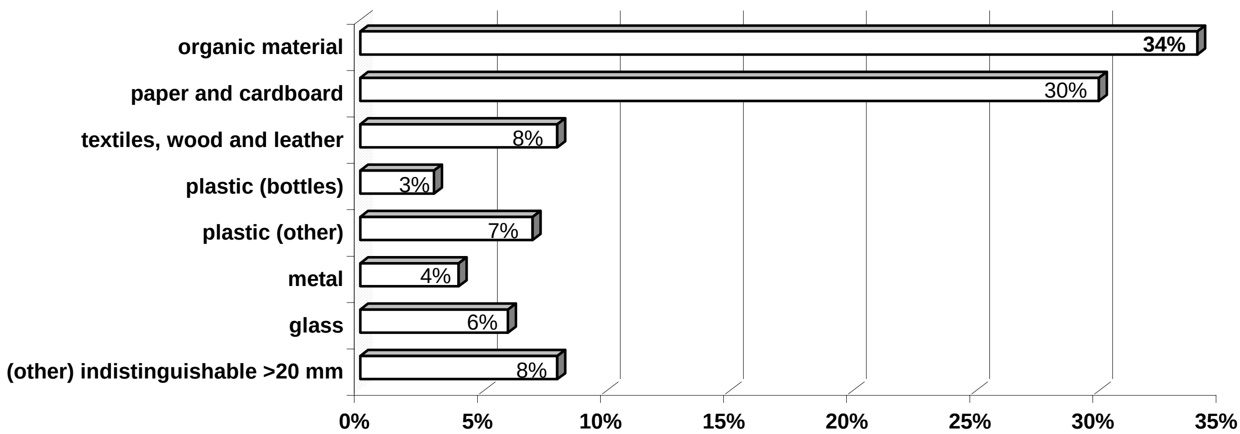
INTRODUCTION

This document, which was prepared by the FWD group of UIDA [Unione Imprese Difesa Ambiente – "Environmental Defense Initiatives Union"] (Member of the ANIMA Federation) is intended for all operators in the industry and the authorities who generally work in the collection and disposal of solid municipal waste.
As is now well-known, Italy is facing a decisive turning-point in the way it manages waste, particularly municipal waste.
A radical change is needed away from the negative habits that in the last forty years have led to a level of environmental degradation unacceptable in a civilized country.
Waste should not be an inconvenience or problem, but an asset and a resource. This is the goal of community standards adopted in the nation.
To move from words to deeds, new and more efficient economic activities connected to waste should be and can be created. This can often be achieved partly through the aid of technological innovation.
It is just as clear that this change can find its lifeblood in the actions of individuals, whether they be representatives of the public administration, operators in the industry, or even private citizens who, as they are not professionals in the field, should, all the more, find a convenient aid in ease of use.

SEPARATE COLLECTION OF SOLID MUNICIPAL WASTE

In Italy, the composition of the SMW varies quite a lot depending on the areas studied.
It is nonetheless possible to identify a composition type within which the different parts have more or less the following percentages by weight:



This means that in theory a separate collection system based on the collection of organic materials, glass, plastic packaging, paper and cardboard, could reach the up to 80% of the SMW.
On the one hand, that means strengthening the traditional collection service and, on the other hand, enacting advanced technologies for the treatment of waste.
Studies in the sector have clearly demonstrated that the effectiveness of separate collection is strictly connected to the installation of collection systems closest to the source of production, i.e.: bringing the collection to homes. (**1**)
It is easy to understand how the management of the "dry" fractions does not present particular problems other than in volume, while the organic fraction presents additional problems mainly connected to its fermentability.

For part of the dry fractions, there is already a target market. For the wet fraction, reusing it in the composting industry has encountered obstacles, primarily linked to product purity and, in part, to the reluctance of agriculturalists and nurseries concerned about the excess of salts and various impurities, as well as the low content of nitrogen and phosphorous.
This is why a large part of the wet waste that has been laboriously separated by citizens ends up as a filler of technical compartments of dumps, or, in the best case, used as a filler for highway elevations or environmental renovations.
It follows that only a limited part of that waste finds a use as part of soil improvers sold for agronomic use in flower cultivation, agricultural fertilizers and leisure gardening.

