Banpu Public Company Limited

Waste Management - Hazardous and Non-Hazardous Waste

Management Standard

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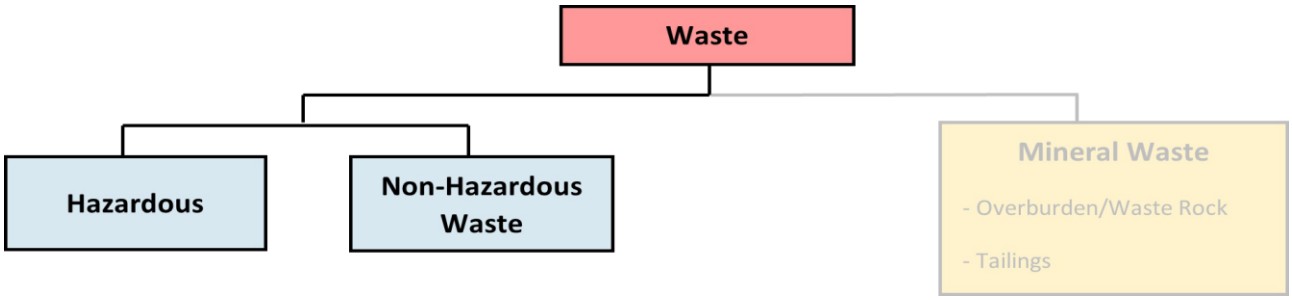
Introduction

Waste management is an integral component of Banpu's environmental management system in accordance with the Sustainable Development Goal (SDG) 12: Responsible Consumption & Production. Waste management practices aim to reduce waste generated from business operations through prevention, minimization, reuse, recycling and effective utilization of resources. In case that disposal of wastes is inevitable, the company expects everyone to strictly adhere to regulations or industry best practices whichever are more stringent for both onsite and offsite disposals.

The standard practice manual of waste management covers management practices of

(1) all waste streams associated with business operations, and
(2) potential impacts on existing environmental values.

Waste can be structured as below:



• Hazardous and non-hazardous waste is the waste generated from operational processes, supporting facilities such as port and train loading facilities, and offices.
• Mineral waste consists of overburden/waste rock and tailings from extraction, beneficiation and/or processing of mining business, which is not included in hazardous and non-hazardous waste categories. The generated volume of this waste is basically much higher than hazardous and non-hazardous waste. Therefore, it is needed to closely monitor and manage in proper way so as to minimize negative environmental impacts and risks that might occur in the future.

This standard practice manual (Waste Management – Hazardous and Non-Hazardous Waste) has been developed from Banpu Waste Management Policy. The document focuses only on the management and reporting details of hazardous and non-hazardous waste, while the management and reporting details of mineral waste are detailed in the Standard Practice Manual of Waste Management - Mineral Waste separately.

Objective

The objectives of this standard practice manual are:
• To outline framework and broad principle of hazardous and non-hazardous waste management
• To provide information and guideline for the sites to establish their work procedure (WP) and/or work instruction (WI) (if applicable), and waste management plan as well as implement waste management program for hazardous and non-hazardous waste

Scope

This standard practice manual shall be integrated and applied to Banpu and its subsidiaries where we have management control including employees, contractors and suppliers, and will also be applied for internal consideration during due diligence and/or mergers and acquisition processes where appropriate.

In implementing this manual, we establish measurable indicators and an assurance system to monitor and review performance to ensure that this manual is implemented effectively. Global Corporate Sustainability (GCS) will conduct assurance with the country and/or operations as required by the Sustainability Assurance Division.

Definitions

By-product:
Materials, other than the intended product, generated as a result of an industrial/operational process.

Deep Injection:
An injection process of waste into natural and artificial cavities (e.g. salt domes, wells, mines), or into porous formation of rock.

Disposal:
Any operation which is not recovery, even where the operation has as a secondary consequence the recovery of energy. Disposal is the end-of-life management of discarded products, materials, and resources in a sink or through a chemical or thermal transformation that makes these products, materials, and resources unavailable for further use.

Hazardous Waste (HW):
Waste shares the properties of a hazardous material (e.g. ignitability, corrosives, reactivity, or toxicity), or other physical, chemical, or biological characteristics that may pose a potential risk to human health or the environment if improperly managed. Waste may also be defined as “hazardous” by national/local regulations or international conventions, based on the origin of the waste and its inclusion on hazardous waste lists, or based on its characteristics (refer to Standard Practice Manual of Waste Management – Hazardous & Non-Hazardous Waste).

Incineration with Energy Recovery:
A treatment technology involving destruction of solid waste by controlled burning at high temperatures to reduce its weight and volume, and extracted useful energy (heat) back to the process. It is also known as waste to energy.

Incineration without Energy Recovery:
A treatment technology involving destruction of solid waste by controlled burning at high temperatures to reduce its weight and volume. The energy (heat) generated by combustion is dissipated in the environment.

Landfill:
A final depositing of solid waste at, below, or above ground level at engineered disposal sites. This term refers to depositing of solid waste in sanitary landfills and excludes uncontrolled waste disposal such as open burning and dumping.

Non-Hazardous Waste (NHW):
Waste that does not impose harmful characteristics or contain harmful elements. It can be generated by daily activities such as food residue, typical fibrous material and stationery, or industrial waste such as electric cable, plastic container and wood, which can be safely disposed of in conventional landfills or incineration. Non-hazardous waste may also be defined by national and local regulations.

Recovery:
Any operation wherein products, components of products, or materials that have become waste are prepared to fulfill a purpose in place of new products, components, or materials that would otherwise have been used for that purpose. Reuse and recycling are examples of recovery operations, and this term does not include energy recovery.

Recycling:
Reprocessing of products or components of products that have become waste by changing its structure, to make new materials. This term includes type of recycling operations, such as downcycling, upcycling, composting, or anaerobic digestion.
• Downcycling is a method to convert a waste into a lower quality substance, which is then used to create a lower-grade product.
• Upcycling is a method to convert a waste into a higher quality substance, which is then used to create a higher-grade product.
• Composting is a controlled biological decomposition of organic material in the presence of air to form a humus-like material.
• Anaerobic digestion is a process through which bacteria break down organic matter in the absence of oxygen.

Reuse:
A method of using waste in its original form. Pre-treatments which do not change its structure such as cleaning, repairing or painting can be applied for waste preparation before using again.

Volatile Waste:
Waste which contains organic chemical compounds that have significant vapor pressures under normal atmospheric conditions, and those compounds can affect the environment and human health.

Waste:
Any solid, liquid (such as used oil), or gas that the holder discards, intends to discard, or is required to discard through reuse, recycling, incineration, landfill or other methods. Waste can be a by-product of a manufacturing process or an obsolete commercial product which is defined according to the national/local legislations at the point of generation.

Waste Directed to Disposal:
Waste which is discarded by incineration with/without energy recovery, landfill, and other disposal operations such as deep injection, dumping and open burning. It is the end-of-life management of a discarded product, material, and resource; therefore, it is unavailable for further use.

Waste Diverted from Disposal:
Waste which is discarded by reuse, recycling or other recovery operations, and it is still available for further use.

