JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ULAANBAATAR CITY
MONGOLIA

THE STUDY ON SOLID WASTE MANAGEMENT PLAN FOR ULAANBAATAR CITY IN MONGOLIA

MAIN REPORT

Final Report

March 2007

KOKUSAI KOGYO CO., LTD.

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PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct "The Study on Solid Waste Management Plan for Ulaanbaatar City in Mongolia" and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Susumu Shimura of KOKUSAI KOGYO Co., LTD. between December 2004 and January 2007.

In addition, JICA set up an advisory committee headed by Dr. Hidetoshi Kitawaki, a Professor of Toyo University, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Mongolia and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the implementation of this plan and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Mongolia for their close cooperation extended to the study.

March 2007

Ariyuki Matsumoto
Vice President
Japan International Cooperation Agency

March 2007

Mr. Ariyuki MATSUMOTO
Vice President
Japan International Cooperation Agency

Letter of Transmittal

Dear Mr. Matsumoto

We are pleased to submit the report of the Study on Solid Waste Management Plan for Ulaanbaatar City in Mongolia.

The report consists of three components: a study on the present practices of waste management; the solid waste management master plan until 2020; and the feasibility of the priority projects.

The current issues have been identified by analyzing the existing data and evaluating the results of nine kinds of surveys conducted in the study on the present practices. We set the fundamental goal of the master plan as "To establish an environmentally sound SWM system in MUB by the target year 2020", and in order to achieve this goal, proposed the active promotion of the 3Rs (Reduce, Reuse and Recycle) of waste, as well as final waste disposal to be done in a proper manner without negative environmental impacts. Moreover, we conducted a study on the feasibility to improve the collection system to provide services to all residents, and a proposal for the construction of the Narangiin Enger Disposal Site and development of Narangiin Enger Recycling Complex. Assuredly, the validity of implementation of these projects was verified from technical, social, environmental, financial and economical points of view.

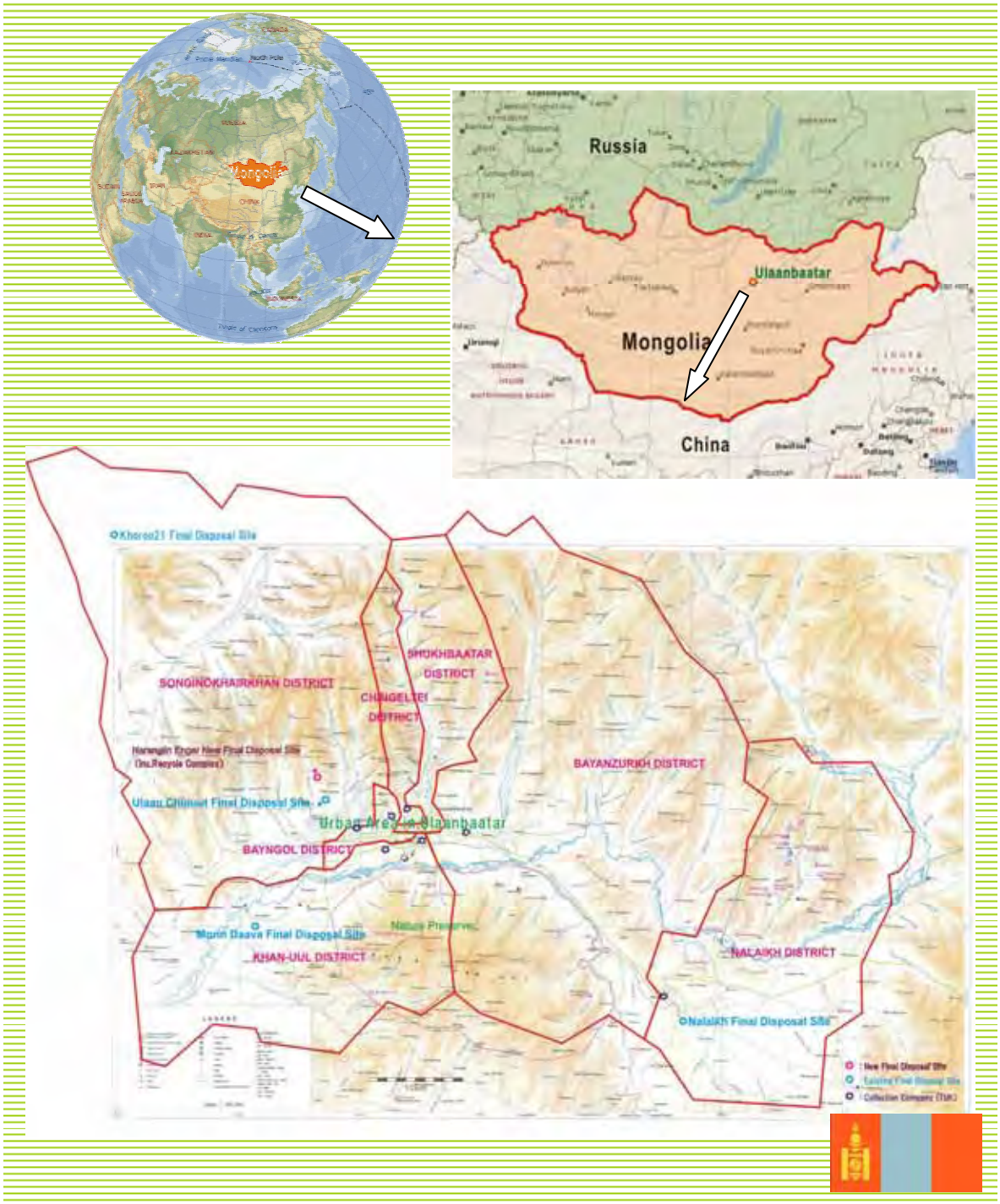
During the study period, the pilot projects such as emergency improvement of Ulaan Chuluut Disposal Site, thermal recycling of "RDF", improvement of the waste collection system, organization of waste pickers and so on were implemented and capacity development of counterparts and stakeholders of solid waste management were conducted Implementation of the master plan is now underway. Upon the recommendations made by the study, the Municipality of Ulaanbaatar established a new organization, the CMPUA (City Maintenance and Public Utility Agency), on 15th September 2006 during the study period in order to strengthen the current organization for solid waste management in Ulaanbaatar replacing the old organization, CMPUD (City Maintenance and Public Utility Department). At this time, the CMPUA wields strong authority to employ the necessary workforce, like an independent organization, to provide solid waste management with as many as 45 MUB members of staff.

We would like to take this opportunity to express our sincere gratitude to your Agency, the Advisory Committee, the Municipality of Foreign Affairs, and the Ministry of Environment of Japan. We would also like to extend our deep appreciation to the Government of Mongolia, The Embassy of Japan and the JICA Mongolian office for their vital cooperation during the implementation of the study in Mongolia.

Last but not least, we hope that the output of the study presented here will contribute to the sustainable development of not only Ulaanbaatar City but the whole country.

Respectfully,

Susumu SHIMURA
Team Leader
The Study on Solid Waste Management Plan for Ulaanbaatar City in Mongolia.



Study Area
for the Study on Solid Waste Management for Ulaanbaatar City in Mongolia

Waste generated in the Apartment area contains a lot of paper and plastic waste, so its relative density is low. A compactor truck is suitable but a dump track is mainly used.

Recently secondhand compactor trucks are used, but the malfunction of the compactor reduces the collection efficiency and could cause an injury.

In the center of the city, there is a daily collection service, but waste heaps are observed all over the area.

In order to remove waste heaps, containers are installed. The container system, however, does not work well, due to the lack of discharge rules and collection vehicles with lifting devices

Waste pickers scatter waste in the container. Waste are always scattered around the container.

High-rise apartments have a dust chute. Waste collected through the dust chute is stored in a storage room. Waste is stored long and often causes odor and breeding of vermin.

Plate 1: Current Conditions of SWM in UB (1): Collection Work in the Apartment Area

<Waste Generated in the Ger Area>
Waste in the Ger Area in the winter mainly consists of ashes. Waste is usually stored and discharged in a drum. It is very heavy.

<Collection Work in the Ger Area>
Dump truck is suitable for collecting heavy waste such as ashes. Loading work is very hard.

<Fee Collection>
Fee collection is conducted along with waste collection work.

<Illegal Dumping of Waste>
In the Ger area, many residents cannot afford to pay the collection fee, and collection service is not provided for those who do not pay the fee. Many of them dump waste in open space.

<Wastewater Treatment>
Residents are requested to discharge wastewater frozen in winter, rather than dumping it on the road, so that road surface freezing can be prevented.

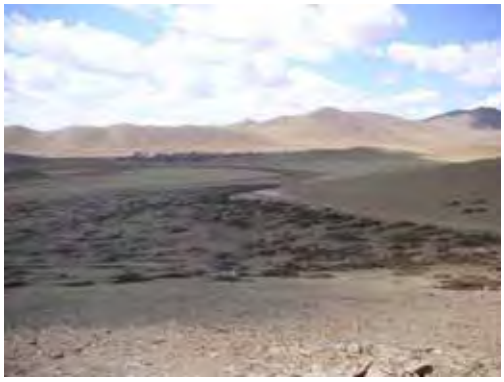
<Container in the Summer House Area>
Many people spend summer time in the Summer House Area. The container collection system is applied in many parts of the area, but this makes it difficult for TUK to collection the collection fee.

Plate 2: Current Conditions of SWM in UB (2): Collection Work in the Ger and Summer House Area

<Ulaan Chuluut Disposal Site, June 2005 >
The UCDS is the largest one in UB, and 90% of the generated waste in UB is disposed of here.

< Morin Davaa Disposal Site, September 2006 >
The MDDS, which is located a few km from the international airport, is the second largest one and 5% of the generated waste in UB is disposed of here.

< Nalaikh Disposal Site, August 2006>
The NDS is exclusively used for the disposing waste generated in the Nalaikh district.



<Khoroo 21 Disposal Site, May 2005 >
The site is located in Khoroo 21 of Songinokhairkhan District, 70km northwest from the center of the city. The site is exclusively used for the waste generated in Khoroo 21.

<Waste Picker (WP) in UCDS>
Around 300 waste pickers are working at UCDS. In order to realize a sanitary landfill operation, it is indispensable to cooperate with them.

<Scattered waste at the UCDS>
Waste is scattered due to the strong wing. This is a serious obstacle for landfill operation.。

Plate 3: Current Conditions of SWM in UB (3): Final Disposal of Waste

<Recycling Activity>
In the center of UB, recyclables are recovered by waste pickers.

<Problem Caused by Waste Pickers>
Recovery of recyclables by waste pickers is one of the main reasons for waste scattering.

<Buy-back Shop>
Street Waste Pickers earn small money by selling collecting valuable resource to a Buy-back Shop shown in a picture.

<Illegal Dumping of Waste>
There are numerous illegal dumping places other than 4 authorized disposal sites. This is one of largest place next to the 4th power plant.

<Illegal Dumping of Waste>
Many parts of the Ger Area are left without a regular collection service. This results in illegal dumping of waste in an open space.

<Illegal Dumping of Waste>
Waste dumped illegally in open space cause serious environment problems such as odor and breeding of vermin in summer. It is urgent for MUB to provide a collection service.

Plate 4: Current Conditions of SWM in UB (4): Recycling Activity and Illegal Dumping of Waste

<Waste Amount and Composition Survey>
The weight of discharged ash waste is measured.

<Time & Motion Survey>
The survey result revealed the collection efficiency of a Japanese secondhand collection vehicle is better than dump trucks.

<Public Opinion Survey>
Interviewers visited selected households in conduct an interview about the opinions about the current SWM in UB and their behaviors.

<Environmental Social Survey>
Interview surveys and focus group meetings were organized at and around disposal sites. The picture shows an interview with a waste picker at UCDS.

<Water Quality Survey in winter>
Water quality of under ground water around existing disposal sites was investigated.

<Medical Institution Survey>
Infectious medical waste in a red bucket is burned in a small incinerator inside the hospital premises.

Plate 5: Field Surveys

<Embankment Dam and Litter Control Fence>
Embankment Dam was constructed on the south edge of the landfill area and litter control fence was installed on the dam.

<Weighbridge>
The weighbridge, which was installed at the gate, measures the weight of waste every time a collection vehicle enters the disposal site.

<Weighbridge Control Office>
Nuut Co staff input data on the weight of waste brought to the disposal site, and the data is compiled into a database.
［Visit of President Enkhbayar to the UCDS］

<Organizing Waste Pickers>
Registration system of waste pickers was established and a meeting with group leaders is organized every week in order to establish and strengthen the relation with them.

<Raw Materials of RDF>
Plastic waste for RDF production. The other raw material is paper waste. Kitchen waste is not used, because it causes a problem such as fermentation, this makes RDF instable.

<RDF Production>
RDF is produced by a locally available machine. After mixing and heating plastic and paper waste, RDF was cast by a extruder.

Plate 6: Pilot Project

(Urgent Improvement of the UCDS/Organizing Waste Pickers/Thermal Recycling “RDF”)

<Mixed Combustion Test>
Combustion test was conducted the Nalaikh Heating Plant, by changing the mixture rate of RDF to coal from 2% to 4%.

<Sampling of Emission Gas>
Sampling of emission gas was conducted using a sampling equipment brought from Japan. The analysis of dioxin was conducted in Japan.

<Chirigami Kokan>
A truck waits for people coming with recyclables while playing a misuc.

<Lifting device>
A lifting device, which makes it easier for collection workers to load heavy waste such as ashes, apply the principle of leverage,

<Community Meeting>
Before the start of discharge rules, community meetings were organized in each housing association.

<New Discharge and Collection System>
In the morning of the collection day, residents place waste at a designated place and a keeper bring it in front of her apartment before a collection vehicle comes.

Plate 7: Pilot Projects

(Thermal Recycling “RDF”/Chirigami Kokan/Examination of the Loading Device for Heavy Waste/Collection System Improvement)

<New Discharge and Collection System>
A collection worker load waste which are placed in front of each entrance of the apartment

<Monitoring Activity>
For several days after the start of discharge rules, people selected by Khoroo were in charge of monitoring at former illegal dumping places

Feasibility Study
<Second Public Hearing>
Public Hearing about the development plan of NEDS and NERC were organized three times

Feasibility Study
<Follow-up Survey>
Every time public hearing was organized, a follow-up survey was conducted.

Capacity Development
<First Seminar>
Three seminars were organized.

Capacity Development
<Third Workshop>
Workshops were organized 4 times.

Plate 8: Pilot Project (Collection System Improvement)

Feasibility Study/Capacity Development

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List of Abbreviations

ADB	Asian Development Bank
ATP	Ability To Pay
BGD	Bayangol District
BKhD	Bagakhangai District
BND	Baganuur District
BZD	Bayanzurkh District
ChD	Chingeltei District
CD	Capacity Development
CDPPD	City Development Policy Planning Division
CMPUD	City Maintenance and Public Utilities Division
CMPUA	City Maintenance and Public Utilities Agency
CPUDC	Construction and Public Utilities Development Center
C/P	Counterpart
CSIA	City Specialized Inspection Agency
CTP	Community thermal plant
DF/R	Draft Final Report
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
F/S	Feasibility Study
GOM	Government of Mongolia
HIW	Hazardous Industrial Waste
IC/R	Inception Report
IEE	Initial Environmental Examination
IT/R	Interim Report
JICA	Japan International Cooperation Agency
JICA ST	JICA Study team
JOCV	Japan Overseas Cooperation Volunteer
JV	Joint Venture
KhUD	Khan Uul District
KH21DS	Khoroo 21 Disposal Site in Songinokhairkhan
M/M	Minutes of Meeting
MDDS	Morin Davaa Disposal Site
MIC	Ministry of Industry and Commerce
MOCUD	Ministry of Construction and Urban Development
MOECS	Ministry of Education, Culture and Science
MOE	Ministry of Environment
MOF	Ministry of Finance
MOH	Ministry of Health
M/P	Master Plan
MSWM	Municipal Solid Waste Management
MUB	Municipality of Ulaanbaatar
NaD	Nalaikh District
NDS	Nalaikh Disposal Site
NEDS	Narangiin Enger Disposal Site
NERC	Narangiin Enger Recycling Complex
Non-HIW	Non-Hazardous Industrial Waste
NPV	Net Present Value
NSO	National Statistical Office
Nuuts	Reserve Company
O&M	Operation and Maintenance
OSNAAG	Ulaanbaatar Housing and Communal Services Company
POS	Public Opinion Survey
P/P	Pilot Project
PR	Public Relations
P/R	Progress Report

RDF	Refuse Derived Fuel
SBD	Sukhbaatar District
SKhD	Songinokhairkhan District
SSIA	State Specialized Inspection Agency
ST	Study Team
St/C	Steering Committee
S/W	Scope of Work
SWM	Solid Waste Management
TFT	Task Force Team
T&M	Time and Motion Survey
TUK	Renovation company which provides which provides waste collection, street sweeping, park cleaning, greening services
TWG	Technical Working Group
UB	Ulaanbaatar
UBCSIA	Ulaanbaatar City Specialized Inspection Agency
UCDS	Ulaan Chuluut Disposal Site
UNDP	United Nations Development Program
UNESCO	United Nations Science and Cultural Organization
USAG	Water Supply and Sewage System Company
USIP	Ulaanbaatar Service Improvement Project
WACS	Waste Amount and Composition Survey
WB	World Bank
WTP	Willingness to Pay

1. Outline of the Study

1 Outline of the Study

1.1 Background of the Study

Ulaanbaatar City in Mongolia occupies an area of 4,704km^2 and has a population of approximately 894,000 (2005) which is where a little under 40% of Mongolia's 2,500,000 citizens live. Due to a recent population surge (3.1% from 1990-2000 and 3.6% from 2001 to 2003) and a switch to a market economy, there has been a variation in consumption resulting in a rise in the amount of discarded waste and issues related to Solid Waste Management (SWM) have become severe.

Under such circumstances, in 2001 the Government of Mongolia (GOM) requested the Government of Japan to conduct Technical Cooperation (Development Study) to formulate a plan for a comprehensive solid waste management system for Ulaanbaatar City (UBC).

On the basis on this request, in September 2004 GOM and the Japan International Cooperation Agency (hereinafter referred to as JICA) agreed on the Scope of Work (S/W) for the "The Study on Solid Waste Management Plan for Ulaanbaatar City in Mongolia[1]" (the study). From this agreement, JICA selected Kokusai Kogyo Co., Ltd to conduct the study for duration of 28 months from November 2004 to February 2007.

1.2 Objectives, Overall Goal and Scope of the Study

1.2.1 Objectives of the Study

The objectives of the study are as follows.

1. To formulate a master plan (Target Year 2020) for SWM in Ulaanbaatar City and conduct a Feasibility Study for the priority projects proposed in the Master Plan (M/P).
2. To enhance the institutional, organizational, and human capacity related to solid waste management in Ulaanbaatar City

1.2.2 Overall Goals

By achieving the above-mentioned objectives, the overall goals are as follows.

Goal 1 . Establish a Sustainable SWM System in Ulaanbaatar City, properly collect daily discarded waste and conduct sanitary landfilling of the collected waste at designated sites.

Goal 2 . Implement the plan, formulated with the cooperation of stakeholders, for SWM in Ulaanbaatar City and enable suitable revision of the plan in response to change of the circumstances.

1.2.3 Study Area

The study area consists of seven (7) districts in Ulaanbaatar City; Sukhbaatar District, Chingeltei District, Bayanzurkh District, Songinokhairkhan District, Bayangol District, Khan-Uul District, and Nalaikh District as shown in the Figure below.

[1] Ulaanbaatar City (UBC) consists of 9 districts (Duureg), however the scarcely populated Baganuur Duureg and Bagakhangai Duureg are excluded from the study area in the Development Study. Thus in this report, UBC in the study refers to 7 districts (area 3,944km^2, population 867,000 (2005)) of if there is no indication like whole UBC, etc.

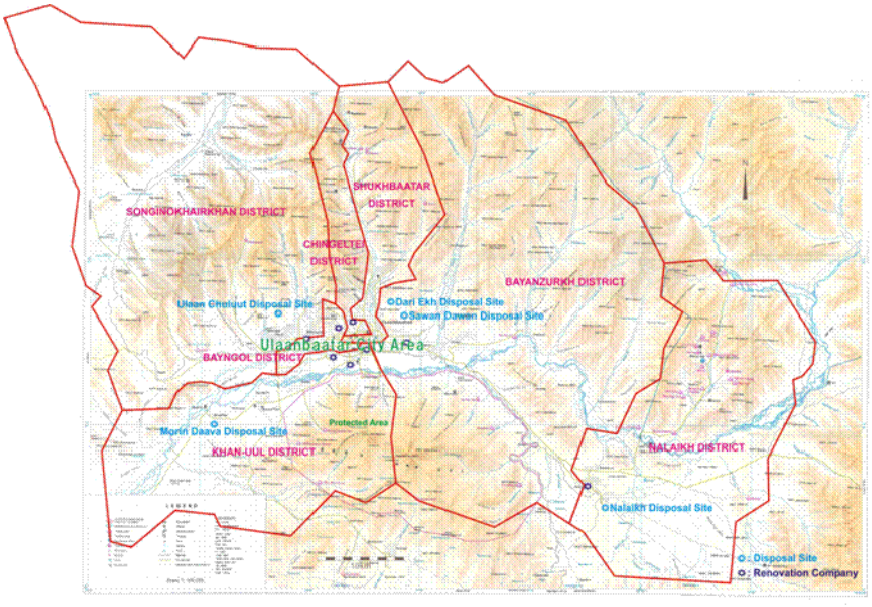


Figure 1-1: Study Area

1.2.4 Target Waste

The target waste in the study is Solid Waste handled by the Municipality of Ulaanbaatar. As for hazardous/infectious medical waste and hazardous industrial waste, the study includes an estimation of the generation rate and proposes general recommendations on how to properly handle the waste based on existing information.

1.3 Description of the Study

1.3.1 Basic Policy of the Study

The ultimate aim of the study is to **construct capable / sustainable organizations for SWM in the study area** that implement an improvement plan for SWM in Ulaanbaatar City and conduct suitable revisions of it (as mentioned in Goal 2 above). Consequently, proper collection and sanitary disposal (as mentioned in Goal 1 above) will be conducted in Ulaanbaatar City.

In order to accomplish this, the study was conducted based on the following basic policies.

Basic Policy 1: Support Construction of Organizations to Resolve SWM Issues in the Ulaanbaatar City

The organizations related to SWM in Ulaanbaatar City (UBC) have to faithfully put into action the plan formulated in the study in order to achieve the above-mentioned overall goals. This is also the case for Japan and other developed nations. However, there are no absolute or permanent solutions for SWM, and new issues which continuously occur due to changes in socioeconomics must be resolved each time they occur. Therefore, the Master Plan (M/P), which will be formulated under the study, should be implemented and amended to respond to changes in socioeconomics. As the study period is limited, the organizations related to SWM in UBC will implement and amend the M/P. With this point in mind, the SWM related organizations in UBC, who will resolve SWM issues, have to be involved in the study and formulation of the M/P. Thus supporting construction of them was one of the basic policies of

the study. This point is extremely important for SWM issues of UBC where there is significant social change.

Basic Policy 2: Support Formulation of a Practical SWM Plan

There are many restraining factors of Ulaanbaatar City's current SWM system. The plan to improve the SWM system has to face the constraints and be executable from a technical, institutional, socio-economic and environmental aspect. Furthermore, many related organizations take part in the SWM system in Ulaanbaatar City, and each organization has various interests in SWM. Unless the roles of these organizations are coordinated and agreement is reached to the greatest extent, there is little hope that the improvement plan will be put into practice. Thus, the second basic policy is to support the Municipality of Ulaanbaatar (MUB) as the main body in formulating a practical SWM plan.

1.3.2 Study Structure

a. Capacity Development

As mentioned in objective 2 of this study, it is essential to "support capacity development at an individual, organizational, institutional and societal level for SWM in Ulaanbaatar City" in order to "create organizations to resolve SWM issues in the study area". However, as capacity development comes from within and is gradual, and as the implementation period of the study is limited, the targets for support have to be limited to a certain extent. Thus, the targets for capacity development are shown in the following diagram.

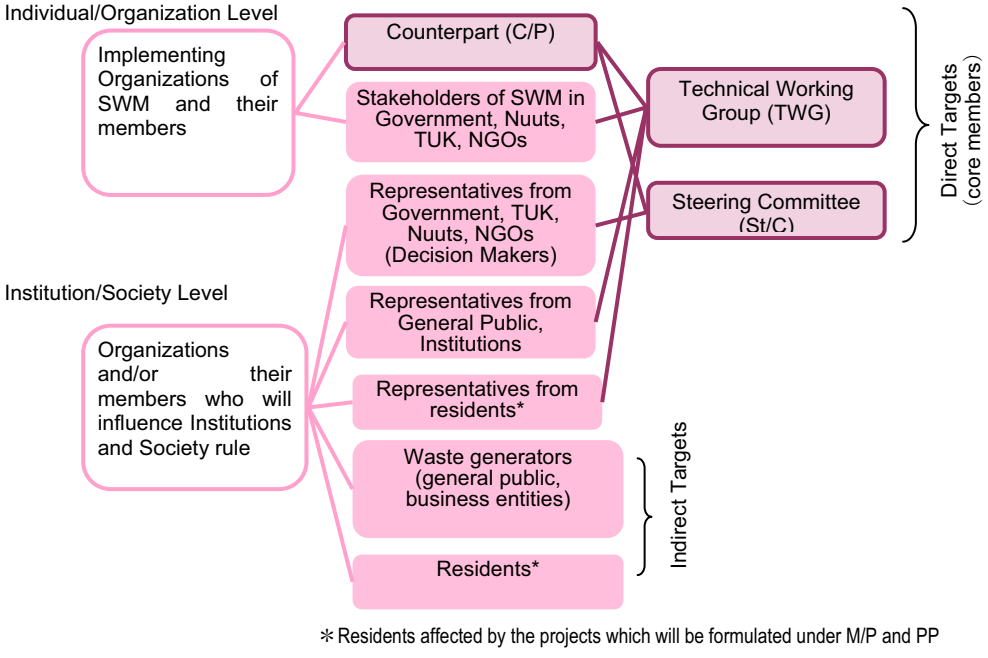


Figure 1-2: Targets for Capacity Development in the Study

b. Structure of the Study

Those with specific central roles in the study are regarded as "direct targets" for capacity development. The direct targets constitute the core members of the study implementation system and suitable organization of this is the first step towards capacity development. As shown in the diagram above, the core members are three organizations; the counterpart (C/P), the technical working group (TWG), and the steering committee (St/C), and the members and

the functions are described in the following table. From these, TWG is responsible for executing the survey, the contents of the plan and implementation. In addition, taking into account the sustainability of the plan, TWG will also be the organization responsible for follow-up of the plan through working level liaison after termination of the study and amending the work when necessary securing the sustainability of the plan. The above system was proposed to the Mongolian side in a consultation when the Inception Report (IC/R) was submitted and with their consent, the members in the following table were appointed.

In the study, promotion of mutual communication and encouragement of indirect targets through the above mentioned direct targets was supported to increases the capacity.

Table 1-1: Core Members and Function

Organization	Member	Function
Counterpart (C/P) 5 persons	Municipality of Ulaanbaatar (MUB)	• Co-study member • Formulation and implementation of SWM plan • Request cooperation from other stakeholders • Coordination with St/C, TWG
Chief Counterpart	Chief of City Development Policy Planning Division (CDPPD)	
Members	One person from CDPPD	
	Three persons from City Maintenance and Public Utility Division (CMPUD)	
Technical Working Group (TWG) 21 persons	Officers in charge of SWM in each organization	• Core member for the study and formulation and implementation of the plan together with JICA ST. • Discussing details of the SWM plan through TWG meetings • There are permanent and temporary members. The former need to fully attend meetings and the latter will be called to attend whenever necessary. • TWG meetings will be held weekly.
Chairman	Chief Counterpart	
Permanent Members: 11 persons	Member of C/P	
	Officer of Sustainable Development and Environment in MOE	
	Officer in charge of Public Health in MOH	
	Inspector of City Specialized Inspection Agencies	
	President of Nuuts Co.	
	Vice president of Baigal-Erdene Fund (NGO)	
	Vice president of Mongolia Ecologist Society (NGO)	
Temporary Members: 10 persons	Officer of the Department of Industrial Policy Adjustment of Ministry of Industry and Trade	
	Chief of the Department of Nature and Environment of Ulaanbaatar City	
	Director of the Institution of Urban Planning, Research and Design, Ulaanbaatar City Government	
	Senior Officer for Budget of the Department of Finance, Economy and Budget, Ulaanbaatar City Government	
	Chief of the Central Water Treatment Facilities of UB City	
	Director of TUK in Khan Uul	
	Head of the Department of Public Service and Utilities, Chingeltei District Government	
	Vice Chief of OSNAAG	
	Head of Information Technology Center of UB Development and Investment Department of the Ulaanbaatar City	
	Head of Land Information Center, Department of Land of Ulaanbaatar City	
Steering Committee 17 persons	Representative from each organizations (Decision Maker)	• Decision of Important Policy relating to the study • Coordination among stakeholders and request cooperation • Meetings held periodically whenever the study policy needs to be decided.
Chairman	State Secretly of Ministry of nature and Environment	
Vice Chairman	General Manager of UB City and Chairman of the Governor's Office	
Secretary	Head of CMPUD	
Members:	Head of the Department of Sustainable Development and Environment of MOE	
	Head of the Department of International Cooperation in MOE	
	Director General of the Department of Economic Cooperation Policy and Coordination of MOF	
	Head of Department of Construction and Public Service Policy Adjustment of MOCUD	
	Head of the Department of Industrial Policy Adjustment of MIC	
	Officer for Environmental Social Health Affairs of Policy Adjustment Department of MOH	
	Head of the Department of Environment, Geodesy and Cartography Inspection, State Specialized Inspection Agencies	
	Chief of City Development Policy Planning Division (CDPPD)	
	Chief of CSIA	
	Chief of the Education Department of MUB	
	Chief of OSNAAG	
	Chief of the Steering Committee of Apartment Owner's Unions	
	President of Baigal-Erdene Fund (NGO)	
	President of the Union of Mongolia Ecologist	

(Note) The members listed above were assigned after the signature of IC/R and, according to the progress of the study, actual members have been changed.

1.3.3 Study Schedule and Description of the Study

a. Overall Study Schedule

The original study schedule consists of the two phases and would end March 2006. As stipulated in the scope of work of the Study, which was discussed and agreed upon between the Municipality of Ulaanbaatar (MUB) and JICA on 13th September 2004, both MUB and JICA have agreed to conduct a Phase 3 study in order to monitor and follow-up the projects and programs to be proposed in the Study. Consequently the Study schedule has been revised as shown in the Figure below and consists of the following three phases:

Phase 1: Formulation of the Master Plan (M/P)

Phase 2: Feasibility Study for Priority Projects and Implementation of Pilot Projects

Phase 3: Monitoring and follow-up of the projects and programs to be proposed in the Study

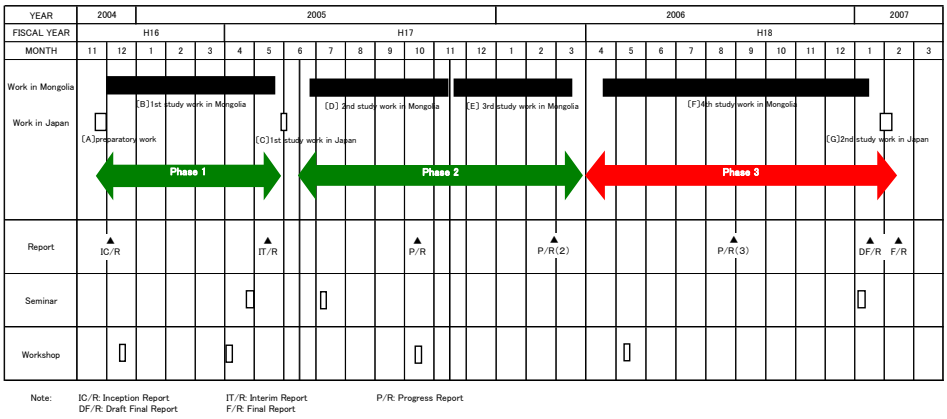


Figure 1-3: Study Schedule

b. Description of the Study

b.1 Phase 1 Study : Late November 2004 until Mid May 2005

Firstly, various kinds of field investigation including the Waste Amount and Composition Survey (winter) were carried out to ascertain the current conditions of SWM in Ulaanbaatar City. Based on the results of the investigation, the population and waste generation amount were estimated until the year 2020, alternatives were examined for improving the situation and the M/P (draft) was formulated with the aim of establishing an environmentally sound SWM system in 2020. Priority projects were selected based on the M/P (draft) and pilot projects were proposed.

