affidavits a time bound scheme for implementation of scientific and hygienic methods of waste disposal. The respondents are directed to seek expert advice in respect of mosquito, flies and other Vectors Control.

The respondents are directed immediately to take steps to phase out the routine use of insecticides like DDT and BHC and similar dangerous insecticides on garbage heaps and dump sites.

The Central Pollution Control Board and all State Pollution Control Boards should ensure compliance of the provisions of the Water (Prevention and Control of Pollution) Act, 1974, by everyone including the local bodies. The respondents are also required to file affidavit of compliance of these directions within eight weeks."

*[None of 41 respondents dissented with the suggestions in the above Note]*

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## **ANNEXURE D : REFERENCES**

**1, Municipal Solid waste (Management & Handling) Rules 2000**

[www.moef.nic.in/legis/hsm/mswmhr.htm](http://www.moef.nic.in/legis/hsm/mswmhr.htm)

**2, SWM in Class 1 Cities March 1999 Report of Supreme Court Committee.**

**3, Planning Commission (Kasturirangan) Report May 2014, especially Chapter 10 : Recommendations**

[http://www.planningcommission.nic.in/reports/genrep/rep\\_wte1205.pdf](http://www.planningcommission.nic.in/reports/genrep/rep_wte1205.pdf)

**4, Municipal Waste Management**

<http://mpcb.gov.in/municipal/recomend.php>:

**5, [www.almitrapatel.com](http://www.almitrapatel.com) For best practices**

**6, <http://www.emro.who.int/child-health/community/information-education-communication.html> for IEC info**

**7, Plastic Wastes (Mgt & handling) Rules 2011**

<http://www.moef.nic.in/downloads/public-information/DOC070211-005.pdf>

**8, Biomedical Waste (Mgt & Handling) Rules 1998**

<http://www.moef.nic.in/legis/hsm/biomed.html>

**NOTE:** The Govt of India Ministry of Environment, Forests and Climate Change invited public comment until 31 July 2015 on several new rules for Management of Solid Waste, Plastics Waste, E-waste, Biomedical Waste, Fly Ash and Hazardous Waste. All these new Rules should be referred to after they have been Notified in the Gazette and become law.

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**On Swachh Bharat website**

[https://swachhbharaturban.gov.in/writereaddata/Swachh\\_Bharat\\_Guidebook\\_v23.pdf](https://swachhbharaturban.gov.in/writereaddata/Swachh_Bharat_Guidebook_v23.pdf)

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