

STUDY ON 3RS OF WASTES AND ECOLOGICAL LANDFILLS

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ABSTRACT

In Japan, the basic plan for promoting recycling-based society was approved in a Cabinet meeting in March, 2003, and as a result, various measures are implemented in accordance with the plan including “3R waste disposal promotion month” and green procurement, aiming at promoting 3Rs of wastes to advance cyclic use of resources as well as substantial reduction of disposed wastes.

As a result of these movements, it is expected that the substantial reduction of disposed waste leads to the decrease of the number of landfills required. But the waste to be disposed into the landfills cannot be eliminated, and thus, the landfills are the facilities essential in our society as one of the social infrastructures.

As our society becomes recycling-based, new functions and roles are demanded for the landfills. LSA, NPO (Landfill Systems & Technologies Research Association of Japan, NPO) has examined what the ecological landfills based on the idea of 3Rs (Reduction, Reuse and Recycling of wastes) should be as the facilities suitable for the recycling-based society.

This paper reviews the definition of the landfills taking 3Rs of wastes into consideration, and reports the results of investigations of existing literatures related to the landfills from which the issues in achieving the ecological landfills having new roles and function have been extracted.

Keywords: Ecological landfill, 3Rs (Reduction, Reuse and Recycling) of wastes, Recycling-based society, Global environment, Regional environment

INTRODUCTION

In Japan, the basic plan for promoting Recycling-based society was approved in a Cabinet meeting in March, 2003, and as a result, various measures are implemented in accordance with the plan including “3R waste disposal promotion month” and green procurement, aiming at promoting 3Rs of wastes to advance cyclic use of resources as well as substantial reduction of disposed wastes.

Although it is expected that the substantial reduction of disposed waste leads to the decrease of the number of landfills required, the waste to be disposed into the landfills cannot be eliminated, and thus, the landfills are the facilities essential in our society as one of the social infrastructures.

As our society becomes Recycling-based, new functions and roles are demanded for the landfills. LSA, NPO (Landfill Systems & Technologies Research Association of Japan, NPO) has examined what the ecological landfills based on the idea of 3Rs (Reduction, Reuse and Recycling of wastes) should be as the facilities suitable for the Recycling-based society.

This paper reviews the above theme of the landfills, and presents the issues in achieving the ecological landfills having new roles and functions that have been collected and arranged from existing literatures related to landfills.

2. CONCEPT OF ECOLOGICAL LANDFILL

1) Definition of ecological landfill

The ecological landfill is defined as “landfills suited to the Recycling-based society” that are designed taking into consideration the local nature, history and culture of the site, giving low impact on the earth and the regional environment to prevent peripheral environment (such as environmental loads and landscapes) from being damaged by the site, and equipped with resource recycling and storage functions, in the process from the planning of the land use to utilization of the site after closing¹⁾. Moreover, the following three requirements are newly added to the above definition as shown in Figure 1 from the viewpoint of “3Rs of wastes (= Recycling-based society)”; the facility is to install measures for storing disposed solid wastes in the

landfill safely without anxiety and those for recycling the resources, the storage and recycling are to be made taking an economic indicator into consideration, and information about risks on the ambient environment is to be disclosed and published.

The term “ecological landfill” covers the concept of the sites for storage and recycling of the wastes as well as “landfilling” of them.

2) Concepts of 3Rs of wastes and ecological landfill

The future waste treatment policy should be moved ahead involving the promotion of the 3Rs of wastes and establishment of the ecological landfills that are to be related unambiguously to each other. This means that it is necessary to build up the policies that focus on the future to develop the measures that will not pass on the negative legacy for future generations.

Based on this standpoint, this paper adds the viewpoint of “3Rs of wastes” to the idea of the ecological landfills by using the indices of the space axis and time axis in the discussion of positioning of the ecological landfill.

As described in Figure 2 “Conceptual view of 3Rs of wastes and Ecological landfill”, the space axis here is the form of the recycling-based society, where the promotion of the 3Rs of wastes is implemented thoroughly to minimize the amount of the waste to be disposed and the waste is stored to be recycled in the ecological landfill that provides the space for recycling, and thus, it is positioned as the “space for ecological disposal of wastes”.