In formulating the M/P (draft), essential site selection works for the future final disposal site were carried out with cooperation from the Mongolian side. As the disposal site is an inconvenient facility, it is important for site selection work to be as fair and transparent as possible. Therefore, as stated in chapter 3, the Mongolian side was the main actor in carrying it out and the study team has been concentrating on supporting the selection work. In addition, workshops and seminars were held to reflect the opinions of the people concerned as much as possible including the residents staying near the future disposal site. Furthermore, the procedures for site selection were communicated as much as possible to residents of Ulaanbaatar through mass media publicity. Site selection work, which commenced in December 2004, was carried out to select a future disposal site for the central 6 Duuregs

(Districts) which dispose over 90% of the waste in Ulaanbaatar, and the Narangiin Enger candidate site was selected at the end of April 2005 from 16 candidate sites.

b.2 Phase 2 Study： Mid June 2005 until Mid March 2006

Alongside the Feasibility Study (F/S) carried out for the selected priority projects in the Phase 1 study, a Pilot Project (P/P) was conducted to examine the feasibility of the M/P and ascertain the issues and ways to resolve issues which would accompany the implementation of the M/P.

The priority projects which were the subjects of the F/S were i. improvement of collection system to provide all residents of Ulaanbaatar with a collection service, ii. Development of Narangiin Enger Disposal Site (NEDS) selected by the previously mentioned site selection work, and iii. Development of the Narangiin Enger Recycling Complex（NERC） which is adjacent to NEDS. Alongside the F/S, an Environmental Impact Assessment (EIA) has been conducted for the relevant F/S from August 2005 and the Mongolian Ministry of Environment approved the EIA in February 2006. Moreover, regulations were established in November 2005 restricting land use in the nearby area in order to protect the current disposal site and the future NEDS from the expansion and development of the GER area.

Together with examining the feasibility of the M/P, improvement of the current Ulaan Chuluut Disposal Site (UCDS), production of refuse derived fuel (RRF) to be introduced at NERC and mixed combustion testing of RDF with coal at the existing heating plant, and trials of swapping waste for toilet paper (Chirigami-kokan), experienced widely in Japan after the oil crisis, were carried out in the P/P to obtain the data necessary for the previously mentioned priority project plan.

b.3 Phase 3 Study: Mid April 2006 until Mid February 2007

Based on a request from the St/C held on 26th October 2005, the Phase 3 Study was carried out for the follow-up and monitoring of the study, continuation and development of the P/P, promotion of the implementation of the M/P and F/S and continuation of capacity development (CD).

In addition to the continuation of the P/P implemented in the Phase 2 Study, i. Improvement of collection efficiency（in order to provide collection services to all the residents in UBC） by establishing discharge rules, ii. Experimental introduction of separate collection which is a prerequisite for commercialization of RDF and NERC, and iii. Restriction of the activities of waste pickers (WPs) in the NEDS disposal site and the necessary organization of the WPs has been carried out to promote the implementation of the priority projects which are the target of the F/S. On 13th April 2006, the Mongolian President of GOM inspected the conditions of the P/P improvement at UCDS and instructed the relevant persons to continue the P/P and improve the WP working conditions.

Following the suggestions of this study, in order to significantly strengthen the SWM system, the Mayor's order No.445 was issued on 13th September and some (5 out of 9 people) of the people in charge of SWM in the City Maintenance and Public Utilities Division (CMPUD) were removed, and it was re-established on 15th September 2006 as the City Maintenance and Public Utilities Agency (CMPUA) with jurisdiction over SWM. In addition to the new CMPUA having 45 municipal employees, they are fully authorized as an independent organization and can hire necessary staff members. Furthermore, in order to ensure the resources necessary for adequate SWM, on 24th August 2006 the Ulaanbaatar City Council voted on the amendment of the waste collection and disposal fee based on the financial evaluation in the Development Study, and this was executed on 1st September that year.

Moreover, in order to promptly reform the SWM system in Ulaanbaatar, the Mongolian Government made a request to the Government of Japan in June 2005 for grant aid for the F/S target work; ①Construction of Narangiin Enger Disposal Site (NEDS), ②Construction of Sorting Yard for Narangiin Enger Recycling Complex (NERC),③Equipment for Sanitary Landfilling, ④Waste collection trucks and ⑤Maintenance equipment for collection trucks. The Government of Japan accepted this request and sent a Basic Design Study Team in September 2006 and the possibility of the cooperation is currently under investigation (January 2007).

As mentioned above, together with the current study, reform of the current SWM system is being advanced from various fronts.

1.4 Organization of the Study and Assignment of the Study Team

1.4.1 Organization Structure of the Study

The organizational structure of the study was shown below.

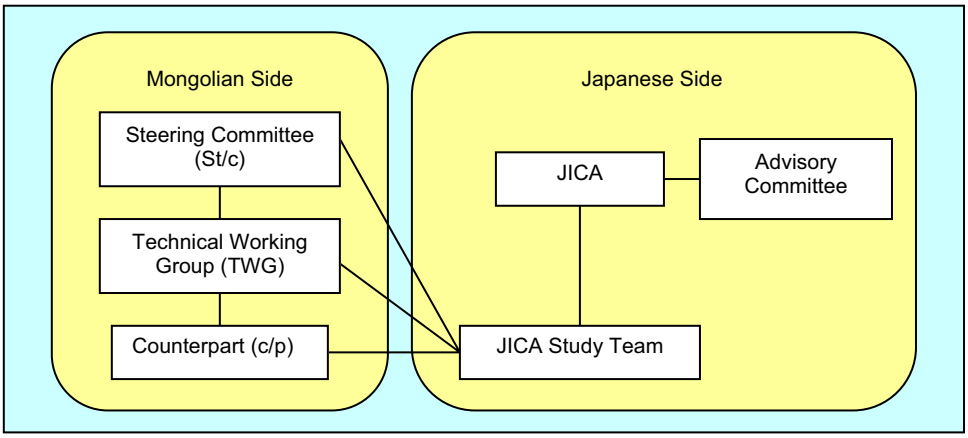


Figure 1-4: Organizational Structure of the Study

1.4.2 Members of the JICA Advisory Committee

The members of the JICA Advisory Committee are as follows.

Assignment	Name	Position
Chairman	PhD. Hidetoshi KITAWAKI	Professor of Toyo University
Member	Mr. Yutaka NAGASE	Sapporo City, Department of Environment, Cleansing Division

1.4.3 Members of the Study Team

The members of the Study Team are as follows.

Assignment	Name
Leader / Capacity Development	Mr. Susumu Shimura
SWM Facility Planning / Environmental Consideration	Mr. Tamotsu Suzuki
Collection and transportation planning	Mr. Akira Doi
SWM Recycling System / Hazardous Waste / Pilot Project	Mr. Ichiro Kono
Construction Planning / Cost Estimation	Ms. Ikuko Kunitsuka
Community Participation / Social Consideration	Ms. Keiko Kani
Institutional Building / Human Resources Development	Mr. William Murray
Finance and Management Analysis	Mr. Shinichi Mori

Equipment Planning	Mr. Masanori Takeishi
Construction Waste Management	Mr. Shinya Kawada
Coordinator	Mr. Takuya Takasho

1.4.4 Members of the Counter Personnel Mongolian Side

The Government of Mongolia formed three types of organizations, which are Counter Part (C/P), Technical Working Group (TWG), and Steering Committee (St/C), for study team for the implementation of the study. Details are explained in Table 1-1: Core Members and Function**.** The C/P assigned in the begging of the study is presented in the Table below.

Table 1-2: C/P Assigned in the Begging of the Study

No	Name	Position
1	Mr. BAT Choimpog	Director of City Development Policy Planning Division, Municipality of Ulaanbaatar
2	Dr. BATSAIKAN Chultemsuren	Officer of City Development Policy Planning Division, Municipality of Ulaanbaatar
3	Mr. BOLD Tsegmid	Director of City Maintenance and Public Utilities Division, Municipality of Ulaanbaatar
4	Mr. DELGERBAYAR Badam	Officer of City Maintenance and Public Utilities Division, Municipality of Ulaanbaatar
5	Ms. BUYANJARGAL Tumurbaatar	Officer of City Maintenance and Public Utilities Division, Municipality of Ulaanbaatar

1.5 Reports

The JICA study team prepared and submitted the following reports to the GOM.

Table 1-3: Reports to be submitted

	Report	Period of Submission	Number of Copies to be submitted
1	Inception Report	December 2004	10 copies (English) 40 copies (Mongolian)
2	Interim Report	May 2005	10 copies (English) 40 copies (Mongolian)
3	Progress Report (1)	October 2005	10 copies (English) 40 copies (Mongolian)
4	Progress Report (2)	February 2006	10 copies (English) 40 copies (Mongolian)
5	Progress Report (3)	August 2006	10 copies (English) 40 copies (Mongolian)
6	Draft Final Report	January 2007	Summary 20 copies (English) Summary 40 copies (Mongolian) Main 10 copies (English) Main 40 copies (Mongolian) Supporting 10 copies (English) Supporting 20 copies (Mongolian) Data Book 10 copies (English) Data Book 20 copies (Mongolian)
7	Final Report	March 2007	Summary 20 copies (English) Summary 40 copies (Mongolian) Main 20 copies (English) Main 40 copies (Mongolian) Supporting 20 copies (English) Supporting 30 copies (Mongolian) Data Book 20 copies (English) Data Book 30 copies (Mongolian)

1.6 Work Flow

The study was conducted in accordance with the Figure below.

2. Profile of the Study Area

2 Profile of the Study Area

2.1 Natural Conditions

Ulaanbaatar City is a basin with an elevation height of 1,350m surrounded by hills and mountains with an elevation variation of 500-700m.

Ulaanbaatar is the coldest capital city in the world, in the winter season it is bitterly cold with temperatures of minus 40 degrees (the average temperature in January is minus 21.8 degrees). Furthermore, it has a continental climate with an extremely large day/night and yearly temperature range, and in summer the temperature occasionally exceeds 30 degrees (the average temperature in July is 16.9 degrees). In addition, there is little rainfall; the average yearly precipitation amount is 230mm. Although the wind is not strong in the summer and winter seasons, there are strong gales at the turn of the seasons in April, May, September and October.

2.2 Social Conditions

2.2.1 Administration

Mongolian legislation provides for three levels of Government in Ulaanbaatar – the City, 9 *Duuregs,* or Districts and 123 *Khoroos*, or sub-districts. Beneath this are *Khesegs,* which are informal groupings of small numbers of streets within *Khoroos*.

Appointment of the City Governor is by nomination of the 40 Citizens Representatives of the City *Hural* or Parliament, subject to Prime Ministerial approval. The City's annual program of activities and budget must be approved by the City *Hural*. Day-to-day responsibility for SWM at this level lies with the MUB City Maintenance and Public Utilities Division reporting to the General Manager. SWM is frequently on the agenda of the fortnightly city management meetings at which District Governors report their activities and plan for the future.

District Governors are appointed by the City Governor, with the legal maximum of 35 staff being professional officers. They implement City policy but the District's annual program and budget must be approved by the District Citizens Representatives' *Hural*, which subsequently monitors performance.

District Governors are required to maintain their public areas in clean condition, to implement waste legislation, to work with an entity in charge of collecting and transporting waste and to provide funds for these operations. Each District has a TUK which undertakes SW collection and transport, as well as other activities. These reports to the City Maintenance and Public Utilities Division and City Property Relations Department as well as to their respective District Departments and Governments. The Law also requires the maintenance of a District Waste Fee Information Database with information to be supplied by the *Khoroo*s, but this has not yet been implemented.

Khoroo level government is regarded by the City as being very important to Municipal success, since it is the main interface with the public. It fulfills a very wide range of civic functions. *Khoroo* Governors are appointed by the District Governors. The *Khoroo* Public *Hural* is consultative only and does not have approval authority for *Khoroo* activities. The

function of the *Khoroo* is to implement decisions made at higher levels. Two or three social welfare staff whose salaries are paid for by the District, assist the Governor. The law requires Governors to monitor illegal dumping and organize appropriate cleaning measures such as campaigns and collections of money from *Ger* area households to contract trucks to remove waste.

There is increasing concern about the quality and efficiency of *Khoroo* government. The populations of *Khoroo*s vary greatly in size, from about 4,000 to 20,000, but have the same number of staff. Not all *Khoroo*s have their own dedicated premises. They are overloaded with work to varying degrees with bombardment of instructions from above and demands from increasing populations below. The quality of the *Khoroo* Governors varies widely, depending on their personal energy and enthusiasm; and the low remuneration is a temptation to corruption.

The *Khesegs* are a post-communist response to increasing population fuelled by immigration to Ulaanbaatar's *Ger* areas. *Kheseg* Leaders are appointed at public meetings called by the *Khoroo* Governor. These positions are voluntary and unpaid, and are usually filled by retired people. Their functions include publicizing decisions made at higher levels, encouraging participation in public meetings and learning about their local residents to the extent that they can advise on who should receive grant food aid, be exempt from SWM charges etc.

2.2.2 Population

The populations of the study area and MUB in 2004 are shown in the table below. Average number of family members in a household is 4.52 persons in the study area. As seen in the table the study area is a thinly populated area and its population density is 2.1 persons per hectare.

It can be seen from this table that in Ulaanbaatar City most people live in the urban centre. From the viewpoint of SWM, it is privileged as the site of a waste treatment and disposal facility which is a very serious issue for SWM.

Table 2-1: Population of the Study Area in 2004

District	Area (ha)	Household	Population in 2004	Population Density	Population in 2005*[1]
Bayangol	2,949	34,124	153,562	52.1	160,982
Bayanzurkh	124,412	40,106	172,824	1.4	178,809
Songinokhairkhan	120,063	38,572	182,153	1.5	185,634
Sukhbaatar	20,840	23,522	106,167	5.1	108,480
Khan-Uul	48,466	17,289	81,140	1.7	82,787
Chingeltei	8,930	27,218	122,483	13.7	124,640
Nalaikh	68,764	5,475	24,687	0.4	25,259
Study Area	394,424	**186,306**	**843,016**	**2.1**	866,591
Baganuur	62,020	5,881	23,249	0.4	23,954
Bagakhangai	14,000	747	3,647	0.3	3,770
MUB	470,444	**192,934**	**869,912**	**1.8**	**894,315**

(Source) "Ulaanbaatar - XX Century" Statistical Handbook, 2004
(Note) *1: Estimated by the Study Team

There is extreme population inflow from rural areas to Ulaanbaatar City, and according to the 2000 population census, 64% of Mongolia's population migration from 1995 to 2000 consisted of people moving from rural areas to Ulaanbaatar City. In addition, the population

growth rate of the City was 3.1% from 1990 to 2000 but this increased to 3.6% from 2000 to 2003.

2.3 Urban Structure

2.3.1 Apartment Area (Planned Area) and Ger Area (Unplanned Area)

In view of the formation process as a city the Ulaanbaatar City (UBC) is divided into two areas; i.e. Apartment area (Planned area) and Ger area (Unplanned area). The Apartment area is established according to the city development plan while without a plan the Ger area grows by rapid migration from the country. The two areas differ significantly from each other not only city view but also urban infrastructure such as roads, water supply, sewerages, heating system, etc. As for the SWM the two areas also vary remarkably on waste storage, discharge and collection system as well as waste collection charge system. Most of business enterprises and urban facilities are located in the Planned area, the Apartment area. In addition to these areas in the summer season, there is the Summer House Area which is a district of resort houses on the outskirts, the features of which are shown in the following table.

Table 2-2: Apartment, Ger and Summer House Areas

Item	Apartment Area	Ger Area	Summer House Area
Urban Structure	Created based on town planning	Randomly created	Planned but some parts were randomly created
Building	Multistory	One-story	One-story
Water Supply	Equipped with Household water supply	Purchased from a water kiosk and transported by wheelbarrow	Obtained from a neighbourhood well/surface water or purchased from a water wagon
Toilet	Drainage sewers are installed	Toilet in the residence garden *1	Toilet in the residence garden or a shared toilet
Waste	100% Collection	Collection service is provided at the same time as fee collection	Collection service is provided at the same time as fee collection

（Note）*1 : As the pumping service is not fully diffused, there is an issue with human waste being disposed together with waste in the cold months.

Rough breakdown[1] of Planned area (Apartment area) and Unplanned area (Ger area) population according to Khoroo is presented in the "Permanent Settled Population of UBC" published by the Department of Statistics, Information Research of MUB. Based on it, the Study Team estimates populations of Planned area and Unplanned area by supposing both Apartment area and Ger area indicated in the book as 100 % of each area, and the Mixed area described in it as 50 % of each area. Consequently, the population of Planned area and Unplanned area in 2004 is 424,679 and 418,337, respectively. The portion of population in the Planned area and Unplanned area is almost equal, 0.504:0.496.

2.3.2 Land Use

According to the "Ulaanbaatar - XX Century" Statistical Handbook 2004, 60% of land use is for agriculture (mostly grassland), and even when combined with roads and railways, the residential land use accounts for only 7%. The remaining land is accounted for by forests and national preservation areas.

[1] It informs us each Khoroo as a Ger area, an Apartment area or a Mixed area.

2.3.3 UBC Development M/P

The Ulaanbaatar City Development Master Plan (UBC Development M/P) has been elaborated in 2000 and consists of the 6 volumes that reflect all aspects of the UBC development until 2020. The Government of Mongolia approved the M/P in February 2002. Currently the MUB has to update the M/P. According to the official of the UBC Urban Planning Institute the City Government has made a proposal to the Canadian side to cooperate in this field.

2.4 Economy and Finance

At the beginning of the 1990s the Mongolian economy shifted from a planned economic system to a market economy and a fundamental economic reform program was launched including privatization of state-run enterprises, introduction of foreign capital and reform of the tax and banking systems. Following this trend, the district cleansing corporation (TUK), which was carrying out cleaning activities in all of the districts in the study area, was privatized with the exception of Nalaikh District (Duureg).

Although the GDP became negative at the initial stage of the transition to a market economy system, since 1994 the GDP figures turned positive and growth is continuing. The industry with the largest proportion of GRDP in Ulaanbaatar City is the manufacturing industry, accounting for 34% of the GRDP. In addition, the growth rate from 2000-2003 was 25%, the second highest following the education industry's growth rate of 45%.

The Mongolian Government is advancing a financial redistribution policy in order to promote equality in the distribution of financial resources in cities and rural areas. Thus, despite the city tax revenue for Ulaanbaatar City being 26.6 billion MNT in 2004, 13.5 million MNT was paid to the central government. In addition, no funding is allocated to Ulaanbaatar City for SWM operations from the central government budget.

3. Field Investigations

3 Field Investigations

In collaboration with the counterparts (C/P) and local consultants, the study team is carrying out the following field investigations to fully understand the present SWM conditions in the study area:

- Waste amount and composition survey (WACS) in winter and summer
- Time and motion survey (T&M survey) in winter and summer
- Public opinion survey (POS)
- Environmental survey on the conditions around final disposal sites
- Survey on medical waste management
- Survey on industrial waste management
- Survey on recycling market
- Survey on final disposal amount
- Study on construction waste

3.1 Waste Amount and Composition Survey (WACS)

3.1.1 Waste Generation Rate and Amount

a. Waste Generation Rate and Amount

The WACS identifies generation ratio of each generation sources in winter and summer season as shown in the table below. The daily waste generation amount is calculated by multiplying the number of generation source with generation ratio of it.

Table 3-1: Estimation of Waste generation amount in Study area (2005)

Generation Source		Number of Generation Source	Unit	Generation Ratio (g/day)		Daily Generation Amount (ton/day)	
				Winter season	Summer season	Winter season	Summer season
Household Waste	Apart	450,627[*1]	g/person/day	256	228	115.4	102.7
	Ger*1	415,964[*1]	g/person/day	951	202	395.6	84.0
	Total	**866,591[*1]**	**g/person/day**	**590**	**216**	**511.0**	**186.7**
Commercial Waste (Restaurant)		41,812[*1]	g/chair/day	250	270	10.5	11.3
Commercial Waste (Other Shop)		3,009[*1]	g/shop/day	1,200	1,640	3.6	4.9
Office Waste		105,376[*1]	g/employee/day	130	180	13.7	19.0
Market Waste		4,354[*2]	g/stall/day	850	1,720	3.7	7.5
School Waste		271,378[*1]	g/student/day	3	1.5	0.8	0.4
Hotel Waste		11,506[*1]	g/room/day	130	110	1.5	1.3
Business Total		-	-	-	-	**33.8**	**44.4**
Public Area Cleaning Waste		3,266,375[*2]	g/m2/day	**3.0**	**5.1**	**10.0**	**17.0**
Total						**554.8**	**248.1**

(Note)

*1: Source: Department of Statistics, Information and Research of Ulaanbaatar

*2: Based on the information obtained in the interviews to managers and responsible persons during the Study

*3: The generation rates of summer house in winter and in summer are 1,060 and 190 g/person/day respectively. The generation rate of summer house is included in it of Ger area.

The calculated generation ratios according to the generation sources and those obtained from other JICA SWM studies are shown in the table below. The average household waste generation ratio is lower than other economically comparable countries if ash from unplanned area is excluded; i.e. 216 g/person/day in summer.

Table 3-2: Comparison of Waste Generation Rate

Country/City		Population (Person)	Study Year	GNP per Capita in 1998 (IDA)US$/Year	Generation Rate of Household Waste	Generation Rate of MSW*1
			Year	US$/Year	g/person/day	g/person/day
Mongol Ulaanbaatar	In winter	866,591	2005	552 in 2004	590	640
	In summer	866,591	2005	552 in 2004	216	286
Laos*3	Vientiane	142,700	1991	330	753	970
Cambodia*4	Phnom Penh	1,199,414	2003	268	498	556
Poland*5	Poznan	590,500	1992	3,900	654 (470, 913)*2	NA
	Lublin	352,500	1992	3,900	399 (336, 542)*2	NA
Paraguay*6	Asuncion	510,500	1994	1,760	961	1,312
	F.Mora	99,201	1994	1,760	961	1,098
Nicaragua*7	Managua	834,400	1994	390	664	802
Tanzania*8	Dar es Salaam	2,030,000	1996	210	698	873
Nicaragua*9	Leon	134,000	1996	390	736	762
	Chinandega	100,700	1996	390	630	756
	Granada	76,300	1996	390	661	749
Philippines*10	Quezon	1,989,400	1997	1,050	423	524
	Makati	484,200	1997	1,050	416	670
	Paranaque	391,300	1997	1,050	418	556
Honduras*11	Tegucigalpa	848,859	1998	730	375	566
Azerbaijan*12	Baku	2,025,300	1999	849 in 2000	233	244
Turkey*13	Adana	1,196,620	1999	3,160	498	696
	Mersin	634,850	1998	3,160	473	703

Note *1: MSW : Municipal Solid Waste
*2: Figures in parentheses are generation rates of households with and without central heat supply, respectively.

Sources:
*3: The Study on the Solid Waste Management System Improvement Project in Vientiane, Lao People's Democratic Republic, Final Report, August 1992
*4: The Study on Solid Waste Management in the Municipality of Phnom Penh in the Kingdom of Cambodia, Final Report, March 2005
*5: The Study on the Solid Waste Management for Poznan City, the Republic of Poland, Final Report, May 1993
*6: The Study on the Solid Waste Management for the Metropolitan Area of Asuncion in the Republic of Paraguay, Final Report, August 1994
*7: The Study on the Improvement of The Solid Waste Management System for the City of Managua, May 1995
*8: The Study on the Solid Waste Management for Dar es Salaam City, Final Report, September 1997
*9: The Study on the Improvement of Urban Sanitation Environment of Principal Cities in the Republic of Nicaragua, January 1998
*10: The Study on Solid Waste Management for Metro Manila in the Republic of the Philippines, March 1998
*11: The Study on Solid Waste Management of the urban area of Tegucigalpa's Central District in the Republic of Honduras, Final Report, March 1999
*12: The Master Plan Study on Integrated Environmental Management in Baku City in Azerbaijan Republic, March 2001
*13: The Study on Regional Solid Waste Management for Adana-Mersin in the Republic of Turkey, Final Report, January 2000

b. Findings

The followings are main findings:

1. The waste generation rate (amount) in winter and in summer differs significantly, especially household waste in Ger area, i.e. it in winter is 4.71 times more than it in summer. This is mainly due to the coal ash from Ger area in winter.
2. To the contrary, waste generation rate (amount) of Business waste in summer is 1.31 times more than it in winter. The reason of this fact is assumed that business in summer is more active than it in winter.
3. As a conclusion, generation rate (amount) of municipal solid waste (MSW) in winter is 2.24 times more than it in summer.
4. The table above shows MSW generation rate and amount in 2005, i.e. WACS results. However, it does not include those of construction waste, non-hazardous wastes from factories and non-infectious waste from hospitals although those wastes are disposed of at the current municipal landfills. Those are presented in the other sections.

3.1.2 Waste Composition

a. Waste Composition

The present compositions of household and MSW (municipal solid waste) in the study area and those obtained from other JICA SWM studies are as shown in the following tables. As observed in other cities, Kitchen wastes are the most dominant component of the household wastes. However, the proportion of that in Ulaanbaatar is lower than that in other cities.

Table 3-3: Comparison of Physical Composition of Household Waste

Country / Physical Composition	Unit	Mongol Ulaanbaatar*1		Turkey	Cambodia	Poland		Paraguay	Philippines	Tanzania	Honduras
		Winter	Summer	Adana	Phnom Penh	Lublin		Asuncion	Manila	Dar es Salaam	Tegucigalpa
						With ash	Without ash				
Kitchen waste	%	32.7(4.9)	35.7(30.4)	75.53	63.6	45.25	65.26	36.60	45.82	42.00	47.20
Paper	%	12.7(2.4)	21.7(13.9)	9.88	4.6	13.67	11.11	6.40	15.39	3.10	11.50
Textile	%	4.6(1.0)	4.1(6.2)	1.77	2.5	2.10	3.77	1.30	4.33	1.20	2.80
Plastic	%	22.4(2.2)	14.5(16.3)	5.87	18.0	4.40	3.80	3.90	15.60	2.20	7.10
Grass & Wood	%	1.1(0.2)	5.3(3.9)	1.62	6.0	1.61	2.30	22.20	7.45	25.30	11.60
Leather & Rubber	%	0.7(0.1)	0.4(0.8)	0.29	0.1	2.67	1.83	0.70	0.80	0.90	2.20
Combustible Total		**74.2(10.8)**	**81.7(71.5)**	**94.96**	**94.8**	**69.7**	**88.07**	**71.1**	**89.39**	**74.7**	**82.4**
Metal	%	4.0(0.6)	1.8(6.4)	0.53	0.7	3.31	3.05	1.30	5.47	2.00	1.90
Bottle & Glass	%	12.4(3.0)	9.5(12.9)	3.33	0.6	5.23	6.51	3.10	2.69	3.50	3.50
Ceramic & Stone	%	4.4(0.9)	6.5(7.1)	1.14	1.6	21.74	2.38	2.50	1.26	0.40	12.10
Miscellaneous	%	5.0(1.8)	0.5(2.1)	0.04	2.3	-	-	22.00	1.19	19.40	0.10
Ash		0(82.9)	0(0)	-	-	-	-	-	-	-	-
Incombustible Total		**25.8(89.2)**	**18.3(28.5)**	**5.04**	**5.2**	**30.3**	**11.93**	**28.9**	**10.61**	**25.3**	**17.6**
Total	%	100.00	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
ASG	kg/l	0.11(0.27)	0.12(0.12)	0.19	0.25	0.18	0.215	0.22	0.19	0.39	0.20

Note *1: Figure is the Planned area (Unplanned area). Planned area includes business waste.
Sources: The same as Table 3-2: Comparison of Waste Generation Rate

Table 3-4: Comparison of MSW Composition

Country / Physical Composition	Unit	Mongol Ulaanbaatar*1		Turkey	Cambodia	Poland		Paraguay	Philippines	Tanzania	Japan
		Winter	Summer	Adana	Phnom Penh	Poznan	Lublin	Asuncion	Manila	Dar es Salaam	Tokyo 1994
Kitchen waste	%	12.6	33.8	64.41	63.3	33.96	61.11	37.40	45.35	45.03	25.11
Paper	%	5.2	18.9	14.80	6.4	19.34	14.18	10.20	16.80	4.07	35.64
Textile	%	2.0	4.8	1.62	2.5	7.27	3.10	1.20	3.88	1.10	3.44
Plastic	%	7.8	15.2	5.92	15.5	7.89	4.41	4.20	15.62	2.01	15.16
Grass & Wood	%	0.5	4.8	2.66	6.8	5.90	2.33	19.20	6.71	25.11	4.42
Leather & Rubber	%	0.2	0.6	0.30	0.1	2.26	2.09	0.60	0.74	0.71	1.38
Combustible Total		**28.3**	**78.1**	**89.71**	**94.6**	**76.62**	**88.06**	**72.80**	**89.10**	**78.03**	**85.15**
Metal	%	1.5	3.5	1.40	0.6	3.76	3.29	1.30	5.21	1.65	6.43
Bottle & Glass	%	5.4	10.5	3.08	1.2	15.16	6.69	3.50	3.37	2.90	5.46
Ceramic & Stone	%	1.9	6.8	2.17	1.5	1.53	2.81	2.50	1.12	0.33	0.40
Miscellaneous	%	2.7	1.1	3.64	2.1	2.93	-	19.90	1.20	17.09	2.56
Ash		60.2	-	-	-	-	-	-	-	-	-
Incombustible Total		**71.7**	**21.9**	**10.29**	**5.4**	**23.38**	**11.94**	**27.20**	**10.90**	**21.97**	**14.85**
Total	%	100.00	100.0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Sources: The same as Table 3-2: Comparison of Waste Generation Rate.

b. Findings

The present compositions of household and MSW (municipal solid waste) in the study area and those obtained from other JICA SWM studies are as shown in the following tables. A prominent feature of the waste composition in the study area is:

- Regarding household waste, the same as waste generation there are quite big difference in waste composition of apartment area and Ger area, and winter and summer.
- The Study, therefore, examines the waste amount and composition dividing into those of planned (apartment + business) area and unplanned (Ger) area, and winter

and summer. Since most of business generation sources locate in the planned area, wastes generated from business activities are categorized into planned area.

- Regarding household waste in planned area, there is not so big difference in waste composition of winter and summer. Contrary to the planned area, there is very big difference in it in unplanned area of winter and summer due to the large amount of ash from heating facilities.
- Household waste in planned area contains a large portion of recyclable waste, i.e. papers, textiles, plastics, metals and bottles/glass. Especially portion of papers and plastics (high calorific wastes) is quite high of 35.1 % in winter and 36.2 % in summer that exceeds it of kitchen waste, 32.7 % and 35.7 % respectively. This characteristic of waste composition also applies to the waste in unplanned area in summer although it is quite different in winter.
- Regarding MSW there are quite big difference in waste composition of winter and summer. Because portion of ash overwhelms in winter; 60.2 % of MSW while it in summer is nil.