A Possible Solution

UIDA agrees with the opinion held by many (**2**) that the most maligned of the "municipal transport systems", i.e. the sewers, may be usefully employed to move a significant amount of collected organic waste, transporting it to a single collection site, the wastewater treatment plant, that would treat, reuse it and/or finally dispose of it, offering a series of environmental and managerial advantages.
In this transport system, food waste can be conveyed as long as it is first cut into small pieces and made fluid with cold water, making it possible to transport it.
The keystone and first link of the system is the "Food Waste Disposer", which for brevity's sake, we will call "FWD".
Located under the kitchen sink and based on the principle of centrifugal force, it brings kitchen scraps into contact with an abrasive fixed metal ring that reduces the scraps into very small pieces. The sewage produced in this manner reaches the sewage system through the domestic conductors and then the treatment plant.

THE INTERNATIONAL LANDSCAPE

In the United States, the FWD has been widely used since the 1950s and therefore has been thoroughly proven, satisfying tens of millions of users.
Today, a large part of the 110 million operating FWDs in the entire world are installed in the houses of Americans with a degree of saturation at around 48%.
In 2000 over 4.5 million were sold in the U.S. In all American cities, it is now permitted to use them in homes without any restrictions, and in some cities, such as Detroit, Los Angeles and Denver, they are required in new constructions.
The city of New York is a special case in the history of the use of the FWDs. A brief summary of the situation could aid in understanding the reasons for their use or non-use.
In the city of New York, until October of 1997, a ban was in effect against the use of FWDs in areas where wastewater or rainwater flowed in a single sewerage pipe, merited by a series of concerns, the most serious of which included: the risk of frequent obstructions in household pipes and major deposits in the sewerage pipes due to the high quantity of material, especially put into inadequate and out-of-date pipes.
After a preliminary study lasting 21 months ordered by Mayor Giuliani, these doubts were allayed and the ban was lifted. (**3**)
In November of 2000, evidencing the correctness of the decision made (both from an ecological and economic perspective), the city authorities decided to give citizens who wished to install an FWD a waste disposal tax reduction of US$300. (**4**)
In the rest of the world, FWDs are also spreading. It is estimated that the market penetration in Australia and Canada is at 10%, in New Zealand at 20%, while in the remaining countries there is a growth trend, though it is starting at not particularly meaningful levels.
In Europe, FWDs have arrived more recently while, in some countries, other food waste collection systems have been established.
In Great Britain the spread is estimated at 5% while in other countries it is certainly less. In all, it is estimated that about 100,000 FWDs a year have been sold in Europe.

SYSTEM DESCRIPTION

In this section, we would like to contribute to understanding of the parts that constitute this system of collection and food waste disposal.

The Disposer

The device was invented in 1927 by the American architect John Hammes. It is normally applied under the kitchen sink and consists of the following main parts: (**a**) grinding chamber and (**b**) electric motor —

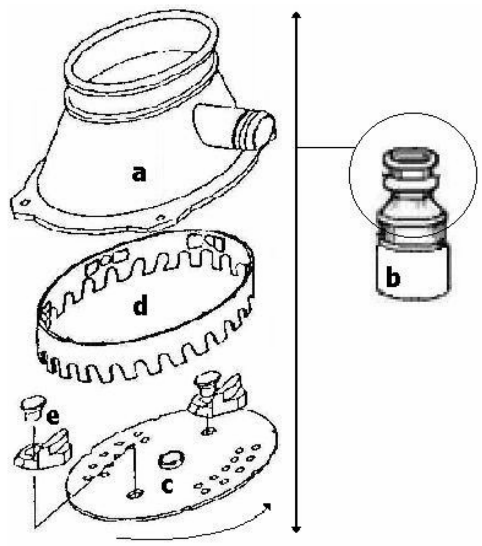
The food waste is put into the disposer together with flowing cold water.

A rotating steel plate is housed in the grinding chamber (**c**) connected to the electric motor that through the use the applied rotation, pushes the waste by centrifugal force against the internal wall.

A fixed, serrated grinding ring is located on that wall (**d**).

The waste pressed against the ring is ground through cutting and abrasion into very small particles that are pushed by the water flow through the small holes in the plate in the wastewater column.

Two metal elements are applied to the rotating disk (**e**) that are able to move in a radial direction (mallets), and contribute to the work of fragmenting the waste.



We must emphasize that, contrary to popular conception, food waste disposers are not equipped with blades.