The time axis of the concept of the landfill is the time required for storage of the waste to be disposed properly. The wastes that are properly disposed by the ecological landfill reduce their environmental load as the time elapses, and thus, their recyclability as resource is improved. The time is positioned as the one needed for the process.

Moreover, to make the ecological processing of wastes completely circulative, each of the 3Rs of wastes are essential, and thus, their details require reexamination and discussion in the future based on the previous contents of the studies.

As may be known from the above description, the ideas of the 3Rs of wastes and ecological landfill involve the style of storage of wastes focusing on the era of unavailability of natural resources. However, the storage of the waste should be made by sufficiently examining and estimating its economic effects and technological development, and should never be the nest of negative legacy. Thus, the development of legal systems with regard to the storage of the resources is an essential issue to be examined in the future.

3. Roles and functions of ecological landfill obtained from investigation of existing literatures related to landfills.

We obtained knowledge and case examples of the ecological landfill about their roles and function from the existing literatures. This chapter presents the concepts of the ecological landfills and their issues evolved from the investigation.

The contents of the literatures are arranged with regard to the following ten matters; ①roles of the ecological landfills, ②functions of the ecological landfills, ③ evaluation of the ecological landfills, ④system of the ecological landfills including pre-processing of wastes, ⑤ promotion of 3Rs of wastes by the ecological landfills, ⑥ regional environment of the ecological landfills, ⑦contribution of the ecological landfills to the global environment, ⑧ waste processing and disposal system of the Recycling-based society, ⑨ proposal of the model of the Recycling-based society and ⑩education for diffusion of the Recycling-based society. The contents of these matters are arranged to identify the keywords, and important subjects and issues are extracted from the results.

Based on the results of investigation of the literatures related to the landfills, it was found that the following subjects are to be discussed.

1) Roles of ecological landfills and future landfills

From the literatures that were investigated, the following results were obtained with regard to the roles of ecological landfills.

- ① Role as a storage facility: Storing wastes as resources as well as landfilling them
- ② Role as an emergency disposal facility: Accepting wastes in a time of disaster
- ③ Role as providing an image of safety and ease of mind: Eliminating the bad image of the facilities by discontinuing their operations in earlier stage

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the roles of the ecological landfills include clarification of positioning of the facility, principles of setting the goals of the facility, and development of technologies for earlier discontinuation of the operation.

- ① It is necessary to use the open type facilities and closed type facilities separately in accordance with the purpose of disposal of wastes. It is also necessary to reconsider the positioning of landfills based on the viewpoint that “what kind of wastes the facility is to dispose (stabilize) and store.”
- ② The wastes like those generated by disasters that are discharged much at a time cannot be sorted out in the disaster site. Therefore, the landfills should have a function as a temporary storage of the wastes where they are classified and

reduced.

Definition of Ecological Landfill		
Landfills with waste recycling and storage functions that are designed taking into consideration, in the process from the planning of the land use to utilization of the site after closing, the local nature, history and culture of the site, giving low impact on the earth and the regional environment to prevent peripheral environment (such as environmental loads and landscapes) from being damaged by the site, and equipped with resource recycling and storage functions, .		
ecological landfills		Additional items
1) Landfill that is designed by taking preservation of ambient environment into consideration	①Landfill that is designed by taking preservation of local environment into consideration ②Landfills that have low risk on the ambient environment	③ Landfills that can disclose proper information in a timely manner ④ Landfills that can widely publish knowledge obtained
2) Landfill that is designed by taking preservation of global environment into consideration	①Landfill that is designed by taking global warming into consideration ②Landfill that utilizes natural energy effectively ③Landfills that utilizes energy saving technologies	
3) Landfill that promotes recycling positively in the project and management of the site	① Implementation of green purchase and green procurement ②Utilization of matters produced by recycling of wastes in the landfill	③Landfill that has established priority for the 3R of wastes policy and intermediate treatment of the wastes ④ Landfill that adopts economic indicators to promote recycling at the best time and place
4) Landfill that is designed by taking harmonization with its ambient area into consideration	① Landfill that takes local residents into consideration ② Landfill that takes advantage of resources peculiar to the locality such as nature, history and culture ③Landfill that takes local industries into consideration ④Landfill that allows utilization of the site after closing by taking harmonization with its ambient area into consideration	⑤ Landfill that promotes quicker stabilization of the site for earlier utilization of the site
5) Landfill facility that is capable of controlling the properties of wastes to adapt itself to the Recycling-based society	①Landfill that can be understood as a recycling facility in the long view ② Landfill that is equipped with resource storage function	③Landfill with a waste disposal system that minimizes the amount of final wastes ④ Landfill that accept recyclable solid wastes ⑤Landfill that always incorporates the latest maintenance and management technologies ⑥Landfill that stores wastes by taking economic indicators into consideration
6) Landfill that performs sound operation and evaluation	① Landfill that performs sound formulation and evaluation of project planning ②Landfill that performs evaluation of ecological level through the process from land use planning, operation and management, to utilization of the site after closing	③ Landfill that implements educational activities for proper treatment of wastes