3.2 Time and Motion Survey

The Time and Motion Survey was conducted twice; January 17 to 28, 2005 in winter and August 24 to September 3, 2005 in summer.

3.2.1 Findings of the Survey in Winter

a. Efficiencies of Activities

The results of ten days survey identify that collection time of unplanned and planned areas shares 52.3 % and 46.3 % of whole working time respectively while time spent for travel is 29.8 % and 37.0 % respectively. This indicates the collection efficiency of planned area is higher than it in unplanned area. The details of the analysis are provided in the Annex 2.2.3.

b. Institutional System related to the Waste Collection System

The main objectives of the T&M survey is to well observe the current waste discharge, collection and haulage operations and to analyze the technical and public participation factors which currently affect the present activities so that the findings will be taken into account for the improvement plan. However, we have found that the current institutional system affect the current waste collection efficiency greater than the technical system and public participation. Therefore, the institutional system which seriously affects the waste collection operation at present is briefly described.

a) Six TUKs of the central Duuregs in MUB which deal with most of waste collection services in the study area are private companies which were privatized in April 2004. Since TUKs manage their waste collection service with only waste collection fee which they collect without any financial support by MUB and Duureg offices, TUKs are concessionaire but not contractors for the waste collection work. Therefore, TUK has extensive freedom in their management.

b) TUK well utilize their right of freedom in the management. One of management measures which seriously affect the waste collection operation is the rental contract for drivers and waste collectors. At present, in any TUK the salary system for drivers and collection workers is not based on the basic working hours and overtime hours. Their incomes are the remainder after deducting the petrol expense, spare parts expense, etc. from the certain percentage of the total revenue from customers' payment

for fee. This is actually same as the contracting out. Therefore, both of them are not interested in the improvement of the waste collection work efficiency because the payment from TUK to a crew is fixed and the working hours are not related to their income of the crew at all. The way to increase the income of the crew under this system is only to minimize the petrol consumption amount and number of workers involved. Therefore, what are actually done are 1) minimization of collection and haulage distance even though taking a long time, and 2) reduction of collection workers. This employment system greatly hinders the improvement of the collection work efficiency.

c) In unplanned area, the waste collection work is greatly influenced by the fee collection efficiency because waste is collected in return for fee payment. The present fee collection system has limited the options of waste collection system.

c. General

a) The waste collection service is irregular and waste collection days and times is not fixed. Waste dischargers such as residents and business entities don't know the waste collection days.

b) There are no fixed collection routes and it depends on the drivers.

c) Each waste collection crew decides their working hours by themselves.

d) Each TUK verifies all their trucks' entrance records to the Ulaan Chuluut disposal site with the entrance certificates issued at each entry to the disposal site by Nuuts Co. in order to ensure all trucks to carry waste to the disposal site. However, it was found that some of trucks got the all entrance certificates at one time instead of every entry. Therefore, the present control system somehow has been deteriorated.

e) Some of trucks have to be pushed by many people to start their engines in the morning due to having no properly functioning batteries. These trucks have to keep the engines operational (cannot turn off its engine) until their arrival to the garage and it is very costly. This battery problem is caused by very cold climate.

f) Ordinary departure times of trucks are between 8:30 am and 10 am and the arrival times are between 6 pm and 11 pm. In addition, there are some trucks do the night collection.

g) According to the staff at the control house in the Ulaan Chuluut disposal site, generally the last truck come to the disposal site around 4 am and the first truck comes around 6 am.

d. Maintenance condition

a) Each TUK have a wide and nice garage with heating system. Heating system is essential for the smooth operation of trucks during hard winter although its heating cost is very costly.

b) There are few repairing tools and equipment in the garages.

c) Drivers generally repair their trucks and it is the conventional system in Mongolia. They are familiar with repairing Russian made trucks but they are not familiar with others.

d) The existing maintenance system is insufficient to maintain compactor trucks and trucks using diesel.

e) Most of all trucks are decrepit. Trucks often leak oil and then they generally refill it with used oil which drivers get from petrol stations in free of charge.

e. Planned area

The present discharge, storage, collection systems are summarized as follows.

e.1 Apartment with dust chute

Advantages

a) This system is very convenient for both dischargers and collectors due to the following reasons.

- People can easily discharge their waste anytime.
- Collectors can do the waste collection work any time they like, even midnight, due to no required public cooperation. In addition, they can ignore the collection frequency for a quite many days. The collection cost at the low collection frequency is cheap because a large amount of waste can be loaded at one collection point.

b) There is no scattered waste because they are kept within a waste chamber until being collected.

Disadvantages

a) Waste often clogs dust chutes.

b) Waste in waste chamber often burn and smoke come out to all floor through a dust chute and opening.

c) Offensive odor and many flies generated from waste in waste chamber and come into the inside of the apartment. Very unsanitary impact.

d) Loading work is very labor intensive because public cooperation for this activity is not applicable.

e) It decreases people's consciousness on the waste issue because the system is too convenient for them.

Evaluation

The dust chute system should be prohibited although it is very convenient for everybody because of the many associated problems and their serious negative impacts.

e.2 Apartment with waste storage room

System

People discharge their waste in a waste storage room which often installed under the stair at the ground floor inside the entrance. Waste collectors scrape waste from a storage and load them onto a truck. This system is often used for old apartments.

Advantages

a) Although people have to bring their waste to the ground floor, it is still very convenient for them because they can discharge their waste in a storage room any time.

b) There is no scattered waste because they are kept within a waste chamber until being collected.

Disadvantages

a) It is very unsanitary because large amount of waste is kept in a storage room.

b) Loading waste onto a truck is very labor intensive and inefficient because:

- Most waste are discharged in a storage room without packing.

- No pubic cooperation for loading work.
- It decreases people's consciousness on the waste issue because the system is too convenient for them.

Evaluation

The waste storage room system should be improved by the application of the proper waste discharge rule such as compulsory use of plastic bags for waste.

e.3 Apartment with a waste storage house outside of the building

System

People discharge their waste at a storage facility installed at the part of land of apartments. Waste collectors collect and load waste from a storage facility onto a truck.

Advantages

a) Although people have to bring their waste to the yard, it is still very convenient for them because they can discharge their waste there anytime without packing.

b) The condition is sanitary because the waste storage keep a certain distance from apartments.

c) There is no scattered waste because it is kept within a waste chamber until being collected.

Disadvantages

a) In most cases, the house structure is not convenient for waste collection due to ignorance of waste loading work.

Evaluation

This system can be one of appropriate options.

e.4 Apartment using a part of land for waste storage

System

People discharge their waste at the part of land of apartments which is specified as waste storage yard. Waste collectors collect and load waste onto a truck.

Advantages

a) Although people have to bring their waste to the yard, it is still very convenient for them because they can discharge their waste there anytime without packing.

Disadvantages

a) Very ugly and unsanitary due to terrible scattered waste.

b) Dogs and birds scavenge food and scattered waste.

c) Waste pickers scatter waste through collecting recyclable materials from waste.

Evaluation

This system should be prohibited due to very unsanitary and ugly condition.

e.5 Apartment using a bell collection system

Advantages

a) There is no scattered waste because waste is taken care by cleaners or guards within apartment until being collected.

b) Easy for loading waste onto a truck because cleaners, guards and residents carry waste to a truck.

Disadvantages

a) Public cooperation is necessary.

Evaluation

This system is the most appropriate system among the current systems.

e.6 Communal container system

Advantages

a) Anybody can discharge waste into communal containers anytime.

b) Easy for loading waste from communal containers because the compactor truck have lifting device.

c) This system is suitable for business which can be taken care by the business entity.

Disadvantages

a) There are a lot of scattered wastes around communal containers. There are two causes for scattered waste.

- Nobody take care communal containers because no ownership feeling to anybody.
- Waste pickers scatter waste when they scavenge recyclables from waste in container.

b) During winter waste are often frozen in containers and stick to container. Waste collectors have to remove frozen waste adhered to containers by iron bars to load waste onto a compactor truck. It is very hard work and time consuming.

c) Homeless people often burn waste in containers to warm themselves. There are many containers which have been burned.

d) After only two years use of 150 containers, most of all have been defected especially cover plates and wheels.

e) The compactor truck is too large for UB City in terms of accessibility and however to lift a 1m3 container requires such heavy equipment.

Evaluation

This system is not appropriate system for communal use due to the above reasons, especially lack of ownership. It is, however, effective for the larger waste generator if the ownership of the container would be achieved.

f. Unplanned Area

a) Waste collection frequency is generally once a month. This is because they collect money once a month and they collect waste in return for waste collection fee payment.

b) Most of waste contents in unplanned areas is ash. People discharge waste in a drum or poly sacks which packed coals when they buy coal. It is very hard to load ash waste in a drum onto a truck because it is too heavy.

c) Dischargers are responsible for carrying their waste to a truck and load it onto a truck. A waste collection worker is generally responsible for receiving waste on a truck carrier. Public cooperation level is very high.

d) The side open truck is easier to load waste on a carrier than the rear open truck.

e) All trucks cover waste on the carrier with sheet to prevent waste from scattering during haulage of waste from the collection area to the disposal site.

g. Collection work data

a) The average number of trips per day during the ten days T&M survey was 2. Considering the trucks generally made two trips in Bayanzurkh duureg which is the farthest from the Ulaan Chuluut disposal site, it is presumed that the average number of trips per day in the whole study area is more than two.

b) The total working hours per day in the unplanned area is longer than that in planned area by 35 minutes. T&M survey suggested that it is caused by complex factors and it is too difficult to identify a main cause.

c) The total collection time in planned area is shorter than that in unplanned area by about 60 minutes. It is considered mainly due to the effect to the loading waste by the use of compactor trucks for planned area while dump trucks are used for unplanned area. As the other possible factor, it can be pointed out that the fee collection being done together with the waste collection work.

d) The time spend for informal recycling activity by workers is negligible, only less than 1% of the total working hours. It implies that the recycling by workers is not active and little influence to the waste collection work.

h. Fee Collection in Unplanned Areas

a) In unplanned area, the waste collection work is carried out together with the fee collection work. There are little differences in the fee collection system between Bayanzurkh TUK and Chingeltei TUK.

b) In Bayanzurkh, a staff belonging to the Khoroo office collects fee when the waste collection is carried out. Therefore, money collectors are different by Khoroo. In addition, the staff in the Khoroo office sometimes randomly visits houses to check if they have paid fee.

c) Chingeltei TUK directly employs fee collectors and they work like a chief of a collection crew.

d) The reason why the system doesn't function well in the other Khoroo is that most Khoroo governors have lack of interest for waste fee collection, especially after TUK was privatized.

e) There are many cases of bargaining for the waste collection fee at site.

f) The fee which has not been paid is accumulated. It is therefore very difficult for residents to clear non-payment.

3.2.2 Findings of the Survey in Winter

a. Efficiency of Activities

The results of twelve days survey identify that average time required for a trip collection of unplanned and planned areas 390 minutes and 339 respectively while time spent for collection work per trip is 173 and 184 respectively. This indicates the collection efficiency of planned area is not so efficient although waste collection points are concentrated in planned area while dispersed in unplanned area. The details of the analysis are provided in the Annex 2.2.4.

b. Ger Area

1) The physical composition of waste discharged in summer is very different from that in winter.

- The waste in summer doesn't contain ash of coal.
- The waste in summer and contain light waste such as paper and plastic which are supposed to be burnt in winter.
- The waste in summer contains construction waste because many gers repair their houses in summer.
- They discharge even wooden furniture.

2) The waste in summer is generally still heavy and too difficult for loading because it contains soil and stones. (WACS in summer season, however, did not receive such waste so much.)

3) The waste collection fee in summer is cheaper than that in winter in Chingeltei Duureg.

c. Apartment Area

1) The collection method in Sukhbaatar is unsystematic and its work is very low efficiency. There are many on site communal waste bins and communal containers and waste is manually loaded onto the dump truck. The waste loading from those storages is very difficult. There is no skipper truck instead of there are many skip containers placed.

Collection workers load waste from a container onto the truck due to no skip container truck.

2) Most collection trucks in Sukhbaatar TUK are bad condition. Tires often went flat and the tube had many patching.

3) Sukhbaatar TUK use only one compactor truck which has 4 m^3 capacity.

d. Summer House Area

1) There are several communal collection points. People carry their waste to these points by their cars. TUK's dump truck come to such collection points and load waste onto the truck. The collection system is, therefore, the station collection but not the door-to-door system.

2) The waste physical composition in summer house areas looks similar to the waste in the planned area because it contains many packaging waste.

There are lots of waste scattered at most communal collection points in summer house areas.

3) Therefore, there are waste pickers collecting recyclables at collection points.

4) There are waste fee collectors for summer houses. The waste collection fee for a summer house is 5,000 Tg. per season, for collecting waste for four months.

5) There are some permanent residents in summer houses throughout a year and such houses are increasing. It is expected that the summer house area will be an outskirts residential area because the distance from the summer house area to the city center is only less than 15km..

6) The regular waste collection service throughout a year will be necessary in near future due to the increase of permanent residents.

e. TUK

1) TUK doesn't properly control the employees. It caused the disorder of works.
2) TUK ignoring customers, especially residents. TUK's drivers collect waste when they want to collect. Their own convenience first.
3) Collection workers work is very labor intensive.
4) Drivers often ignore the road and drive on grassland. They often take short cut routes and even cross streams.
5) Most TUK's trucks are in bad condition. During the time and motion for summer, five trucks out of 12 trucks, 42% of working days, had tire puncture.
6) TUK doesn't have any future plan nor marketing plan. They have very poor business mind.
7) To change TUK's minds and attitudes is essential to improve SWM.

f. General Findings

1) The dust chute system causes many problems such as irregular waste collection, fire, flies, lack of consciousness on waste by public, unsanitary condition.
2) The system of discharging waste outside causes following problems in many places.
   - Waste scattered by waste pickers.
   - Waste pickers burn waste in winter.
   - Waste frozen in winter. It probably occurs from Nov. to March.
3) Public cooperation is very good in some points.
   - People who discharged waste in ger area help load their heavy waste.
   - In some apartment areas, people carry waste to the truck when it arrives.
4) The collection of waste from gers and organizations is inefficient. This is because the waste is collected together with the inefficient fee collection. To improve the waste collection efficiency for ger and organizations, the fee collection system should be separated.

3.3 Public Opinion Survey

3.3.1 Objective of the Survey

There are no easy solutions to the problems related to Solid Waste Management (SWM). The SWM system should be formulated based on a precise grasp of natural and socioeconomic conditions, the state of the present SWM system and the lifestyle of local residents along with the opinions of all the people in the target area. In addition, the MSWM system should include a mechanism that increases people's awareness and promotes public participation, because active public involvement is indispensable for a sustainable MSWM system.

An effective method for obtaining a precise grasp of the opinions of local residents is a Public Opinion Survey (POS). In particular, a POS can give us essential information for formulating the M/P, such as the way people discharge wastes in their daily lives and the level of waste

tariff people are willing to pay. In addition, a POS can show us the level of people's environmental awareness and give us a hint about acceptable approaches for local people to improve the SWM system.

Therefore, the team decided to conduct a POS, targeting all the households and business establishments in UB, in order to obtain the basic information, which is summarized below.

At present in UB, the social and economic conditions as well as the waste collection method in the Apartment area and the Ger area are very different. In the POS, the team aimed at gathering opinions on the current collection service, as well as information on awareness level of social and environmental issues, while paying an attention to their difference in types of residence..

(1) Household Survey

1) In the Apartment area

- Generation and recycling of waste at the source
- Way of storing and discharging waste
- Awareness of environmental issues, in particular SWM

2) In the Ger area

- Generation and recycling of waste at the source
- Way of storing and discharging waste.
- Awareness of environmental issues, in particular SWM
- Need of waste collection service and willingness to pay (only for those who do not receive a collection service at present)

(2) Business Establishments Survey

- Generation and recycling of waste at the source
- Way of storing and discharging waste.
- Awareness of environmental issues in particular SWM

The result of the survey was reflected in the draft of M/P, aiming at increasing people's environmental awareness, improving waste collection services, examining the introduction of separate waste collection and reducing waste amount.

3.3.2 Method of the Survey

The survey is divided into two parts: the household (residential source) survey and the business establishment (non-residential source) survey. The household survey has two different targets: those who live in the Apartment area and the others who live in the Ger area.

In total, there were 500 samples, and 400 of the samples were allocated to the household survey and 100 to the business establishment survey as shown in the tables below.

Table 3-5: Planned Sample Frame by Duureg and Area for the Residential Survey

Duureg	Apartment area	Ger area	Total
Khan-Uul	12	28	40
Bayanzurkh	40	41	81
Sukhbaatar	26	27	53
ChinGertei	15	44	59
Bayangol	80	-	80
Songinokhairkhan	27	60	87
Total	200	200	400

Table 3-6: Planned Sample Frame by Duureg and Sector for the Non-residential Survey

Duureg/Sector	Shops	Restaurants	Offices	Hotels	Total
Khan-Uul	3	3	3	3	12
Bayanzurkh	4	3	3	3	13
Sukhbaatar	3	3	4	3	13
ChinGertei	3	3	3	3	12
Bayangol	4	4	4	4	16
Songinokhairkhan	3	4	3	4	14
Total	20	20	20	20	80

3.3.3 Findings of the Survey

The fieldwork started at January 13 and was completed on February 2. The results of the Survey are presented in Annex 2.3.3. The main findings of the survey are presented below.

(1) Awareness of environmental and waste issues

As a whole, the results of the POS indicate a high environmental awareness. Since pollution problems such as air pollution will be worsen for a while, people in UB would be more interested in environmental issues.

In the Ger area, due to the insufficient waste collection service, various problems such as scattered waste and illegal dumping along the main streets and in open spaces occurred. The result of the POS shows that people in the Ger area were more aware of problems caused by improper solid waste management than people in the Apartment area.

(2) Discharge and collection of waste in the Apartment area

In the Apartment area, most of waste was collected regularly, even though the quality of collection service was not high. In UB, apartments have keepers, who are in charge of keeping common space clean as well as securing safety of their apartment. As for the solid waste management, these keepers play an important role, and residents do not have to pay much attention to collection work. Consequently, the result of the POS could not show the actual situations of discharge and collection of waste, because respondents do not know well. Comparison with the result of the follow up interview survey with apartment keepers would be able to show actual conditions and problems to be solved.

(3) Discharge and collection of waste in the Ger area

In the Ger area, the majority of the respondents were not satisfied with the collection service, since the collection fee was high and its frequency was low. The need for a waste collection service in the Ger area is very high, but many people actually did not receive the collection service regularly because they could not pay the fee. As a result, many of them dumped their waste in an open space illegally, and this worsens the environmental conditions further in the Ger area.

(4) Recycling

The recycling rate in UB is not high. Since the number of final users of recyclables in UB is very limited, there are not many intermediate buyers, and ordinary people did not know where they could sell recyclables.

Glass and plastic bottles are two main items of recyclables in UB.

3.4 Environmental Survey on the Conditions around Final Disposal Sites

3.4.1 Social Environment Survey

At present, there are three final disposal sites in UB. Due to the inappropriate operation and management, these three disposal sites cause environmental problems around the sites. In particular, it is urgent for MUB to take necessary measures to improve the operation of the disposal site in Ulaan Chuluut, which is the main final disposal site in UB.

In Ulaan Chuluut, a large number of people are living near the disposal site and along the main street, where many collection vehicles pass every day, while more than 200 waste pickers are working at the disposal site. In order to mitigate negative impacts of the improvement plan on these people, it is important for MUB to grasp the current environmental and living conditions of these areas and opinions of both local residents and waste pickers on the disposal site. Therefore, the team decided to conduct a social environmental survey around three final disposal sites.

a. Objective of the Survey

The social environmental survey has two different targets: (1) local resident living near disposal sites and along a main street where collection vehicles pass and (2) waste pickers. The local resident survey was conducted in three Khoroos, located in Duureg Songinokhairkhan, Khan Uul and Nalaikh respectively, while the waste picker survey was conducted only in Ulaan Chuluut, because the number of waste pickers at the two other disposal sites was not large. The location of three sites is shown in Figure 3-1.

Figure 3-1: Location of Survey Sites

b. Method of the Survey

b.1 Design of the Survey

The local resident survey was conducted in three Khoroos, which are summarized in the table below. Ulaan Chuluut is located relatively near from the center of the city, while two other sites are far away from it, as described in Figure 3-1.

Table 3-7: Information on Three Target Khoroos

	Ulaan Chuluut	Morin Davaa	Nalaikh
Location Duureg Khoroo	Songinokhairkhan, Khoroo 4	Khan Uul, Khoroo 3	Nalaikh Khoroo 12
Total Household Number in Khoroo	1,911	1,062	938
Total Population in Khoroo	Male: 4,826, Female: 5,034	Male: 2,225, Female: 2,607	Male: 2,004, Female: 2,119
Waste Pickers	Male: 83, Female: 98, Children: 72	Male: 7 Female: 8	12 persons officially informed but the locals said 40
Household number (waste pickers)	80	15	

Data were obtained from three Khoroo governments

Both the local resident and waste picker surveys consist of two parts: (1) an interview survey and (2) a focus group meeting. As already mentioned, the local resident survey paid more attention to Ulaan Chuluut, so the focus group meeting was organized only in Ulaan Chuluut.

In both survey, an interview survey was conducted first to obtain a general view. Based on the result of the interview survey, several topics for the focus group meeting were selected and discussed deeper at the meeting. The result of the interview survey was introduced at the meeting.

The basic design of both surveys is summarized as follows.

b.1.1. Local Resident Survey

(1) Interview Survey

1. Target area: the following areas in three Khoroos
   - within a radius of 1km from the disposal
   - along a main street where collection vehicles pass
2. Number of samples: 50 in Ulaan Chuluut and 15 in Morin Davaa and Nalaikh
3. Number of questions: around 40
4. Subject of survey:
   - Problems caused by the disposal site and opinion about possible solutions
   - Awareness of environmental and solid waste management issues

(2) Focus Group Meeting

1. Target group: all the households located in the following areas in Khoroo 4 (Ulaan Chuluut)
   - within a radius of 1km from the disposal (30 households)
   - along a main street where collection vehicles pass (135 households)
2. Participants: one person from all the households in the target area
3. Number of participants: 50-100
4. Location: Cultural center
5. Subject of discussion:
   - Introduction of the basic policy of solid waste management of MUB and a plan of pilot project at the Ulaan Chuluut disposal site
   - Result of interview survey

- Current problems related to solid waste management including disposal site issuers
- Causes of problems and possible solutions.

b.1.2. Waste Picker Survey

(1) Interview Survey

1. Target group: waste pickers working at the disposal site
2. Number of samples: 20
3. Number of questions: around 40
4. Subject of survey:
    - Problems they face while working at the disposal site
    - Opinion about possible solutions
    - Living conditions and environmental awareness
    - Future plans

(2) Focus Group Meeting

1. Target group: all the waste pickers working at the disposal site in Ulaan Chuluut
2. Location: beside the office of Nuuts Company at the disposal site
3. Subject of discussion:
    - Introduction of the basic policy of solid waste management of MUB and a plan of pilot project at the Ulaan Chuluut disposal site
    - Result of interview survey
    - Problems they face while working at the disposal site
    - Causes of problems and possible solutions.
    - Opinion about the plan of the pilot project

c. Findings

c.1 Opinion Survey for Residents

(1) Awareness of problems caused by improper solid waste management

Local residents were aware of problems caused by improper solid waste management in Ulaan Chuluut. In particular, they were concerned environmental degradation in Ulaan Chuluut by the disposal site and illegal dumping, and its negative impact on their health.

The result of focus group meeting shows that some of them already considered possible solutions seriously.

However, their knowledge on solid waste management is limited. It is necessary for the team to support them to deepen the knowledge on SWM.

(2) Disposal Site

Most of the local residents want the disposal site to be moved to somewhere else. But they welcome the pilot project at the UCDS.

(3) Illegal Dumping

Whole the area in Khoroo 4, waste is scattered. In particular, plastic bags were flying everywhere. Most of meeting participants wanted to clean their areas.

Even though large-scale waste generators were main source of illegal dumping, local residents also dump their waste in an open space. According to the result of the focus group meeting, many of meeting participants recognized this. However, it seems difficult to stop local resident from dumping waste in an open space soon, because poor quality of collection service and its high collection fee are main factors for them not receiving the collection service.

(4) Khoroo Government

The government of Khoroo 4 was also concerned about problems caused by waste, and was willing to take a leading role to solve these problems. It is important for the team to support Khoroo 4 to increase people's awareness on SWM and to promote public participation to SWM.

(5) Others

This environmental social survey provided an opportunity for local residents to express their concerns about solid waste management in Ulaan Chuluut and to discuss with MUB. The result of the interview survey was fed back to them at the focus group meeting. This could show them how their opinions were reflected in the plan of the pilot project at UCDS. As a result, MUB and the team could gain the confidence of local residents.

It is important to strengthen the relation by opening information further and exchanging opinions with them.

c.2 Opinion Survey for Waste Pickers / Recyclers

(1) Establishment of Mutual Trust

Since most of waste pickers had a deep distrust of outside people, it is critical for MUB and the team to establish mutual trust with them in order to implement the pilot project at the UCDS.

This survey provided the first opportunity for both sides to know each other. Waste pickers could express their concerns and requests to MUB for the first time. It was a good opportunity for MUB to explain the plan of the pilot project directly to them, since there were inaccurate rumors about the future of the UCDS.

It is important for MUB and the team to continue to open information on the future plan of the UCDS to them and to arrange a place where the both side exchange opinions in order to establish mutual trust.

Even though the purpose of the visit is for the public interest, those who visit the disposal site to study the conditions of waste pickers should pay respect to them. Their right of to refuse to be photographed should also be considered seriously.

(2) Working Conditions

Waste pickers faced various problems. What they were concerned most was the possibility of accidents. The pilot project could decrease the risk of accidents considerably.

They also wanted to improve sanitary and hygienic conditions of the disposal site. At the focus group meetings, they requested to install toilets and water supply facilities.

(3) Living Conditions

Since many of them lived near the disposal site, their living conditions were also affected by the disposal site.

(4) Future Plan

Even though all the respondents wanted to deal with other jobs, they thought it was difficult to find other jobs. Therefore, if the disposal site moves to somewhere else, the majority of them wanted to continue to work at the disposal site.

(5) Child Waste Pickers

There are a lot of waste pickers, and many of them dropped out of school.

3.4.2 Water Quality Survey

The water quality survey was conducted twice in winter season and summer season.

a. Objectives

The purpose of this work is to obtain data on the water quality of leachate and underground water around disposal sites (UCDS, MDDS, NDS) and Narangiin Enger PDS. Based on the field investigation carried out at and around disposal sites and Narangiin Enger PDS, there is no leachate observed due to climate conditions and/or characteristics of waste composition. Therefore, the Study Team decided to take samples from following points.

- Underground water at wells around UCDS, MDDS and NDS
- Surface water around UCDS and Narangiin Enger PDS
- Surface water at Tuul River near MDDS

b. Samples and Sampling Points

The sample number and sampling points are shown below.

Table 3-8: Sampling Points and Location

No of Sample	Location			Water Sources	Sampling Season	
	Name	North latitude	East longitude		Winter	Summer
1	Ikh naran	N 47055'53.4	E 106047'41.4	Well	Done	Done
2	Baga naran-1	N 47055'43.8	E 106047'03.8	Well	Done	Done
3	Baga naran-2	N 47055'47.4	E 106047'33.5	Well	Done	Done
4	School of #65. south	N 47055'15.1	E 106047'39.3	Well	Done	Done
5	Morindavaa	N 47050'15.3	E 106041'07.5	Well	Done	Done
6	Nalaikh	N 47047'41.8	E 107025'13.5	Well	Done	Done
7	Tuul River	N 47051' 20.0	E 106042'35.0	Surface water	Done	Done
8	Spring of Naran (1)	-	-	Surface water	-	Done
9	Spring of Naran (2)	-	-	Surface water	-	Done
10	North spring of Naran	-	-	Surface water	-	Done
11	Entrance of UBDS	-	-	Surface water	-	Done
12 Reference well	Centre water source (Tuv San)	N 47046'23.0	E 107016'20.7	Tap water	-	Done
13	Bore-hole at Naran	-	-	Ground water	-	Done

The above sampling points and reference well are shown in the following figures.

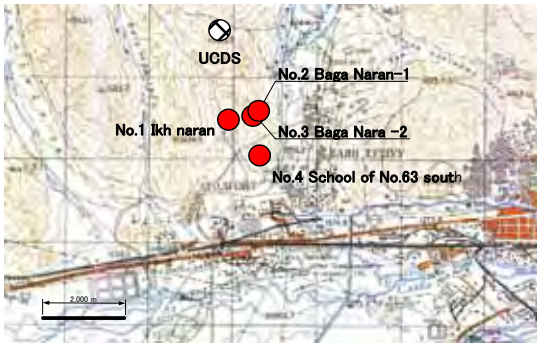


Figure 3-2: Sampling Point around UCDS

Figure 3-3: Sampling Point around MDDS

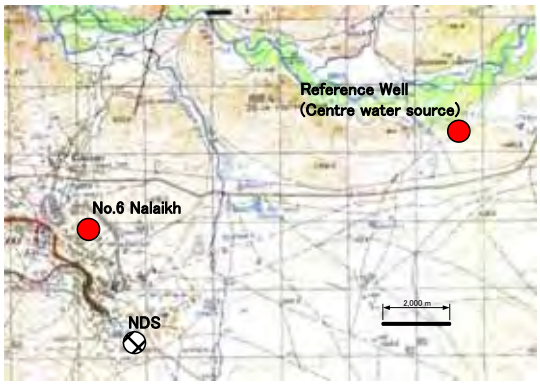


Figure 3-4: Sampling Point around NDS

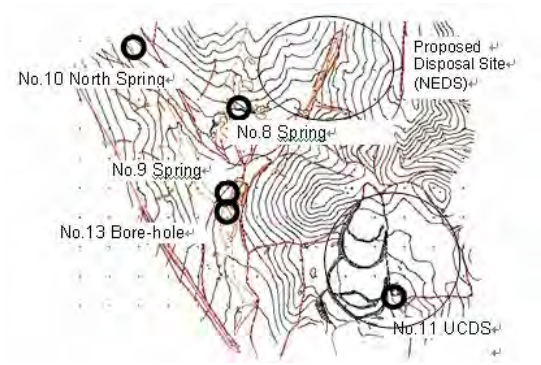


Figure 3-5: Sampling point around Narangiin Enger

c. Results of Water Quality Survey

The results of the water quality analysis are shown in the tables below.

