

Technical reference

“Classification of Disaster Waste”

1 Policies concerning the classification of disaster waste

The feasibility of the quick removal and treatment of disaster waste varies with the recovery phase of the disaster.

- (1) Immediately after the breakout, large debris from collapsed building structures or sediments, mud, driftwood, etc. due to tsunamis and floods should be removed because they are obstacles to life-saving activity/seeking missing people. Also, highly diffusible toxic substances and infectious waste, which may widely affect health, must be placed in isolation.
- (2) At an early recovery phase, temporary evacuees may go back to the residential areas, and so to ensure habitability and safety, the removal of hazardous waste such as asbestos contained in demolished houses, and putrefactive waste such as animal/plant residue or sludge by house cleaning is required. To quickly transport disaster waste to primary temporary storage sites, the route should be secured and therefore debris should be removed.
- (3) In full-scale restoration and reconstruction, to shorten the time to complete the treatment of disaster waste, it is required to promote recycling / thermal utilization and to reduce the amount of disposal by separating waste in secondary temporary storage sites.

It is important that the transition phase from (1) to (2), or duration from (2) to (3) depends a great deal on the type of disaster and the situation of the affected area. Therefore, in the classification of disaster waste, it is also essential to provide information about waste types separated with high priority soon after the occurrences in time series.

Considering the above, for the classification of disaster waste, the characteristics are assembled and described from the following viewpoints.

(a) Hazardousness

Removal of risk relating to toxicity, explosibility, and infectivity is indispensable to prevent secondary damage from disasters. Hazard should be considered in removing collapsed houses, and collecting/carrying out of /treating waste.

(b) Emergency

The waste category that must be quickly removed with high priority will be varied depending on the phase of disaster recoveries such as lifesaving or seeking activity or the recovery of infrastructure. In principle, emergency on the treatment of disaster waste is closely related to the hazardousness. In this series of technical references, waste categorized in high hazardousness will be automatically categorized in a high emergency as well.

(c) Feasibility (Possibility) of Separation

It should be carefully discussed whether the separation of waste is reasonable or not, i.e. not only the easiness of the separation but also the reasons or prospects that the separation promotes recycling and treatment.

2 Important waste types for each disaster

2.1 Classification and comparison in DW guideline and UN-OCHA guideline

The results of comparing the disaster waste classifications between DW guideline, and UN-OCHA guideline, Annex II /III are shown in Table1 as below.