Process / Content

Hazardous and Non-Hazardous Waste Management Principle and Hierarchy
The standard practice manual provides guidance for hazardous and non-hazardous waste management through hazardous and non-hazardous waste management principles and hierarchy. The principles are:
• Prevention and minimization the quantities of waste generation both hazardous and non-hazardous waste
• Reuse materials and products that have become waste
• Recycling waste that can be reintroduced into the processes or activities of the site
• Other recovering waste excluding energy recovery
• Disposal with all measures that avoid potential impacts to human health and the environment as well as to comply with national and/or local regulations

The above five principles form a hierarchy and provide a basis for waste management programs. Waste should be managed by following the hierarchy below:

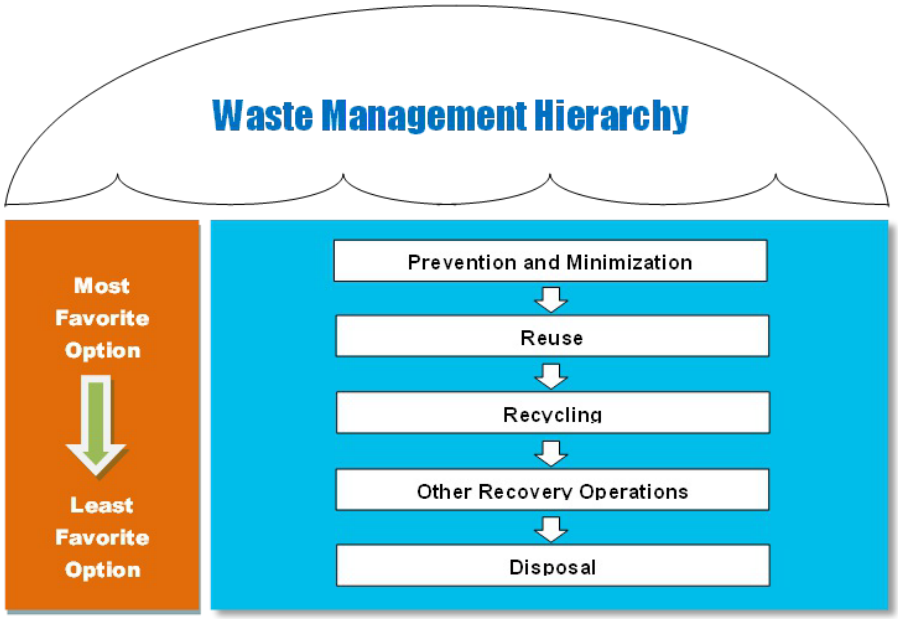


Figure 1: Banpu Waste Management Hierarchy

Waste management hierarchy is a list of approaches to manage waste, arranged in order of preference. Above is a graphical representation of waste hierarchy with the most preferred option located at the top and the least preferred option located at the bottom. When applying the hierarchy, all business functions of Banpu and its subsidiaries shall take measures to encourage the approaches that deliver the best overall environmental and human health outcomes.

Prevention and Minimization

Waste prevention and minimization is the first step in reducing amount of waste produced. The processes of the site should be designed and operated to prevent and minimize the quantities of waste generated and hazards associated with the waste generated in accordance with the following strategies:

• Establishing explicit objectives, action plans and/or programs of waste prevention and minimization as well as formal tracking of waste generation

• Reducing the use of raw and finite materials by procuring secondary materials (e.g., used or recycled input materials) or renewable materials

• Substituting raw materials or inputs with less hazardous or toxic materials, or with those whose processes generate lower waste volumes

• Applying manufacturing processes that promote materials usage efficiently and provide higher product output yields, including modification of the production process designs, operating conditions, or process controls

• Seeking opportunities to invest in innovation and Research & Development (R&D) to prevent and minimize waste from the processes

• Instituting good work-area management and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off-specification, contaminated, damaged, or excess to site needs

• Minimizing contamination of non-hazardous waste with hazardous waste by implementing stringent waste segregation. For this reason, generation rate of hazardous waste will not be increased from contamination

• Instituting procurement measures that recognize opportunities to return usable materials, such as containers which could prevent the waste containers
• Engaging in or setting up industrial symbiosis as a result of which the Company's waste or other outputs (e.g., by-products from production) become inputs for other companies
• Providing training and communication programs of waste reduction and waste separation to employees and related people involved in to raise the environmental awareness, in part of waste prevention and minimization

Reuse

Reuse can be defined as recovering value from a waste in its original form without reprocessing or remanufacture. The definition of reuse does not preclude relatively minor pre-treatments such as cleaning, repairing or painting. Reuse is given priority over recycling within the waste hierarchy because it is assumed to provide greater savings in resource consumption. Many types of waste have the potential to be reused enabling cost savings from landfill avoidance and from not having to make or use new products. Examples of reuse include:
• Product Waste Reuse - used tyres, used plastic bags, second hand clothes, and repairing machines and appliances etc.
• Materials Waste Reuse - scrap paper and metal etc.

Recycling

Recycling occurs when materials from waste streams are reprocessed or remanufactured by changing its structure. The amount of waste can be significantly reduced through the implementation of recycling plans, inclusive of the following elements:
• Evaluating waste generating processes and identifying potentially recyclable wastes
• Defining steps and methodologies of recycling activities including collection, sorting, reprocessing, and manufacturing
• Recycling potential wastes that can be reintroduced into the processes or activities of the site in order to reduce waste to landfill
• Investigating external markets for recycling by other industrial processing operations located in the neighborhood or region of the site (e.g. waste exchange)
• Establishing recycling objectives, action plans and/or programs as well as formal tracking of waste recycling rates
• Providing training programs and incentives to employees in order to meet objectives, action plans and/or programs

To make reuse and recycling achievable, waste should be separated into various categories and collected in suitable containers at the point of generation. Some of these collected wastes will likely have more market values and opportunities to reuse and recycle if the wastes are not contaminated by other wastes.

Other Recovery Operations

Other recovery operations occur when waste is prepared to serve a useful purpose by replacing other materials which would otherwise have been used for that purpose by means of any other processes, excepting reuse and recycling.

Energy recovery from incineration/co-incineration and landfill is not defined as other recovery operations.

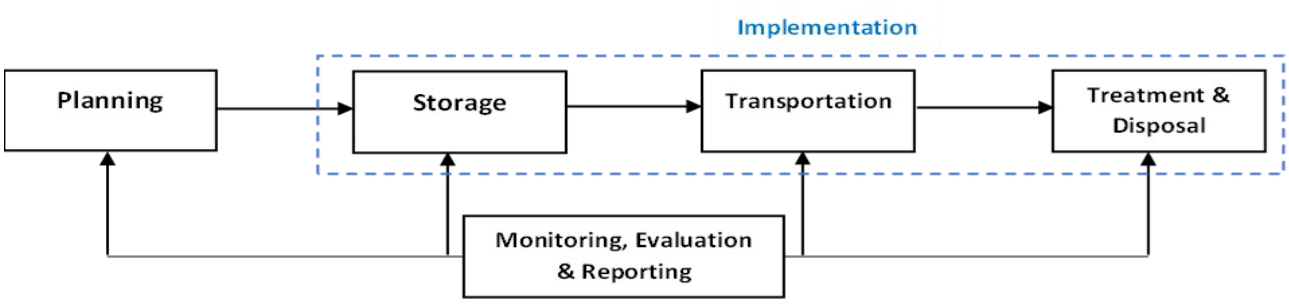
Disposal

If wastes are still generated after the implementation of feasible waste prevention, minimization, reuse, recycling and other recovery operations measures, the residual wastes must be treated and disposed of with all measures that avoid potential impacts to human health and the environment as well as to comply with national and/or local regulations.