Table 3-9: Results of Water Quality Analysis (winter season)

No	Analysis item	Unit	Number of Samples								Detection Limit (DL)	Mongolia Standard		WHO
			1	2	3	4	5	6	7	Reference		Surface water quality standards	Drinking water quality standards	Drinking Water Guideline *2
			Ikh naran	Baga naran -1	Baga naran -2	School of #65. south	Morindava a	Nalaikh	Tuul River	Tuv San				
			Well	Well	Well	Well	Well	Well	Surface water	Central source*1				
1	Groundwater level	m	4.2	12	30	54	42.0	80	-	-	-	-	-	-
2	Temperature	^{0}C	4.1	4.0	3.6	3.9	4.1	4.2	4.6	9.3	DL= 0.1	-	-	Acceptable
3	pH	-	7.7	7.8	7.7	7.7	7.7	7.8	7.0	6.8	DL= 0.1	6.5 - 8.5	6.5-8.5	-
4	Electric conductivity	µs/cm	787	477	508	810	311	502	131	113	DL= 1	-	-	-
5	Turbidity	FAU	1.0	< 0.1	< 0.1	< 0.1	1.0	< 0.1	< 0.1	0	DL= 0.1	-	5.0 mg/l	Average (1 NTU) Single sample (5 NTU)
6	Color	grade	colorless	colorless	colorless	colorless	colorless	colorless	colorless	60	-	-	20 grade	15 grade
7	BOD_5	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	1.2	-	DL= 0.5	3 mg/l	3 mg/l	-
8	COD	mg/l	8.2	8.5	9.0	8.4	9.2	9.0	8.3	-	DL= 0.5	10 mg/l	10 mg/l	-
9	SS	g/l	0.7	0.5	0.5	0.7	0.3	0.1	0.9	-	DL= 0.1	-	1000 mg/l	-
10	Hardness *3	mg-eq/ml	9.7	5.3	5.2	9.5	3.5	0.8	40.6	-	DL=0.1	-	7 mg eq/l	-
		mg-$CaCO_3$/l	470.4	265.2	260.2	475.4	175.2	40.0	5.6	-	DL= 0.1	-	300 mg/l	-
11	Ammonium (NH_4^+)	mgNH_4/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.007	DL= 0.1	0.5 -	1.0 mg/l	-
12	Nitrogen nitrate (NO^{2-}) *3	mgNO_2/l	92.0	28.2	32.9	85.8	17.4	0.7	21.6	0.0	DL= 0.1	9.0 mg/l	10 mg/l	-
13	Sodium (Na^{2+})	mgNa/l	24	26	28	26	17	3	29	-	DL= 1	-	-	200 mg/l (c)
14	Potassium (K^+)	mgK/l	0.6	0.6	1.2	1.2	0.6	0.6	0.7	-	DL= 0.1	-	-	-
15	Calcium(Ca^{2+}) *3	mgCa/l	132.1	72.1	80.1	132.1	40.0	14.0	35.5	1.04	DL= 0.1	-	100 mg/l	-
16	Magnesium (Mg^{2+}) *3	mgMg/l	34.1	20.7	14.6	35.3	18.2	1.2	19.4	6.41	DL= 0.1	-	30 mg/l	-
17	Sulfate (SO_4^{2-})	mgSO_4/l	72.0	33.6	24.0	67.2	28.8	19.2	40.0	5.3	DL= 0.1	-	300 mg/l	250 mg/l (c)
18	Chloride (Cl-)	mgCL/l	106.3	34.5	48.8	103.4	14.4	5.7	42.6	6.6	DL= 0.1	300 mg/l	300 mg/l	250 mg/l (c)
19	Hydrocarbonate(HCO_3^-)	mgHCO_3/l	229	256	244	223	195	40	256	-	DL= 1	-	-	-
20	Total phosphorus	mgP/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.017	DL= 0.1	-	3.5 mg/l	-
21	Hexavalent chromium	mgCr^{6+}/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	DL= 0.1	0.01 mg/l	-	-
22	Cadmium (Cd)	mg/l	0.04	0.03	0.03	0.03	0.04	0.04	0.05	-	DL= 0.01	0.005 mg/l	0.01 mg/l	0.003 mg/l
23	Lead (Pb)	mg/l	0.05	0.02	0.06	0.04	0.03	0.04	0.06	0.0129	DL= 0.01	0.01 mg/l	0.03 mg/l	0.01 mg/l
24	Zinc (Zn) *3	mg/l	0.12	0.12	0.05	0.07	0.06	0.14	0.16	0.124	DL= 0.01	0.01 mg/l	3.0 mg/l	3 mg/l (c)
25	Total mercury (Hg)	mg/l	0.0002	0.0003	0.0003	0.0002	0.0002	0.0002	0.0003	-	DL=0.0001	0.0001 mg/l	0.001 mg/l	0.001 mg/l
26	Total chromium	mgCr/l	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	DL= 0.1	0.05 mg/l	0.05 mg/l	0.05 mg/l (p)
27	Alkalescency	mg-eq/l	4.1	4.6	4.1	5.0	3.4	1.2	5.6	43	DL= 0.1	-	-	-
28	Oil content	mg/l	3.2	1.72	<0.01	<0.01	<0.01	<0.01	<0.01	-	DL= 0.01	0.05 mg/l	0.05 mg/l	-
29	Number of colon bacteria	ml	1ml=100	1ml=6	1ml=4	1ml=2	1 ml=5	1ml=4	1ml=260	0.2	DL= 1	-	100 number/1cm^3	-

Note: *1: Source: The study on water supply system in Ulaanbaatar and surroundings, JICA, 1995

*2: WHO drinking water guideline: P = provisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited; T = provisional guideline value because the calculated guideline value is below the level that can be achieved through practical treatment methods, source protection, etc.; C = concentrations of the substance at or below the health-based guideline value may affect the appearance, taste or odour of the water, resulting in consumer complaints.

*3: Measurement in winter season

Table 3-10: Results of Water Quality Analysis (summer season)

No	Analysis item	Unit	Number of Samples													Detection Limit (DL)
			1	2	3	4	5	6	7	8	9	10	11	12	13	
			Ikh naran	Baga naran -1	Baga naran -2	School of #65. south	Morindava a	Nalaikh	Tuul River	Spring of Naran (1)	Spring of Naran (2)	North spring of Naran	Entrance of UCDS	Central water source	Bore-hole at Naran	
			Well	Well	Well	Well	Well	Well	Surface water	Well	Surface water	Surface water	Surface water	tap water	Ground water	
1	Groundwater level	m	4.2	12	30	54	42.0	80	-	-	-	-	-	Tap	---	-
2	Temperature	^{0}C	9	5	6	7	5	9	16	20	18	16	-	16	17.1	DL=1
3	pH	-	7.0	7.0	7.0	7.2	7.4	7.3	6.8	7.9	7.1	6.8	6.9	6.1	7.6	DL=0.1
4	Electric conductivity	µs/cm	1103	937	650	1046	420	738	68	233	540	420	Impossible to Measure	61	450	DL=1
5	Turbidity	FAU	6	< 1	< 1	< 1	<1	< 1	9	4	180	376	Impossible to Measure	<1	**	DL=1
6	Color	degree	0	0	0	0	0	14	11	31	375	456	4844	0	4.0	-
7	BOD_5	mg/l	3.0	5.0	4.1	2.2	3.7	3.8	3.8	3.7	2.8	2.6	1176.4	4.1	43.6	DL=0.1
8	COD	mg/l	10.0	2.5	21.3	12.5	10.0	15.0	18.8	8.8	8.8	5.0	875.0	3.8	1500.0	DL=0.1
9	SS	g/l	1088	79	48	94	36	486	46	195	417	381	4604	113	484.5	DL=!
10	Ammonium (NH_4^+)	mgNH_4/l	0.12	0.09	0.14	0.12	0.07	0.13	0.15	0.09	0.14	0.14	0.35	0.15	1.50	DL=0.01
11	Total Nitrogen (T-N)	mgN/l	0.28	0.19	0.27	0.23	0.18	0.31	0.39	0.15	0.32	0.39	0.71	0.28	1.95	DL=0.01
12	Sodium (Na^{2+})	mgNa/l	26	31	25	25	14	5	5	15	20	12	1805	3	10.05	DL-1
13	Potassium (K^+)	mgK/l	3.1	2.1	1.8	2.2	1.6	1.6	1.5	2.1	5.5	2.4	813.3	1.0	9.65	DL=0.1
14	Sulfate (SO_4^{2-})	mgSO_4/l	40.3	40.5	50.6	81.6	45.2	56.3	56.2	49.9	72.0	45.2	105.5	62.4	52.83	DL=0.1
15	Chloride (Cl-)	mgCl/l	136.3	108.0	69.8	131.3	58.1	58.1	53.2	66.5	76.4	76.4	412.3	66.5	13.91	DL=0.1
16	Hydrocarbonate(HCO_3^-)	mgHCO_3	262	238	244	276	192	290	46	99	281	220	3721	38	244.0	DL=1
17	Total phosphorus	mgP/l	0.42	0.03	0.02	0.14	0.20	0.14	0.21	0.20	0.12	0.18	0.86	0.24	0.05	DL=0.1
18	Hexavalent chromium	mgCr^{6+}/l	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	0.015	< 0.001	---	DL=0.001
19	Cadmium (Cd)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.014	DL=0.001
20	Lead (Pb)	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.12	<0.005	0.005	DL=0.005
21	Total mercury (Hg)	mg/l	0.0074	0.0003	0.0004	<0.0001	0.0004	0.0002	0.0008	0.0008	0.0013	0.0005	0.0004	0.0007	0.0038	DL=0.0001
22	Total chromium	mgCr/l	< 0.01	0.12	< 0.01	0.06	0.21	0.14	0.24	0.04	0.11	0.120	8.83	0.40	0.138	DL=0.01
23	Alkalescency	mg-eq/l	4.3	3.9	4.0	4.5	3.2	4.8	0.8	1.6	4.6	3.6	61.0	0.6	4.0	DL=0.1
24	Oil content	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.19	<0.01	---	DL=0.01
25	Number of colon bacteria	ml	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	---	DL=1
26	CN^- *1	mg/l	0.04	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.02	DL=0.01
27	As *2	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	DL=1.0

*1 Measurement in summer season, Drinking water standard = 0.03 mg/l

*2 Measurement in summer season, Drinking water standard = 0.01 mg/l

d. Summary of Findings

- The measurement results of other points were evaluated based on the results of the central water source of drinking water sampling point No.12 and the surface water of sampling point No.11 at the entrance to UCDS which can be considered as leachate. It has been identified from the evaluation results that the impacts by leachate from the disposal sites seem to be less to the wells and surface water located near the disposal sites.
- The reason why leachate from the disposal site is not detected even in the rainy summer season is thought to be a combination of there being a low absolute amount of rainfall in the study area, high moisture evaporation, low moisture content of collected waste and few water discharge from waste consolidation.
- Periodic measurement shall be carried out for the comparative figure sampling points No.8, 9 and 10 from the commencement of service of the proposed disposal site (NEDS) and the data will be accumulated.
- The climatic conditions of the Study area vary greatly in the winter and summer seasons. Thus, the following trends were identified from the measurement results in both seasons.
  - Many water quality items exceed the Drinking Water Quality Standard in Mongolia in the winter season compared with the summer season. This is thought to be due to the fact that in the winter season groundwater stagnates but in summer groundwater flows due to rainfall. Also, as the seasonal trend for water quality items varies, the living activities of residents also vary depending on the season.
  - There are the following differences in water quality items according to the winter and summer seasons.
    - BOD_5 component, Total chromium: virtually undetected in the winter season but detected at many sampling points in the summer season.
    - colon bacteria, Cadmium and Lead: tends to be detected in the winter season but not in the summer season.
  - It is possible that the above mentioned results are due to the flow of groundwater and differences in living activities however, it is undeniable that there could have possibly been issues with the treatment of sampling water at the time of measurement and analysis.
- In comparison with the average groundwater in Japan, the ion concentration of these measurement results show a high concentration in many water quality items. These results were discussed with a local analyst however, even when the analyst compared the values with those of another project, the values were not remarkably different and there was the view that it was extremely common. Considering this, it is thought that in terms of the water quality of wells and surface water in the vicinity of Ulaanbaatar, high concentrations can be seen depending on the item and there is considerable geological impact.
- As toxic contents were detected in all the wells and surface water used for drinking water, the Study Team suggests that these waters should not be used for drinking purposes. It is also essential to conduct a detailed study of the sampling point and the neighboring conditions and identify the contamination cause.

3.4.3 Topographic Survey

Topographical maps of Morin Daava and Ulaan Chuluut final disposal sites are prepared in the scale of 1/1,000. Those maps will be used for the improvement plan of the sites.

3.5 Survey on Medical Waste Management

3.5.1 Objectives and Definitions

a. Objectives of the Study

Medical waste requires appropriate treatment and disposal based on its physical, chemical and pathological properties. For example, as this waste is handled carelessly, medical staff sometimes injure themselves with sharps. Moreover, when medical waste is disposed of together with general waste, the toxic chemicals and pathogens that it contains may have a grave impact, whether directly on the staff in charge of collection and landfill work, or indirectly on the surrounding environment and the residents living near the disposal sites. Adequate care needs to be taken in its treatment and disposal.

This survey for medical institutions aims to elucidate how infectious, hazardous and general waste generated by medical institutions in Study area is handled, treated and disposed of. The results of this study should also be useful for the establishment of the future medical waste management system necessary in Study area.

b. Definition of Waste Generated in Medical Institutions

The WHO (World Health Organization) defines the waste generated in a medical institution as “health-care waste”. In this questionnaire, it is divided into two; i.e. medical waste (hazardous healthcare waste or healthcare risk waste) and general waste (non-risk healthcare waste).

- **Medical waste** in this questionnaire is **hazardous healthcare waste** of WHO classification. A detailed classification of medical waste is summarized in the table below.
- **General waste** in this questionnaire is **non-risk healthcare waste** of WHO classification. It comes mostly from the administrative and housekeeping functions of medical institutions and may also include waste generated during the maintenance of medical institutions.

3.5.2 Method of the Survey

There are a total of 550 medical institutions in the target areas generating medical waste according to the Ministry of Health (WACS study, 2005). Fifteen (15) medical institutions in the study area were selected for the survey (see the Table below). The survey is based largely on the information collected directly from doctor, manager, and those responsible for medical waste management of the selected 15 medical institutions.

The interview focused on the generation, segregation, storage, discharge, collection, treatment, and disposal of medical waste. The detailed result of the survey is available in the Annex 2-5.

Table 3-11: Medical Institutions Surveyed

Category of The Institution	No of Response	Number of Beds				
		Total		Average	Maximum	Minimum
		No	%			
1. Hospital	2	688	24.3	344	498	190
2. Poly-clinic	6	1,277	45.1	213	400	90
3. Clinic	5	465	16.4	116	240	0
4. Others	2	402	14.2	201	402	0
Total	15	2,832	100.0	-	-	-

3.5.3 Findings

a. Amount of Wastes Generated

Study area, that is the capital city of Mongolia, is with the highest population growth rate in the country. Consequently, the number of the medical institutions in Study area has remarkably grown and has been generating a larger amount of medical waste than the other cities. The findings of the survey conducted in January, 2005 are described below.

a.1 Generation Rate of Medical Waste

Generation rate of the medical waste generation at the target institutions is summarized in the table below. The generation rate is obtained by dividing the total waste amount by (i) the number of beds, (ii) the number of patients (the sum of in-patients and out-patients) and (iii) the number of employees.

Table 3-12: Generation Rate of Medical Waste (per number of Beds)

Generation Source	No of Response	Generation rate (kg/bed/day)		
		Average	Maximum	Minimum
1. Hospital	2	0.436	0.584	0.287
2. Poly-clinic	3	0.122	0.356	0.002
3. Clinic		-	-	-
4. Others	1	0.003	0.003	0.003
Weighted Average	6	0.207	-	-

Table 3-13: Generation Rate of Medical Waste (per number of Patients)

Generation Source	No of Response	Generation rate (kg/patient/day)		
		Average	Maximum	Minimum
1. Hospital	2	0.519	0.715	0.323
2. Poly-clinic	3	0.051	0.145	0.000
3. Clinic	3	0.107	0.179	0.000
4. Others	2	0.011	0.016	0.006
Weighted Average	10	0.153	-	-

Table 3-14: Generation Rate of Medical Waste (per number of Employee)

Generation Source	No of Response	Unit generation rate (kg/employee/day)		
		Average	Maximum	Minimum
1. Hospital	2	0.289	0.338	0.239
2. Poly-clinic	3	0.108	0.320	0.001
3. Clinic	3	0.213	0.591	0.005
4. Others	2	0.036	0.070	0.001
Weighted Average	10	0.161	-	-

a.2 Generation Rate of General Waste

Generation rate of the general waste at the target institutions is summarized in the table below. As in the case of medical waste, the generation rate of general waste was calculated in three ways.

Table 3-15: Generation Rate of General Waste (per no of Beds)

Generation Source	No of Response	Unit amount (kg/bed/day)		
		Average	Maximum	Minimum
1. Hospital	2	3.671	6.767	0.574
2. Poly-clinic	3	0.395	0.476	0.253
3. Clinic	1	0.417	0.417	0.417
4. Others	1	4.478	4.478	4.478
Weighted Average	7	1.917	-	-

Table 3-16: Generation Rate of General Waste (per no of Patients)

Generation Source	No of Response	Unit amount (kg/patient/day)		
		Average	Maximum	Minimum
1. Hospital	2	4.470	8.295	0.645
2. Poly-clinic	3	1.412	3.808	0.022
3. Clinic	4	1.145	4.348	0.016
4. Others	2	4.086	7.826	0.345
Weighted Average	11	2.357	-	-

Table 3-17: Generation Rate of General Waste (per no of Employees)

Generation Source	No of Response	Unit amount (kg/employee/day)		
		Average	Maximum	Minimum
1. Hospital	2	2.1995	3.92	0.479
2. Poly-clinic	3	0.338	0.698	0.136
3. Clinic	5	0.171	0.403	0.061
4. Others	1	1.818	1.818	1.818
Weighted Average	11	0.735	-	-

a.3 Estimation Method

The figure below shows the process of estimating the medical waste generation amount from all the medical institutions in the city, taking the example of hospitals. The solid lines were the procedure originally intended by the team. The total waste amount could have been estimated in two ways: one using the unit generation rate per employee (and/or patient) per day and the other using the unit generation rate per occupied bed per day, both of which were calculated in the previous section.

These two ways, however, necessitate data of the number of employees (indicated in Box D in the figure) or the number of beds and bed occupancy rates (in Box E in the figure) of all the medical institutions in the city.

The number of beds and that of employees at every medical institution in Study area are obtained from “Statistical Handbook of Ulaanbaatar, XX Century.” Using these figures and the unit amount of the target institutions, we estimated the total amount of medical waste and general waste generated at the medical institutions in Study area. Information on total number of beds and employees in Study area for each category of medical institutions (Hospital, Polyclinic, Clinic and Others) is not available so the estimation was conducted without such categorization. Consequently, the weighted average generation rates were used for estimation.

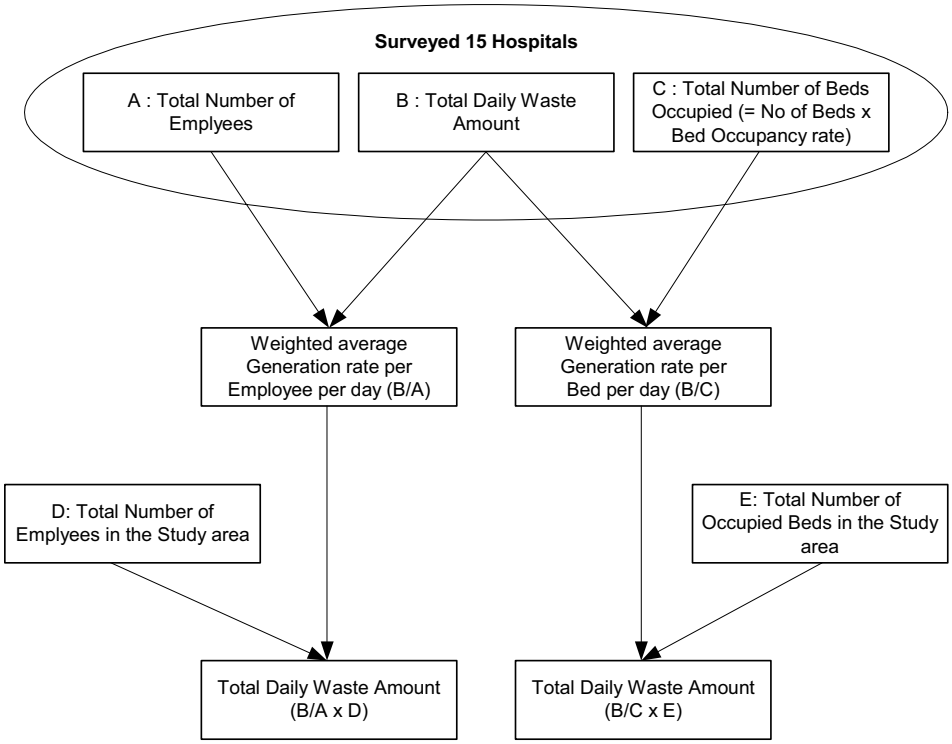


Figure 3-6: Waste Amount Estimation Process

a.4 Estimation of Waste Generation Amount in Study area

The number of beds and that of patients at every medical institution in Study area are obtained from MOH WACS study, 2005, and the number of employees is obtained from "Statistical Handbook of Ulaanbaatar, XX Century." Using these figures and the three weighted generation rates (per bed, per patient and per employee) obtained from of the target institutions, we estimated total amount of medical waste and general waste generated at the medical institutions in Study area. Consequently three generation amounts are calculated. Through the examination of previous survey data, the Study Team applies the generation amount based on the number of beds as shown in the table below.

Table 3-18: Generation Rates and Amount of General and Medical Waste applied to the Study

Category of Waste	Generation Rate (kg/bed/day)	Number of Bed	Generation Amount (ton/day)
Medical waste (Hazardous/Infectious)	0.207	7,721	1.6
General waste	1.917	7,721	14.8

The tables below show generation amount and rate per capita of general and medical waste.

Table 3-19: Medical Waste Generation Rate in Other Cities

Country/City	Study Year	Population	Generation Amount (kg/day)	Unit Generation (g/person/day)
Chile / Santiago[1)]	1995	5,642,000	20,000	3.54
Turkey / Adana[2)]	1998	1,196,620	4,401	3.68
Turkey / Mersin[2)]	1998	643,850	1,539	2.39
Azerbaijan / Baku[3)]	2000	2,051,200	12,892	6.28
Cambodia / Phnom	2003	1,199,414	961	0.80

Country/City	Study Year	Population	Generation Amount (kg/day)	Unit Generation (g/person/day)
Penh[4)]				
Sri Lanka / Kandy[5)]	2002	110,049	530	4.81
Mongol / Ulaanbaatar	2005	866,591	1,600	1.85

Source:
1. Final Report of The Master Plan Study on Industrial Solid Waste Management in the Metropolitan Region of the Republic of Chile, March 1996, JICA
2. Final Report of The Study on Regional Solid Waste Management for Adana-Mersin in the Republic of Turkey, January 2000, JICA
3. Final Report of The Master Plan Study on Integrated Environmental Management in Baku City in Azerbaijan Republic, March 2001, JICA
4. Final Report of The Study on Solid Waste Management in the Municipality of Phnom Penh, March 2005, JICA
5. Final Report of The Study on Solid Waste Management for Secondary Cities in Sri Lanka, December 2003, JICA

Table 3-20: General Waste Generation Rate in Other Cities

Country/City	Study Year	Population	Generation Amount (kg/day)	Unit Generation (g/person/day)
Chile / Santiago	1995	5,642,000	44,658	7.92
Turkey / Adana	1998	1,196,620	11,805	9.87
Turkey / Mersin	1998	643,850	4,663	7.24
Azerbaijan / Baku	2000	2,051,200	20,588	10.04
Cambodia / Phnom Penh	2003	1,199,414	9,719	8.10
Sri Lanka / Kandy	2002	110,049	4,734	43.02
Mongol / Ulaanbaatar	2005	866,591	14,800	17.08

Source: The same as the above table.

b. Overall Evaluation

The team concludes that the management system of medical waste in Study area requires much improvement. The important issues revealed by the present survey are as follows:

- Even though in house collection and storage are separated from medical wastes to general wastes, many cases are observed that those wastes are mixed during discharge to the collection and transportation to disposal site.
- One of the reasons why they are mixed is that neither the staff of the medical institutions nor the waste collection workers are fully aware of the possible risks posed by medical waste.
- The second reason is that there are few facilities that can appropriately treat medical waste in the study area. This makes the medical staff and the collection workers reluctant to strictly separate medical waste.

The leadership of the responsible authorities including the Ministry of Health and UBC in the development of a medical waste management system, particularly in raising public awareness of health risks, should be urgently strengthened.

3.6 Industrial Waste

3.6.1 Objectives and Schedule of the Survey

a. Objectives

The objective of the survey is to obtain basic data that is necessary for estimating the total amount of industrial waste (IW) generated in the Study area at present and to forecast that in

the future. The estimation and forecast support the part of IW management system of the master plan (M/P).

b. Schedule of the Survey

The survey on industrial waste management was carried out twice according to the following schedule.

- First Survey: The Study Team conducted interview surveys of 18 factories in February 2005.
- Second Survey: The Study Team conducted interview surveys of 17 factories in September 2005. The second survey was carried out to identify the status of hazardous industrial waste (HIW) discharge. The factories interviewed in the second survey included 6 factories from the first survey on HIW discharge, as the volume and variety of HIW from these factories was not clear.

3.6.2 Method of the Survey

a. Preparation of the Survey

a.1 Classification of IW

In this factory survey, IW was divided into two types: non-hazardous and hazardous. Non-hazardous industrial waste (non-HIW) and hazardous industrial waste (HIW) are further divided into groups as shown in the two tables below.

There is no official classification of industrial waste (IW) in Mongolia. The Team set up the following classification of non-HIW and HIW for the Study based on the past experience.

Table 3-21: Classification of Non-Hazardous Industrial Waste (Non-HIW)

Type of Non-Hazardous Industrial Waste	Non-HIW Code
Waste generated from non-production sources (general industrial waste)	GIW
Waste from animal such as bone, skin, hair	NH01
Wood	NH02
Paper	NH03
Plastic or polymers and resins	NH04
Textile and fiber	NH05
Grease, animal oil, vegetable oil	NH06
Natural rubbers	NH07
Metals and metal alloys such as aluminum, copper, bronze	NH08
Ceramics& Glass	NH09
Stone, ash/dust from coal-fired power plants, sand or material that have composition of soil such as tile, brick, gypsum, cement	NH10
Mixed waste	NH11
Others	NH12

Table 3-22: Classification of Hazardous Industrial Waste (HIW)

Type of Hazardous Industrial Waste	HIW Code	Example of Hazardous Industrial Waste
Inorganic acid	HW01	Sulfuric acid (H_2SO_4), Hydrochloric acid (HCl), Nitric acid (HNO_3), Phosphoric acid (H_3PO_4), Other inorganic acids
Organic acid	HW02	Acetic acid (CH_3COOH), Formic acid (HCOOH), Other organic acids
Alkalis	HW03	Caustic soda (NaOH), Ammonia (NH_3), Sodium carbonate (Na_2CO_3), Other alkaline materials
Toxic-Metal Compounds	HW04	Salts (Hg, As, Cd, Pb, Cr, etc)
Inorganic Compounds	HW05	Plating wastes, Cyanides, Picking waste, Sulfide, etc.
Other Inorganic	HW06	Asbestos, Slug, etc.
Organic Compounds	HW07	Reactive chemical wastes (Oxidizing agents, Reducing agents, etc), Solvents etc.

Type of Hazardous Industrial Waste	HIW Code	Example of Hazardous Industrial Waste
Polymeric Materials	HW08	Epoxy resin, Chelate resin, Polyurethan resin, Latex rubber etc.
Fuel, Oil and Grease	HW09	Fats, Waxes, Kerosene, Lubricating oil, Engine oil, Grease etc
Fine Chemicals and Biocides	HW10	Pesticides, Medicine, Cosmetic, Drugs, etc.
Treatment Sludge and contaminated rubbish	HW11	Inorganic sludge, Organic sludge etc.
Ash including from incinerator	HW12	---
Dust and APC products	HW13	Soot and dust waste from incineration facilities, treating exhaust gas
Other Hazardous substance (besides HW01-HW13)	HW14	HIWs other than the above

a.2 Preparation of Survey Sheet

The 1st survey should clarify the current generation, reuse/recycling and treatment/disposal. The contents of the questionnaire of the survey are divided into two parts: (1) general information and (2) IW management.

a.3 List of Factories

There are three kinds of factory lists. One is submitted by MOE and the second is submitted by MUB by the request of the JICA preparatory study. The third one is in the statistic handbook of Ulaanbaatar[1]. The number of factories listed in three reports is different.

The study team has estimated the number of factories basically based on the list submitted by MOE, and some categories like furniture and paper processing are based on the list submitted by MUB. The table below shows the number of factories in UBC, together with the factory category code that was used in the study.[2]

Table 3-23: Number of Factories in UBC

Code	Description	Range of Number of Employees					Source
		10>	11-100	101-500	>501	Total	
G01	Agriculture, Food, Dairy product	2,346	487	42	3	2,878	MOE
G02	Leather	107	23	0	0	130	MOE
G03	Textile	55	53	10	4	122	MOE
G04	Chemical	51	21	2	0	74	MOE
G05	Cement & Brick	42	25	9	1	77	MOE
G06	Metal processing	12	4	0	0	16	MOE
G07	Furniture	120	35	2	0	157	UBC
G08	Paper Processing	124	28	1	0	153	UBC
G09	Mining industry, Metallurgy	132	91	21	7	251	MOE
G10	Others	399	233	30	1	663	MOE
	Number of Factories	3,388	1,000	117	16	4,521	-

b. Method of the Survey

The survey was conducted as follows:

- Select target
  - First Survey : Target factories were selected taking into account their type and number of employees
  - Second Survey: (1) 6 factories which responded that HIW is being discharging as a factory process in 1st survey and (2) 11 factories which were selected as possible of discharging HIW

[1] Statistical Handbook of Ulaanbaatar, XX century, VIII Living conditions table2., 1) Agriculture, hunting and forestry; fishing 2) Mining and quarrying 3) Electricity, gas and water supply 4) Construction 5) Sum amount of Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods

[2] In case there are categories but no factory is categorized in MOE list, data in UBC is used to fill in the list.

- Questionnaires were distributed to the target factories to be interviewed and appointments were made for interviews
- The owners or representatives of the target factories were interviewed
- The results were analyzed

The number of factories surveyed in each industrial sector is shown in the table below. The team tried to cover factories with a large number of employees and overall categories of factory, but not all the factories that the team planned to visit accepted the survey due to the nature of the survey.

In 2nd Survey, as it was important to identify the status of HIW discharge, factories with one location (railway company, electric power plant, waste water treatment plant and cement factory) in the study area were also selected.

Table 3-24: Target Factories of the Survey

Factory Code	Factory Type	Number of Factories			
		1st Survey	2nd Survey		
			New Factory	Duplicated factory in 1st Survey	Total
G01	Food, Dairy product	**5**	1	1	**2**
G02	Leather	**2**	1	1	**2**
G03	Textile	**4**	-	1	**1**
G04	Chemical	**1**	1	1	**2**
G05	Cement & Brick	**2**	1	-	**1**
G06	Metal processing	**3**	1	2	**3**
G07	Furniture	**-**	-	-	**-**
G08	Paper Processing	**-**	-	-	**-**
G09	Mining industry, Metallurgy	**-**	-	-	**-**
G10	Others	**1**	6	-	**6**
Total		**18**	11	6	**17**

Remark: Factory code has been set up by the study team in ten categories.

The results of the Survey are presented in the Section 2.6 of the Annex report.

3.6.3 Findings

a. Waste Generation

a.1 Generation Rate of Industrial Waste Generation

The generation rate of the industrial waste generated at the target factories is summarized in the table below. The generation rate was obtained by dividing the waste amount by the number of employees.

Table 3-25: Generation rate of Industrial Waste Generation (per employee)

Factory Code	Unit amount (kg/employee/day)		
	1st survey	2nd survey	Average
G01	0.47	0.32	0.40
G02	2.29	-	2.29
G03	0.36	-	0.36
G04	-	1.88	1.88
G06	0.23	1.08	0.65
Average (All Waste amount / All number of employees)	0.86	-	0.86

a.2 Estimation of Waste Generation Amount in Study area

a.2.1. The Total Number of Employees in Study Area

The number of employees in the whole study area, necessary for estimating the IW generation rate, was calculated as follows.