Table 1 Comparison of The DW guideline and UN-OCHA guideline

DW Guideline		UN-OCHA Guideline	
1	Green waste	Vegetation such as fallen trees, glasses and timbers	<i>Not classified in this guideline</i>
2	Building rubble (concrete/brick)	Concrete/bricks *Asbestos should be categorized as	Concrete/bricks
3	Building rubble (woody material)	Timber, wood chips, waste wood (such as column, beam wall-material), bulky items, cables	Timber
4	Building rubble (metal material)	Steel, rebar, aluminum material, etc.	Cables, etc.
5	Household materials	Food wastes, tatami mats, wastes mixed with fibers, paper, wood chips, packaging materials, household furnishing and belongings, other wastes (such as plastics, cardboard, paper)	Household furnishings and belongings
6	Electrical appliances	Televisions, washing machines, and air conditioners discharged from affected houses, which are damaged by disasters and become unusable	
7	Automobiles	Vehicles, motorcycles, and bicycles that are damaged by disasters and cannot be used	
8	Momentos valuables	Albums, photos, Ihai tablets, cash, passbooks, precious metals	
9	Mixed wastes	Mixed wastes consisting of a small amounts of concrete, wood chips, plastics, glass, soil and sand, etc.	Other wastes such plastics, cardboard, paper
10	Vessels	An unusable ship damaged by a disaster	<i>Not classified in this guideline</i>
11	Waste difficult to treat properly	Dangerous goods, such as fire extinguishers, cylinders; and items which are difficult to treat at local government facilities, such as pianos and mattresses (including radiation sources for nondestructive inspection), fishing nets, gypsum boards, etc.	<i>Not classified in this guideline</i>
12	Tsunami sediment	Sand and sludge sediments launched to land from the bottom of the sea as well as farmland soils by tsunami	Soil and sediments
13	Sand and stone	Sand and stone launched to land from mountains, rivers and other areas	Bulky items
14	Household wastes	General and bulky wastes discharged from households	
15	Hazardous wastes	Hydrocarbons, such as oil and fuel; paint; varnishes and solvents; pesticides and fertilizers; medical waste in debris; waste posing healthcare risks; asbestos-containing waste; PCB; infectious waste; chemical substances;	Hazardous materials and substances
16	<i>Not classified in this guideline</i>	Healthcare waste (from clinics and hospitals - not considered as risk waste)	Heavy metal contaminated materials Hydrocarbons such as oil and fuel Paint, varnishes and solvents Pesticides and fertilizers Household cleaning products Medical waste in the debris Health care risk waste Other potential industrial waste
17	Industrial wastes, Commercial	Bulky wastes, hazardous wastes, food wastes, marine products and	Commercial waste Industrial waste
18	Wastes from evacuation centers	Waste discharged from evacuation centers, waste from relief supplies	Food waste Packaging materials Excreta Waste from relief supplies
19	<i>Not classified in this guideline</i>	In post-conflict area	Unexploded Ordnance (UXO) Landmines and ammunition within the debris Military vehicles Phosphorus and other weapon contaminates

(Disaster Waste Guideline for Asia and the Pacific (Ministry of Environment, Japan) and Disaster Waste-Management Guidelines (UN OCHA), modified by authors.)

As a result, the following features were found in the classification in both guidelines.

- In UN-OCHA guidelines No. 16 Healthcare waste (waste from non-hazardous hospitals) is classified, however in DW guidelines does not show that item.
- In UN-OCHA guideline, No. 17 Industrial waste/Commercial waste and No.18 Waste from Evacuation are classified from the viewpoint of source, and Debris is further subdivided by the type of waste.
- No.16 Hazardous wastes are further subdivided into smaller classifications in UN - OCHA guidelines.
- In DW guidelines categorize No. 2 Green Waste (plants garbage), No. 11 Vessel (scrapped vessels), and No. 12 Waste difficult to treat proper.
- In DW guidelines, household waste is classified such as No.5 Household materials and No.14 Household wastes.
- In UN - OCHA guidelines Hazardous waste is classified in both No.18 Industrial waste / Commercial waste and No.16 Hazardous wastes.

2.2 Characteristics of waste types by the disaster in DW Guidelines

In DW guidelines Table 2-4, for each waste type of disaster, such as earthquakes, tsunamis, floods, and typhoons, the disaster waste is divided into two categories; "Frequency/quantity is relatively high" and "Frequency/quantity is normal". Among all disaster wastes "Frequency and quantity are relatively high" is "Mementos, Valuables".

Further, disaster waste caused by volcanic damage will be examined in the future. In UN-OCHA guidelines, wastes due to human disasters like military conflicts are covered along with those due to natural disasters such as earthquakes, floods, tsunamis, typhoons, and hurricanes. Risk assessment using assessment sheets is carried out for each disaster by considering the frequency, waste types, time, location of occurrence, etc.

3 Classification criteria by waste management condition in normal time in each city/region

3.1 Classification criteria by waste management condition in normal time

To properly proceed with disaster waste management, it is important to consider countermeasures according to the characteristics of the target city and region. Categorizing cities and regions the criteria are as follows.