Selected disposal approaches should be consistent with the characteristics of the waste and the regulations. However, there are three main categories of disposal, namely, incineration, deep injection and landfill. Waste generated from sites must be transferred and disposed by authorized companies or the site themselves with permitted facilities such as landfills or incinerators designed for the respective type of waste.

Hazardous and Non-Hazardous Waste Management System

Hazardous and non-hazardous waste management at a particular location must include all wastes presented at a site. The waste management system should address all issues concerning planning, storage, transportation, treatment & disposal, and monitoring, evaluation & reporting as the process diagram below:



1. Planning

Planning is the first step to establish waste management strategy based on understanding of potential risks and impacts from waste generation and its consequences. Effective planning of waste management strategy should include the following steps:

• Reviewing new waste sources and designing activities during planning, siting, equipment modifications and process alterations to identify expected waste generation, pollution prevention opportunities, and necessary treatment, storage, and disposal infrastructure. Waste shall be identified as hazardous and non-hazardous in accordance with the Waste Identification Flowchart.

• Collecting data and information about the process and waste streams in the existing facilities, including characterization of waste streams by type, quantities by direct weight or estimation, and potential use/disposition

• Mapping the process and waste streams through the Waste Process Flow development to show where waste is generated in the value chain or where outputs become waste

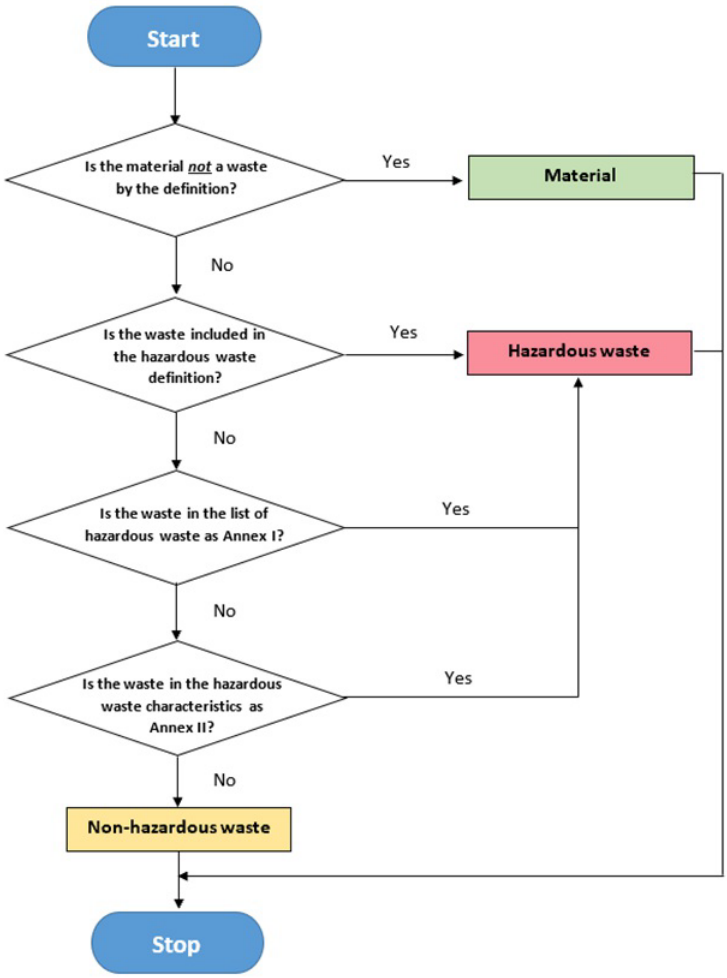
• Defining opportunities for waste prevention, minimization, reuse, recycling and other recovery operations through objectives, action plans and/or programs establishment

• Defining options/procedures/operational controls for treatment and final disposal

• Establishing priorities based on a risk analysis that takes into account the potential EHS risks during the waste cycle and the availability of infrastructure to manage the waste in an environmentally sound manner

1.1 Waste Identification Flowchart

Waste identification flowchart is a step to determine if a material is classified as waste, hazardous waste and non-hazardous waste. This chart can be applied to all states of waste (solid, liquid and gas).



Step 1: Is the material not a waste by the definition?

The first step is to determine if a material is classified as a waste by the definition. If the material does not meet the waste definition, it is not a waste and cannot be neither hazardous nor non-hazardous waste. On the contrary, if it is included in the definition, it is a "Waste" and needs to be identified as hazardous or non- hazardous waste in further steps

Step 2: Is the waste included in the hazardous waste definition?

After waste determination in step 1, the next step is to identify if that waste is included in the hazardous waste definition. If the waste is included in the definition, it is defined as a "Hazardous Waste". If not, it will be considered in step 3 and 4 respectively.

Step 3: Is the waste in the list of hazardous waste as Annex I?

The third step is to determine the waste excluded from the hazardous waste definition in step 2. If that waste is listed in the hazardous waste list as Annex I, it is also identified as a "Hazardous Waste". If not, it will be reconsidered in the last step (step 4). It should be noted that the hazardous waste may not only be in the list as Annex I, but it can also be variable by laws and regulations of each country.

Step 4: Is the waste in the hazardous waste characteristics as Annex II?
To identify hazard of the waste in the final step, hazardous characteristics based on the Basel Convention and EC-Council Directive on hazardous waste (91/689/EEC) are used. If that waste exhibits at least one of these characteristics in Annex II, it is classified as a "Hazardous Waste". If not, it will be defined as a "Non-Hazardous Waste".

Remarks:
• **The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal,** usually known as **the Basel Convention**, is an international treaty that was designed to protect human health and the environment against the adverse effects of hazardous waste. The Convention is also intended to reduce of hazardous waste generation and the promotion of environmentally sound management of hazardous waste, wherever the place of disposal, to restrict of transboundary movements of hazardous waste except where it is perceived to be in accordance with the principle of environmentally sound management, and to set a regulatory system applying to cases where transboundary movements are permissible.
• **Council Directive on hazardous waste (91/689/EEC**) is a legal act on hazardous waste management of the European Union.

1.2 Waste Process Flow Development
Waste process flow is a tool to visualize the information required to be reported under the GRI Disclosure 306-1. A graphic illustration of the waste process flow can help the Company and its stakeholders understand how inputs and outputs move through the Company's own activities as well as through the activities of entities upstream and downstream in its value chain. It shows where waste is generated in the value chain or where outputs become waste.

The Company can also use the waste process flow to illustrate information that is required under other disclosures of the GRI306 Standard, such as:
• actions taken to prevent waste generation (Disclosure 306-2);
• composition of waste generated (Disclosure 306-3);
• recovery operations used to divert waste from disposal (Disclosure 306-4);
• disposal operations (Disclosure 306-5).

Additionally, the other advantages of developing the waste process flow include:
• Providing a holistic overview of waste generation and its causes, which in turn can support the Company in identifying opportunities for waste prevention and for adopting circularity measures
• Serving as supporting information for planning and decision-making related to the waste management of the Company
• Assessing inputs, activities, and outputs which lead or could lead to significant waste-related impacts using the criteria in the **Waste-related Impact Assessment**
• Acting as a reference for collecting and reporting waste data

The waste process flow development should cover all activities and specify the types of inputs and outputs consisting of raw materials, process and manufacturing materials, leaks and losses, waste, by-products, products, or packaging across value chain. Activities, inputs and outputs before Commercial Operation Date (COD) are excluded from the waste process flow. More importantly, waste disposal of downstream focuses only on the third-party (1st Tier).