Sewerage

This is the most fragile element of the system because of the status quo and the characteristics typically connected to local environmental situations (slopes – maintenance status – mixed or separated pipes, etc.).

Nonetheless, as far as the specific impact of the waste that has been ground we can say that:

the increase in water use has been calculated at 2.1 m^3/year per typical family (2.7 individuals). (**5**)

Field tests conducted in Italy (**6**) have shown negligible increases in tank emptying operations.

In Sweden in the city of Surahammar (3,000 FWDs out of 6,000 homes) after months of use of the machines, no particular blockage or sewer overflow problems arose. (**7**)

Laboratory studies conducted in Italy did not show significant increases of deposits or the formation of bio-gas within the sewerage pipes with consideration of the average holding time for an Italian city (**8**).

The Treatment Plant

It is known that the level of Italian systems for purifying municipal wastewater is not comparable to those of other countries, though important steps are being taken in the area.

In some specific cases, including those of large cities or in certain hilly or mountainous areas, the systems are already characterized by “low organic loads”. Put more simply, the wastewater arriving at the treatment plant is not in the most favorable conditions for purification (the quantity of organic material is too diluted).

Among the causes of these conditions, we can note the phenomenon of urban commuting and the high water supply (liters per resident per day).

Staying with general terms, the breaking down of nitrogen and phosphorous in the water exiting the treatment plants, which is a process that in technical terms is defined as “DENITRIFICATION and DEPHOSPHORYLATION”, require, especially in the circumstances cited above, a considerable addition of carbon that is currently supplied in the form of acetic acid, methanol or other substances.

Major studies (**2** and **9**) have shown that an alternative source of these chemical additives could be considered in the quantity of food waste sent to the system through the use of FWDs, thereby achieving an integrated management of the water cycle and waste (of course, of those compatible with the purifying systems, i.e. food waste).

Typical amounts of BOD5, SS, TKN, and TP are listed in Table 1 below.

Table 1	Grams/res./day FWD
BOD5	9.0
COD	18.0
SS	20.0
TKN	1.0
Tot. phos.	0.1
Oils and fats	8.0

Table 2 (**10**) provides the values of the typical amounts generated from an FWD in terms of basic chemical elements.

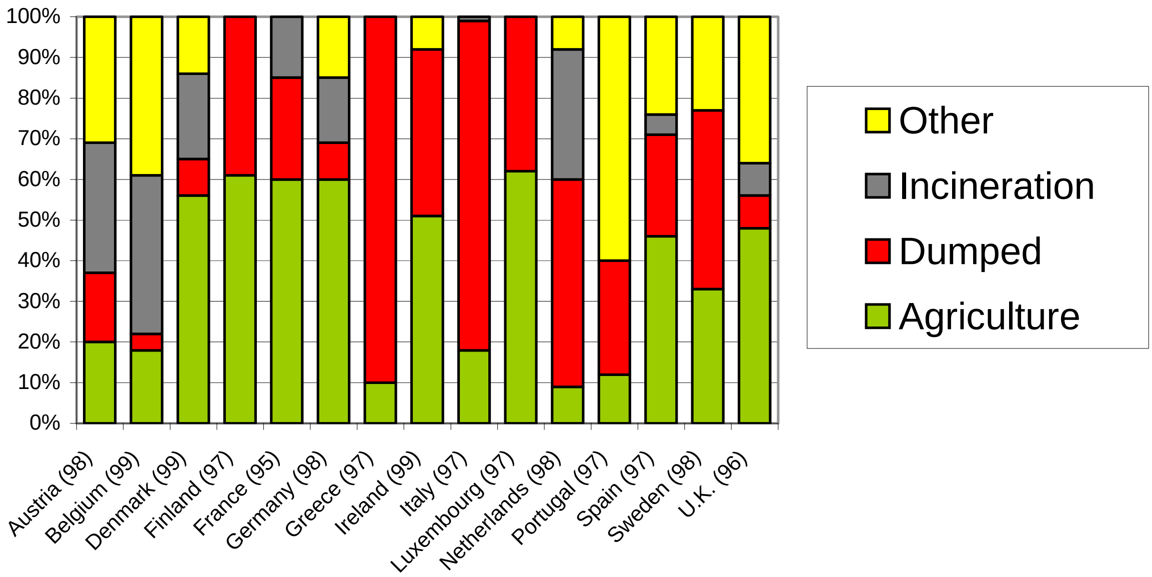
Table 2	%C	%H	%0	%N	%S
Human Waste, Solid Organics	59.7	9.5	23.8	7.0	0
Food Waste, Solid Organics	50.5	6.72	39.6	2.74	0.44