Table 2 Examples of categorization for each city/region

Country – City Name	Collection rate of MSW	Source separation in normal time	Rate of incineration / disposal to be improved *	Result of categorization	Ref: Country GDP per capita at 2020** (USD/year, cap)
Indonesia-Jakarta	80%	Yes	0% / 92.5%	C	3,870
India-Delhi	76%	Yes	32% / 37%	A	1,928
Thailand-Bangkok	100%	Yes	0% / 0%	B	7,187
Malaysia-Kuala Lumpur	80%	Yes	0% / 90%	C	10,412
Vietnam-Hanoi	92%	No	5% / 21%	B	2,786
Vietnam-Ho Chi Minh City	97%	No	0% / 0%	B	2,786
Philippines-Cebu	100%	No	0% / 60%	C	3,299
Philippines-Quezon City	100%	No	0% / 0%	B	3,299

* Disposal to be improved includes open dump, unspecified landfill, waterways/marine disposal or any other inappropriate waste management practice and unaccounted waste

(The World Bank: What a Waste Global Database (2018), <https://datatopics.worldbank.org/what-a-waste/>)

Source for GDP: The World Bank, <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD>

Table 3 Classification of criteria

Indicator	A	B	C
Collection rate of Municipal solid waste	More than 70%	More than 70%	Less than 70%
Source separation in normal situation (Yes/No)	Yes	Yes (partly)	No
Rate of incineration / disposal to be improved	Incineration rate is more than 20% and rate of disposal to be improved is less than 50%	Incineration rate is less than 20% and rate of disposal to be improved is less than 50%	Rate of disposal to be improved is more than 50%

(The World Bank: What a Waste Global Database (2018), <https://datatopics.worldbank.org/what-a-waste/>)

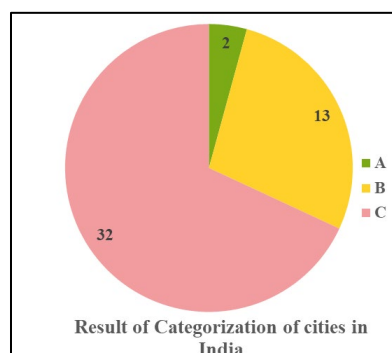
3.2 Practice of Classification

We categorized large Asian cities as an example. We have arranged the countries' GDPs for reference because GRP data of the cities are not available.

In case the data is not available, it is evaluated based on existing data.

3.3 Differences in categorization results between cities in the same country (case of India)

We categorized 47 cities in India to analyze the variability in categorization among cities in the same country.