Figure 1 Definition of ecological landfills

Concepts of 3R of wastes and ecological landfills

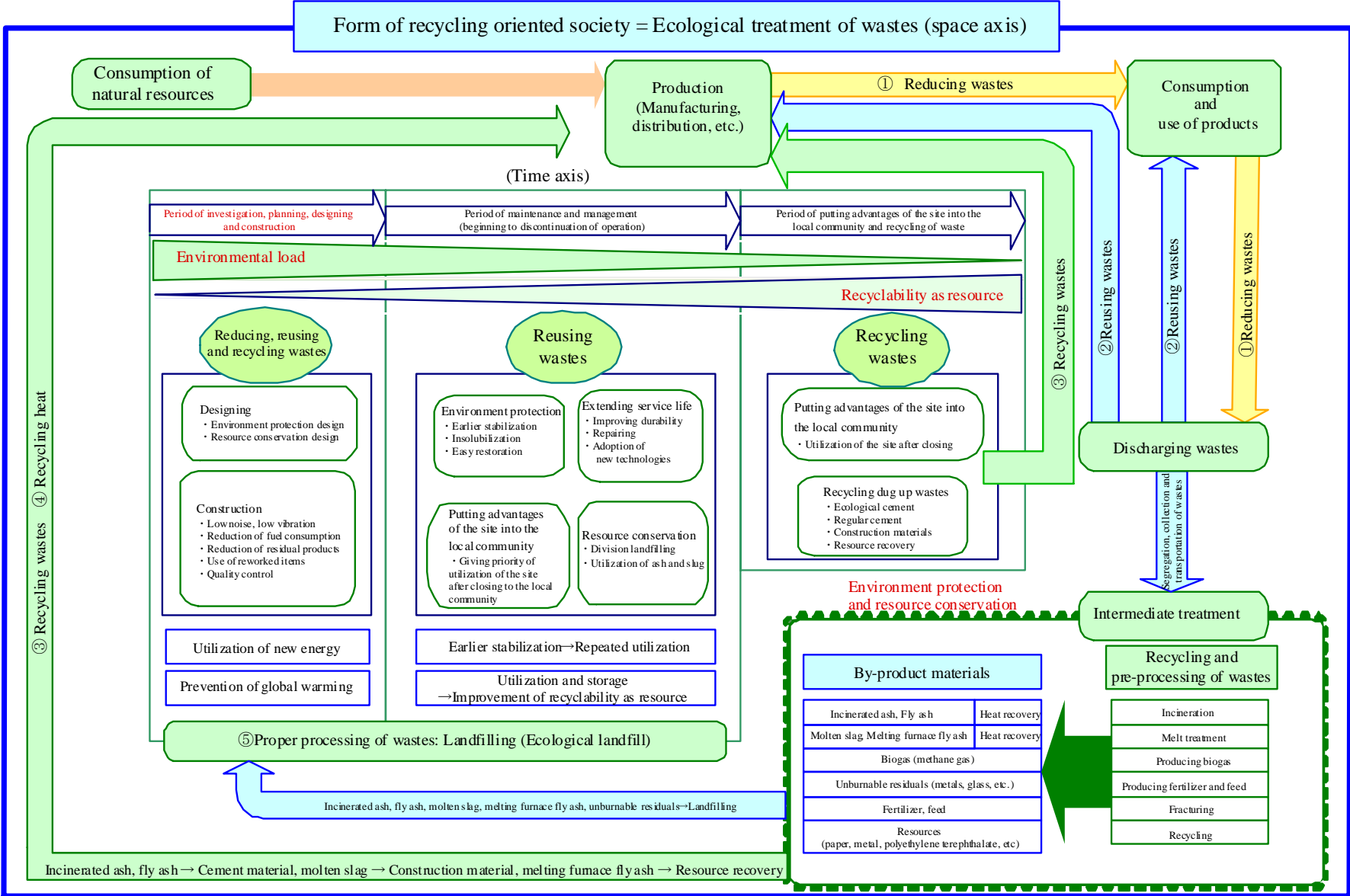


Figure 2 Concepts of 3R of wastes and ecological landfills

- ③ The past landfills that dispose the wastes inadequately are now “negative legacies” that give bad images of the facilities to the peripheral residents. To make the image of present ecological landfills fixed as the ones that are standard, it is necessary to develop technologies for earlier discontinuation of the operation.
- ④ As a part of a system of the resource-Recycling-based society, landfills should change their roles substantially aiming at protection of their environment, earlier stabilization of the wastes, promotion of effective utilization of the site after closing their operation, ablation of wastes for reduction of load on the leachate treatment facility, shortening of period from closing of the operation to disuse of the facility, clarification of nature of the site after closing the operation, and formation of the Recycling-based society.

2) Functions of ecological landfills and future landfills

From the literatures that were investigated, the following results were obtained with regard to the functions of ecological landfills.

- ① Waste storage function: Storing and managing wastes for the purpose of reusing them as resources in the future by digging them up
- ② Stabilization promoting function: Promoting stabilization of waste for the purpose of realizing earlier discontinuation of the operation of landfills
- ③ Environment protection function: Implementing sufficient measures for prevention of environment by performing thorough risk management
- ④ Function of putting advantages of the site into the local community: Educating local residents about disposal of wastes, disclosure of information

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the functions of the ecological landfills include making the site multifunctional, improvement of landfilling technologies, clarification of positioning of the facility, principles of setting the goals of the facility, and development of technologies for earlier discontinuation of the operation.