In summary, the water line of a normal treatment plant is not diminished in functionality. The impact can be lesser or greater depending on the installations existing in the area.
Experience shows that up to 15–20% of established users do not result in significant variations in the characteristics of the arriving sewage. Between 20–35%, an increase in energy consumption of the system is observed due to the greater respiration of the active biomass and a larger production of excess sludge. Beyond 35–40% diffusion, additional works must be done to the treatment plant.

The Sludge

The use of FWDs generates primary sludge because it is held in the primary settler or by the fine screen, fuller of organic content than in normal conditions.
If in an anaerobic digester the presence of the grounds can only increase the quantity of biogas produced.
The increase of secondary sludge coming from suspended solids that can be deposited is less than for the primary sludge and is therefore easier to manage.
In the EU member states, in which the effective use of treated sludge has increased, recourse to dumping it for its disposal has inversely decreased.
Approximately 44% is currently used as fertilizer on agricultural terrains. This should increase in the future as this use is considered the best environmental solution as it concludes the Reuse Cycle of the nutrients.

STATISTICS FOR THE USE OF TREATED SLUDGE IN THE EU MEMBER STATES MOST RECENT AVAILABLE DATA



Unacceptable sludge in agriculture can of course find a use in wooded areas, environmental improvements, golf fields, public gardens, etc.
Additionally, in areas in which the desertification of the land is beginning to become a serious problem, its use may be considered a valid alternative.
We would also like to add that the addition of a quantity of organic waste carefully selected through FWDs dilutes the concentration of heavy metals, reducing fears about their agricultural reuse.
We also maintain the opinion that the elimination of heavy metals should be part of a program of action at the source, i.e. before their introduction into the municipal wastewater.
Other laboratory studies indicate that the residue of the grounds in the form of sludge is around 30–50% of the contribution, which is a function of the engineering of the treatment plant.

STANDARDS FRAMEWORK

Italian legislative decree 22/97, the "RONCHI Decree", and Italian Legislative Decree 152/99, subsequently modified in decree 258/2000, are clearly the standards framework for FWDs.
While the separate collection of organic substances and particularly food waste have met with success in specific regional areas, in other circumstances such collection resulted in complex management problems.
Starting from these considerations, it seems logical to examine all of the new solutions that technology offers in so far as they are ecologically acceptable and economically advantageous.
The FWD is certainly among these, as it fragments food waste and mixes it with tap water, producing "wastewater" that can be conveyed through the sewer and to the treatment plant.
Moreover, the "Ronchi" decree 22/97 in articles 5, 6 and 32 establishes that:

a) Actions must be favored that are focused on reducing the quantity and danger of waste products and on developing clean technologies that provide increased savings of natural and economic resources.
b) Actions and measures must be favored that enable the greatest possible recovery and recycling of the substances sent for disposal.
c) The waste must be recovered or disposed of without danger to the health of humans and without using procedures or methods that could cause damage to the environment.

The use of FWDs in the light of the cited standards is an acceptable treatment in that:

- Water (from the tap) and food waste are mixed, which is a treatment operation allowed by art. 6 22/97 "Ronchi" decree in that neither waste product is dangerous.
- The machine does not modify the nature of the waste, only its size (from pieces to grounds).

The mixture (water and fragments) are within the definition of Domestic Wastewater as that which "comes from residential homes and from toilet facilities and derives primarily from the human metabolism and domestic activities".
It also does not seem that the use of FWDs violates the exclusivity right reserved to local authorities in managing municipal waste in that:

- the substance introduced into the public sewer system after the FWD treatment is wastewater regulated by article 35, decree 152/99 and therefore, on the formal level, it goes beyond the area of the judicial exclusivity system provided by decree 22/97.
- the disposal takes place through the public sewerage and water treatment systems and is therefore in basic respect of the exclusivity system.