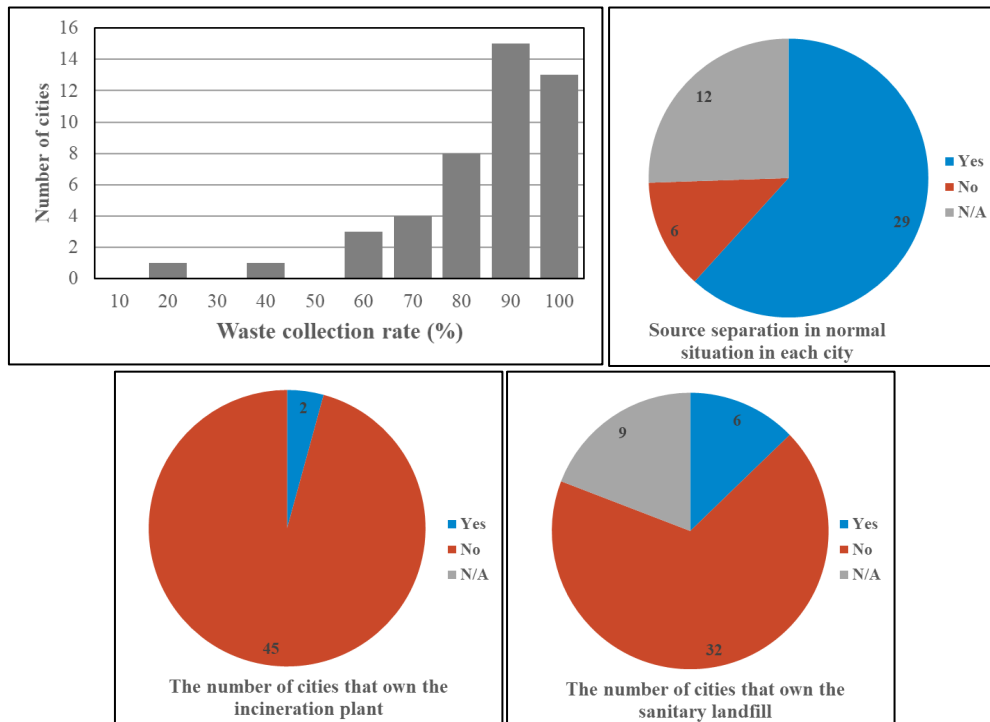


Figure 1 Example of Categorization (Case of India)

(The World Bank: What a Waste Global Database (2018), <https://datatopics.worldbank.org/what-a-waste/>)

4 Classification and criteria for hazardousness related to classification of disaster waste

A large variety of wastes in large amounts are generated from disasters at once when disasters occur. Hazardous substances etc. mixed with other wastes are accumulated, therefore separation is inevitably required to treat them properly. Generally higher toxic wastes need to be separated with high priority. However, waste with less toxicity may require to be separated and/or treated quickly due to health risks or environmental risks depending on the location or time. Decaying organic matter accumulating near rivers and waters needs especially quick treatment. Even in temporary storage sites, improper condition may cause a fire accident. The required responses vary depending on the phase.

[Definition of hazardousness]

Generally, hazardousness is a concept that includes both toxicity and danger. It has a nature such as explosiveness, flammability, spontaneous combustibility (it also means flammable gases are generated with water), oxidizing, corrosive, acute toxicity, infectiousness, generating toxic gases with air or water, delayed toxicity, chronic toxicity, and ecotoxicity.

However, a characteristic risk from disaster, i.e., “disaster hazard”, should be considered, not only generally “hazardousness” mentioned above. Apart from toxic waste defined by each country’s regulations, waste causing toxicity under the unusual condition as a disaster (no toxicity in usual condition) must be considered. In this guideline bearing survival threat risks, health risks, and environmental risks in mind, it is pointed out that appropriate treatments are required not only for disaster waste but also for (ordinary) household waste, evacuation site garbage, and human excretion.

As a survival threat risk, the collapse of garbage disposal and the involvement in the fire, etc. is possible. Regarding a health risk, the damage of medical institutions, the risk of infection due to scattering of medical waste in home care, the development of infectious diseases by the deterioration of the sanitary environment, the health damage by air pollution, etc. need to be considered. There may be some injury by protruding objects. The environmental risks include soil pollution by accumulated disaster waste, the water pollution, the generation of harmful gas or greenhouse gas, the outbreak of fire, and the generation of offensive odors by decaying organic waste.

(1) Hazard H: Waste category of highest toxicity

Wastes of the highest hazardousness category should be removed rapidly and treated properly as soon as possible. In that category food waste, decaying organic matter such as seafood and agricultural products, medical waste and explosive / inflammable materials like aerosol cans etc. are included. Waste causing health risks needs to be treated rapidly. Additionally, wastes and excreta from evacuation centers must be treated correctly to maintain good sanitary conditions for evacuees. In temporary storage sites garbage should not be piled up high to avoid fire.

[City/Region Group A]

Hazard H: All wastes with high toxicity, not only decayed organic matter, are separated and removed. Asbestos, plaster boards, and CCA processed wood etc. are included in demolished construction are removed rapidly and treated properly. Decayed organic matter is incinerated or composted apart from other wastes’ treatment.

[City/Region Group B]

Hazard H: All wastes with high toxicity, not only decayed organic matter, are separated and removed. After that, the treatment begins considering the financial situation etc.