- ① Initially, the demand from the residents included simply the construction of the civil engineering structure. But the demand is now extended to give the facility the functions such as the environmental protection, putting advantages of

the site into the local community, and residents participation, and recently, the function that promotes the stabilization of the wastes, storage of wastes (for future recycling) and disclosure of information.

- ② Problems of wastes cannot be resolved by passive activity that simply disposes the wastes brought into the landfill site.
- ③ Reviewing cost of intermediate treatment of wastes and landfilling aiming at the high level treatment of wastes
- ④ At present, reduction of the amount of landfilled waste is sometimes implemented by unreasonable recycling of or control over the wastes
- ⑤ It is possible to return the wastes to the environment by depending of the biodegradability of the landfill site and/or relaxational capability of the soil.
- ⑥ Utilization of landfilling technologies may be more sustainable than unreasonable reduction of the amount of wastes to be landfilled. Achieving that way requires improvement of the technologies inevitably.
- ⑦ Landfills that are designed suitable for control of generation of wastes, recycling of wastes at the time of generation, and reduction of the amount of wastes.
- ⑧ Sustainable landfills are the ones that are designed taking utilization of the site after closing into consideration or as facilities that have a waste recycling function.
- ⑨ Recycling-based society demands multifunctional landfills, and thus, development of landfilling technologies that can deal with such demands is needed.
- ⑩ Preparation of landfills suited to cover wider areas to reduce the number of landfill sites
- ⑪ Regeneration of closed landfills by recycling buried wastes
- ⑫ Putting advantages of landfill sites into the local community by utilizing them after closing

3) Evaluation of ecological landfills and future landfills

From the literatures that were investigated, the following results were obtained with regard to the evaluations of ecological landfills.