- For factories with less than 10 employees it was assumed that discharge is the same as that of households and business enterprises and the number of employees for estimated generation rate was not included.
- The average number of employees was determined as shown below.
  - Range of Employees 11-100 : 50 employees
  - Range of Employees 101-500: 300 employees
  - Range of Employees >501: 750 employees

Table 3-26: Number of Employees in the Study Area

Code	Description	Range of Employees			
		11-100	101-500	>501	Total
G01	Agriculture, Food, Dairy product	24,350	12,600	2,250	39,200
G02	Leather	1,150	-	-	1,150
G03	Textile	2,650	3,000	3,000	8,650
G04	Chemical	1,050	600	-	1,650
G05	Cement & Brick	1,250	2,700	750	4,700
G06	Metal processing	200	-	-	200
G07	Furniture	1,750	600	-	2,350
G08	Paper Processing	1,400	300	-	1,700
G09	Mining industry, Metallurgy	4,550	6,300	5,250	16,100
G10	Others	11,650	9,000	750	21,400
	Number of Factory	50,000	35,100	12,000	**97,100**

a.2.2. Estimation of Waste Generation Amount in Study Area

The team estimated the IW generation amount from all the factories in the study area as shown in the table below. For the waste generation unit of the industrial sectors which were not covered by the present factory survey, the average of the unit generation rates of the industrial sectors covered by the present survey was substituted.

As a result, the total IW amount from factories in the study area was calculated at about 64 tons. The major sources were agriculture/food/dairy product factories (15.7 tons/day) and mining industry/metallurgy factories (13.8 tons/day), accounting for 46% together.

It was estimated that the amount of HIW generated in the whole study area was only 0.1 ton/day. This amount was calculated based on the answers provided by two factories, thus the calculated amount may be much lower than the actual figure. For example, waste oil and grease are surely generated if they use machinery at factories, but in this survey only four factories answered that they generated these.

Generally in Mongolia knowledge of factories on HIW management is very limited. This is because of unclear definition of HIW, lack of HIW management facilities, etc. This fact is proved by the fact only 4 factories could reply the amount of HIW while 6 among 10 factories, that generate HIW, could not. It is urgent issue that the MOE in cooperation with the other responsible organizations conduct a comprehensive HIW management study which forces the factories to reply actual management and formulate a HIW management plan including immediate, medium and long term measures.

Table 3-27: Generation Amount of IW

Type of Factory	Code	No of Factory*1 (no)	No of Employees (persons)	Non-HIW		HIW	
				Generation Rate*1 (kg/employee/day)	Generation Amount (ton/day)	Generation Rate (kg/employee/day)	Generation Amount (ton/day)
Food, Dairy product	G01	2,878	39,200	0.40	15.7	-	-
Leather	G02	130	1,150	2.29	2.6	-	-
Textile	G03	122	8,650	0.36	3.1	-	-
Chemical	G04	74	1,650	1.88	3.1	0.03	0.1
Cement & Brick	G05	77	4,700	0.86*1	4.0	-	-
Metal processing	G06	16	200	0.65	0.1	-	-
Furniture	G07	157	2,350	0.86*1	2.0	-	-
Paper Processing	G08	153	1,700	0.86*1	1.5	-	-
Mining industry	G09	251	16,100	0.86*1	13.8	-	-
Others	G10	663	21,400	0.86*1	18.4	-	-
Total		4,521	97,100	---	64.3	---	0.1

(Note) *1: The average value (0.86 kg/ employee/ day) was used for all data.

a.3 Generation Forecast

The generation amount of industrial waste for the year 2010, 2015 and 2020 was estimated according to the economic growth in the study area from 2005 to 2020. As shown in the following table, industrial waste (Non-HIW + HIW) generation is estimated as 84.0 ton/day in 2010, 109.7 ton/day in 2015 and 143.4 ton/day in 2020 respectively.

The amount of industrial waste also increases by more than 2.2 times from 64.4 ton/day in 2005 to 143.4 ton/day in the year 2020.

Table 3-28: Generation Amount Forecast

Year	Non-HIW (ton/day)	HIW (ton/day)	Total (ton/day)
2005	64.3	0.1	64.4
2010	83.9	0.1	84.0
2015	109.6	0.1	109.7
2020	143.3	0.1	143.4

* See population forecast.

b. Tannery factory HIW

A tannery factory in Khan-Uul and leather waste water treatment plant was surveyed.

As the tannery factory uses various chemicals for tanning leather, extracting hide and fur, they generate a lot of residue waste water and pieces of fur/hide contaminated by those chemicals.

- Waste water: waste water is directly delivered from the factory to the leather waste water treatment plant and treated. After dehydrating the sludge generated at the leather waste water treatment plant, the dehydrated sludge is stored in an outdoor pile in the plant. Also, overflow from the sedimentation basin is discharged sewage and is disposed at the sewage treatment facility.
- Residue fur and hide: Disposed at UBDS and MDDS after draining.

It is necessary to formulate appropriate HIW counter measures to improve the current situation in which leather sludge storage piles and residue are being disposed as is, without being treated.

c. Liquid HIW

Cases of untreated liquid waste being discharged into the sewage system could be seen at textile factories. As there are two separate systems for discharging domestic waste water and industrial waste water in the sewage facilities in UBC, it is only natural that this kind of behaviour would be common for factories.

However the sewage amount is increasing and it is not possible to maintain the two sewage systems. The capacity of sewage facility in UBC is already limited and it is expected to have serious effects on the environment, thus it is necessary for UBC and MOE to investigate setting up a waste water treatment plant specifically for HIW or installing waste water treatment equipment in the individual factories.

d. Recycling at Cement Factories

Limestone and other raw material are burned at rotary kiln in cement factory and the cement is produced. If the kiln conforms to the conditions, it may be possible to treat HIW such as waste oil and sludge, etc..

As there is no cement factory in UBC, the cement factory in Darkhan city was visited and studied.

The details of the cement factory are as follows.

- Operation start-up : 1968
- Cement production : 185,000 ton/year
- Line of kiln : 2 lines
- Fuel : Coal

The facility is well maintained but it is old and small-scale (cement production amount). Thus, the following matters have to be investigated on the premise of using this facility for treating HIW without affecting the cement products.

- Survey the facility fully and examine possible HIW mixing and feeding process.
- Estimate the amount and type of treatable HIW.

e. Future IW management

In order to carry out appropriate IW management, it is necessary for administrative bodies such as MUB and MOE to clearly define HIW and introduce to factories methods for adequately disposing HIW. Moreover, they must promptly establish an intermediate treatment plant and final disposal site specific for HIW in order to support factories.

3.7 Survey on Recycling Market

3.7.1 Introduction

Two surveys were carried out for the recycling market. The first survey was conducted in February 2005 and individual interview surveys were carried to the following parties:

- Five recyclable waste markets;
- Three end users; i.e. two plastic bag production companies and one toilet paper production company.
- One exporter; and
- Two waste pickers

Since the first survey could not provide sufficient figure of current recycling market, the second survey was carried out in August 2005 in order to obtain information such as regulations of recycling and associations or organizations for recycling activities. In addition, interview surveys were extended to waste buyers, recycling companies and end users to identify flow of recycling items in UBC. For this purpose the following individual interview surveys were carried to parties:

- Twelve end users; i.e. four metal processing factories, one toilet paper production company, four plastic products companies and three plastic (PET) exporters; and
- 92 recycling depots

3.7.2 The First Recycling Market Survey

a. Objectives

The objective of the survey is to understand the current situation of the recycling market in Study area determining its size, traded items and their prices. This is one of the most essential tasks to formulate a SWM master plan.

b. Survey Method

The Study team conducted interviews to those engaged in the recycling market. Interviewees were asked to provide answers for the questionnaire. Price and amount of traded wastes are summarized by their category. The amount of traded wastes is calculated by simply summing up amount of wastes that the survey targets buy.

b.1 Survey Targets

The Study team interviewed 5 recyclable waste markets, 3 end users (recycling companies), an exporter and 2 waste pickers in the street. The interviewees are shown in the table below.

The Recycling market survey has been conducted as follows:

- Distribute the questionnaire to the target recycling markets to be interviewed and make appointments for interviews.
- Interview the owners or representatives of the target recycling markets
- Analyze the result

Table 3-29: Survey targets

Type of the targets	Number of target(s)	Description of the targets
Waste market	5	Waste market buy and/or collect reusable and/or recyclable wastes from waste pickers, households etc.. They sell those wastes to domestic recycling companies and/or export them.
End user (recycling company)	3	Recycling companies buy and/or collect reusable and/or recyclable wastes. One out of the three targets produces toilet paper and the other two produce polythene bags.
Exporter	1	The target buys / collects PET bottles and aluminum metal. It only exports those wastes. It is a Mongolian and Chinese based joint venture company.
Waste picker	2	Both targets collect reusable and/or recyclable wastes in the central area of the city, not in the final disposal site. They sell those wastes.

b.2 Wastes traded in the recycling market

Traded wastes in the market are categorized as follows:

- Paper wastes: Office paper and, Cardboard
- Plastics: PET bottles, Plastic containers and Polythene bags
- Metal: Aluminum cans, Iron, Copper, Brass, Fusible alloy and Lead
- Glass bottles
- Others

c. Results

Prices and amounts of the wastes traded by the survey targets are summarized by each category in the table below. Amount of traded wastes was calculated by summing up the amount of wastes the survey targets buy and is shown as "Including factory wastes." The figure obtained by subtracting factory wastes from that amount is shown as "Excluding factory wastes," that corresponds to traded MSW.

Table 3-30: Price and amount of traded wastes

Category of traded wastes	Sub No	Category of traded wastes	Unit	Price (MNT)		Amount of traded wastes (kg/day)	
				Buy	Sell	Including factory wastes	Excluding factory wastes
Paper wastes	1	Office paper	kg	20-25	-	1,700	510
	2	Cardboard	box	50-100	100-150	345	135
Plastics	1	PET bottles	kg	200-300	350-400	1,807	1,807
	2	Plastic container	kg	20-50	70	382	382
	3	Polythene bag	kg	100-150	-	450	328
Metal	1	Aluminum can	kg	550-900	700-1200	2,135	2,135
	2	Iron	kg	40	60	6,500	6,500
	3	Copper	kg	2300	2400	650	650
	4	Brass	kg	900	1000	425	425
	5	Fusible alloy	kg	900	1000	650	650
	6	Lead	kg	200-300	300-400	125	125
Glass Bottles	1	Bottles	bottle	5-150	20-100	2,525	2,525
					Total	17,694	16,172

d. Findings of 1st Survey

- Some wastes are recycled in Study area but the recycling system still needs to be improved.
- Mainly iron, glass bottles, aluminium cans and PET bottles are traded in the recycling market. Copper and aluminium cans are very highly priced, and PET bottles are fairly highly priced. This is consistent with what the Study team has observed in other cities of developing countries.
- Most of the reusable and recyclable wastes brought to the targets categorized as waste buyer is collected by waste pickers. The rest is directly brought to them from households and shops. In one of the cases of this survey, 85 to 90 percent of the traded wastes the waste buyer buy is brought by waste pickers.
- The target recycling company that produces toilet paper collects paper wastes by themselves. However, the amount of the paper wastes collected is so small that the company utilize only 30% of the capacity of its plant. The company is only processing paper wastes of high quality that is categorized as office paper. It has a plan to process paper wastes categorized as cardboard also.

- The target recycling companies that process plastics collect available wastes generated only in certain specific plants including their own and shops. This is because plastics of such material and purity that those recycling companies can utilize are very limited. The companies have the same difficulty in collecting enough amount of recyclable waste as the paper recycling company does.
- The target exporter trades PET bottles and aluminium, mainly with China. The target waste buyers export recyclable wastes that are not marketed domestically to China.
- Bottles are reused in Study area. Recycled wastes are almost limited to paper wastes and plastics of certain specific material. Very little amount of iron is also recycled in a works producing ornaments on gates. The recycling market in Study area is very little.
- The target waste pickers earn around 200 to 3000 MNT individually per day. The amount of the wastes they collect was not provided with in the survey.
- No information is available that can precisely tells the total number of waste pickers in Study area. According to the target waste pickers, there might be 50 to 150 waste pickers.

3.7.3 The Second Recycling Market Survey

a. Objectives

The existing condition of the recycling market was surveyed in detail including regulations for recycling and associations or organizations for recycling activity. At the same time a survey was conducted of end users who use valuables recycled as raw material for production and export of recycling materials.

b. Method

- Review of document from MUB and central government (Ministry of Commerce, Ministry of Industry, etc.)
- Interview of waste buyers, recycling companies and end users

c. Number of Recycling Company and Depot in UBC

c.1 Recycling Company

There are 37 secondary raw material (SRM) processing factories in Mongolia: 9 plastic processing factories, 21 licensed metal processing factories of which 13 are operational and the remaining 8 are ready to produce, and one paper processing factory in Ulaanbaatar; one small scale plastic processing and 1 bigger scale metal processing factories in Darkhan city; 3 large scale metal factories and one paper producing factory with waste wood in Erdenet city.

There are 23 recycling factories in Ulaanbaatar city in total; i.e. 4 operating in Bayangol, 6 in Bayanzurkh, 3 in Songinokhairkhan, 2 in Sukhbaatar, and 8 in Khan Uul districts.

c.2 Recycling Depot

An interview study was held for TUK and the results of the survey of a number of recycling depots are shown in the table below. Through the survey it has become apparent that there are 228 recycling depots in the study area.

Table 3-31: Recycling depot in Study Area

№	District name	Number of suppliers
1.	Bayangol	25
2.	Bayanzurkh	44
3.	Sukhbaatar	67
4.	Songinokhairkhan	31
5.	Chingeltei	39
6.	Khan-Uul	22
	Total	228

The breakdown of capital for these recycling depots is shown below. From these figures it is apparent that the recycling depots are mostly small-scale. In addition, 9 of these depots are corporate organizations and 219 are private operations.

Table 3-32: Turn-over Asset Size of Recycling Depots

№	Classification	Turn-over asset /MNT.thousand/	Quantity /no./
1.	Very small	-80.0 ≤	116
2.	Small	< 80.0-200.0≤	76
3.	Medium	< 200.0-3.000.0≤	34
4.	Bigger	< 3.000.0-	2
	Total		228

d. Findings of 2nd Survey

1. **Laws and Regulations for recycling;** No laws or regulations for recycling are legislated at present in Mongolia although there are laws for companies to obtain registration certificates and special permission to operate. The certificate is issued from the office of the District in which the company is located.
2. **Associations or Organizations for recycling;** No associations or relevant organizations for recycling have been established yet. Some of the recycling companies consider that the formation of an organization for recycling activity is necessary.
3. **Distribution of Recycled Items in UBC;** The distribution of recycled items in UBC is illustrated in the following figure. The daily amount of recycled items can be estimated as approximately 25.7tons.

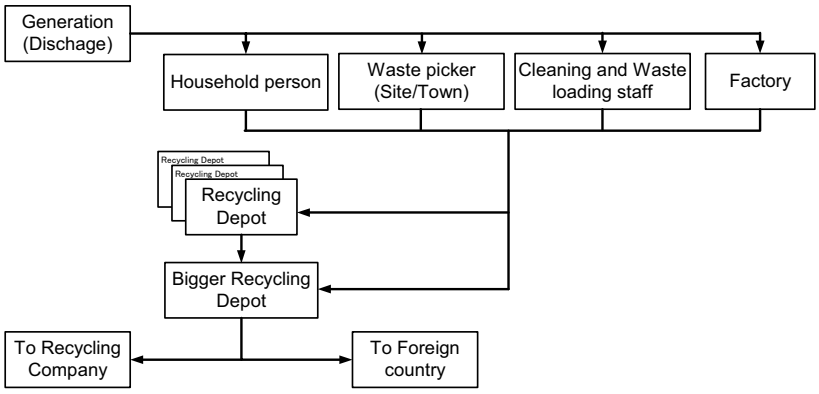


Figure 3-7: Distribution of Recycled Items in UBC

4. **Recycling Company and Depot in UBC;**

- ✓ One hundred and eight (108) waste buyers among 228 were visited and surveyed. Since the law against trans-border export of metal came into effect on the 1st August 2005, many of the buyers who were trading metal closed.
- ✓ Recyclable waste is purchased mainly from waste pickers (on the site and in the city), drivers of waste collection vehicles and factories and sold to other waste buyers (43%), end users (22%) and export companies (26%).
- ✓ Glass bottles, PET bottles and metal are principally bought and sold and only three (3) buyers trade paper and plastic. The amount of trading by 108 buyers a day is approximately 39.0 tons in total.

5. End users in UBC;

- ✓ Among twenty-three (23) factories which utilize recycled waste as raw material for production, three (3) plastic processing factories, four (4) ferrous metal factories and one (1) paper processing factory were selected and interviewed.
- ✓ Total amount of recyclable materials utilized by 8 factories above mentioned is 0.5 tons/day of plastic, 7tons/day of ferrous metal and 1.75tons/day of paper. These materials are purchased from waste buyers, factory and business enterprise.
- ✓ Glass bottles recycled are sold and reused at vodka and beer production companies. PET bottles are, after washing, cutting in pieces and packing up, exported to foreign countries (mainly China). Ferrous metal and non-ferrous metal had been exported actively to foreign countries before effectuation of trans-border export prohibition law. Most of big buyers are funded by Chinese capital and there are little buyers supported by Mongolian capital.

3.8 Construction Wastes Survey

3.8.1 Objectives and Contents of the Survey

a. Survey to the Construction Companies and Sites

a.1 Objective

One of the biggest problems relating to the SWM in Ulaanbaatar is the illegal dumping and prevention of it is one of the most important targets of the Master Plan.

It is estimated that the construction wastes are the main cause of the illegal dumping and occupy biggest part of it. Nevertheless, there is no data available relating to the amount and quality of construction wastes so far.

Construction wastes survey was carried out in order to grasp above conditions and data obtained by the survey is utilized for making future plan to prevent illegal dumping.

a.2 Survey Area

Survey area is 7 districts in Ulaanbaatar out of 9 districts, excluding Baganuur and Bagakhangai district.

a.3 Survey Item

50 construction companies and sites are visited by the local consultant together with study team and conduct interview survey according to the questionnaire. Contents of the questionnaire include followings.

- Amounts of the construction wastes
- Type of construction wastes
- Method and location of disposal of wastes
- Recycling
- Method of transportation of wastes

b. Survey for Illegal Dump Site

b.1 Objective

The illegal dumping sites were surveyed and a large amount of information was obtained about the volume and quality of waste, illustrating the flow of waste in the survey area.

b.2 Survey Method

The Study Team visited the site and calculated the content through simple measurement. Furthermore, the general composition of the quality of waste was visually determined.

b.3 Survey Point

The survey point was decided through information obtained by the CMPUD of MUB.

3.8.2 Results of the Survey

a. Generation Amount of Construction Waste

Construction waste generated in UBC is calculated using the waste generation rate by project budget and amount of construction work in 2004. Construction waste generated daily in UBC is estimated at 82.5 tons/day as shown in the table below.

Table 3-33: Construction waste amount discharged in UBC

	Apartment	Commercial	Hospital, School, Cultural	Office, Storage Facilities	Energy	Communication	Road Works	Dams, Drainage	Others	Renovation Works	Total
Project Scale (million Tg)	36,333	7,152	4,510	3,743	6,896	412	1,853	3,387	3,456	3,635	71,377
Unit waste generation (tons/1,000 Tg)	1.4859×10^{-4}	1.4859×10^{-4}	1.4859×10^{-4}	1.4859×10^{-4}	14.0664×10^{-4}	14.0664×10^{-4}	4.13997×10^{-5}	14.0664×10^{-4}	13.3849×10^{-4}	13.0805×10^{-4}	---
Waste generation (tons/year)	5,398.7	1,062.7	670.1	556.2	9,700.2	579.5	76.7	4,764.3	4,625.9	2,667.3	30,101.6
Waste generation (tons/day)	14.8	2.9	1.8	1.5	26.6	1.6	0.2	13.1	12.7	7.3	82.5

b. Illegal Dumping of Construction Waste

Fifty (50) companies answered to the question “Where do you transport construction waste?”. It includes 16 companies which answered “We do not know where we transport construction waste.” Local surveyors say that the companies answering “Do not know” may disposed of construction waste illegally. If it is true, 36% of construction companies are disposing of construction waste illegally every day in UBC.

Table 3-34: Disposal site for Construction Waste

NO	Disposal Site	Companies	%
	Ulaan Chuluut Disposal Site	27	54
	Morin Davaa Disposal Site	2	4
	Own storage facility	1	2
	Sell to buyer	1	2
	Unload at ger household	1	2
	Tsagaan Davaa /illegal/	1	2
	Disposal Site /illegal/	1	2
	Do not know	16	32

3.8.3 Findings

The findings of the survey are summarized below.

- According to the 2004 records, the yearly average construction waste amount, which is illegally dumped, is estimated as 82.5 ton/day.
- The temperature in winter in Ulaanbaatar City can drop below minus 20, as outdoor construction activities in particular are extremely restricted, the generation amount of construction waste is lower than in the summer season according to the data from the weighbridge at the disposal site and observation of collection at the disposal site.
- The proportion was determined, as shown in the table below, by referring to the market waste generation amount which is considered to have a similar generation pattern and the generation amount of construction waste in the summer season is estimated to be double that of the winter season.

Table 3-35: Estimated Generation Amount of Construction Waste（2004）

	Summer Season（Apr- Sep）	Winter Season （Oct-Mar）
Construction Waste Generation Amount	110.6 ton/day	54.5 ton/day

- According to the 2005 field survey results of the JICA Study Team, approximately 13,000m^3 of waste was illegally dumped in the survey area with the majority being disposed in the southern part of the city (Bayangol and Songinokhairkhan districts). Furthermore, according to the CMPUD survey results[3], the amount will be 65,500m^3 in 2006, despite the survey location being different, the amount of waste shows an increasing trend alongside economic activity.
- Construction waste is identified as accounting for approximately 80% of the illegally dumped waste.

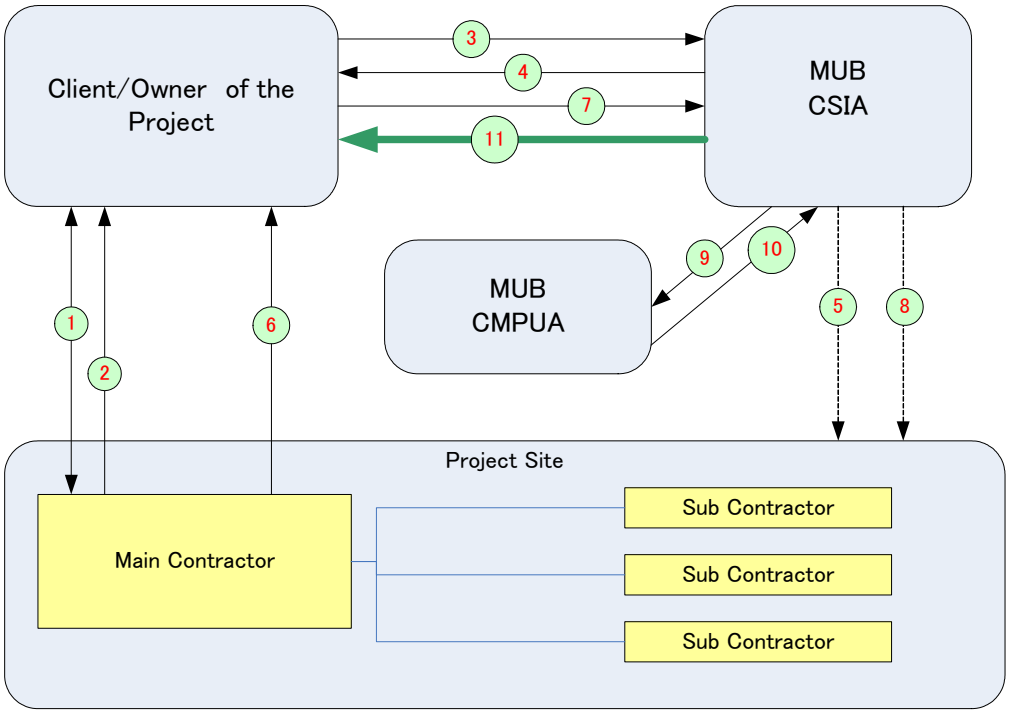
3.8.4 Plan for Control of Construction Waste

In the winter season, construction waste accounts for 10% of the weight of the city's waste generation amount and approximately 5% in summer. Strengthening the control of this waste is essential for eliminating illegal dumping and also improving the financial affairs of CMPUA.

Moreover, it is important for the generators, owner of the project, and the governments to each fulfill their obligations in respect to their positions in order to appropriately dispose construction waste.

[3] Presentation material for the explanation of new organization of CMPUA carried out on September 2006.

A proposed control system for appropriate disposal of construction waste is illustrated in the Figure below.



CSIA: Ulaanbaatar City Special Inspection Agency,
CMPUA: City Maintenance and Public Utility Agency

Figure 3-8: Control System for Construction Waste

① Main contractor and client/owner of the project enter a construction contract.

② Main contractor presents a waste disposal plan to the client prior to the commencement of construction work.

③ Client presents the waste disposal plan in to CSIA.

④ After confirming the contents, there will be changes instructed if there are any deficiencies and if everything is satisfactory, approval will be given to commence work.

⑤ Spot investigations will be carried out during the construction work, if required, to identify if the work is being implemented as scheduled in the plan.

⑥ At the time of work completion, the main contractor will submit a work completion report to the client, reporting whether or not waste was disposed of as set out in the plan.

⑦ The client will submit a work completion report to CSIA after confirming the contents as mentioned above in .

⑧ CSIA will inspect the site if required and confirm whether or not waste disposal has been carried out appropriately.

⑨ CSIA will refer to the CMPUA whether construction waste were transported to the designated disposal site or not.

⑩ CMPUA will confirm it based on the data from the weighbridge at the final disposal site.

⑪ If the above procedures have been performed then a construction completion certificate will be issued and commercial utilization will be allowed.

The major point of this control system is that there are limitations such as, unless the client presents the waste disposal plan then construction work cannot commence and in accordance with the approved waste disposal plan, if the waste is not disposed off then a construction completion certificate is not issued and the building cannot be used commercially.

3.9 Survey on Final Disposal Amount

3.9.1 Final Disposal Amount Survey at 3 Official Disposal Sites

a. Objectives

Waste amount survey was carried out in order to grasp final disposal amount in three disposal site (UCDS, MDDS and NDS) in the study area.

- To analyse the data, which incoming collection vehicles registered at the site office at three disposal site and to grasp the number and type of the vehicles
- To grasp the specific gravity of the wastes which carried by each type of collection vehicle and calculate weight of wastes disposed at disposal sites.

b. Survey method

- Data Analysis of Incoming Collection Vehicles

Following is the data obtained from each disposal site.

Table 3-36: Surveyed Data for Dumping Waste Amount

Disposal site	season	Year	Month
UCDS	Winter	2003	12
		2004	01
	Summer	2004	07
			08
MDDS	Summer	2004	07
			08
NDS	Winter	2003	12
	Summer	2004	07

(Source): Nuuts data on incoming collection vehicle to three disposal sites

- Measurement of Apparent Specific Gravity of Waste

12 different types of collection vehicle were selected and measure the weight and volume of wastes carried by vehicles in order to obtain apparent specific gravities. Weight is measure by weighbridge at construction material supplying company.

c. Findings of the Survey

c.1 Analysis of Collection Vehicles.

Average number of vehicles and waste volume carried by the vehicles at each disposal site in a month are shown in the following table.

Table 3-37: Number and Volume of Collection vehicles at each Disposal Site

Disposal site	Number of Vehicles		Waste Volume	
	Vehicles / month	%	m^3/month	%
UCDS	137.8	90.4	841.3	91.8
MDDS	8.5	5.6	51.5	5.6
NDS	6.0	4.0	23.5	2.6
Total	152.4	100.0	916.3	100.0

It was observed that number of vehicles at UCDS and MDDS in summer are more than those in winter. But it was vice versa at Nalaikh Disposal Site. Further clarification wias carried out in the next phase.

c.2 Calculation of Apparent Specific Gravity of Wastes

Average apparent specific gravity of wastes in compactor truck and open truck is 0.32 ton/m3 and 0.28 ton/m3 respectively and there is not much different between these. The reason might be either compaction is not functioning well in the compactor truck or open truck used in Ger area carries a lot of ash especially in winter season or both.

Table 3-38: Apparent Specific Gravity of Wastes in each Type of Vehicle

Type of Vehicle	Apparent Specific gravity (ton/m^3)
Compactor (on average)	0.32
Open truck (on average)	0.28
Average	0.31

c.3 Total Final Disposal Amount in Existing Disposal Site

Final disposal amount is calculated using specific gravity of wastes at 0.31 ton/m^3 and incoming wastes volume which recorded by Nuuts company and summarised in the following table. As a result, the daily final disposal amount in the study area is estimated in the range of 250 ton to 320 ton per day.

Table 3-39: Total Final Disposal Amount

year	month	Volume (m^3/month)	Weight	
			ton/month	ton/day
2003	12	24,509	7,598	253
2004	01	24,216	7,507	250
	07	29,022	8,997	300
	08	31,209	9,675	323

3.9.2 Final Disposal Amount Survey at UCDS

a. Construction and Installation of Weighbridge

Construction and installation of the weighbridge began in April 2005 and was completed in December 2005.

b. Operation of Weighbridge

Operation of Weighbridge (WB) started on 26 December 2005. There are three female staffs, who were formally working as dispatchers, are now working as WB operators. Each operator works 24 hours continuously and has the following two days off. In other words, they work one in three days. This is due to incoming trucks at midnight or early morning from Narantuun Market which is the biggest market in UB city.

3.9.3 Estimation of Final Disposal Amount in the Study Area

a. Disposal Amount by Season

The average daily disposal amount per month at UCDS is summarized as follows. This data was obtained using weigh bridge data from December 2005 to Jun 2006.

Table 3-40: Average Daily Disposal Amount (ADDA) Per Month at UCDS

Year/Month	Daily Disposal Amount (ton/day)
2005/12	343.1
2006/01	322.8
2006/02	308.5
2006/03	402.6
2006/04	465.4
2006/05	508.3
2006/06	498.7
Average	411.2

The above results indicate the following tendency. The ADDA from December to February is almost equivalent to 300 to 340 tons/day. This starts to increase in March up to 400 ton/day. From April to June, the ADDA shows similar figures as 460 to 500 ton/day.

Based on the above result, there is the tendency that in the summer season the ADDA is much more than in the winter season. This result is contrary to the WACS survey result that the generation amount of MSW in winter season is much more than in the summer season. Following are the estimated reasons why the ADDA in summer was higher than the ADDA in winter.

(1) There are many activities called “Clean up campaign” after the winter season is over. It means the waste which is illegally disposed during the winter season is collected and transported to the disposal site in the summer season.

(2) Construction activities become very active during the summer season. → Generation of construction waste increases since construction and renovation of buildings is carried out in the summer season due to limited working time in severe weather conditions in the winter season.

Based on the weighbridge data and the above analysis, the tendency of the waste amount at the disposal site is categorized into two seasons as follows.

- Winter season: 6 months from October to March.
- Summer season: 6 months from April to September.

The average daily disposal amount in the winter and summer season is calculated as follows and these amounts will be used for working out the waste flow.