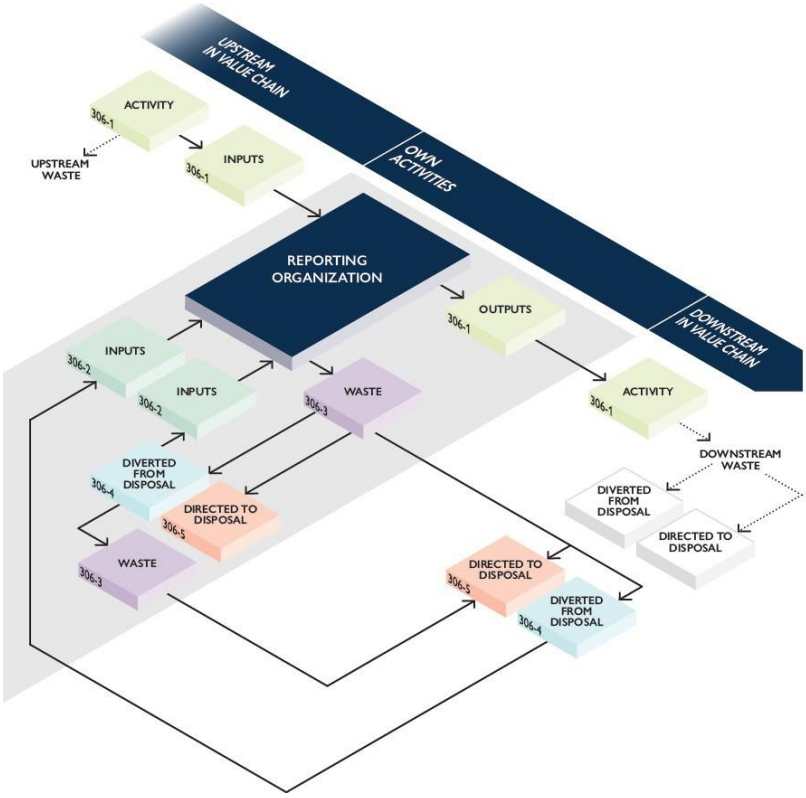


Figure 2: Generic Example of Waste Process Flow
(Global Reporting Initiative, 2020)

All business units or operational sites shall develop the waste process flow as well as review in response to any changes of the operational processes and waste management plans including revise if necessary, or once in every two years.

1.3 Waste-related Impact Assessment

Waste-related impact assessment can be conducted through Aspect Identification under ISO 14001 or any guidance in accordance with national/local standards. The Waste Process Flow with the following criteria can be also a guidance to assess significant waste-related impacts of inputs, activities and outputs unless the above methods are applicable.

- Quantity of waste outputs generated in the Company's own activities
- Hazardous characteristics of waste outputs
- Characteristics of waste outputs that limit or prevent their reuse, recycling and other recovery operations
- Potential negative threats associated with specific materials when they are discarded. For example, the potential threat of marine pollution resulting from leakage of discarded plastic packaging into waterbodies.
- Types of activities that lead to significant quantities of waste generation or to generation of hazardous waste

Specific details of the criteria such as generated quantity and hazardous characteristics of waste outputs shall be defined by means of national/local regulations to identify significant waste-related impact of each country. Any cases meeting the criteria or falling under "significant waste-related impact" need to be set action plans, improvement programs or applicable mitigation measures to prevent and minimize the impact which might occur in the future.

2. Implementation

2.1 Storage

Waste must be stored so as to prevent or control accidental releases to air, soil, or water resources. Recommended measures for waste storage include:

• After waste identification as hazardous and non-hazardous, the waste shall be stored each type of waste in separated areas.

• Storage facility must be stable and strong, closed and well ventilated, especially where volatile wastes are stored.

• Fixed roof and its closure devices shall be installed to minimize exposure of waste to sunlight, wind, and rain.

• Floor must not absorb liquids, resistant against water and chemicals, smooth and level, non-slippery, no cracks and easy to be cleaned.

• Waste is stored in a manner that prevents the commingling or contact between incompatible wastes, and allows for inspection between containers to monitor leaks or spills. Examples include sufficient space between incompatibles or physical separation such as walls or containment curbs.

• Waste that could be affected by floods, tides, etc. shall be suitably stored to prevent their being washed away or damaged due to those situations.

• Secondary containment systems (i.e. a temporary or mobile system required to be in place in response to any emergency spillage) should be constructed with materials appropriate for the wastes being contained and adequate to prevent loss to the environment.

• Storage facility should provide appropriate fire protection equipment and install emergency alarm system.

Hazardous waste storage activities must also be subjected to special management which include:

• The available volume of secondary containment should be at least 110 percent of the largest storage container, or 25 percent of the total storage capacity (whichever is greater), in that specific location.

• Necessary equipment and absorbent materials such as sawdust and sand should be provided for handling leaks or spills.

• Avoiding underground storage tanks and underground piping of hazardous waste

• Developing a hazardous waste inventory and tracking system to manage hazardous waste volume in waste storages

• Clearly identifying (label) and demarcating the area, including documentation of its location on a facility map or site plan

• Providing appropriate PPE such as chemical protection gloves, safety glasses etc. as well as washing hand area for employees and related people

• Providing readily available information on chemical compatibility to employees and related people, including labeling each container to identify its contents

• Limiting access to hazardous waste storage areas to the employees or related people who have received proper training

• Conducting periodic inspections of waste storage areas and documenting the findings

• Preparing and implementing spill response and emergency plans to address their accidental release. In case of a moderate and major spillage incident occur, Corporate Incident Reporting Investigation and Follow-up Procedure shall be implemented.

These recommended practices are only provided for temporary storage which hazardous and non-hazardous waste is temporarily stored on a site and then transferred to disposal areas.

2.2 Transportation

Onsite and offsite transportations of waste should be carefully conducted so as to prevent spills, releases, and exposures to employees, communities and the environment. Recommended management strategies include:

• Encouraging separation of recyclable wastes at the points of generation, so that the collection points do not become sorting points.

• Implementing a regular collection schedule with sufficient frequency to avoid accumulation of garbage
• Using vehicles appropriate for the geographic conditions and waste types to maximize reliability of transportation and minimize the environmental impacts
• Cleaning and inspecting vehicles used for waste hauling before and after transportation
• Ensuring that the vehicle is designed to contain spillage until the vehicle reaches a safe discharge location
• Covering collection and transfer vehicles along the entire route of transportation to avoid windblown litter

Additional recommendations for hazardous waste transportation include:
• Following applicable national regulations and internationally accepted standards for packaging, labeling, and transportation of hazardous waste
• Using tanks and containers specially designed and manufactured with good condition and compatible for hazardous waste
• Ensuring that the volume, nature, integrity and protection of packaging and containers used for transport are appropriate for the type and quantity of hazardous waste and modes of transportation involved
• Adequately labeling all transport tanks and containers to identify the contents, hazards, and actions required in emergency situations
• Ensuring safety specifications of transportation vehicles (e.g. installation of fire extinguisher, properly inflated tires, using of placarding and safety labels)
• Providing a shipping document (e.g. waste manifest) that describes the contents of the load and its associated hazards in addition to the labeling of the containers. Waste manifest should establish a chain-of-custody using multiple signed copies to show that the waste was properly shipped, transported and received by the recycling or treatment/disposal facility.
• Training employees and related people involved in the transportation of hazardous waste regarding proper shipping procedures and emergency procedures
• Providing the necessary means for emergency response

A waste manifest must be prepared for the hazardous waste being transferred and disposed. The information provided in manifest typically include:
• Generator and hauler
• Disposal contractor name, address, and license numbers
• Properties of the waste
• Special handling technique required
• Precautions to be taken in the event of spillage or emergency

A waste manifest must be signed by the authorized persons prior to transferring waste offsite. Entitled site's staff must review the information carefully before signing the document to ensure accuracy. The waste manifest must be accompanied the hazardous waste whenever it changes hands until it reaches the final disposal facilities. Signatures are required between transfers.