- ① Functional evaluation: Evaluation of the landfills with regard to the state of the operation (and maintenance)
- ② Evaluation on environmental load: Evaluation on environmental load of individual life-cycle stages that constitute the entire system
- ③ Evaluation on quality control and assurance: Evaluation on the state of quality control and

assurance of landfills in the period from the planning to the end of landfilling

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The issues on the evaluation of the ecological landfills include the method of objective evaluation of landfills as ecological landfills and items of the evaluation.

- ① As it is necessary to evaluate ecological landfills with regard to the level of ecological capability of the facility and the ecological functions, we will promote establishment and operation of a third-party organization that is capable of performing objective evaluation.
- ② For proper operation of landfills, it is necessary not only to meet minimum laws and regulations but also to clarify the method and items of evaluation on the capability of the facilities on the protections of regional environment and natural environment.

4) System of ecological landfills and future landfills including pre-processing of wastes

From the literatures that were investigated, the following results were obtained with regard to the systems of ecological landfills.

- ① Stabilization system: A system that stabilizes wastes for earlier discontinuation of the operation of landfills
- ② Pre-processing system: A system that performs processing such as fracturing or irrigation of wastes before landfilling
- ③ Landfilling system: A system that accepts wastes as a final disposal facility and allows utilization for other purposes after closing.
- ④ Control system: A system that controls gas, water and heat in the facility and in the layer of wastes

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the systems of the ecological landfills include the waste acceptance system, and methodology for protection and control of landfill environment.

- ① Landfills are forced to accept the wastes to be landfilled that are determined by the system on their upstream as a “final receiver of risks”. Some landfills are not capable of selecting wastes to be accepted.
- ② It is absolutely necessary to select a civil engineering structure and a site that allow control of natural uncertainties. Moreover, finding the risk management method for environment outside and inside of landfills that require controls of gas, water and heat in the

facility and in the waste layer and the mechanism of stabilization of the wastes, continuously monitoring the process of the control, and properly disclosing the information can contribute much to the improvement of the safety and transparency of the facility.

- ③ It is difficult to know the current remaining capacity of landfills. Therefore, the landfill operator should recognize the capacity regularly, prepare the records and disclose the information.
- ④ Landfilling wastes with low organic matter content or low hazardous material content required pre-treatment of the wastes.
- ⑤ The cause that a landfill becomes a negative legacy of an area is that it produces leachate and/or gases from the landfilled matters for long time after discontinuation of the operation. Discontinuation of operation of a landfill in a short period from ending of the landfilling requires an inactivation of the landfilled matters.
- ⑥ To realize landfills that affects less adversely in the following generations, it is necessary to design facilities that are safe and give ease of mind to the residents through pre-treatment and management and utilization of the site after closing suited to the waste carried into them.
- ⑦ Present landfills are constructed using advanced seepage control technologies, and are equipped with excellent leakage detection systems, repairing and other backup systems and leachate treatment systems, which are sometimes superfluous.

5) Promotion of 3Rs of wastes

From the literatures that were investigated, the following results were obtained with regard to the promotion of 3Rs of wastes of ecological landfills.

- ① Recycling of landfilled wastes: Utilizing incineration ash as a part of materials for producing ecological cement or regular Portland cement
- ② Recycling of by-product salt: Collecting concentrated salt and refining it to produce industrial salt, and treatment of the salt with bipolar membrane to collect acid and alkali
- ③ Recycling of food scraps and other raw waste: Fermentation of the materials to stabilize them while collecting methane gas as energy
- ④ Utilization of wastes as civil engineering materials: Some wastes can be made civil engineering materials through a primary treatment using asphalt or concrete. Incineration ash can be utilized as a civil engineering material after an advanced treatment such as melting

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the promotion of 3Rs of wastes of the ecological landfills include the states of wastes prior to discharge, treatment of byproducts that are difficult to utilize, and utilization of green procurement.