[City/Region Group C]

Hazard H: It would need a long time before beginning the waste treatment due to the financial situation or the level of treatment technology. We should check on the damage and remove the waste easily decayed quickly out of the water.

(2) Hazard M: Waste category of intermediate toxicity

Wastes of the intermediate toxicity category include home electric appliances and vehicles such as private cars and motorcycles. It does not need to be immediately treated; however it needs to be separated because of metals. It is necessary to be careful of fuel and oil in vehicles, and hybrid cars involve the risk of electric shock.

[City/Region Group A]

First, wastes are separated and removed, to prevent fires caused by fuel or oil from breaking out. Recyclable waste of normal time should be recycled as much as possible.

[City/Region Group B]

First, wastes are separated and removed, to prevent fires caused by fuel or oil from breaking out, and then they are checked on recyclability.

[City/Region Group C]

First, wastes are separated and removed, to prevent fires caused by fuel or oil from breaking out.

(3) Hazard L: Waste category of low toxicity

Wastes of the low toxicity category include inorganic or low-biodegradable waste, such as debris or fallen trees. (However soon after the occurrences it often requires the quick removal from the viewpoint of life-saving, and at the phase of the recovery/reconstruction, securing the distribution channel and lifeline.) Debris includes asbestos, plasterboard, CCA processed wood, etc. which must be careful with.

[City/Region Group A]

Wastes are separated and removed as much as possible.

[City/Region Group B]

Wastes are separated and removed as much as possible.

[City/Region Group C]

Wastes are separated and removed as much as possible.

5 DW Classification and criteria based on emergency

In terms of emergency, the necessity of DW classification relates closely to hazardousness and differs substantially according to each phase, such as the initial phase, emergency phase, and recovery phase.

Any high hazardous DW should be removed immediately and managed appropriately. Thus, waste categorized as hazardousness level-H is dealt with emergency level-H here.

This technical reference goes on to state the classification of waste requiring emergency attention, the criteria, and the ways of collection and treatment on an emergency basis.

(1) The waste requiring urgent treatment shortly after a disaster breaks out (initial/emergency phase)

Lifesaving and seeking missing people are high-priority activities. To remove DW preventing the activities and to recover infrastructure for command systems are implemented.

(a) Concrete, Asphalt, Brick, and other soil and stone waste

[City/Region Group A] Emergency Level H

DW is appropriately classified in the process of removing collapsed houses and rebuilding roads, bridges, and tunnels, which are transferred to temporary storage sites via emergency temporary spaces. This process enables to contribute smooth recycling in later phases and proceed to quick recovery from disaster.

[City/Region Group B] Emergency Level H

This group needs a high-emergency level as same as City/Region Group A. Also, difficulties to arrange heavy equipment to remove large-sized debris and financial concern might exist in this group.

Resources loading for the work, e.g., budget, equipment, human resources, should be prioritized as much as possible.

At the same time embrace of international support is also worthy of consideration.

[City/Region Group C] Emergency Level H

Cities and regions which have difficulties in arrangement for heavy equipment, delays in a fiscal stimulus, and have a heavy dependence on international support are in this group.

The cities and regions in this group require a zoning and a timely fiscal stimulus according to the scale of damage.

(b) Timber • Large-scale wood waste

[City/Region Group A] Emergency Level H

To remove wood waste, such as timber in collapsed houses, power poles, and driftwood appropriately and transfer them to temporary storage. Wood waste can be recycled for energy use, but long-term storage of the waste, needs careful attention to be a cause of self-heating and auto-ignition. Especially wood waste which is generated in the storm, flood damage, or tsunami is taken into careful consideration.

[City/Region Group B] Urgent Level H

This group needs a high-emergency level as same as City/Region Group A.

In case delay arrival of heavy equipment, cutting wood waste at a site may come first rather than removing them to prior to life savings.

Even though the wood waste becomes into pieces, they should not be mixed up with other categories of waste and collected and managed separately. This is an important treatment in terms of the prevention of self-heating and auto-ignition at temporary storage sites.