Apart from waste manifest, selection of waste transportation contractor also facilitates the site to diminish the environmental impacts and risks. A list of criteria for consideration of waste transportation contractor is provided as follows:
• Contractor reputation (consider references, external assessment performed by third-parties)
• Structure of the operation including company management system (e.g. EMS), caliber of senior management and site staffs, equipment and facility
• Availability of a transportation vehicles
• Overall housekeeping

• Compliance history
• Details of transportation license allowances (waste types, amount, etc.)
• Documentation (certificate of transportation)

Final selection should be made only when the site is satisfied that the waste will be disposed of in a responsible, safe, legally compliance, and environmentally acceptable manner.

2.3 Treatment and Disposal

Waste generated after the implementation of feasible waste prevention and minimization shall be considered to reuse, recycling and other recovery operations as the **Banpu Waste Management Hierarchy.** Remaining waste that cannot be reused, recycled, and/or recovered must be treated and disposed in proper way so as to minimize the environmental impacts and risks. The management method of each waste can be identified according to the disposal permits or licenses of authorized companies who are in charge of waste management; otherwise, can be determined by the **Waste Management Method Identification Flowchart.**

There are plenty of treatment and disposal approaches available depending on waste types, states, available facilities and national/local regulations. Recommended treatment and disposal approaches include:

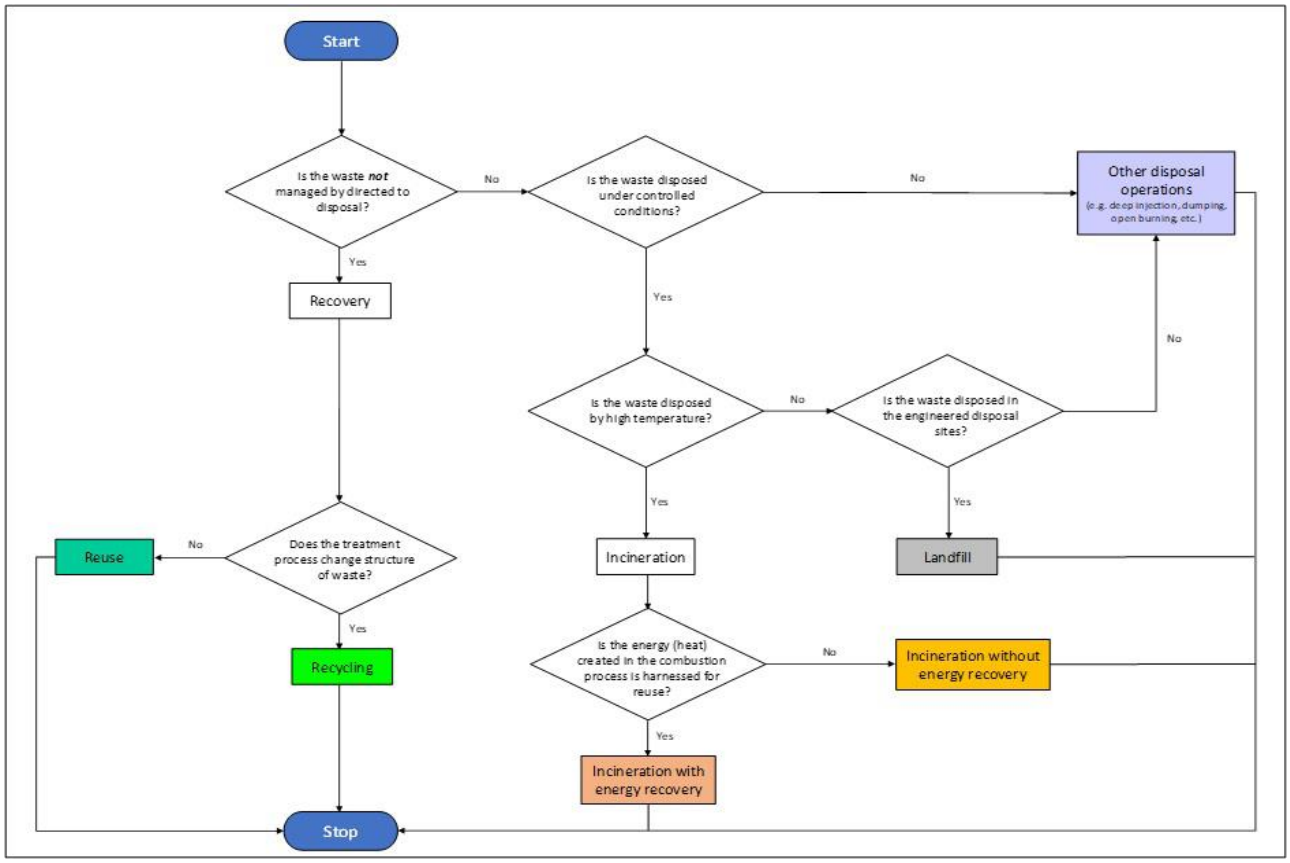
• Non-hazardous waste (i.e. food waste and plastic bags) must be treated and disposed by appropriate approaches such as landfill and incineration with suitable technical control in line with national/local legislations. When an offsite facility is not available within a feasible distance, the site should establish and operate its own disposal with appropriate regulation permits.

• Hazardous waste (i.e. used oil, fluorescent lamp and oily rags) must be handled by authorized companies who have appropriate facilities and permits to treat and dispose of hazardous waste. When their services are unavailable with any conditions, the site can also establish and operate its own waste facilities with the necessary permits depending on laws and regulations of each country. In case that onsite disposal of hazardous wastes is not allowed by law or authority, those wastes must be kept properly in accordance with laws and regulations while waiting for future disposal.

See the disposal details of both hazardous and non-hazardous in the **Waste Disposal Options.**

2.3.1 Waste Management Method Identification Flowchart

Waste management method identification flowchart is a step to determine a management method of waste in case that the information is not available or cannot be directly provided by the authorized companies of waste management.



Step 1: Is the waste not managed by directed to disposal?

The initial step is to determine whether a waste is managed by directed to disposal. If the waste falls under the directed to disposal, it should proceed to step 3 for inspection. Conversely, if the waste is not managed by directed to disposal, the management method of the waste is identified as “Recovery” and needs to be explored more either the waste is reused or recycled in the step 2.

Step 2: Does the treatment process change structure of waste?