- ① The treatment of wastes after they are discharged, even if it is made properly, cannot solve the problems of wastes essentially if no other measure is taken.
- ② It is necessary to review the ideal way of the waste management including the management of the source at upstream side of the facility.
- ③ Ensuring the methods of reuse of by-products such as by-product salt that are difficult to use
- ④ Utilizing the maximum of the green procurements for construction of landfills

6) Protection of regional environment (Restoration of environment, participation of neighborhood, safety and ease of mind for the residents)

From the literatures that were investigated, the following results were obtained with regard to the protection of regional environment of ecological landfills.

- ① Remediation of images of landfills: Positively utilizing the cooperation of local residents in the areas such as daily management of the facility and monitoring of the waste collection vehicles by reflecting their opinions and providing information such as project planning to the neighbors
- ② Multiple environment protection: Requiring a multiple environment protection system that consists of hardware and software technologies
- ③ Harmony with the environment: Taking action to prepare the habitats for fish, insects, and other lives in the landfill sites.

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the protection of the regional environment include the need of environmental education and prevention of environmental destruction.

- ① Lack of environmental education for general citizens and children
- ② Landfills ecologically friendly to peripheral areas are those that make full use of the characters of the local nature to contribute to the area
- ③ Enforcement of policies built of the principles that prevents environmental destruction

7) Protection of global environment (Prevention of global warming, utilization of natural energy, saving energy, LCA (Life Cycle Assessment))

From the literatures that were investigated, the following results were obtained with regard to the protection of global environment of ecological landfills.

- ① Prevention of air pollution: Atmosphere conscious operations of landfills including practice of idling stop of vehicles used in the sites
- ② Prevention of global warming: Effectively utilizing methane gas generated in the landfills to reduce environmental load resulting in preventing the global warming
- ③ Utilization of site after closing: Restoring the natural environment better than the original conditions

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the protection of the global environment include the lack of target setting for reduction of the environmental load.

- ① Lack of target setting for control of natural resource consumption, reduction of environmental load, and energy security.
- ② Nature conscious landfills are the facilities that take energy saving operations into consideration and utilize natural energy.

8) Waste treatment and disposal system of recycling-based society

From the literatures that were investigated, the following results were obtained with regard to the waste treatment and disposal system of recycling-based society.

- ① General concept of waste treatment: Establishment of a Recycling-based society requires both recycling and proper disposal of wastes and obtaining the consent of local residents. The measures to be taken are desired to totally consider generation, discharge, recycling, intermediate treatment and final treatment of wastes (storage).
- ② Control of wastes: It is important to have a point of view of waste control paying attention to the properties of wastes and their flow (mass balance) and conversion into resources (function of facility)
- ③ Reuse of landfills: Retaining landfill space through retreatment and recycling buried solid wastes of existing landfills
- ④ Landfills covering broad area: Promoting preparation of landfills that cover areas wider than cities, towns or villages based on the viewpoint of strengthening of management

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the waste treatment and disposal system of Recycling-based society include the establishment of waste control methods and development of social infrastructure such as legal systems .

- ① Establishment of a Recycling-based society requires both recycling and proper disposal of wastes and obtaining the consent of local residents.
- ② Future landfills are required not only to have the waste disposal facility but also to be a total system that takes into consideration the waste management system upstream of the site and its mode of utilization.
- ③ The measures that controls the properties and amount of wastes include the software and hardware. The software mainly includes the polluter-pays principle (PPP), extended producer responsibility (EPR) and economic approach, and the hardware mainly covers fracturing, sorting, incineration, melting of wastes, making fertilizer, and landfills.
- ④ To achieve establishment of Recycling-based society, the need of material circulation is emphasized as a means of recycling. Also, it is necessary to take a comprehensive view that considers environmental protection and resource preservation behind the need of material circulation and 3Rs of wastes and their proper treatment.
- ⑤ For the establishment of Recycling-based society, an important issue is how to minimize the final treatment system by taking into consideration its efficiency of operation and reduction of the environmental load.
- ⑥ It is important to make a social system by utilizing a legal system, economic method, and ecological educations and studies to get rid of illegal dumping of wastes to lead such deed to proper treatment of wastes, and to establish a technological system that is a social infrastructure such as waste recycling and treatment facilities.
- ⑦ To dispel resident unease, it is necessary to make the process from generation of wastes to the final treatment transparent, that is, to recognize the flow and conversion of wastes quantitatively and manage the risks.
- ⑧ Waste recycling and treatment facilities recycles the landfilled solid wastes to make raw materials for products.