Table 3-41: Daily and Average Disposal Amount by Weighbridge Data

Year/Month	Season	Average Disposal Amount Per Season (ton/day)
2005/12	Winter	345.7
2006/01		
2006/02		
2006/03		
2006/04	Summer	489.9
2006/05		
2006/06		
Average	411.2	

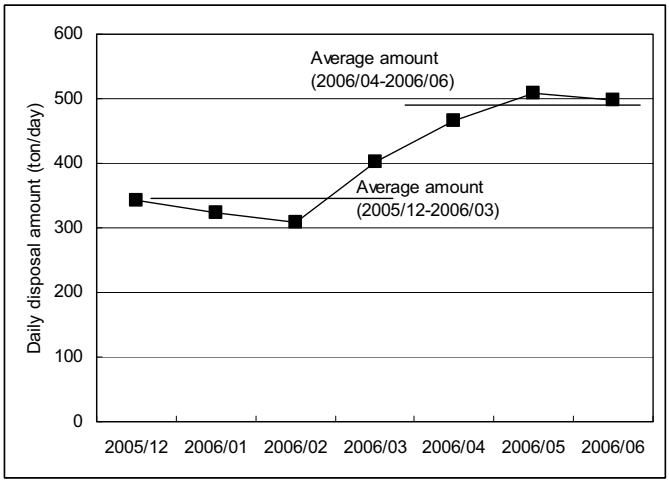


Figure 3-9: Daily and Average Disposal Amount by Weighbridge Data

b. Disposal Amount in the Study Area

b.1 Calculation of Disposal Amount at UCDS, MDDS and NDS

A comparison of the waste amount disposed at each disposal site is calculated based on the available data which is shown below. This data is accumulated before installation of the weighbridge and the number of trucks which come to disposal site and their official carrying volume is utilized for the calculation.

Table 3-42: Surveyed Data for Calculating Disposal Amount at Three Disposal Sites.

Disposal Site	Season	Year	Month
UCDS	Winter	2003	12
		2004	01
	Summer	2004	07
			08
MDDS	Summer	2004	07
			08
NDS	Winter	2003	12
	Summer	2004	07

Obtained from Nuuts Co.

UCDS :Ulaan Chuluut Disposal Site, MDDS:Morin Dava Disposal Site, NDS: Nalaikh Disposal Site

Using the above data, the average number of trucks and waste volume which was transported to each disposal site is shown below.

Table 3-43: Number of Trucks and Waste Volume Arriving at Each Disposal Site

Disposal site	Number of Trucks		Waste Volume		
	Trucks/ day	%	m^3/day	ton/day*1	%
UCDS	137.8	90.4	841.3	260.1	91.8
MDDS	8.5	5.6	51.5	16.0	5.6
NDS	6.0	4.0	23.5	7.3	2.6
Total	152.4	100.0	916.3	283.4	100.0

Note *1 : the apparent specific gravity of the wastes : 0.31 ton/m^3

b.2 Disposal Amount at Khoroo-21(KH-21) Disposal Site.

The disposal amount at KH-21DS is not available, thus the disposal amount at KH-21DS was estimated based on following calculations.

＜Input and basic conditions＞

- Population at Kh-21（year 2005）：4040 person
- Resident at Kh-21：all stay at Ger
- Unit generation amount in Ger in winter : 951 g/day/person (general waste 163 g/day/person, Ash 788 g/day/person)

＜Calculation result＞

- Waste Generation Amount at Kh-21 in winter（year 2005）

  3.8 ton/day (= 4040 x 951 /1,000,000)

- Waste Generation Amount the whole study area in winter（year 2005）

  554.8 ton/day

- Ratio of generation amount at Kh-21 to the whole study area

  0.7 % (= 3.8 / 554.8)

b.3 Proportion of Waste Disposal Amount at Four Official Disposal Sites in UBC

Based on the above calculation, the proportion of waste disposal amount at four official disposal sites was calculated as follows.

Table 3-44: Proportion of Waste Disposal Amount

Name of the landfills	Disposal Amount (ton/day)	Proportion of each Disposal Site(%)	Revised Portion of each Disposal Site (%)	Adopted Portion of each Disposal Site (%)
UCDS	260.1	91.8	91.1	91
MDDS	16.0	5.6	5.6	5
NDS	7.3	2.6	2.6	3
KH-21DS	NA	—	0.7*1	1
Total	283.4	100.0	100.0	100

(Note) *1: The portion is calculated based on the population of the Khoroo.

b.4 Final Disposal Amount in the Study Area

A weighbridge was installed at UCDS and commenced its operation from December 26, 2005. Since the weighbridge provides very precise final disposal amount at UCDS, the final disposal amount indicated in the Table above is revised as shown in the Table below based on the weighbridge data obtained from December 26, 2005 to June 19, 2006.

Table 3-45: Final Disposal Amount of Respective Disposal Site in 2006

Name of the Landfills	Disposal Amount (tons/day)	Disposal Amount (tons/day)
	Winter	Summer
UCDS	338.4	483.0
MDDS	18.5	26.1
NDS	11.3	16.1
KH21DS	3.8	5.5
Total	372.0	530.7

4. Current Solid Waste Management

4 Current SWM (Solid Waste Management)

4.1 Current Waste Flow

4.1.1 Survey conducted for the Elaboration of Current Waste Flow

The waste stream of Ulaanbaatar in 2006 is elaborated in this Section based on the following survey results:

- WACS in 2005
- Survey on medical waste management in 2005
- Survey on industrial waste management in 2005
- Study on construction waste in 2005 (estimation of generation amount is made for 2004)
- Survey on final disposal amount in 2005 and 2006

The detailed information is available in the Section 3.1 of the Annex report.

4.1.2 Method and Conditions for Elaboration of Current Waste Flow

Based on the results of the above-mentioned surveys current waste flow in the study area in 2006 is elaborated. The Table below presents method and conditions for elaboration of current waste flow. For better understanding of the method and conditions for elaboration, the Team prepare a sample waste flow as shown in the Figure below.

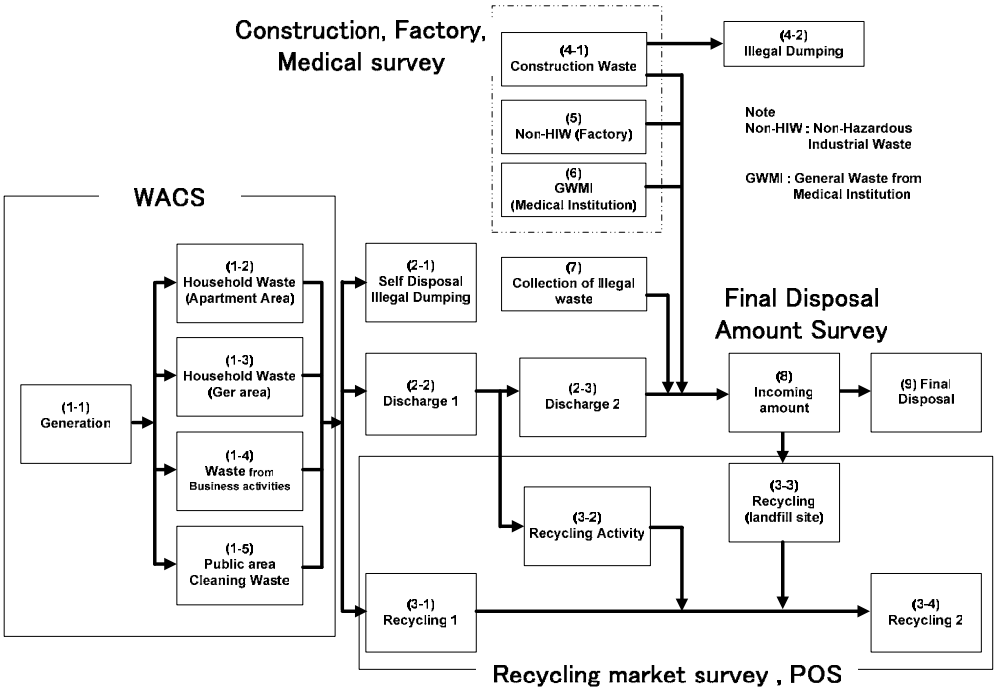


Figure 4-1: A Sample Waste Flow for Elaboration of Current Waste Flow

Table 4-1: Conditions of Setting

Item		Name of relevant survey	Methods of Calculation, Setting	Amount in 2006	
				Winter	Summer
(1-1)	MSW Generation	WACS (Winter season : 2004/12, Summer season : 2005/07)	(Waste generation rate), which was obtained in WACS, x (population, number of business entities, cleaning area)	Generation : 565.8 ton/day	Generation : 263.9 ton/day
(1-2)	Household Waste (Apartment Area)			Generation amount (ratio): 127.0 tons/day (264 g/person/day)	Generation amount (ratio): 113.0 tons/day (235 g/person/day)
(1-3)	Household Waste (Ger Area)			Generation amount (ratio): 391.8 tons/day (general waste 168 g/person/day, Ash 788 g/person/day	Generation amount (ratio): 85.2 tons/day (general waste 208 g/person/day)
(1-4)	Waste from Business Activities			Generation : 36.7 ton/day	Generation : 48.2 ton/day
(1-5)	Public Area Cleaning Waste			Generation : 10.3 ton/day	Generation : 17.5 ton/day
(2-1)	Self Disposal / Illegal Dumping	POS (2005/02) and Questionnaire survey on WACS (Winter season : 2004/12, Summer season : 2005/07)	It is assumed that All Self Disposal / Illegal Dumping be occurred in ger area. Therefore, the amount is calculated by the formula below. (2-1) = (1-1)-((2-2)+(3-1))	306.5 ton/day	20.2 ton/day
(2-2)	Discharge 1	---	(2-2) = (2-3)+(3-2)	257.2 ton/day	241.4 ton/day
(2-3)	Discharge 2	---	(2-3) = (8) - ((4-1)-(4-2)+(5)+(6)+(7))	252.3 ton/day	235.9 ton/day
(3-1)	Recycling 1	POS (2005/02) and Survey on Recycling market (2005/02, 2005/08)	Generation rate for each recycling activity was obtained based on the POS and Recycling Market survey.	Amount : 2.1 ton/day	Amount : 2.3 ton/day
(3-2)	Recycling activity			Amount : 4.9 ton/day	Amount : 5.5 ton/day
(3-3)	Recycling (landfill area)			Amount : 11.1 ton/day	Amount : 11.5 ton/day
(3-4)	Recycling 2	---	(3-4) = (3-1) + (3-2) + (3-3)	Total 18.1 ton/day	Total 19.3 ton/day
(4-1)	Construction Waste	Study on Construction Waste (2005/08)	Generation amount of construction waste is estimated as 30,110 tons/year, i.e. 82.5 ton/day in 2004 based on the construction waste survey. This amount will increase to 91.8 ton/day in 2006 in proportion to the GDP growth. Generation in summer is assumed to be two times more than in winter because of severe working conditions in winter. (This ratio was obtained form market waste survey results since generation pattern shall be almost similar)	60.6 ton/day (91.8 x 12 x 0.33 / 6)	123.0 ton/day (91.8 x 12 x 0.67 / 6)

(4-2)	Illegal dumping amount of Construction waste		Ratio for illegal dumping of construction waste was set to 36 % in year 2004 based on the construction waste survey results. This ratio will decrease to zero in year 2010.	14.5 ton/day	29.5 ton/day
(5)	Industrial waste (IW)	Survey on Industrial Waste Management (2005/02 & 2005/09)	Generation rate per employee x number of employee	Non-Hazardous Industrial waste (Non-HIW): 67.8 ton/day HIW: 0.1 ton/day (excluded from waste flow)	
(6)	Medical waste	Survey on Medical Waste Management (2005/01)	Generation rate per bed x number of beds	General waste: 15.2 ton/day Medical waste: 1.6 ton/day (excluded from waste flow)	
(7)	Collection of Illegal Waste	---	The waste, which was not collected during winter season, is collected in summer season. The amount is calculated by the following formula. (7) = (8) – ((2-3) + (4-1) – (4-2) + (5) + (6))	---	128.1 ton/day
(8)	Incoming amount	Survey on final disposal amount, i.e. weighbridge data of UCDS, the number of incoming vehicles, etc. of the other disposal sites	Based on the survey on final disposal amount	383.1 ton/day	542.2 ton/day
(9)	Final disposal amount	---	(9) = (8) – (3-3)	372.0 ton/day	530.7 ton/day

4.1.3 Current Waste Flow

Since waste generation pattern and waste stream in the study area differs significantly according to Season; i.e. winter or summer and Area; i.e. apartment (planned) are or ger (unplanned) area, the waste flow is elaborated in accordance with these conditions.

a. All Study Area

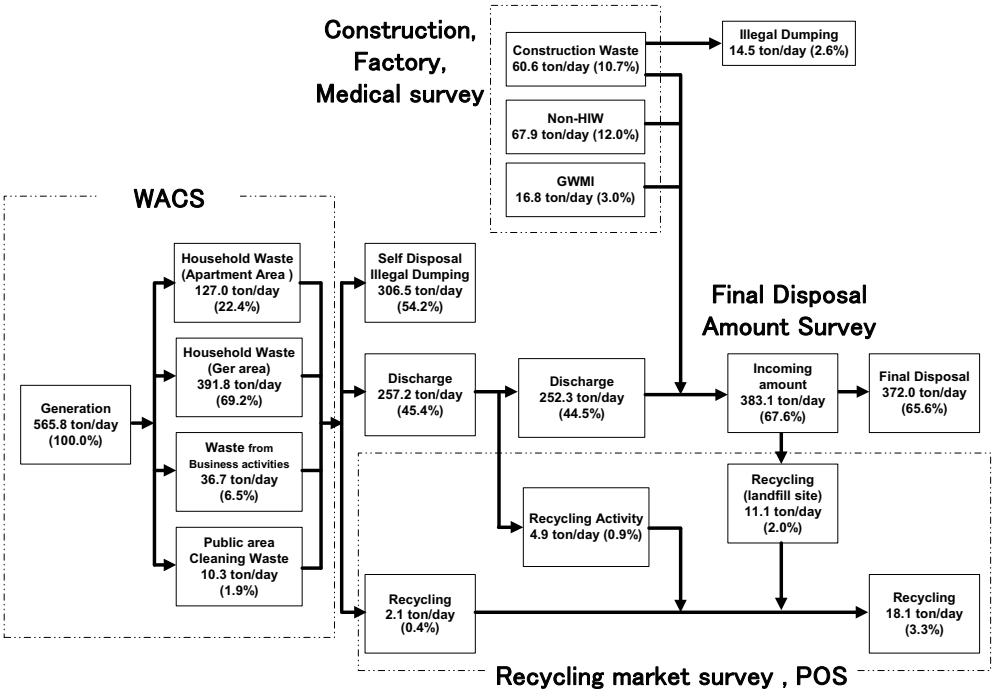


Figure 4-2: Waste Flow of All Study Area in Winter (2006)

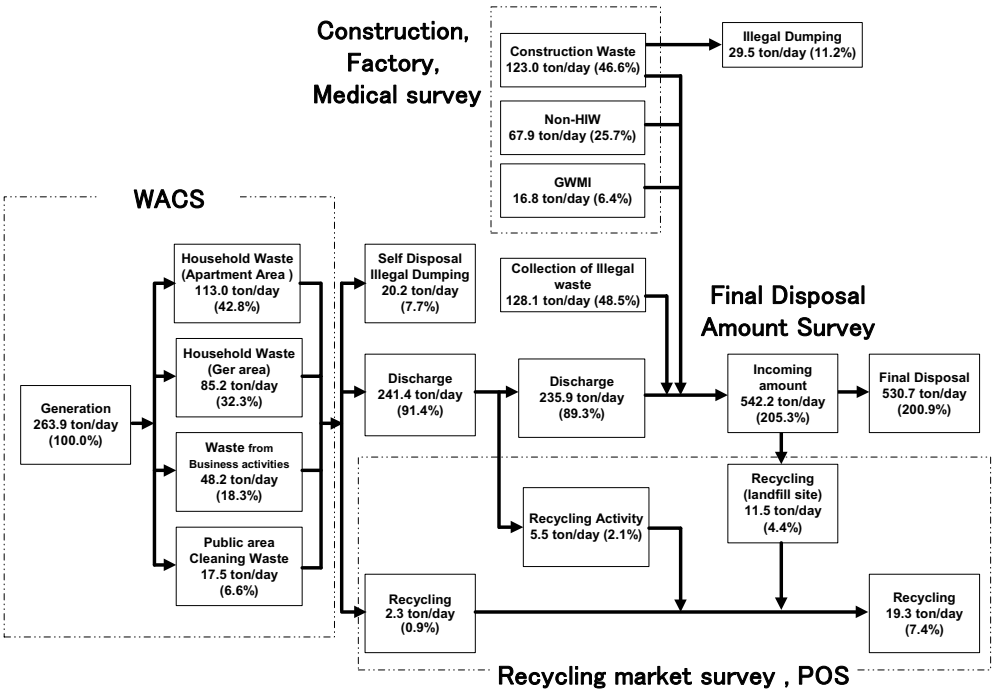


Figure 4-3: Waste Flow of All Study Area in Summer (2006)

b. Planned Area

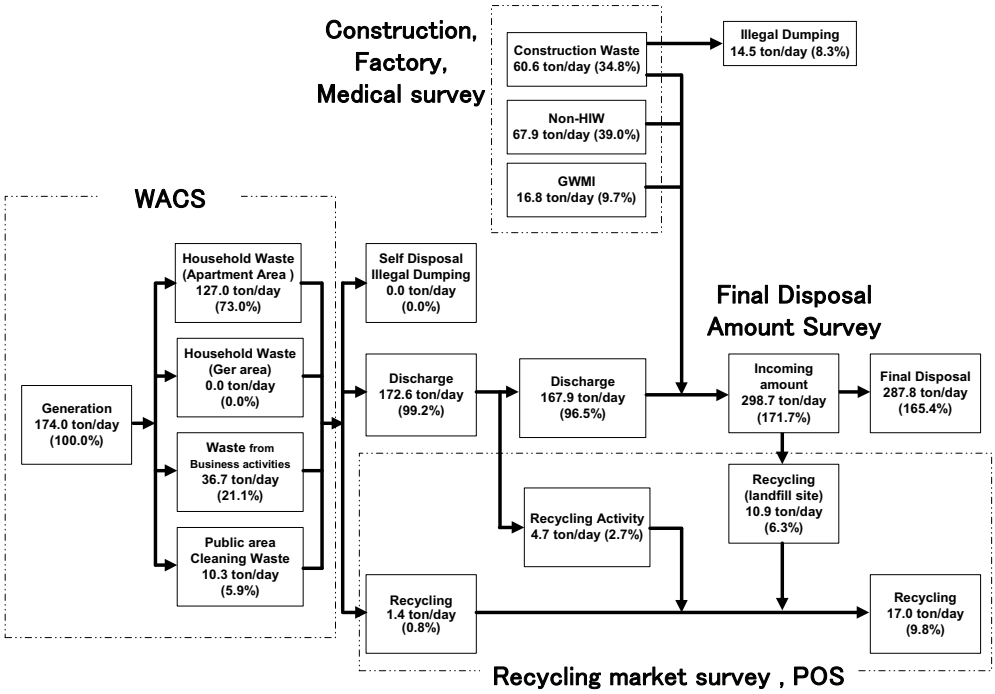


Figure 4-4: Waste Flow of Planned Area in Winter (2006)

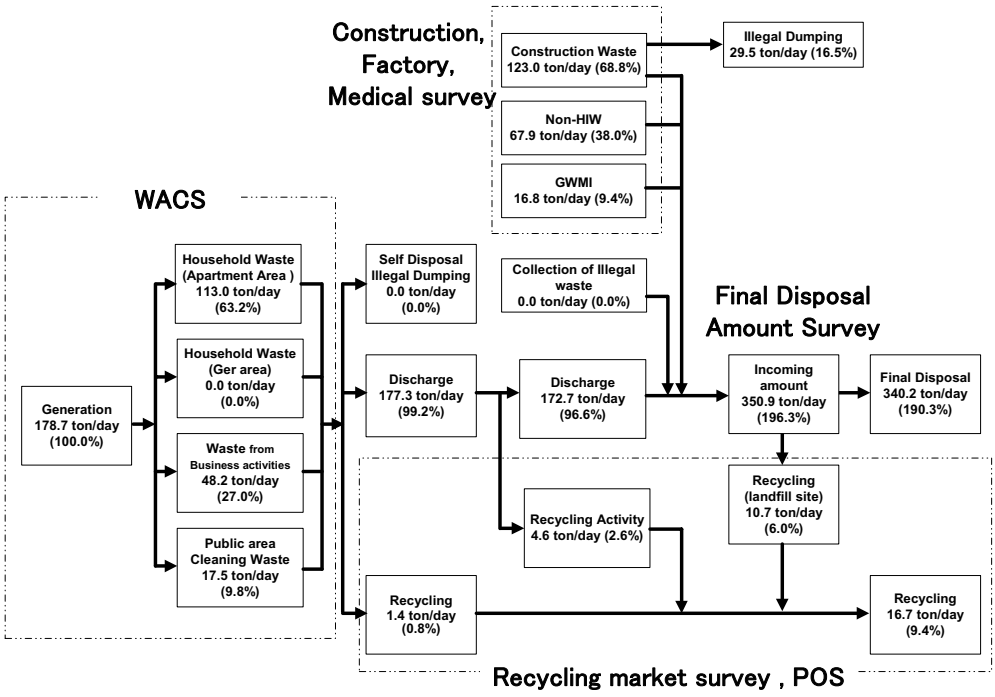


Figure 4-5: Waste Flow of Planned Area in Summer (2006)

c. Unplanned Area 2006 Winter

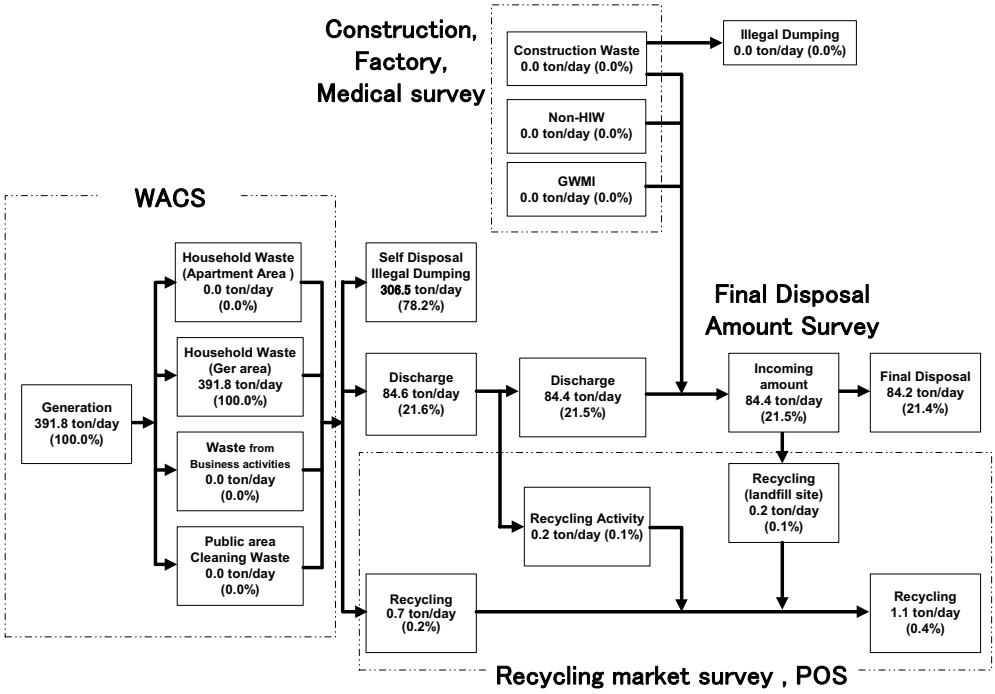


Figure 4-6: Waste Flow of Unplanned Area in Winter (2006)

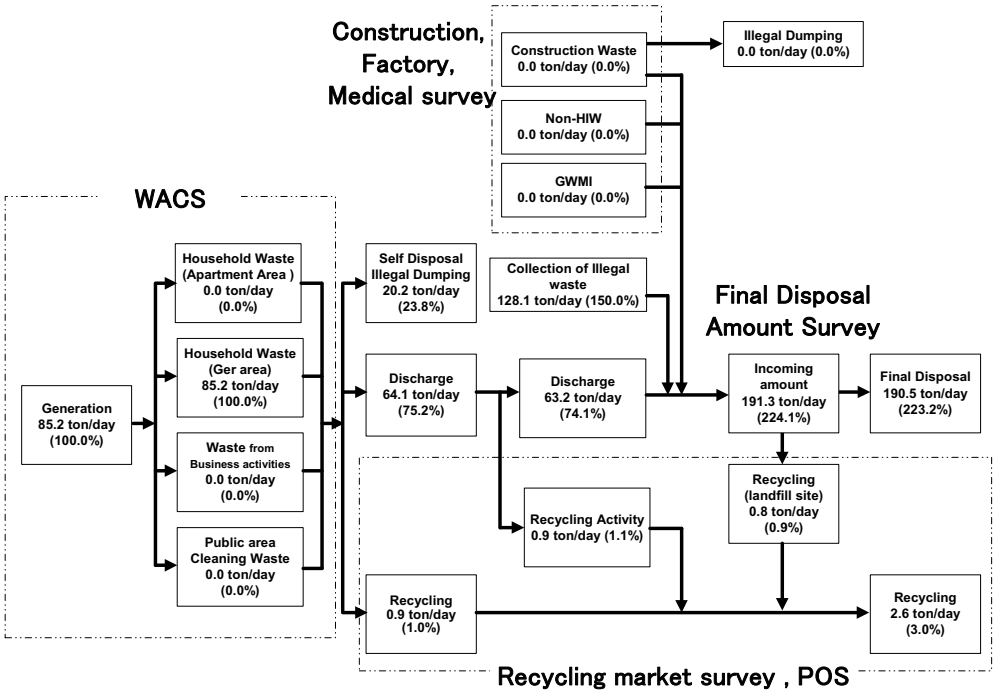


Figure 4-7: Waste Flow of Unplanned area in Summer (2006)

4.2 Technical System

The current technical system for SWM in the study area in May 2005 is summarized in the table below.

Table 4-2: Current Technical system in 2005

Items	Current Situation		
1. Waste generation in 2006 (ton/day)	Generation Source	Winter	Summer
	1. MSW		
	Household waste	518.8	198.2
	Commercial waste (Restaurant)	11.4	12.3
	Commercial waste (Other Shop)	3.9	5.4
	Office waste	14.9	20.6
	Market waste	4.0	8.1
	School waste	0.9	0.4
	Hotel waste	1.6	1.4
	Road cleaning waste	10.3	17.5
	Total	**565.8**	**263.9**
	2. Other Waste		
	Construction waste	60.6	123.0
	Non-HIW	67.9	67.9
	GWMI including treated medical waste	16.8	16.8
	Total	**145.3**	**207.7**
2. Storage and Discharge	Planned Area: • No specific container for storing mainly in plastic bags • Discharge to a collection vehicle when it comes, a dust chute, a communal container or place waste in heaps. Unplanned Area: • No specific container for storing mainly in metal drum containers • Discharge to a collection vehicle when it comes		
3. Collection and haulage			
3.1 Population in 2005			
Whole area		866,591	
Planned area		450,627	
Unplanned area		415,964	
3.2 Population with collection service (coverage rate in terms of population)			
Whole area		679,407 (78.4%)	
Planned area		450,627 (100%)	
Unplanned area		174,705 (42.0%[1])	
3.3 Collection system			
Planned area	• Bell collection • Dust chute collection • Door to door collection • Curb side collection • Communal container collection • Point collection without communal container		
Unplanned area	• Door to door collection		
3.4 Collection frequency			
Planned area	• Range from everyday to once a month		
Unplanned area	• Once a month in average		
3.5 Collection vehicle that MUB rents out TUKs[2] (including a few equipment purchased by TUKs)	• Compactor truck	33	
	• Dump truck	49	
	Total	**82**	
3.6 Equipment for other services that MUB rents out TUKs[3] (including a few equipment purchased by TUKs)	• Open truck	36	
	• Septic truck	5	
	• Excavator	4	
	• Crane	1	
	• Wheel loader	3	
	• Supervise vehicle	14	
	Total	**63**	

[1] Service fee collection rate identified by the Questionnaire survey to the Khoroo governors in ger area in August 2006

[2] Running vehicle excluding grounded ones

[3] Running equipment excluding grounded one

Items	Current Situation
3.7 Number of staff of each TUK	• BGD TUK 143 • BZD 151 • SKhD 142 • SBD 135 • KhUD 137 • ChD 145 • NaD 42 **Total** **895**
3.8 Unit cost for collection service by TUK (MNT/ton)[4]	• BGD TUK 15,479 • BZD 15,899 • SKhD 7,845 • SBD 20,472 • KhUD 8,856 • ChD 18,270 • NaD 10,221 **Average** **13,514**
4. Road and public area cleansing	
4.1 Road cleaning by MUB	• about 50 km
4.2 Road and public area cleansing by Duureg	• 317 ha
5. Intermediate treatment	• There is no intermediate treatment facility other than small incinerators for medical waste combustion. • Five incinerators were identified by the Survey on Medical Waste Management. Although they are old (more than 17years old) except one (5 five years old), all are still working.
6. Recycling	• There is no recycling facility owned by the public sector. • Wastes collected for reuse are very limited and only some kind of bottles (vodka, beer, water, etc.) • Reused and recycled material amounts to about more than 20 tons/day. • Final users of material recycling in the country are limited and most of users are in China.
7. Final disposal	
7.1 Disposal site	Three main disposal sites are operated in May 2005. • Ulaan Chuluut disposal site (UCDS) in SKhD serving for the central 6 Duuregs • Morin Daava disposal site (MDDS) in KhUD for some of Khoroos in KhUD • Nalaikh disposal site (NDS) in NaD for NaD Remote Khoroo governments dump their wastes at their own disposal sites in stead of the above three. There are many illegal dumpsites.
7.2 Disposal method	All are open dumping operation.
7.3 Land use in the surrounding area	Pasture or vacant lands
7.4 Haulage distance from center of the city (Sukhbaatar Square)	• UCDS: 13 km • MDDS: 23 km • NADS: 38 km
7.5 Organization in charge (number of staff)	• UCDS: Nuuts Co., (9 persons) • MDDS: Nuuts Co., (1 person) • NADS: Nalaikh Duureg government (no person)
7.6 Landfill equipment	• UCDS: Two bulldozers, one folk lift, one water tanker • MDDS: One bulldozer (grounded long time) • NADS: None but rent a bulldozer
7.7 Unit cost for landfill operation (MNT/ton)[5]	• UCDS: 703 • MDDS: NA • NADS: NA
8. Maintenance of equipment	• Each TUK has one garage for store and repair equipment for cleansing works. • Nuuts does not have a garage

[4] Based on data provided by TUKs the study team estimated.

[5] Based on data provided by Nuuts the study team estimated. Annual disposal amount (373,127m^3) / annual cost (81,475,000MNT) / unit weight (0.31ton/m^3)

4.3 Institutional System

The current institutional system for SWM in the study area is summarized in the table below.