In case the determination of waste management method is “Recovery” in step 1, the second step continuously identifies the management method by the question: “Does the treatment process change structure of waste?”. If the structure of the waste is changed after passing through a treatment process, the management method is defined as “Recycling”. If not, it is defined as “Reuse”.

Step 3: Is the waste disposed under controlled conditions?

The third step is to ascertain the management method of the waste in case that it is managed by directed to disposal in step 1 by the question: “Is the waste disposed under controlled conditions?”. If the waste is disposed under controlled condition, it needs to be inspected in the further steps. Conversely, if the waste is not disposed under controlled conditions, the management method is determined as “Other disposal operations” such as deep injection, dumping and open burning.

Step 4: Is the waste disposed by high temperature?

The fourth step is to continuously discover the management method of the waste by using the high temperature criteria through the question: “Is the waste disposed by high temperature?”. If the waste is disposed by high temperature, the management method is defined as “Incineration” and needs to be explored more whether the waste is disposed by incineration with or without energy recovery in step 5. On the contrary, if the waste is not disposed by high temperature, it needs to be specified the management method in step 6.

Step 5: Is the energy (heat) created in the combustion process is harnessed for reuse?
To further specify the management method of step 4, the fifth step is to consider whether the energy (heat) created in the combustion process is harnessed for reuse. If the energy (heat) from combustion is harness for reuse, the management method is determined as “Incineration with energy recovery”. Whereas if not, it is defined as “Incineration without energy recovery”.

Step 6: Is the waste disposed in the engineered disposal sites?
The last step of waste management method identification is to more determine the management method of the waste which is not disposed by high temperature through the question: Is the waste disposed in the engineered disposal sites?”. If the waste is disposed in the engineered disposal sites, the management method is identified as “Landfill”. If not, it is determined as “Other disposal operations” such as deep injection, dumping and open burning.

2.3.2 Waste Disposal Options

Waste disposal options should be consistent with the characteristics of the waste and regulations. Nevertheless, there are three main categories of disposal which are incineration, deep injection and landfill as detailed below.

Incineration
A waste treatment technology, which includes the combustion of waste for recovering energy, is called as “incineration”. Incineration coupled with high temperature waste treatments are recognized as thermal treatments. During the process of incineration, the waste material that is treated is converted into gases, particles and heat. These products are later used for generation of electricity. The gases, flue gases are first treated for eradication of pollutants before going into atmosphere.

Incineration reduces the mass of the waste from 95 to 96 percent. This reduction depends upon the recovery degree and composition of materials. This means that incineration, however, does not replace the need for landfilling but it reduced the amount to be thrown in it. Incineration comes with a number of benefits in specific areas like medical wastes and other life risking waste. In this process, toxins are destroyed when waste is treated with high temperature.

Incinerator can be understood more precisely as a furnace where waste is burnt. Modern incinerators are equipped with pollution improvement systems, which play their part in cleaning up the Flue gas and such toxicants. Following are the types of plants for burning waste:

<u>Moving Grate:</u>
The incineration plant used for treating municipal solid waste (MSW) is moving grate. Moving-grate incineration requires that the grate be able to move the waste from the combustion chamber to allow for an effective and complete combustion. A single incineration plant is able to process 35 metric tons of waste per hour of treatment. The MSW for a moving grate incinerator does not require pretreatment. For this reason, it is easier to process large variations and quantities. Most of these incineration plants have hydraulic feeders to feed as- received MSW to the combustion chamber (a moving grate that burns the material), a boiler to recover heat, an air pollution control system to clean toxins in the flus gas, and discharge units for the fly ash. The air or water- cooled moving grate is the central piece of the process and is made of special alloys that resist the high temperature and avoid erosion and corrosion.

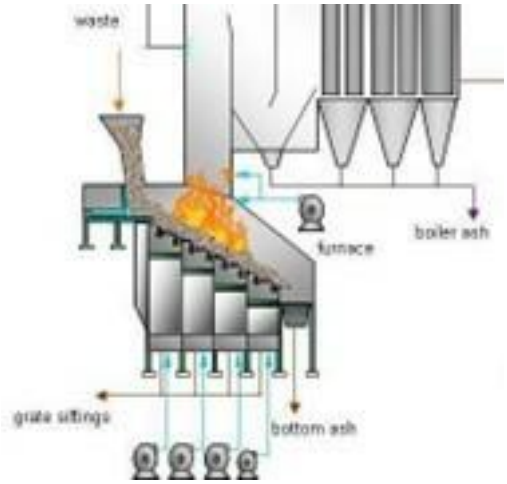


Figure 3: Moving Grate Incinerator (Igniss Energy, 2024)

Fixed Grate:

This incinerator was the fixed and much older version for grate. This kind generally is lined with the brick while lower or ash pit is made up of metal. This grate generally has an opening at the top and for loading purpose; a side of the grate is left open. A number of fixed grates were first formed in houses, which today are replaced by waste compactors.

Rotary-kiln:

Rotary kiln incineration is ideal for processing mixed industrial and hazardous wastes that include a combination of solid, sludge, and liquid waste streams. This incinerator basically consists of two chambers and can be paired with custom engineered air pollution control systems for a turnkey solution to control the environment. The primary chamber in a rotary kiln incinerator consists of an inclined refractory lined cylindrical tube. Movement of the cylinder on its axis facilitates movement of waste. In the primary chamber, there is conversion of solid fraction to gases, through volatilization, destructive distillation and partial combustion reactions. The secondary chamber is necessary to complete gas phase combustion reactions.

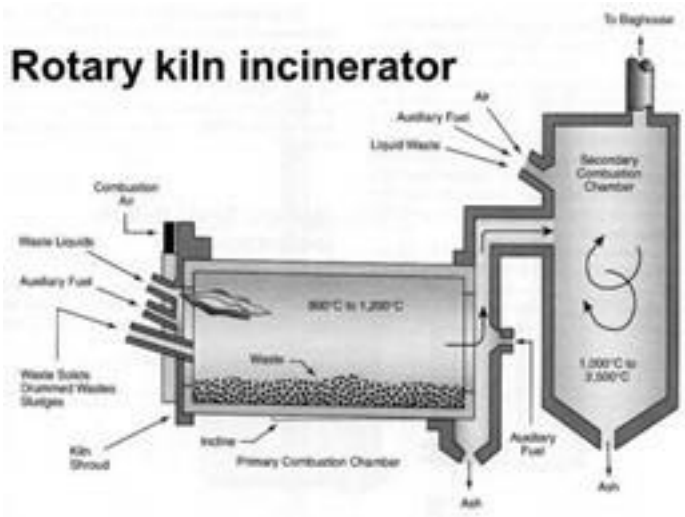


Figure 4: Rotary-Kiln Incinerator (Igniss Energy, 2024)

Fluidized Bed:

In the fluidized-bed incinerator, wastes are quickly and uniformly incinerated with utilizing thermal capacity of hot fluidizing sand. It can therefore be applied for a wide range of wastes; municipal solid wastes, low-calorific wastes like waste liquids or sludge, and also high-calorific wastes like discarded tires or waste plastic. In addition, the fluidized-bed incinerator is also well suited for mixed firing together with refuse dug up from final disposal sites, excreta sludge or sewage sludge.