It is clear that the use of the FWD puts food waste in another perspective due to a technological innovation.
An amusing parallel can be found in a similar situation, though one from long ago.
Up until the second half of the 19th century throughout the world, in the best cases, the collection of human faeces occurred by street collection, transporting sewage in excrement carts. With the invention of the flush toilet by Thomas Crapper, the evacuation of that which could be considered organic waste passed under the jurisdiction of the municipal wastewater with advantages to the environment and society that are clear to all.
The activity of separate collection that the legislature promotes finds a considerable aid in FWDs as these machines that work on the principle of abrading the material using centrifugal force are perfect selectors.
Materials other than food waste are not quite ground (plastic) and may lead to the device jamming as is the case with bottle caps, can tabs or other such items. Furthermore, the entranceway of the machine, limited to the size of a fork tong is an excellent screen for bulkier waste (incidentally, the size screen is the principle applied in the case of door-to-door collection of wet materials through small buckets).

Decrees 152/99 and 258/00 establish that domestic wastewater can always be emptied into the sewers as long the regulations are respected as established by the Manager of Integrated Water Services. The paragraphs 1 and 3 of article 36 provide that the authority in charge of the particular requirements and the residue capacity limits of the treatment system may "authorize the manager of the wastewater system to the disposal of liquid waste limited to the type of those compatible with the purification process."
The 3rd paragraph provides that the management of the water service must be authorized to accept waste consisting of wastewater in the treatment systems so long as:

- the systems have adequate features and purifying capacities and in all cases respect the limit values established by the standard.
- the limit values established for draining into the sewerage are respected.
- they come from the draining of domestic wastewater or even industrial wastewater produced in the same Land Region.

At this point, we must still reestablish if what comes out of an operating FWD can be defined "Domestic Wastewater".
From Article 2 (definitions), of annex 5 of decree 152/99 in addition to numerous laws (**2d**), it can be deduced that wastewater can be defined as that which is composed of a fluid, liquid or semi-liquid (i.e. with suspended solids in it) that can be conveyed in the sewerage system, coming from residential homes and toilet facilities and deriving from the human metabolism and domestic activities.

The European standards landscape, though it has different attitudes, which are also changing over time, presents a situation that we consider as inspired by one of the most correct and basic principles that is defined as the subsidiarity of systems.
In this specific case, this is manifested as the principle of free choice of a waste management system, among a range of options that are substantially equal in their ecological and economic values.
The current situation has:

- no restrictions on use (United Kingdom, Ireland and Portugal)
- permit requested (Denmark, Finland, France, Norway and Sweden)

In light of this, we feel that from a legislative perspective the FWD could be used in the presence of water purification systems as:

- it performs a type of efficient (because residential) separate collection that is highly selective (because mechanical) as oppose to other methods that rely only on individual education —
- it entrusts the remainder of the selection, with reduced volumes, to a secure system (the sewerage) and is does not depend on the good will of the individuals in charge of collection —
- it reuses waste through the use of the sludge and the production of biogas in the water treatment systems —
- it responds to the principle of subsidiarity described above —
- by eliminating road transportation, it contributes to reducing exhaust emissions —
- it eliminates road leachate and unpleasant odors —

Thoughts on the Use of Food Waste Disposers

We do not feel that there is only one solution in the environmental arena, but that there are different solutions and that this thinking responds to an "environmental-anthropocentric" (**11**) solution with which we entirely agree.
To put it more plainly, we feel that the education of the user to another system (such as, for example, the door-to-door collection of wet waste) has met with success only in certain circumstances with favorable cultural and environmental conditions, while in other circumstances the system found greater or insurmountable problems. The choice should be to offer other systems that can meet with more rapid success with consequent benefits for the environment.

The economic aspect of one system compared to another should not be overlooked.
An important American study (**10**) demonstrated that between five different systems, the one consisting of FWDs/Sewerage/Treatment Plant was the best, in consideration of 12 different economic and ecological parameters. The other four systems considered were: (1) street collection/dumping (2) home collection/composting (3) street collection/incineration (4) FWD/home composting.
The choice of a subsidiary system must also be delegated to the local organization as occurs in the rest of Europe and requires one devolutionary policy director whose responsibility is currently divided among many.
In this case, the responsible choice, for better or worse, will be made by one who knows the specifics of the problems and will personally respond to them.