Table 4-3: Current Institutional System

Items	Current situation
1. Central government organizations concerned in SWM	
1.1 MOE (Ministry of Environment)	• Responsible for assessing the environmental impacts of SW, and if appropriate closing a disposal site for example; maintaining statistical records on hazardous waste
1.2 MCUD (Ministry of Construction and Urban Development)	• Responsible for advising Government on the policy framework for urban development, housing and public services, including SWM and for ensuring implementation of State policy and national programs on waste management. • The Ministry's Construction and Public Utilities Support Centre has been newly charged by the new Government with national responsibility for implementing SWM policy, including setting national standards and improving management in the sector.
1.3 MOH (Ministry of Health)	• Responsible for establishing the new legal context for improvements in public health and health care waste.
2. City government organizations concerned in SWM	
2.1 Governor's Office a. City Development Policy Planning Division	• Principally responsible for SWM policy within the City
b. Environmental Protection Department	• Nurturing the natural environment and expect to be charged with rehabilitation of closed disposal sites
c. City Specialized Inspection Agency	• Prime responsibility for legislative enforcement
d. Property Relation's Department	• Holding SWM assets used by TUKs
2.2 Mayor's Office a. City Maintenance and Public Utilities Division	• Principally responsible for SWM operations.
b. Nuuts Company	• Final disposal site operation
c. OSNAAG (Housing & Communal Service Authority)	• Apartment SWM charges
d. "Water Facility" Company	• SW cleaning of storm water drainage
e. USAG (Water Supply and Canalization Authority)	• Sewage treatment and disposal
2.3 Duureg Government District Maintenance and Public Utilities Department	• The Duureg government is required to maintain its public area in clean condition, to implement waste legislation, to work with an entity in charge of collecting and transporting waste and to provide funds for these operations. • The Law also requires the maintenance of a District Waste Information Database with information to be supplied by the Khoroos, but this has not yet been implemented.
2.4 Khoroo government	• The law requires Governor of Khoroo government to monitor illegal dumping and organize appropriate cleaning measures such as campaigns and collections of money from Ger area households to contract trucks to remove waste.
3. Financial situation	
3.1 MUB in 2004 (Unit: million MNT)	• Revenue (actual) 13,100 (10.99 million US$)[6] • Expenditure (actual) 13,100 (10.99 million US$)

[6] Exchange rate on March 31, 2004: 1US$ = 1,192 MNT

Items	Current situation
3.2 Budget for cleansing services in 2004 (Unit: million MNT)	MUB 28 (23,489 US$) Total of 7 Duuregs 674 (565,436 US$) • BGD 81 • BZD 135 • SKhD 80 • SBD 120 • KhUD 105 • ChD 108 • NaD 45
3.3 Income and Expenditure of TUKs in 2004 (Unit: million MNT)[7]	Income (Expenses) Total of 7 Duuregs 2,375 (2,449) • BGD 418 (392) • BZD 492 (464) • SKhD 290 (328) • SBD 540 (562) • KhUD 257 (286) • ChD 312 (339) • NaD 66 (78)
3.4 Fee collection system (Nalaikh Duureg) a. Apartment area b. Business c. Ger area	 • OSNAAG (Direct collection by NaD TUK) • Direct collection by TUKs • Direct collection by TUKs
3.5 Average fee collection rate a. Apartment area b. Business c. Ger area	 • 80 - 85 % (due to false declaration of family numbers) • NA • 17 %
3.6 Collection service fee for central 6 Duuregs (Nalaikh Duureg) a. Apartment area b. Business c. Ger area	 • 200 MNT/person/month (150 MNT/person/month) • 1,000 to 27,000 MNT/organization/month • 500 – 2,500 MNT/household/month (700 MNT/h/m)
4. Legal Basis a. Mongolian Law on Environment Protection, March 30, 1995	 • Fundamental law for environmental protection
b. Mongolian Law on Protection from Toxic Chemicals, April 14, 1995	• Main objective of the law is to regulate the production, export, import, storage, trade, transport, use and disposal of toxic chemicals.
c. Environmental Impact Assessment Law (EIA) of 1998, and its Amendments of November 22nd 2001	• Key law concerning environmental assessment in Mongolia, and is implemented by the MOE in collaboration with the Municipality.
d. Measures for Strengthening Waste Management - Mongolian Government Resolution No. 256, 3 November 2001	• It is essentially a SWM Action Plan. It provides a set of 6 Purposes, each with a number of Processes, and identifies responsible institutions, financial sources, timings and expected results.
e. Requirements for the Removal and Disposal of Hazardous Waste - Mongolian Government Resolution N0. 135, 3 July 2002	• It is issued to regulate requirements for hazardous waste management.
f. Joint Order by the Minister of Health and the Minister of Environment and Nature on the Improvement of Waste Management of Health Organizations. 17 Sep, 2002. Ref. No 249/201	• It is issued in order to implement Government Resolutions No. 256 and No. 135, by approving instructions for dealing with health care waste, obliging relevant Governors and Officers to provide appropriate budget allocations and providing for suitable training.
g. Joint Order by the Minister Of Health and the Minister of Environment and Nature On Chemical Waste Management, 2002/3	• It provides a classification of chemical waste, primarily as toxic or hazardous. It adds detail to the Mongolian Law on Protection from Toxic Chemicals, April 14, 1995
h. 2003 Law on Domestic and Industrial Waste, effective from July 2004	• It is currently being converted into practical regulations by the MOE and MUB's City Maintenance and Public Utilities Division, and these are expected shortly to be considered by the City assembly. Following approval there they will then require the sanction of the Government Cabinet before they can be implemented.

[7] TUKs and the Estimate by JICA Study Team

4.4 Assessment of Present SWM

The current SWM system in the study area has been assessed, and the results are shown in the table below.

Table 4-4: Assessment of Current SWM Conditions in the Study Area

Items		Planned (Apartment) Area	Unplanned (Ger) Area
Technical System	1. Waste generation and composition in 2006	**Waste generation** • The generation rate of household waste and other MSW in winter is 590 g/person/day and 640 respectively and it is more or less the same as other economically comparable countries. • The rate in summer (if ash is excluded), however, is only 216 g/person/day and 286 respectively, which are small by international standards.	
		• The generation rate of household waste (256 g/person/day in winter and 228 in summer respectively) is lower than other economically comparable countries.	• The generation rate of household waste (951g/person/day) in winter is almost four times more than planned area due to high percentage of ash (788 g/person/day). • However the generation rates of wastes other than ash are only 163 g/person/day in winter and 202 in summer, much less than the generation rate of household waste in the planned area, 256 g/person/day in winter and 228 in summer respectively.
		Waste composition • The proportion of ash both in household waste and MSW is overwhelming in winter; 64.1% and 60.2 % respectively.	
		• The proportion of kitchen waste is low (32.7% in winter and 35.7% in summer). The proportion of recyclable matters such as metals, papers, plastics, metals and bottles is very high 51.5% in winter and 47.5% in summer all together. Of that, the proportion of plastic is 22.4% and 14.5%, which is strikingly high. Plastic bottles have become popular and the use of plastic bags has drastically increased; their consumption rate is equal to that of developed countries.	• As ash comprises 82.9 % by weight in winter, the other components' shares are small. The proportion of kitchen waste and recyclable matters is only 4.9% and 8.2 % respectively in winter while they are 30.4% and 49.5% in summer. Consequently, collection of recyclables in this area is not promising.
	2. Waste disposal at source in 2006	• According to the waste flow elaborated by the Study based on the WACS in winter season, 54.2% of waste generated is self disposed or illegally dumped by the generators while rate of self-disposal + illegal dumping is only 7.7% in summer. Only less than 1.0 % of waste generated is recycled at generation sources. This figure is relatively low.	
		• Since the collection service covers the whole population of the area, waste generated is neither self-disposed nor • The other reason is that the area is highly urbanized and it is hard to find vacant land or gardens, thus self-disposal or illegal dumping is not practically possible. • Only 0.8 % of waste generated is recycled at generation sources. This figure is relatively lower than other economically comparable countries.	• As much as 23.3 % of waste generated is self-disposed of by the generators. Illegal dumping is estimated to be an additional 22.3%. • The primary reason for the high self-disposal and illegal dumping rates is the low coverage of waste collection services. Secondly, the area is not urbanized and there is vacant land and houses with empty space, making self-disposal and illegal dumping possible.
	3. Storage and Discharge in May 2005	There are no waste storage and discharge rules established. It is quite difficult to establish rules because the waste collection service is irregular and waste collection days and times are not fixed.	
		• Although plastic bags are widely used to store waste before discharge, the method of waste discharge varies from place to place as follows:	• There are many waste piles or dumps in the streets and vacant areas where waste collection service is not provided or is insufficient; thus making a mess in the areas and degrading public health.
		• Although the dust chute system is convenient for both waste dischargers and collectors (they can collect at any time), it should be prohibited because of the many associated problems and their serious negative impacts on public health such as odor and burning of wastes in the chute and chamber. • The waste storage room system (in a building) and waste storage house system (outside the building) should be improved by the application of proper waste discharge rules such as compulsory use of plastic bags for waste.	• People discharge waste in a drum or poly coal sacks. In winter it is very hard to load waste in a drum onto a truck because most of waste content is ash. Dischargers are responsible for carrying their waste to a truck and loading it onto a truck. Public cooperation is high.

Items	Planned (Apartment) Area	Unplanned (Ger) Area
	• The waste storage and discharge to a part of land of a building without any facility should be prohibited due to very unsanitary and ugly condition. • In view of sanitation and efficiency problems of the collection service waste discharge following a bell collection system is the most appropriate system among the current discharge systems. • Due to lack of clear ownership storage and discharge to a communal container is not an appropriate system for communal use. It is, however, effective for the larger waste generator if clear ownership of the container is achieved.	
4. Collection and Haulage in May 2005	• The waste collection service is irregular and waste collection days and times are not fixed. Current old and dilapidated collection fleets can not provide punctual and regular service. Waste dischargers such as residents and business entities don't know the waste collection days and times. • The rental contract between TUKs and their collection crews, drivers and waste collectors, hinders the improvement of collection work efficiency. Because in this contract the payment from TUK to a crew is fixed and the working hours are not related to income of the crew at all. The way to increase the income of the crew under this system is only to minimize the petrol consumption amount and number of workers involved. Consequently neither TUKs nor their collection crews are interested in the improvement of the waste collection work efficiency. • Each TUK verifies all their trucks' entrance records to the Ulaan Chuluut disposal site (UCDS) with entrance certificates issued by Nuuts Co. in order to ensure all trucks carry waste to the disposal site. However, this control system is not functioning well as there is a big difference between officially collected and disposed waste volumes. The former is double of the latter according to the record of 2004. • There has been a significant deterioration in SW collection in the Ger areas since 1995 according to the interview survey results of some 2,000 households in 7 Ger areas in UB in 1995 and 2003 conducted by USIP-1. • It appears that privatization of TUKs has brought a distinct shift in resources away from the difficult and more-expensive-to-serve Ger areas in favor of the easy-to-serve apartments and businesses according to the Study Team's POS results. • The key "collection and transport" component is in the initial stages of privatization but is operating in an information vacuum. Performance under the existing arrangements can only be properly assessed and improved by introducing well defined performance measures, vigilant monitoring, enforceable sanctions for non-performance and cost accountability. Beyond this increased transparency and competition are required to maximize SWM efficiency.	
	• The waste collection service covers 100 % of population. The primary target of SWM in cities, i.e. the removal of waste from the living environment, has thus been achieved. • Though 100 % collection service is provided, much waste scattering is observed, especially in areas where waste storage and discharge is to a part of the land of a building and where communal containers are used.	• The waste collection coverage rate in terms of population is estimated at about 42.0 % according to the questionnaire survey to the Khoroo governors in Ger area in August 2006. The primary target of SWM in cities has not been achieved. • This low coverage rate is mainly due to the present fee collection system whereby waste is collected in return for fee payment, higher fee rate than planned area (though the poorer are living), and lack of cross-subsidy. There are some areas where a collection vehicle is physically hard to access.
	• The loading of waste discharged requires manpower, which reduces the collection efficiency except for areas where the bell collection system is applied. • The communal container system does not function well due mainly to lack of ownership; and it causes scattering waste around the container and even fires.	• Though higher fee rate than planned area, waste collection frequency is once a month in most areas. This is because TUKs collect money once a month and they collect waste in return for waste collection fee payment. • The fee collection system greatly influences waste collection work and restrains the options of waste collection systems.
5. Road and park cleaning in May 2005	• Road and park cleaning works of the Duureg budget are contracted out to each TUK. • Duureg governments allocate a considerable amount of budget to road and park cleaning works, 674 million MNT in total in 2004 for the seven Duureg governments of the study area.	

Items	Planned (Apartment) Area	Unplanned (Ger) Area
	• The area is generally maintained in a clean condition due to the high collection service rate and the satisfactory public area cleaning operation. Cleaning services are provided to major roads and parks in the area, which contribute to city beauty. • Machinery is used for cleansing services in limited areas. Manual cleaning is the main practice, thus creating jobs.	• Street sweeping services are provided only to the paved trunk roads. • Manual cleaning is the main practice, thus creating jobs. • There are waste heaps along roads at many places but little scattered waste. In other word, there is little littering but much illegally dumped waste within the residential areas. Because such waste heaps contain a large proportion of ash, the suspected violators are residents of the neighborhoods most probably.
6. Recycling and Intermediate treatment in May 2005	• The recycling rate of the city in winter is estimated at only 3.3 % (18.1 tons/day) of total waste generation, which is lower than other economically comparable countries. This is because of the overwhelming portion of ash, 60.2 % of total. In summer (not including ash) it is estimated at 7.4% (19.3 tons/day) and is more than half of that in Japan (13.1 % in 1999). Recycling systems in the two countries are, however, largely different. In Japan, recycling is done by community groups (5.1%), recycling facilities and machinery, while in Ulaanbaatar recycling is an informal activity using cheap labor. • The recycling system of individual recyclers is not well developed. Because final users of recycled materials in the country are limited, and many users are in China. • Informal recycling by street waste pickers at the source and waste discharge points is active. Their recycling is estimated at between 27% (winter) and 28.4% (summer) of total recycling in the Study area, 4.9 to 5.5 tons/day. • At the Ulaan Chuluut disposal site, the main dump site in the Study area, there are more than 300 waste pickers engaged in resource recovery. • A resource recovery system by an informal sector at the source and waste discharge points is working. Resource recovery at waste discharge points, however, causes problems such as the scattering of waste. With regard to waste reduction, recycling and city cleaning, source separation is preferable. • There is no recycling facility owned by the public sector. • There is no intermediate treatment facility other than small incinerators for medical waste combustion. Major hospitals have small incinerators for treating infectious waste. However most of them are not working because they are too old.	
7. Illegal dumping and final disposal in May 2005	• Illegal dumping is commonly seen in the study area. In river beds and vacant lands, as near the cemeteries, waste is often dumped; and in some places waste is dumped by dump trucks almost everyday. • Construction waste is the main item for illegal dumping and is usually handled by the contractors rather than the TUK. They persistently dump mainly construction waste on their way to collect construction sand and gravel. The system whereby commercially contracted waste should pay a disposal fee at the official landfills discourages them from actually delivering the waste.	
	• There are three official final disposal sites in the study area. All of the sites are operated in so-called open dumping, posing serious negative impacts on the surrounding environments. Air pollution by smoke caused by fire and scattering wastes by wind, especially in the spring season, is particularly serious not only for the immediate area but also for a wide area of the city. • Among the three, Ulaan Chuluut disposal site (UCDS) is the biggest one receiving about 91 % of the wastes generated in the study area. The adverse impacts are very serious and sometimes fire at the site spreads to neighboring houses. MOE cautioned MUB to close it unless MUB improves it. The improvement of the site is therefore an urgent matter. • Although there are staffs of Nuuts Co., the operator of the sites, to record incoming vehicles in UCDS and Morin Daava DS (MDDS), the incoming vehicles to three sites are not strictly controlled. It is not known what kind of waste is disposed of in which part of the landfill. It is doubtful that infectious and hazardous waste is disposed of without being distinguished from municipal waste. • The remaining service life of the UCDS is only a few years and a residential area is approaching less than 800 m away from the site due to rapid expansion of Ger area. Therefore, a new disposal site needs be constructed as soon as possible and the existing site must be closed. • More than 300 waste pickers are working without any rules. Their resource recovery activities interfere with landfill operations and put their lives at risk. It is urgently required to segregate the working area of waste pickers and the working area of heavy machinery and waste collection vehicles so as to realize efficient landfill operation and safe material recovery. • There are two bulldozers in UCDS, but they frequently breakdown due to lack of spare parts and poor condition of machinery. The landfill operation is not operated properly because of financial problems. • Since the study area is large, there are many disposal sites operated by remote Khoroo governments in addition to the three. Khoroo governments neither operate nor maintain them.	
8.Operation and Maintenance (O&M) of Machinery in May 2005	• Most of the equipment used by TUKs is second hand and 15 years or more old. 90% of equipment is Russian and the remainder is Japanese and Chinese. The usefulness of this equipment is decreasing year by year and within 3-5 years it will be necessary to renew the equipment • Present maintenance management in TUKs does not have proper maintenance system in terms of mechanical personnel, workshop, facilities, tools and store. • All SWM facilities and equipment owned by MUB is leased to TUKs and Nuuts Co. MUB	

Items		Planned (Apartment) Area	Unplanned (Ger) Area
		• The driver manages collection works and conducts equipment maintenance by contract with the TUK except for Chingeltei and Nalaikh. According to the contract, the expenditure for the work, purchase of fuel and parts, is deducted from the salary every month. This contract hinders preventive (periodical) maintenance because drivers use equipment as long as possible instead of paying for parts. • In the garages of TUKs there are neither facilities nor tools required for a workshop. A maintenance manual written in Mongolian language is not seen at all. • Most of TUKs have no technical person in charge, only the person in charge of the equipment section who manages drivers. There is a repair assistant worker, who is called repair man or welder, and the driver is doing the actual repair work only by experience. There is no training program for mechanicians and drivers. • Though equipment ledgers and maintenance records are prepared in most TUKS, these are not united and management is vague. The united and clear ledger and record are very important for proper maintenance and management of equipment,	
Institutional System	9. Legal system in May 2005	• The Mongolian Law on Domestic and Industrial Waste, coming into force in July, 2004, is the fundamental law on SWM. It is supported by Government Resolution No. 135 Requirements for the Removal and Disposal of Hazardous Waste, 2002; and Joint Orders of the Ministers of Health and Environment on the Improvement of Waste Management of Health Organizations, 2002 and On Chemical Waste Management, 2002. However since the Law on Domestic and Industrial Waste only sets an overall framework, it should be strengthened and detailed on the following issues: ➢ Detailed regulations, standards and guidelines should be established based on the Law. ➢ The Law states that waste is divided into domestic waste, industrial waste and hazardous waste (HW), but a more detailed classification is necessary for proper SWM, especially for identification of the body (producer) responsible for the disposal of the SW. ➢ The details of the waste fund such as collecting and managing organizations, tariff, method of collection, etc. • By-laws on SWM and guidelines on waste discharge and others aspects to request public cooperation are necessary for municipalities to properly carry out SWM. There are, however, no such by-laws or guidelines. • Whilst there are many levels of SW inspection they are ineffective in curbing illegal dumping. The responsibility for enforcing the environmental laws and regulations are not supported by effective sanctions against offenders at any level in the Government hierarchy. Even the State authorized Inspectorate is regarded as being ineffective: there are a few fines imposed each year, on enterprises but not individual citizens, for SW infringements; but these are generally too low to be an effective commercial deterrent.	
	10. Administration and Organization in May 2005	• SWM in Ulaanbaatar is much better organized than in the cities of most developing countries. There is now a sophisticated legislative basis and clear separation between policy, regulation, executive and management functions. However there are some fundamental problems which, if not addressed, may lead to further deterioration in operational performance despite attempts at improvement. If the current arrangements persist it is inevitable that the Districts and TUKs will continue to develop in different ways and with different levels of effectiveness. • The most important problem is the fragmentation of the executive responsibility for waste collection and transport. SWM in Ulaanbaatar has, with the TUK management contracts, made a nominal move in the direction of privatization; but the current situation is unsatisfactory in all three crucial areas of competition, transparency and accountability. • The fact that there are no less than three government signatories to the TUK management contracts exemplifies the diffusion of responsibility. It means that no one is effectively held responsible, and indeed there is no effective i.e. performance related, responsibility to higher levels of the City's administration. Consequently there is little effective pressure or incentive to improve the situation. • The tender process for management privatization was loosely handled by international standards, and there is a need to introduce proper tendering arrangements for any further privatization. • The TUKs have a monopoly in their Districts, and the lack of competition will inevitably give rise to inefficient services and unnecessarily high prices. OSNAAG's records are well organized and detailed, and there would be few administrative difficulties in organizing competitive tendering and managing a single or several contracts for servicing the planned areas in a District. • In view of the relative attractiveness of servicing the apartment, as opposed to ger, areas, it is preferable to recognize the differences in separate contracts for each area, and with higher rates being paid for ger area operations. • The waste collection and cleaning service being provided by TUKs and other private collection enterprises as a whole are hardly monitored. A monitoring and control system for SWM should be established to detect illegal dumping by TUKs and private waste collectors; as well as effectively coordinating and managing city-wide operations. • It would be most efficient to concentrate the development of modern SWM institutional capacity in a single entity, most obviously MUB's Maintenance and Public Utilities Division. Standardization, efficiencies and economies of scale in competitive tendering and management could then be achieved; and the higher levels of City Government would have measured assurance that SWM was improving.	
	11. Human Resource Development in May 2005	• Management is now striving towards comprehensive market economy improvements, however officers are doing this principally on the basis of their long training and experience in a command economy. They are effectively being required to independently invent systems which have been refined and documented at best-practice levels in developed countries for many years.	

Items	Planned (Apartment) Area	Unplanned (Ger) Area
	• Senior staff in the sector are invariably both educated to a high level and experienced in SWM. Since 1990 a number of senior policy and monitoring staff have benefited from some SWM training and seminars abroad as well as in Mongolia, and they have also been exposed to foreign practice and the latest technologies. However such exposure is much less common at the operational level. There is virtually no comparison of practice between TUKs, so that innovations are very slow to spread for the City's wider benefit. At the operational level any training for new recruits is done unsystematically on-the-job. • Whilst many believe that SWM is understaffed, the constraints on Government structures make it difficult to increase this. On the contrary the staff of MUB's Maintenance and Public Utilities Division has recently been reduced from 11 to 8. The Division was in fact seeking approval from the City's Representatives Khural for an additional two or three staff, which would have eventually required Government Cabinet approval.	
12. Public-Private Partnership in May 2005	The current contracts with TUKs have the following problems: ➢ Service performance and costs of the private contractor's work is not fully detailed or monitored by the responsible organization of MUB and Duureg governments. ➢ The contractor is not accountable to the client and customers for the standards and manner in which his service is provided. ➢ In addition to the aforementioned problems with the contract, the monitoring and control systems of MUB and Duureg governments for SWM are weak, as described in the following. • The baseline data necessary for SWM, such as data on the rate of population without waste collection services and data on the waste disposal quantity from each generation source, district, or collection company is not sufficient. Moreover the data collection system is not well-developed. • Due to insufficient baseline data, the unit cost of each sub-component of SWM (i.e. waste collection, road cleaning) is not known. ➢ As shown above, the compilation of basic data on SWM and the development of a database are urgently needed.	
13. Financial system in May 2005	Financial analysis of TUKs indicates as follows: • None of the TUKs has a detailed cost accounting system. • Revenues from Ger areas account for only a minor share in most TUKs • Waste collection revenues from apartment areas are larger than those from ger areas, except for Chingeltei and Nalaikh TUKs. • Among seven TUKs, only Bayangol and Bayanzurkh TUKs recorded a positive net income in 2004. • All TUKs are losing money in waste collection ger areas; among others, the scales of loss in ger area of Songinokhairkhan and Chingeltei TUKs are quite large, significantly eroding these TUKs' viability. • Given the drawbacks of the current fee collection system, the larger the ger area is, the less viable becomes the waste collection. Therefore, from the commercial point of view, TUKs would be better off if they reduced the size of ger area to which they provide services. • Waste collection from apartments and organizations is mostly profitable, although there are some TUKs, including Sukhbaatar TUK, that are still making losses in apartment areas. • The unit costs for waste collection services significantly vary between districts regardless of the distance from the final disposal sites. It seems that the lack of competition in selecting each TUK's management team would constitute a major reason of the low efficiency in TUKs' operation. Problems related to the current fee collection system: ➢ Low fee revenue and fee collection rate caused by the following: • Since there is practically no effective measure against non-payers of waste fee in Ger area, the fee collection rate is very low, constituting a main reason of TUKs' low fee revenue. • Apartment residents often falsely declare the number of their family members since most of apartment utility fees as well as waste fee are set per person, not per household. • TUKs do not effectively control fee collectors working for Ger areas and small businesses, thus there may be many cases of fraud by fee collectors. ➢ Large difference in the level of fees and lack of cross-subsidy between districts • In each district, waste collection services are operated financially independently, and there is a large difference in the level of fees in Ger areas of different districts. The difference in efficiency is largely attributable to the different sizes of Ger areas. However, there is no cross-subsidy system between districts to reduce the burden of less privileged districts. ➢ Existence of Ger areas only partially covered by waste collection service or without service • The major reasons why there are ger areas that are only partially covered or are not at all covered by waste collection service are: (1) some ger areas are difficult to reach; and (2) there are people who either cannot afford or do not want to pay the fees. Since TUKs' fee collectors do not collect wastes from those people who cannot or do not pay, the latter usually dump their waste illegally. ➢ Increase of illegally dumped waste • There is no monitoring system for the business entities that transport their wastes by themselves; some of them dump waste illegally in order to avoid related costs. ➢ High fees in Ger areas vis-à-vis apartment areas • Waste collection fees are much higher in Ger areas than in apartment areas, simply reflecting the difference in waste collection costs. As a result, poor people in Ger areas are obliged to pay much higher fees than rich people in apartment areas do.	

Items	Planned (Apartment) Area	Unplanned (Ger) Area
	➢ Open dumping at the final disposal site • Most waste is not compacted and covered with soil at the final disposal site because of the low budget from MUB for the final disposal operation. • There is no transfer of revenue from waste collection to disposal operation.	
14. Public education and cooperation in May 2005	• Sustainable SWM cannot be realized without the sufficient understanding and cooperation of residents. SWM authorities in developed countries try to raise people's awareness and ask for cooperation in many ways. Such public relations activities are not sufficient in the departments responsible for SWM in MUB and Duureg governments. • In order to reduce waste scattering and increase the collection efficiency, it is necessary to establish waste discharge rules and promote a public education campaign to disseminate the rules by the joint effort of the TUKs and the public. The departments responsible for SWM in MUB and Duureg governments should support such activities. • In order to keep the city clean and to conserve the sanitary environment, people's cooperation is necessary. The authorities have to actively carry out PR activities.	
15. Hazardous waste management in May 2005	• Capabilities, both technology and staff, to monitor toxicity are very limited in Mongolia and hazardous waste management remains weak, with some 20% (World Bank, Mongolia Environment Monitor 2004) being stored in non-standard facilities and a further 20% at open sites. There is no inventory of industrial, hazardous or toxic wastes. Concerns are increasing about possible consequent water pollution and soil contamination. • Infectious medical waste is disinfected before being dumped; and there is supposed to be a designated area at the dump for burying medical waste. The activities of the many new private hospitals are not well controlled. The principle issue currently concerning the Ministry of Health in this area is whether to try and get a large incinerator or a more expensive but more environmentally friendly autoclave for the treatment / disposal of medical waste. • The team studied SWM at 18 factories but no factory reported hazardous waste generation. This shows a lack of consciousness about the definition, character and identity of hazardous waste. • According to the results of survey on 15 medical institutions, all of them conduct source separation of infectious or hazardous waste • Even though in house collection and storage are separated from medical wastes to general wastes, many cases are observed that those wastes are mixed during discharge to the collection and transportation to disposal site. • One of the reasons why they are mixed is that neither the staff of the medical institutions nor the waste collection workers are fully aware of the possible risks posed by medical waste. • The second reason is that there are few facilities that can appropriately treat medical waste in the study area. This makes the medical staff and the collection workers reluctant to strictly separate medical waste. • The leadership of the responsible authorities including the Ministry of Health and UBC in the development of a medical waste management system, particularly in raising public awareness of health risks, should be urgently strengthened.	

5. Planning Frameworks for a Master Plan

5 Planning Frameworks for a Master Plan

5.1 Siting of Future Final Disposal Sites

5.1.1 Procedure of the Site Selection

Any MSWM (municipal solid waste management) needs at least one final disposal site (landfill). MSWM in the study area, seven districts of Ulaanbaatar city, is being managed by only collection and final disposal systems.

It is indispensable to decide future disposal site(s) for the formulation of the MSWM master plan (M/P) and to formulate practical M/P with consensus among the stakeholders. The Mongolian counterpart (C/P) and the Study Team discussed and agreed about the procedure/schedule of the site selection for future disposal system as shown in the table below.

Table 5-1: Procedure and Schedule of the Site Selection

December, 2004	➢ 1-10: Explanation of the procedure/schedule of the site selection for future final disposal system and request for the candidate sites by the Team
January, 2005	➢ 11-20: Presentation of the candidate sites by the Mongolian side ➢ 21- 31: Collection of data and reconnaissance of the sites by the Team
February, 2005	➢ 1-20: Screening of the sites by the Team ➢ 21-28: Presentation of the M/P alternatives by the Team according to the 6 candidates
March, 2005	➢ Examination of the alternatives by the Team
April, 2005	➢ 1-10: 2nd Workshop => Recommendation of the optimum alternative, i.e. the most suitable future final disposal site(s), by the Workshop => Selection of the optimum one by the St/C ➢ 11-20: 1st Seminar => Consensus on the optimum alternative => Completion of site selection work
May, 2005	➢ Formulation of a draft M/P

5.1.2 Presentation of the candidate sites by the Mongolian side

In response to the agreement on the procedure/schedule of the site selection, the Minister for Environment and the Governor of MUB issued joint decree to establish the working group to select a new waste disposal site.

The waste disposal selection process was done in cooperation with specialized organizations and has taken into account the UBC development plan until 2020, the fresh water reserves, borders of the protected areas, the city green area and mineral reserves. The members of the working group are from Ministry of Environment, Ministry of Construction and Urban Planning, Ministry of Health, Institute of Urban Planning, Research and Design, Faculty of the Environment and Geography of Mongolian National University, Land Department and IT Center, UBC Government, Governor's Office, "Nuuts" Company and etc. The UBC has limited land resources and during the selection process the working group faced number of difficulties such as the rapid expansion of the living area, the close location of the Bogduul mountain protected area in the south, the fresh water reserves located in the east and north-east side and the city green area that covers the northern side of the city.

The working group examined 16 candidate sites and in cooperation with the JICA study team made several site visits to the places such as Bayangiin Khonkhor and coal mining sites

located in the area of Nalaikh District, the used coal mine in the Baganuur district, the Uliastai valley, Tsagaan Davaa, valleys located nearby old Dari Ekh Disposal Site, the valley located in the north of Gants Hudag in the Bayanzurkh District, Khanyn Materialyn Kombinat, Narangiin Enger, vicinities nearby the 22nd autopost in the Songinokhairkhan District, Morin Davaa, Ulziit Horoolol in the Khan Uul district. It was the end of February when the working group finally selected the 6 future candidate sites after careful consideration of the environment impact, social aspects, economic activities, urban planning and others issues of the above mentioned places.

Consequently the schedule was revised as shown in the Figure below.