[City/Region Group C] Emergency Level M

Cities and regions which have difficulties in arrangement for heavy equipment, delay in a fiscal stimulus, and have a heavy dependence on international support are in this group. Leaving the waste at a site over the long term shall be avoided and to use as a useful heat source at evacuation centers can be considered.

(2) The waste requiring urgent treatment in the recovery phase (early reconstruction phase).

During activities for the reconstruction of the living environment, DW generation increases in earnest, and the amount of them in temporary storage sites rapidly increases in this phase. Prompt classification for recycling and disposal is necessary.

(a) Putrefactive waste, Excreta

“Putrefactive waste” here includes fishery and livestock waste, products which lost commercial value due to loss of storage function, and food waste and garbage.

[City/Region Group A] Emergency Level H

Cities and regions being operated treatment facilities appropriately in normal time, which is capable to adapt for rapid recovery measurement are in this group.

Putrefactive waste and excreta should be removed promptly from residents, evacuation centers, and shelters for public health, such as protection against infectious diseases and fecal odor control.

Until recovery of treatment plants, the waste should be discharged separately and stored in containers or keep in reclusive areas to prevent pest and vermin outbreaks and odor diffusion.

[City/Region Group B] Emergency Level H

Cities and regions which require much time to restore treatment systems to the normal condition are in this group.

In order to prevent from impediments for the safe living environment due to long-term waste storage, exceptional treatment, e.g., soil undergrounding, disposal to the oxidation pond, may be assumed. However, the volume should be limited so that influence on the environment does not occur. Never dump sewage in rivers and waterways.

[City/Region Group C] Emergency Level H

Cities and regions which have the trouble with appropriate collection and treatment systems in normal time are in this group.

In case of carrying out undergrounding or open burning unavoidably, careful consideration should be given to the distance from the site to residential areas, the hydrological characteristic, and weather conditions. Never dump sewage in rivers and waterways.

(b) Soil and stone, Sediment

[City/Region Group A, B] Emergency Level M

The waste is capable to use as regeneration sand and is useful as construction materials in the recovery phase.

The waste requires a scheduled recycling and treatment plan because they might occupy a large space of temporary storage for a long period of time. In case the sediment is generated by tsunami or flood, as they might contain organic materials or hazardous substances, an appropriate fraction should be necessary.

[City/Region Group C] Emergency Level L

Cities and regions which have low amounts of civil engineering works lead to recovery are in this group. The emergency level is low as far as the waste does not prevent immediate recovery works, which are excluded from living areas and stored in a certain site.

However, in the case of the sediment generated by tsunami or flood, they might contain organic materials or hazardous substances. Thus, after appropriate categorization, land disposal and/or ocean dumping are assumed to avoid long-term storage.

(3) The waste requiring relatively medium-urgent treatment during a long-term reconstruction process

(a) Home appliances, End-of-life vehicles

[City/Region Group A] Emergency Level M

Not only waste is directly generated from disasters, but also activities in recovery and reconstruction in the post-disaster phase also generate waste continuously.

In cities and regions which have a recycling system on this waste category in normal time, it is important to sort the waste following the system and proceed to the next steps, such as transporting to certified contractors, sorting and separation, appropriate treatment, and recycling.

[City/Region Group B] Emergency Level M

After removing materials, including printed wiring boards, fluorocarbon refrigerant, waste-oil, and fuel from bodies, the treatments restart after waiting for a recovery of private treatment and recycling sectors.

[City/Region Group C] Emergency Level L

After immediate transport to the areas without interference in the living environment, store them until treatment.

6 DW Classification and criteria based on the feasibility (possibility) of separation

In proceeding with DW treatment, that inevitably requires sorting. Generally, the higher hazardousness of the waste is, the higher the emergency separation it needs. However, even the low hazardous waste might require

prompt separation and treatment, in case health risk and environmental risk occur depending on where and how the DW is generated. Also, separation policies according to each phase could be necessary, considering the necessity of long-term treatment from the emergency phase to the recovery phase.