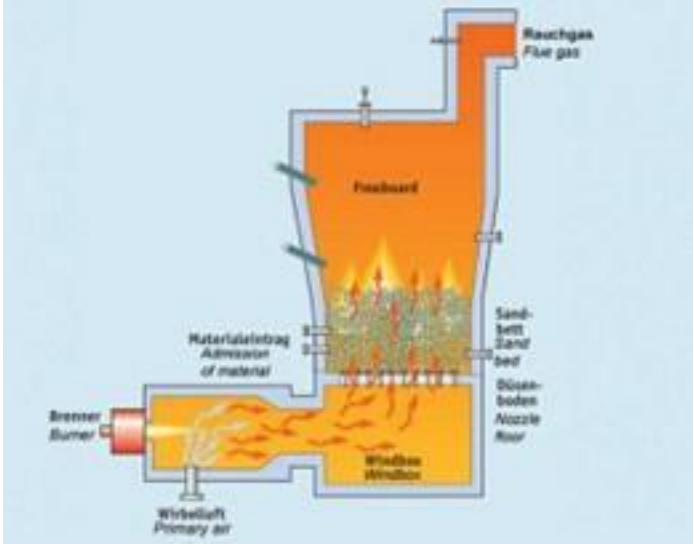


Figure 5: Fluidized-Bed Incinerator (Igniss Energy, 2024)

Deep Injection

A deep injection is used to place fluid underground into porous geologic formations. These underground formations may range from deep sandstone or limestone to a shallow soil layer. Injected fluids may include water, wastewater, brine (salt water), or water mixed with chemicals. Injection construction is based on the type and depth of the fluid injected. For example, wells that inject hazardous wastes or carbon dioxide (CO2) into deep isolated formations have sophisticated construction. These wells are designed to provide multiple layers of protective casing and cement. In contrast, shallow wells are usually of simple construction.

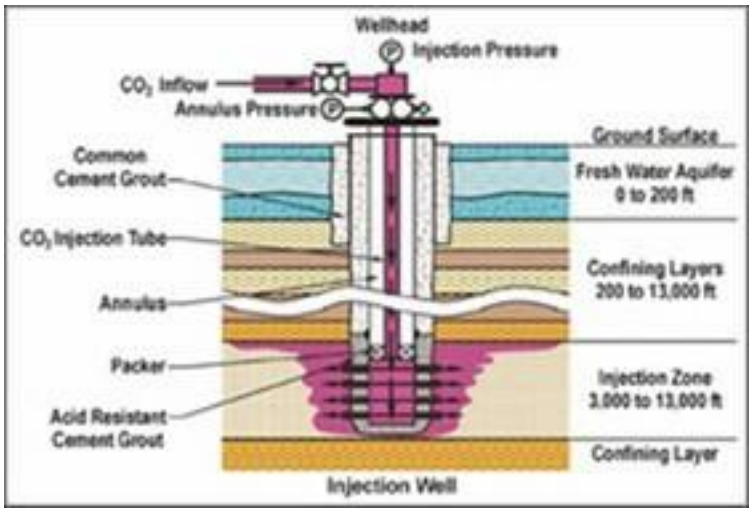


Figure 6: Deep Injection
(Ökopol GmbH Institute for Environmental Strategies, 2004)

Landfill

Landfills are well-engineered and managed facilities for the disposal of solid waste. Landfills are located, designed, operated and monitored to ensure compliance with federal regulations. They are also designed to protect the environment from contaminants, which may be present in the waste stream. Landfills cannot be built in environmentally sensitive areas, and they are placed using onsite environmental monitoring systems. These monitoring systems check for any sign of groundwater contamination and for landfill gas, as well as provide additional safeguards. Today's landfills must meet stringent design, operation and closure requirements established under standards and regulations of each country. There are three major types used in landfilling.

• Municipal Solid Waste Landfills (MSWLFs) – Specifically designed to receive household waste, as well as other types of non-hazardous wastes.

• Industrial Waste Landfill – Designed to collect commercial and institutional waste (i.e. industrial waste), which is often a significant portion of solid waste, even in small cities and suburbs.

• Hazardous Waste Landfills - Facilities used specifically for the disposal of hazardous waste.

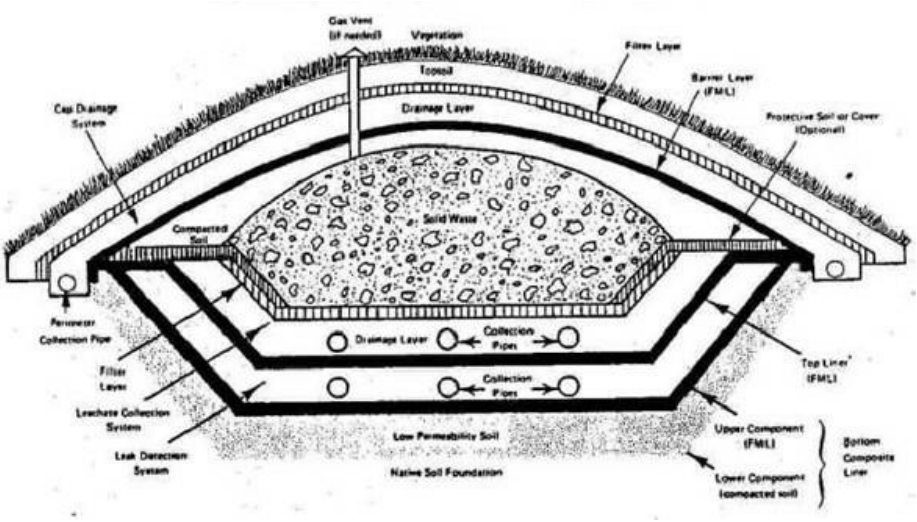


Figure 7: Landfills
(Ökopol GmbH Institute for Environmental Strategies, 2004)

The disposal options can probably be any other management methods which are not provided above. All business functions in Banpu and its subsidiaries that generate hazardous and non-hazardous waste have to provide appropriate disposal technology relying on regulations and standards of each country.

3. Monitoring, Evaluation & Reporting

Monitoring, evaluation and reporting activities associated with the management of non-hazardous and hazardous waste should include:

• Following up and tracking action plans and/or programs of waste management to ensure effective implementation

• Regular visual inspecting all waste collection and storage areas for evidence of prevention of accidental releases and verify that wastes are properly labeled and stored. When significant quantities of hazardous wastes are generated and stored onsite, monitoring activities should include:

- Inspecting vessels for leaks, drips or other indications of loss,
- Identifying cracks, corrosion, or damage to tanks, protective equipment, or floors,
- Verifying locks, emergency valves, and other safety devices for effective operation,
- Checking the operability of emergency response systems,
- Documenting results of testing for integrity, emissions, or monitoring stations,
- Documenting any changes to the storage facility, and any significant changes in the quantity of materials in storage.