9) Proposal of ecological landfill models

From the literatures that were investigated, the following results were obtained with regard to the proposed models of ecological landfills.

- ① Early stabilization model: Burying only wastes that can be reduced to soil in the future
- ② Target setting: Setting quantitative target for control of consumption of natural resources, reduction of environmental load, and resource and energy security
- ③ Multifunctional landfill: The facilities that can be reconciled to the local community and have a waste storage function for recycling (pre-treatment of wastes) and energy collecting function

The issues of the landfills that are extracted from the results of investigation of the literatures are as described below. The principal issues on the proposed model of ecological landfills include the setting of wastes that are allowed to bury and the multifunctionality of the facilities.

- ① Wastes that are allowed for final disposal are to be designated in accordance with the mode of utilization of the landfill (such as the utilization of the site after closing).
- ② The final disposal system should be determined by taking into consideration the waste management system upstream and the mode of utilization downstream of the facility.
- ③ The facilities that can be reconciled to the local community, and have a waste storage function for recycling (pre-treatment of wastes) and energy collecting function

10) Activities for promotion of broad use of ecological landfills

From the literatures that were investigated, the following results were obtained with regard to the activities for broad use of ecological landfills.

- ① Educational learning programs: Providing students with the opportunities for leaning the environment to make them conscious of the issues of wastes, and positively providing press and mass communication media with information about the facilities
- ② Communications with local residents for sound understanding of landfills
- ③ Residents participation: Participation of residents into the construction process of project including the planning and designing of the facility, determination of the monitoring method, and other details through discussion in an easily understood manner

The issues of the landfills that are extracted from the

results of investigation of the literatures are as described below. The principal issues on the activities for promotion of broad use of ecological landfills suited to the Recycling-based society include preparation of basis for accepting recycled matters from the facilities.

4. Conclusions and future issues

The Basic law for Establishing a Recycling-Based Society and other waste recycling laws have been enforced and/or amended, and in such situation, the landfills are required to provide new functions in the recycling-based society such as being facilities that is capable of preserving resources, protecting environment, and being accepted by the ecological system of the site and the local society.

We have reviewed the definition of the ecological landfill based on the viewpoint of 3Rs of wastes, and investigated existing literature discussing on the theme. From the results, we extracted the knowledge and case examples that can be informative for reviewing the roles and function of ecological landfills to obtain the concept and issues of the facility.

1) Concept of ecological landfill

Using the indices of space axis and time axis, we reviewed the definition of the ecological landfill based on the viewpoint of 3Rs of wastes.

As for the space axis, the ecological landfill is defined as the space that allows recycling of wastes by thoroughly performing promotion of 3Rs of wastes, driving efforts that minimize the amount of wastes to be disposed, and storing the wastes that are properly treated in the site, and thus, the space is positioned as "the place for ecological processing of wastes"

The time axis is the storage time that is needed for utilization of the wastes that are properly treated as resources. Because the wastes that are properly treated in the facilities reduce the environmental load as time elapses, the storage time is positioned as the period needed for improvement of recyclability of wastes as resource.

2) Roles and functions of ecological landfill obtained from discussions in existing literatures

The roles of the ecological landfills include storage of wastes, accepting wastes in a time of disaster, and providing images of safety and ease of mind in the operation. Their functions extracted from the discussion include storing wastes, accelerating stabilization of wastes, protection of environment, and putting advantages of the site into the local community.

From the results of investigation of the literatures, issues are obtained from individual subjects of discussion.

In the future, we are going to associate the results and issues obtained here with the concept of the ecological landfills and investigate the case examples of

the ecological landfills, as well as reviewing concrete models of the facilities.

5. Acknowledgement

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References:

- 1) Naoto Usui et al : " Study on Eco Landfill Sites" (Proceedings of The Fourth Asian-Pacific Landfill Symposium in Shanghai 2006 Volume Posters), 2006, PP.121~128