Moving from general outlines to practice, we would like to list the advantages and disadvantages that are implicit in the use of FWDs as tools of separate collection.
For organization, we have divided them into four categories:

- for the user
- for the environment
- for the public decision makers and managers
- for employment

USER	
ADVANTAGES	DISADVANTAGES
▪ Simplification of the selection of the organic fraction from the remaining SMW fractions ▪ Elimination of placement of wet waste into common collection containers (boxes) ▪ Elimination of temporary storage of food waste needed because of the time frames and frequency of collection ▪ Elimination of unpleasant odors and insects and animals attracted to the waste ▪ Elimination of the risk of pathogens from the aerosol generated by the fermentation of stored waste	▪ Slight increase of water consumption calculated at approximately 1% of the average consumption of a typical family (about 4 Lt./Kg. of food waste) ▪ Negligible increase of electric energy consumption valued at approximately 0.1% of average consumptions of a typical family (average operation time 4 min/day or 8.5 Kwh/year (**5**)) ▪ Cost of purchase and installation of device ▪ Risk of clogging domestic drains if they are old or small – can be solved with enzyme treatments that are currently easy to obtain

PUBLIC DECISION MAKERS AND MANAGERS	
ADVANTAGES	DISADVANTAGES
▪ Low “political” profile of the decision compared to the problems typically connected to choice of dump sites, composting and incineration centers ▪ Excellent acceptance on the part of users, especially once they have “learned” the optimal use of the device ▪ Modular system: installations of devices can be controlled and managed with resulting option of limits (or in extreme cases bans) on the increase in the number of machines if serious problems arise in the sewage/treatment plant system ▪ Savings of management costs in the treatment plant process by the introduction of waste carbon at no cost (denitrification process) (*) ▪ Production of biogas possible given the increase of fermented substances in the primary and secondary sludge (*) ▪ Greater combustion efficiency in the incinerators by the elimination of water in food waste, on average constituting 70% of their weight (*) (**) ▪ Reduction of costs through the decrease of amounts collected (*) ▪ Reduction of costs through the decrease of collection frequency (from bi-weekly to weekly/bi-monthly) (*) ▪ Reduction of costs connected to emergency decisions related to the presence of putrescible fractions (inodorous and toxic) (*) University of Wisconsin study April ’98 (**10**) (**) In the cited study, it is suggested that considering the low thermodynamic performance of incinerating the organic fraction the FWD/treatment plant system should be increasingly promoted as the best way of recycling, as it is “accepted” in the case of other non-combustible fractions (glass and metal)	▪ Possible slight increase in the number of cleaning operations of sewerage system ▪ Possible need of thrust points in the lack of minimal slopes in the sewerage ▪ Adjustment of wastewater treatment system engineering if the degree of penetration of FWDs rises above a certain threshold, on average estimated at between 30% and 40%

ENVIRONMENT	
ADVANTAGES	DISADVANTAGES
▪ Reduction of "greenhouse effect" gas emissions, mainly of methane and carbon dioxide. In the case of methane, it has been calculated that 100 kg. of waste treated with the FWD/treatment plant system or with collection and disposal in dump, the weight ratio of the quantity generated is 1:17,000 if the dump were equipped with an optimal system of gas conveyance, it is estimated that 34% is nonetheless lost in the atmosphere. In this case, the ratio would go down to 1:6,000. ▪ Reduction of exhaust gas of the transportation vehicles used for collection ▪ Decrease of landfill leachate (strongly acidic) that in the case of controlled dumps must be then disposed of in the water purifying systems with new transportation of the waste that has taken on the aspect of sewage ▪ Reduction of the percentage of heavy metals in the treated sludge with resulting improvement in its quality ▪ Reduction of the risk of illegal dumping created by the waste emergencies that finds "justification" in the inodorous emissions created by fermentation and the economic interest of organized crime ▪ Improvement of separate collection of other fractions in terms of amount and quality	▪ Increase in nutrients in surface waters with resulting eutrophication in the absence of purifying systems

EMPLOYMENT	
ADVANTAGES	DISADVANTAGES
▪ Increase of employees for the collection and reuse of other fractions ▪ Increase of specialized and general employment in the construction, installation and maintenance of the FWDs (In England, with a penetration level around 5%, related industries employ about 1,000) (**12**) ▪ Improvement in the work environment for employees in the separation systems through the drastic reduction in the aerosol and fermentation effects ▪ Reduction of discomfort caused by the inodorous emissions during the transportation and disposal of the SMW	▪ Decrease of door-to-door collection employees

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