• Tracking waste generation trends by type and amount of waste generated
• In a case where there is a new waste stream, characteristics of the new waste must be analyzed. Then, the proper management of the new waste must be identified and documented, especially hazardous waste.
• Monitoring records for hazardous waste collected, stored, or shipped should include:
    • Name and identification number of the material(s) composing the hazardous waste
    • Physical state (i.e., solid, liquid, gaseous or a combination of one, or more, of these)
    • Location of each hazardous waste within the site, and the quantity at each location (e.g. kilograms or liters, number of containers)
    • Documenting the data of quantity and type, date dispatched, date transported and date received, record of the originator, the receiver and the transporter
    • Periodic auditing of the third-party providing treatment and disposal services including reuse and recycling facilities when significant quantities of hazardous wastes are managed by third parties. Whenever possible, audits should include site visits to the treatment storage and disposal location.
• Conducting waste management audit by internal or external parties to ensure compliance and identify opportunities for improvement both in performance and management practices
• Any non-conformities and risks have been found through monitoring and evaluation processes, applicable mitigation measures, corrective actions and/or improvement plans shall be proposed.
• Recording and reporting waste performance data of the existing facilities as detailed in Table 1

3.1 Hazardous and Non-Hazardous Waste Performance Reporting

To monitor, recognize and improve performance of hazardous and non-hazardous waste management, recording and reporting of hazardous and non-hazardous waste shall be proceeded to Banpu Corporate on monthly basis as details below:

Table 1 Hazardous and Non-Hazardous Waste Performance Reporting

Hazardous and Non-Hazardous Waste	Data Requested	Reference: GRI Disclosure
Waste generated	- Name of waste - Actual generated amount in metric tons - How to measure the number of waste	306-3
Waste Diverted from Disposal	- Name of waste - Action by site (onsite and offsite management) - Management method - Actual amount of waste reuse, recycling and other recovery operations in metric tons - How to measure the number of waste	306-4
Waste Directed to Disposal	- Name of waste - Action by site (onsite and offsite management) - Management method - Actual amount of waste incineration with/without energy recovery, landfill and other disposal operations in metric tons - How to measure the number of waste	306-5

Direct weight or systematic estimation can be accepted for generated and disposal amount of hazardous and non-hazardous waste. Additionally, “Name of waste collector/processer” are also required to ensure compliance.

The Company has represented hazardous and non-hazardous waste performance and set targets for hazardous and non-hazardous waste directed to disposal (both absolute and intensity). The calculation of waste directed to disposal intensity is indicated as the formula below.

$$\text{Waste directed to disposal} = \frac{Waste\ Directed\ to\ Disposal\ (kg)}{Unit\ of\ Product}$$

Annex I Hazardous Waste List

Table 2 Hazardous Waste List by Business Group (Energy Resources)*

Energy Resources	
Mining Business	**Gas Business**
·Absorbent ·E-Waste (e.g. discarded computers, office electronic equipment, entertainment device electronic, mobile phone, television set, and refrigerator) ·Explosive ·Cleaning agent ·Clinical waste ·Contaminated container (e.g. oil and chemical container) ·Contaminated soil, sludge and wastewater ·Coolant ·General hazardous waste (e.g. fluorescent lamp, dry-cell battery, mobile phone battery) ·Herbicide/Pesticide ·Laboratory waste (e.g. out of date chemical) ·Lubricant ·Oil filter ·Oily rag/Cleaning rag ·Oily sludge ·Oily water/Grease trap water ·Paint and resin ·Solvent ·Spill response kit (e.g. contaminated saw dust, oil absorbent pad/boom) ·Used grease ·Used oil ·Used vehicle battery	·Acid ·Chemical (e.g., corrosion inhibitor, scale inhibitor, biocide) ·Cleaning agent ·Contaminated container (e.g. oil and chemical container) ·Contaminated soil, sludge and wastewater ·General hazardous waste (e.g., fluorescent lamp, dry-cell battery, mobile phone battery) ·Oily rag/Cleaning rag ·Oily sludge ·Paints and resin ·Solvent ·Spill response kit (e.g. contaminated saw dust, oil absorbent pad/boom) ·Used oil ·Used vehicle battery

Remarks:
* This table is hazardous waste list which is generally generated from energy resources consisting of mining and gas businesses. The list can be variable by national regulations and standards.

Table 3 Hazardous Waste List by Business Group (Energy Generation and Energy Technology)*

Energy Generation		Energy Technology
Thermal Power Business	**Renewable Power Business (Solar & Wind Power Plants)**	**Electric Vehicle, Smart Community, Energy Storage & System, and Solar Rooftop & Floating Business**
·Absorbent ·Boiler slag ·Fly & Bottom ash** ·Clinical waste ·Contaminated container (e.g. oil and chemical container) ·Contaminated soil, sludge and wastewater ·Demineralizer regenerant and rinse*** ·Denitration catalyst ·E-Waste (e.g. discarded computer, office electronic equipment, mobile phone) ·General hazardous waste (e.g. fluorescent lamp, dry-cell battery, mobile phone battery) ·Herbicide/Pesticide ·Laboratory waste (e.g. out of date chemical) ·Metal and boiler cleaning waste ·Oily rag/Cleaning rag ·Paint ·Scrubber slurry/FGD sludge ·Spill response kit (e.g. contaminated saw dust, oil absorbent pad/boom) ·Used oil ·Used vehicle battery	·Clinical waste ·Contaminated container (e.g. oil and chemical container) ·E-Waste (e.g. inverter, transformer and other power electronics) ·General hazardous waste (e.g. fluorescent lamp, dry-cell battery, mobile phone battery) ·Herbicide/Pesticide ·Oil filter ·Oily rag/Cleaning rag ·Paint ·Solar panel** ·Solvent ·Spill response kit (e.g. contaminated saw dust, oil absorbent pad/boom) ·Used oil ·Used vehicle battery	·Contaminated container (e.g. oil and chemical container) ·E-Waste (e.g. inverter, transformer and other power electronics) ·General hazardous waste (e.g. fluorescent lamp, dry-cell battery, mobile phone battery) ·Lubricant ·Oil filter ·Paint ·Solar panel** ·Spill response kit (e.g. contaminated saw dust, oil absorbent pad/boom) ·Used grease ·Used oil ·Used vehicle battery

Remarks:

* This table is hazardous waste list which is generally generated from energy generation and energy technology. The list can be variable by national regulations and standards.

** Hazardous properties are identified by laws and regulations of each country.

*** Demineralizer regenerant and rinse are substances used in a water purification process to provide high purity water for a boiler.

Annex II Hazardous Waste Characteristics

(Based on the Basel Convention and Council Directive on hazardous waste (91/689/EEC))

Table 4 Hazardous Waste Characteristics

Characteristic	Definition
1. Explosive / Reactive	An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.
2. Flammable / Ignitable	A flammable/ignitable substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which give off a flammable vapor at temperatures of not more than 60.5°C (closed-cup test) or not more than 65.6°C (open-cup test), or may cause or contribute to fire friction.
3. Oxidizing	Substances or wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.
4. Toxic	Substances or wastes which, if they are inhaled, swallowed, ingested or penetrated the skin, may involve serious, acute or chronic health risks and even death.
5. Infectious	Substances or wastes containing viable micro-organisms or their toxins which are known or suspected to cause disease in animals or humans.
6. Irritant	Non-corrosive substance and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.
7. Harmful	Substances and preparations which, if they are inhaled or infested or if they penetrate the skin, may involve limited health risks.
8. Carcinogenic	Substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.
9. Teratogenic	Substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.
10. Mutagenic	Substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.
11. Corrosives	Substances or wastes which, by chemical action, will cause severe damage when in contact with living issue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.
12. Eco-toxic	Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.
13. Capable, by any means, after disposal, of yielding another material, e.g. leachate, which possesses any of the characteristics listed above	

Remarks:

If any wastes do not meet hazardous waste characteristics in this table but meet hazardous waste characteristics in the Basel Convention or national regulations, it is identified as “hazardous waste”.

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