Based on the above, the necessity of separation for each classified DW is recognized. While going on treatment, even though the waste is in the same classification, flexible actions for treatment might be necessary according to sites, circumstances, and phases where DW is generated. Followings are basic policies. As for detail, each Technical Information provides individually.

(1) The difference in the necessity of separation based on sites

(a) Feasibility of separation in terms of life-saving and security

Lifesaving and the disaster victims' security are the overriding priority at the initial phase.

Regardless of waste categories or countries, in case the waste prevents the activities, immediate removal action is essential especially if there is waste sedimentation near the residential areas.

Removal takes precedence over separation at the time. However, the removal actions are expected to keep the smooth separation in a later phase in mind.

[City/Region Group A] Feasibility of separation level H

Though heavy equipment helps immediate removal, a careful choice of the equipment to use is necessary to balance lifesaving and prompt removal. Immediate removal starts in case there is waste sedimentation on roads to access residential areas as well. To remove waste in lifesaving top priority and at the same time to proceed to separation as much as possible.

[City/Region Group B] Feasibility of separation level H

A careful choice of equipment to use is necessary to balance lifesaving and prompt removal. Immediate removal starts in case there is waste sedimentation on roads to access residential areas as well.

[City/Region Group C] Feasibility of separation level H

A careful choice of equipment to use is necessary to balance lifesaving and prompt removal. Immediate removal starts in case there is waste sedimentation on roads to access residential areas as well.

(b) Feasibility of separation in terms of disaster recovery and reconstruction

Being damaged key infrastructure, such as roadway networks, by disasters leads to big barriers in recovery actions. Removal of waste sedimentation is crucial for key infrastructure recovery. Also, setting separation policies is important as the amount of waste sedimentation, which should be removed, will be enormous.

[City/Region Group A] Feasibility of separation level H

To remove waste immediately with heavy equipment, at the same time to separate them and to load them in collection vehicles, and then transport promptly to temporary storage sites

Basically, inorganic waste, such as asphalt, the concrete mass should also be transported immediately, though it might be possible to store them temporarily in some space around the site depending on the amount, or capacity of storage.

[City/Region Group B] Feasibility of separation level H

To remove waste immediately, and at the same time separate them as much as possible, load them in collection vehicles, and then transport them promptly to temporary storage sites.

Inorganic waste, such as asphalt, concrete mass might be stored temporarily in some space around the site depending on the amount, or capacity of storage.

[City/Region Group C] Feasibility of separation level M

Waste should be removed immediately.

Inorganic waste, such as asphalt, concrete mass might be stored temporarily in some space around the site depending on the amount, or capacity of storages.

(c) Feasibility of separation in terms of vulnerability of contamination

The emergency level for waste treatment is high in places which have a risk of water pollution in rivers, lakes, and sea or groundwater contamination.

In the case of putrefactive organic material sedimentation, immediate actions are necessary. On the other hand, in the case of inorganic waste, the emergency level is low, even in the place where might occur water pollution.

Thus, the actions should be different depending on the waste categories.

As for floods, the draining of the flooded areas is vitally necessary to promote hygiene conditions.

[City/Region Group A] Feasibility of separation level H

To remove waste immediately avoiding to contact with moisture.

Putrefactive organic material requires immediate and appropriate treatment.

Effective utilization, such as composting should be considered.

[City/Region Group B] Feasibility of separation level H

To remove waste immediately avoiding to contact with moisture.

Putrefactive organic material requires immediate and appropriate treatment.

Effective utilization, such as composting should be considered.

[City/Region Group C] Feasibility of separation level H

To remove waste immediately avoiding to contact with moisture.

For putrefactive organic material, the feasibility of effective utilization and appropriate treatment should be examined.