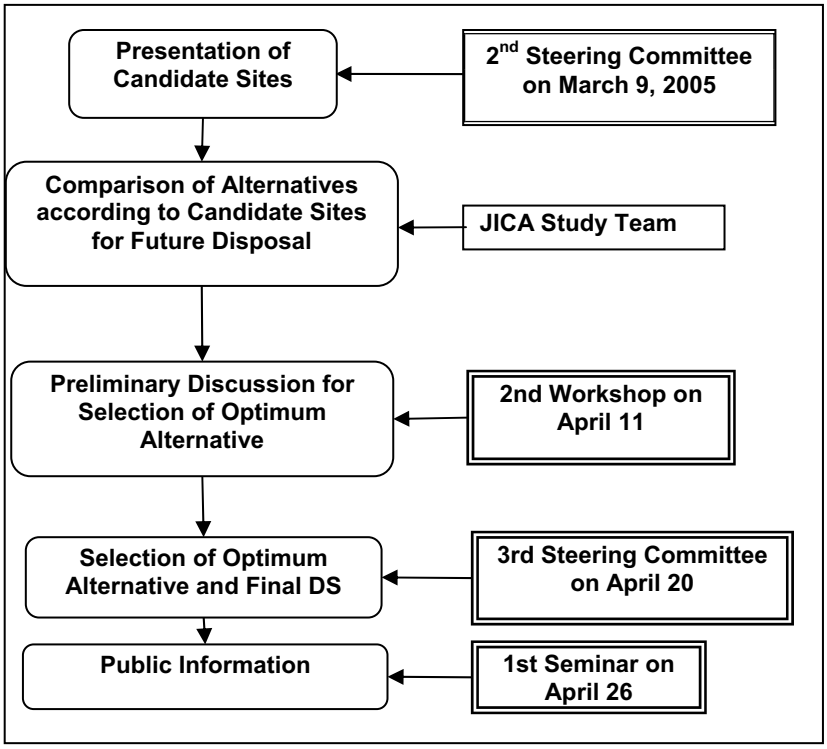


Figure 5-1: Procedure of the Site Selection

5.1.3 Preliminary Selection by the St/C

In response to the recommendation made by the Working Group, on March 9 the Steering Committee (St/C) of the Study selected six (6) candidates for the future final disposal site(s) as listed below.

- NECS: Narangiin Enger candidate site located to the north of current Ulaan Chuluut disposal site;
- XMKCS: XMK candidate site of former borrow pit for building material
- MDCS: Morin Davaa candidate site south of current Morin Davaa disposal site;
- BKCS: Bayangiin Khonkhor candidate site in the south of Nalaikh;
- TDCS: Tsagaan Davaa candidate site located north of former Dari Ekh disposal site; and
- BCMCS: Baganuur coal mining candidate site of former coal mining pit.

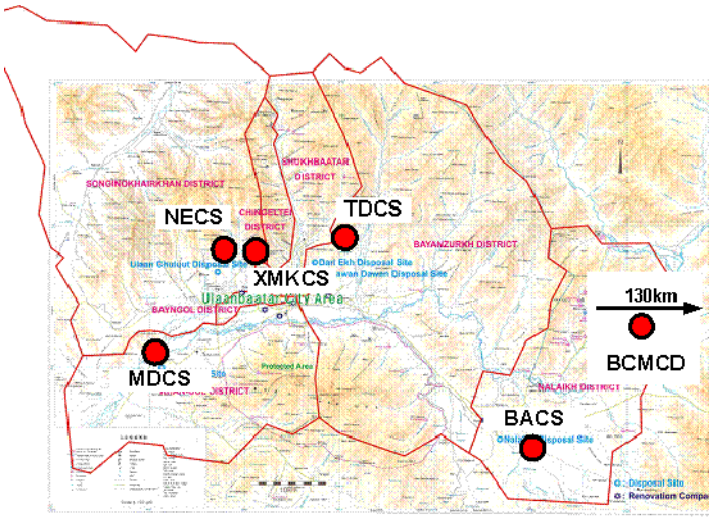


Figure 5-2: Location of Six Candidate Sites

5.1.4 Preliminary Environmental Study and Financial Analysis

The Study Team examined the six candidate sites focusing on the technical and financial aspects and the National University conducted a preliminary environmental study on the candidate sites. The results of both studies are summarized in the following tables:

Table 5-2: Preliminary Environmental Study on Social Aspects (1)

Items	NECS	XMKCS	MDCS
1. Location	SKH District, Khoroo 4: Area 2,226 ha, Population 8,160	SKH District, Khoroo 7: Area 1,292ha, Population 11,179	KHU District, Khoroo 12: Area 10,740 ha, Population 4,719
2. Inhabitants	2 families and 7 persons live at the site.	Densely populated area within 1 km and closest 50 m.	No population within 2 km.
3. Economic Activities	No specific activities except for grazing.	A factory produces bricks, etc. A number of individuals mine clay.	No specific activities except for grazing.
4. Traffic and Public Facilities (PF)	Medium to heavy traffic volume at 9km of 13km access from the City. A hospital is located in the center of the Khoroo.	Large traffic volume on 10km of 11km access from the City. A high school, a kindergarten and a hospital are located in the center of the Khoroo.	Large traffic volume on 19km of 23km access from the City. It may affect traffic to Airport. A secondary school, a kindergarten and a hospital are located in the center of the Khoroo.
5. Cultural Property (CP)	No CP within 4 km	No CP within 4 km	No CP within 4 km
6. Public Health Condition	Possibility of some specific diseases caused by the UCDS	No specific disease	Possibility of some specific diseases caused by the UCDC.

Table 5-3: Preliminary Environmental Study on Social Aspects (2)

Items	TDCS	BKCS	BCMCS
1. Location	BZ District, Khoroo 2: Area 25,442 ha, Population 22,963	Na District, Khoroo 1: Area 5,700ha, Population 5,807	BN District, Khoroo 2: Area 10,000ha, Population 1,008
2. Inhabitants	No population within 1 km.	No population within 1 km except workers at the Anti-air Strike Base	No population within 2 km.
3. Economic Activities	3 brick manufacturing factories with license are located between 1.2 and 1.9 km from the site.	Department for Protection from Air Strike with in 600 m.	The site is located inside a currently operating coal mine. Coordination of mining work is critical.
4. Traffic and Public Facilities	Medium to heavy traffic volume on 6km of 10km access from the City. A hospital is located in the center of the Khoroo.	Medium to light traffic No PF within 3.2 km	By road 130 km from the center of UBC. By rail 150 km and 5 - 6 hours. 4 schools and a hospital are located in the center of the District.

5. Cultural Property (CP)	No CP within 4 km	No CP within 4 km	No CP within 4 km.
6. Public Health Condition	Possibility of some specific diseases caused by the previous Dari Ekh DS.	No specific disease.	Foot and mouth disease through cattle.

Table 5-4: Preliminary Environmental Study on Natural Environment (1)

Items	NECS	XMKCS	MDCS
7. Topography and Geology	A mountain valley. Mainly consists of clayey soils.	Originally gentle hill changed to a big hole by mining. Mainly consists of clayey soils.	A small shallow valley. Mainly consists of sandy soils.
8. Groundwater	4 wells 2.9 -3 km south of the site do not satisfy the sanitary requirement.	Because of clayey soil layer movement of groundwater might be less.	Direction of flow is from south to north, the Tuul river.
9. Hydrological Situation	Nearest river is 6km west.	2.8 km from Bayankhoshuu river.	4km from Tuul river people use water for drinking.
10. Fauna and Flora	No important or rare species registered.	Hard to grow and live due to mining	Important or rare species have not been found within 4-5 km radius.
11. Meteorology	Need to protect the site from strong wind.	Less impacts by wind due to depth of deep hole.	Less impact by wind due to dominant wind direction.
12. Landscape	Though no specific property, it may affect natural view.	Less impacts on landscape because of current land condition, a big hole.	Less impact on landscape because of existence of current MDDS

Table 5-5: Preliminary Environmental Study on Natural Environment (2)

Items	TDCS	BKCS	BCMCS
7. Topography and Geology	A mountain valley. Mainly consists of clayey soils. Geological profile alluvial sandy-clay and clayey coarse breccia deposit.	Gentle concave land covered with dark brown soil.	Originally gentle valley changed to big holes by coal mining. Alkaline soil containing heavy metals like lead and copper.
8. Groundwater	Part of the Selbe river basin. No data available.	Part of the Tuul river basin. No data available.	Coal mining seriously, affects groundwater systems.
9. Hydrological Situation	Land surface erosion observed. 6 km from Selbe river.	6km from Nalaikh river and 7km from Tuul river.	In the center of the coal mine, there is Nuurent spring.
10. Fauna and Flora	No important or rare species registered.	No important or rare species registered.	Hard to grow and live due to mining.
11. Meteorology	Need to consider measures to protect the site from flood by thawing and heavy rainfall.	Annually 70% of days are windy. Need to protect the site from strong wind.	Less impacts by wind due to depth of hole.
12. Landscape	Though no specific property, it may affect natural view.	Though no specific property, it may affect natural view.	No impacts on landscape because of current land condition, a big hole.

Table 5-6: Preliminary Environmental Study on Pollution (1)

Items	NECS	XMKCS	MDCS
13. Air Pollution	Impacts of odor and dust will not be serious because of less populated area.	Odor and dust will affect populated area.	Impacts of odor and dust will not be serious because of wind direction.
14. Water Pollution	Possibility of polluting wells which are located south of the site because flow direction is north to south.	Possibility of polluting wells near the site.	Possibility of polluting surface and ground water because the site mainly consists of sandy soil.
15. Noise and Vibration	No serious impact due to less populated area	Noise and vibration will affect populated area.	No serious impact due to less populated area
16. Others	The rapid expansion of Ger areas may be close to the site in near future.	Location of the site will violate the Law of “Household and Industrial Waste”	Impacts to the Biocombinate shall be examined.

Table 5-7: Preliminary Environmental Study on Pollution (2)

Items	TDCS	BKCS	BCMCS
13. Air Pollution	Low odor impact except on workers at 3 brick manufacturing factories	Low odor impact except for workers at anti-air strike base	Low odor impact except on workers in the coal mine.
14. Water Pollution	Possibility of polluting surface and ground water is located on the east side and down stream of the site.	Possibility of polluting surface and ground water.	High possibility of pollution due to amount of surface and ground water which are connected to each other through hydraulic system.
15. Noise and Vibration	Less impact except on workers at 3 brick manufacturing factories	Less impacts except on workers at anti-air strike base	Less impacts than mining operation.
16. Others	The rapid expansion of Ger areas may be close to the site in near future. Location of the site may violate the Law of "Household and Industrial Waste"	Difficult to get permission from the anti-air strike base	Location of the site will violate the Law of "Household and Industrial Waste" Need to coordinate with railway and mining operation.

Table 5-8: Technical Aspects (1)

Items	NECS	XMKCS	MDCS
1. Current land use	A large and deep valley north of current UCDS	Mine pits about 25 meter deep	A small shallow valley south of current MDDS
2. Future land use	No specific use	Residential area	No specific use
3. Available area	More than 50 ha	about 7 ha Only four years operation	More than 50 ha
4. Direction and direct distance from city center	Northwest 9.7 km	Northwest 7.1 km	Southwest 20.3 km
5. Distance from city center by road	13 km	11 km	23 km
6. Access distance from paved road	1.5 km	0.05 km	2.0 km
7. Access distance for electric supply	1.5 km	0.5 km	1.7 km

Table 5-9: Technical Aspects (2)

Items	TDCS	BKCS	BCMCS
1. Current land use	A large and deep valley	Gentle concave area and pasture land	Big holes by coal mining.
2. Future land use	No specific use	No specific use	No specific use
3. Available area	More than 50 ha	About 20 ha	More than 50 ha
4. Direction and direct distance from city center	Northeast 6.6 km	Southeast 29.4 km	Southeast 107.9 km
5. Distance from city center by road	10 km	38 km	130 km
6. Access distance from paved road	4.0 km	0.6 km	3.0 km
7. Access distance for electric supply	1.2 km	0.6 km	0.3 km

Table 5-10: Financial Aspects (1)

Items	Unit	NECS	XMKCS	MDCS
1. Collection and Transportation Cost	MNT/ton	15,364	13,727	19,323
2. Final Disposal Cost	MNT/ton	3,125	3,396	3,507
3. 1+2	MNT/ton	18,489	17,123	22,830
4. Administration Cost	MNT/ton	1,849	1,712	2,283
5. Total Cost	MNT/ton	20,338	18,835	25,113
6. Waste Generation per Person in 2010	kg/day	0.596	0.596	0.596
7. Average Collection Fee per Person	MNT/month	364	337	449
8. Average Collection Fee per Household	MNT/month	1,636	1,515	2,021
9. Initial Investment	Million MNT	7,035	6,234	8,719
10.Total Annual Cost in 2010	Million MNT	4,874	4,595	5,961

Table 5-11: Financial Aspects (2)

Items	Unit	TDCS	BKCS	BCMCS
1. Collection and Transportation Cost	MNT/ton	15,123	21,058	27,767
2. Final Disposal Cost	MNT/ton	3,576	3,326	3,260
3. 1+2	MNT/ton	18,699	24,384	31,027
4. Administration Cost	MNT/ton	1,870	2,438	3,103
5. SWM Unit Cost	MNT/ton	20,569	26,822	34,130
6. Waste Generation per Person in 2010	kg/day	0.596	0.596	0.596
7. Average Collection Fee per Person	MNT/month	368	480	610
8. Average Collection Fee per Household	MNT/month	1,655	2,158	2,746
9. Initial Investment	Million MNT	7,807	10,938	13,559
10.Total Annual Cost in 2010	Million MNT	4,997	6,299	7,860

5.1.5 Second Workshop

The Second Workshop was held on April 11 in order to examine, discuss and make recommendation regarding future final disposal site(s) for MSWM in the City of Ulaanbaatar. 55 persons from relevant organizations and communities were invited and in total 45 participated including administrative officers of Khoroos where the 6 candidates are located. The participants discussed on the subject based on the report of the technical and financial study and the preliminary environmental study. Then the Workshop recommended the two sites, Narangiin Enger and Tsagaan Davaa, to the St/C for final decision.

The 3rd St/C meeting including visits to the recommended two sites was held on April 26 and made decision on the future disposal site. Narangiin Enger site was finally selected.

In response to the decision, the Study Team conducted a feasibility study for development of new landfill at Narangiin Enger site including preliminary design with mitigation measures against adverse impacts, cost estimation, etc. in Phase 2 of the Study from July 2005. The Environmental Impact Assessment (EIA) was conducted by MUB, the proponent of the project.

5.1.6 First Seminar

The First Seminar was held on April 26 to present decision on the selection of Narangiin Enger candidate site for the future final disposal site in order to achieve consensus among the stakeholders. 100 persons from relevant organizations and communities were invited and in total 61 participated including 13 persons in total from residents and administrative officers of Khoroo No. 4 of SKhD where the Narangiin Enger candidate site is located. In the seminar the following issues were presented by the C/P with the assistant of the Team:

1. Explanation of background and objectives of the first seminar
2. Explanation of sanitary landfill and pilot project for the improvement of UCDS
3. Explanation of six (6) candidates as future disposal site(s), selection process and decision

After the explanation of the above aspects the participants actively asked many questions to clarify the decision, etc. and the C/P replied to every question with little assistance of the Team. The record of questions and answers are presented in the Data Book Chapter 3.

5.2 Socio-Economic Framework

5.2.1 Population Forecast

a. Population Forecast

The UBC Development M/P forecasts four cases of future population of whole UBC (the Nine Duuregs) until its target year 2020 as shown in the table below. However, the population in 2004 of whole UBC shown in the Statistical Handbook of Ulaanbaatar is 869,900; more than the largest case in 2005 of the UBC Development M/P and the Plan is planned to be reviewed.

Table 5-12: Population Forecast of Whole UBC in the UBC Development M/P

Category	2004	2005	2010	2020
UBC Development M/P				
Case 1: No control on migration from country side		780,000	919,000	1,300,000
Case 2: Control on increase by migration		770,000	883,000	1,000,000
Case 3: Suitable coordination with water resources		775,000	900,000	1,140,000
Case 4: Population applied to the M/P		775,000	900,000	1,150,000
Population shown in the Statistical Handbook	869,900			

Therefore, the population forecast for whole UBC shown in the "Population Projections of Mongolia, National Statistical Office of Mongolia, 2002" is adopted for this Study. According to the Population Projections, 3.2 % of growth rate in 2001 will decrease 1.5 % in 2025. The future population of the study area, 7 Duuregs, is forecasted as shown in the table below.

Table 5-13: Population Forecast of the Study Area

Duureg	2000	2005	2006	2010	2015	2020
Bayangol	-	160,982	169,457	205,521	254,782	306,958
Bayanzurkh	-	178,809	185,308	212,120	246,811	281,332
Songinokhairkhan	-	185,634	188,784	200,274	211,575	218,496
Sukhbaatar	-	108,480	110,648	118,848	127,699	134,371
Khan-Uul	-	82,787	84,327	90,068	96,042	100,219
Chingeltei	-	124,640	126,500	133,058	138,898	141,499
Nalaikh	-	25,259	25,785	27,791	29,998	31,723
Study area	-	866,591	890,809	987,680	1,105,805	1,214,598
Baganuur	-	23,954	24,635	27,301	30,566	33,572
Bagakhangai	-	3,770	3,864	4,297	4,811	5,285
Whole Ulaanbaatar	772,126	894,315	919,308	1,019,278	1,141,182	1,253,455

b. Population in Apartment Area and Ger Area

The future of population in Planned area (apartment area) and Unplanned area (Ger area) is forecasted based on the distribution of population predicted in "Master Plan of Ulaanbaatar up to 2020". The Table below present future of population in Apartment area Ger area.

Table 5-14: Population in Apartment Area and Ger Area

	2006		2010		2015		2020	
	Ratio (%)	Population persons	Ratio (%)	Population persons	Ratio (%)	Population persons	Ratio (%)	Population persons
Apartment Area	54	481,037	62	612,362	72	796,180	82	995,970
Ger Area	46	409,772	38	375,318	38	309,625	18	218,628
Whole Study Area	100	890,809	100	987,680	110	1,105,805	100	1,214,598

5.2.2 Economic Conditions

The Ulaanbaatar City's economy experienced an annual growth rate of 14% from 2000 to 2003. Although the overall growth rate slowed down to 2% in 2003, it is expected that manufacturing will continue to grow at around 20% per annum until 2010, taking into consideration that further investment will be made by Chinese capital in the export-oriented textile sector. Construction and real estate businesses are forecast to continue growing fast, at annual rates of 10% and 20% respectively. For other sectors except agriculture, a 5.5% growth rate is applied, which is the same rate applied in the base case scenario in Mongolia's "Economic Growth Support and Poverty Reduction Strategy" (Poverty Reduction Strategy Paper), assuming that balanced growth throughout the country will be attained in the 2010s instead of concentration into one city.

The projection of GDP growth in Ulaanbaatar City by sector and The City's overall GDP growth from 2003 to 2020 are shown in the tables below.

Table 5-15: Projection of GDP Growth of Ulaanbaatar City by Sector

	GDP 2003 Actual (million US$)	Growth Rate 2004-2010	GDP 2010 Projection (million US$)	Growth Rate 2011-2020	GDP 2020 Projection (million US$)
Manufacturing	163.1	20.0%	584.4	5.5%	998.3
Agriculture, Hunting & Forestry	9.0	0.0%	9.0	0.0%	9.0
Construction	13.6	10.0%	26.5	5.5%	45.3
Trade	117.5	5.5%	170.9	5.5%	292.0
Hotels & Restaurants	12.4	5.5%	18.0	5.5%	30.8
Transport, Storage & Communication	73.8	5.5%	107.4	5.5%	183.4
Public Administration	6.5	5.5%	9.5	5.5%	16.2
Education	28.0	5.5%	40.7	5.5%	69.6
Health & Social Work	9.3	5.5%	13.5	5.5%	23.1
Other Community, Social & Personnel Service	8.7	5.5%	12.7	5.5%	21.6
Financial Intermediation	28.3	5.5%	41.2	5.5%	70.3
Real Estate, Renting & Other Business Activities	10.0	20.0%	35.8	5.5%	61.2
TOTAL	**480.2**		**1,069.6**		**1,820.7**

(Source) JICA Study Team

Table 5-16: Projection of GDP Growth of Ulaanbaatar City

Year	GDP (million US$)	Rates of Increase
2003	480.2	-
2004	564.4	17.5
2005	648.6	14.9
2006	732.8	13.0
2007	817.0	11.5
2008	901.2	10.3
2009	985.4	9.3
2010	1,069.6	8.5
2011	1,144.7	7.0
2012	1,219.8	6.6
2013	1,294.9	6.2
2014	1,370.0	5.8
2015	1,445.1	5.5
2016	1,520.2	5.2
2017	1,595.4	4.9
2018	1,670.5	4.7
2019	1,745.6	4.5
2020	1,820.7	4.3

Source: JICA Study Team

Since the growth of the Agriculture sector will not contribute for the generation of MSW, we applied the GDP growth rate of 5.5% to the forecast of waste generation increase.

5.2.3 Financial Conditions

The following are the major assumptions applied in developing an optimum but realizable financial system for solid waste management in Ulaanbaatar.

- Part of waste revenues will be centralized into a municipal-level waste fund (the City Waste Service Fund) so that cross-subsidy is made possible among districts and that the MUB, which has authority to levy penalties against non-payers, will be responsible for fee collection through district governments (the District Waste Service Fund).
- In Ger area, fee payment are made compulsory while waste will be collected from all households, in order to increase the fee revenue and at the same time reduce illegal dumping.
- Strict enforcement measures for payment are introduced to all categories of waste generating sources. As a result, revenues from Ger area will increase significantly.
- A household-based fee[1] are introduced in all residential areas of all districts, including Ger areas and apartment areas, which enables the introduction of cross-subsidy between Ger and apartment areas and between districts.
- Poor residents in Ger areas are exempt from waste fee payment in exchange of labor contribution to waste collection.
- Part of fee revenues is used to finance landfilling at the final disposal site.
- MUB suggested that a waste tax be levied on most imported goods because these constitute major sources of waste. This would supposedly require an increase of custom duties and thus must be discussed at the national level, beyond MUB's control. Since the level of revenue increase in this option is difficult to know, this option is not taken into consideration in the proposed financing system.

5.3 Forecast of Future Waste Flows

5.3.1 Waste Amount Forecast

a. Method of Forecast

Future waste generation amount (WGA_x) is deemed to increase in proportion to the increase in number of generation sources: population in case of household waste, number of stalls in case of market, etc. Accordingly, the future waste generation amount is calculated by multiplying the generation rate (GR_x) at that time by the future number of generation sources (NGS_x). => $WGA_x = GR_x \times NGS_x$

Regarding the future number of generation sources (NGS_x), as for the household waste the population growth is forecasted as shown in the Section 5.2.1 above. As for the business waste the number of generation sources is assumed to increase in accordance with economic growth. Consequently it will increase **5.5 %** per annum, except for number of students.

The future waste generation rate (GR_x) is deemed to increase in proportion with economic growth. It is necessary to examine the relationship between the GNP (GDP or GRDP) and the

[1] Although a floor size-based fee would be more equitable, a household-based fee is applied in this master plan to make comparison between Ger and apartment areas clearer.

increase in waste generation to forecast future generation rate. The waste generation rate (GR_x) of each generation source may increase in proportion to the growth of GDP per capita. The Japanese statistics[2], which were recorded from 1963 to 1988 and are the available data of its kind in the world, show the trend of the rate due to the development of the economy as follows:

- At the time of developing economy (1963-1970):
  Increase of GR_x = 0.55 of GDP growth rate
- At the time of developed economy (1975-1988):
  Increase of GR_x = 0.29 of GDP growth rate

In addition, the increase in the waste generation ratio per year as shown above will not apply to public area cleansing services such as road sweeping and cleaning parks but their amount will be implicitly increased in accordance with the growth of population, expansion of the city, etc. Consequently, we adopt the following assumptions on the future waste generation rate in this report based on the above statistic and past our experience:

- Generation rate of ash and public area cleaning waste will not change in future.
- Generation rate of other waste than ash will increase 3.0 % (5.5 x 0.55 = 3.025 => say 3.0 %) each year

Using the above assumptions, the future waste generation rate and amount in the study area is estimated below.

b. Generation Rate of Waste Generation Sources

The generation rate at each waste generation source is forecasted based on the assumption that it will increase in proportion to the growth rate of GDP. The generation rate of ash at unplanned area is assumed to be same rate up to year 2020.

Table 5-17: Forecast Waste Generation Rate in Winter

Generation source		Unit	2005	2006	2010	2015	2020
Households	Planned area	g/person/day	256	264	297	344	399
	Unplanned area : General waste	g/person/day	163	168	188	218	253
	Unplanned area : Ash	g/person/day	788	788	788	788	788
Commercial	Restaurants	g/chair/day	250	258	290	337	390
	Other shop	g/shop/day	1,200	1,236	1,391	1,613	1,869
Offices		g/office/day	130	134	150	175	203
Markets		g/stall/day	850	876	986	1,142	1,323
Schools		g/student/day	3	3	4	4	5
Hotels		g/room/day	130	134	150	175	203
Road Cleaning waste		$g/m^2/day$	3	3	3	3	3

Table 5-18: Forecast Waste Generation Rate in Summer

Generation source		Unit	2005	2006	2010	2015	2020
Households	Planned area	g/person/day	228	235	264	306	354
	Unplanned area : General waste	g/person/day	202	208	234	271	314
	Unplanned area : Ash	g/person/day	0	0	0	0	0
Commercial	Restaurants	g/chair/day	270	278	313	363	421
	Other shop	g/shop/day	1,640	1,689	1,901	2,204	2,554
Offices		g/office/day	180	185	209	242	280
Markets		g/stall/day	1,720	1,772	1,994	2,311	2,679
Schools		g/student/day	2	2	2	2	2
Hotels		g/room/day	110	113	127	147	171
Road Cleaning waste		$g/m^2/day$	5	5	5	5	5

[2] After 1990, generation rate has been constant, about 1.1 kg/person/day due to promotion of 3Rs.

c. Number of Waste Generation Sources

The number of generation sources are forecasted based on the assumption that it will increase in proportion to the growth rate of GDP.

Table 5-19: Number of Waste Generation Sources

Generation source		Unit	2005	2006	2010	2015	2020
Households	Planned area	person	450,627	481,037	612,362	796,180	995,970
	Unplanned area	person	415,964	409,772	375,318	309,625	218,628
Commercial	Restaurants	chair	41,812	44,112	47,666	53,352	58,620
	Other shop	shop	3,009	3,174	3,430	3,839	4,219
Offices		office	105,376	111,172	120,129	134,460	147,737
Markets		stall	4,354	4,593	4,964	5,556	6,104
Schools		student	271,378	278,977	309,371	346,278	380,472
Hotels		room	11,506	12,139	13,117	14,682	16,131
Road Cleaning waste		m^2	3,337,015	3,430,451	3,801,370	4,254,938	4,674,808

d. Future Waste Generation Amount

Therefore, the waste generation amount forecast was calculated by multiplying the generation rate at that point by the future number of generation sources.

Table 5-20: Forecast on Waste Generation Amount for the Study Area in Winter (2005-2020)

Unit : ton/day

Category	2005	2006	2010	2015	2020
Household Waste	511.0	518.8	548.3	585.4	625.0
General	(183.2)	(195.9)	(252.5)	(341.4)	(452.7)
Ash	(327.8)	(322.9)	(295.8)	(244.0)	(172.3)
Commercial Waste (Restaurant)	10.5	11.4	15.8	24.1	36.4
Commercial Waste (Other Shop)	3.6	3.9	5.5	8.3	12.6
Office Waste	13.7	14.9	20.7	31.5	47.8
Market Waste	3.7	4.0	5.6	8.5	12.9
School Waste	0.8	0.9	1.1	1.4	1.7
Hotel Waste	1.5	1.6	2.3	3.4	5.2
Road Cleaning Waste	10.0	10.3	11.4	12.8	14.0
Total	554.8	565.8	610.7	675.4	755.6

Table 5-21: Forecast on Waste generation Amount for the Study Area in Summer (2005-2020)

Unit : ton/day

Category	2005	2006	2010	2015	2020
Household Waste	186.7	198.2	249.5	327.5	421.2
General	(186.7)	(198.2)	(249.5)	(327.5)	(421.2)
Ash	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Commercial Waste (Restaurant)	11.3	12.3	17.1	25.9	39.3
Commercial Waste (Other Shop)	4.9	5.4	7.5	11.3	17.2
Office Waste	19.0	20.6	28.8	43.6	65.9
Market Waste	7.5	8.1	11.3	17.2	26.0
School Waste	0.4	0.4	0.5	0.5	0.6
Hotel Waste	1.3	1.4	1.9	2.9	4.4
Road Cleaning Waste	17.0	17.5	19.4	21.7	23.8
Total	248.1	263.9	336.0	450.6	598.4

5.3.2 Waste Composition Forecast

Future waste composition is forecast by comparing the results of the WACS with the waste data on other countries. The forecast is mainly based on the following assumptions:

- The generation amount of wastes used for container and packaging of the goods (e.g., **paper, plastic, metal, bottle and glass**) and kitchen waste is assumed to increase in accordance with economic growth. Thus, generation rate of those wastes will increase 3.0 % or more per annum considering the increase of generation rate of waste other than ash, 3.0 %.
- The generation amount of wastes such as **textile, rubber and leather,** (of which discharge rate is very low.) is assumed to increase in accordance with economic growth but less than the above categories of the wastes. Therefore, generation rate of those wastes will increase half of the above per annum.
- The generation amount of garden wastes such as **grass and wood**, **ceramics and stone, miscellaneous** is assumed not to increase in accordance with economic growth due to the increase of Planned (Apartment area). Therefore, generation rate of those wastes will increase 0 % per annum.

Using the above forecasts, the future waste composition in the Study is forecast as shown in the following two tables, i.e. with ash and without ash.

Table 5-22: Forecast on Composition of MSW in the Study Area including Ash in Winter (2005-2020)

Waste Composition of MSW	2005 (%)	2006 (%)	2010 (%)	2015 (%)	2020 (%)
Kitchen Waste	12.6	13.2	16.3	20.7	25.7
Paper	5.2	5.4	6.7	8.5	10.6
Textile	2.0	2.1	2.4	2.9	3.3
Grass and Wood	0.5	0.5	0.6	0.6	0.6
Plastic	7.8	8.2	10.1	12.8	15.8
Leather and Rubber	0.2	0.3	0.3	0.3	0.4
Combustibles	**28.3**	**29.7**	**36.4**	**45.8**	**56.4**
Metal	1.5	1.6	2.0	2.5	3.1
Bottle and Glass	5.4	6.0	7.2	9.3	11.3
Ceramic and Stone	1.9	1.9	2.1	2.3	2.5
Miscellaneous	2.7	2.7	3.0	3.3	3.5
Non-combustibles excluding ash	**11.5**	**12.2**	**14.3**	**17.4**	**20.4**
Other Weight (%)	39.8	41.9	50.7	63.2	76.8
Ash Weight (%)	60.2	58.1	49.3	36.8	23.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5-23: Forecast on Composition of MSW in the Study Area in Summer (2005-2020)

Waste Composition of MSW	2005 (%)	2006 (%)	2010 (%)	2015 (%)	2020 (%)
Kitchen Waste	33.8	33.9	34.5	35.2	35.8
Paper	18.9	19.0	19.3	19.7	20.0
Textile	4.8	4.8	4.6	4.3	4.1
Grass and Wood	4.8	4.7	4.2	3.7	3.3
Plastic	15.2	15.2	15.5	15.8	16.1
Leather and Rubber	0.6	0.6	0.6	0.6	0.5
Combustibles	**78.1**	**78.2**	**78.7**	**79.3**	**79.8**
Metal	3.5	3.5	3.6	3.6	3.7
Bottle and Glass	10.5	10.6	10.7	11.0	11.2
Ceramic and Stone	6.8	6.6	6.0	5.3	4.6
Miscellaneous	1.1	1.1	1.0	0.8	0.7
Non-combustibles excluding ash	**21.9**	**21.8**	**21.3**	**20.7**	**20.2**
Other Weight (%)	100.0	100.0	100.0	100.0	100.0
Ash Weight (%)	0.0	0.0	0.0	0.0	0.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5-24: Forecast on Composition of MSW in Winter for the Planned Area (2005-2020)

Waste Composition of MSW	2005 (%)	2006 (%)	2010 (%)	2015 (%)	2020 (%)
Kitchen Waste	32.7	32.8	33.3	34.3	35.5
Paper	12.7	12.7	12.9	13.3	13.7
Textile	4.6	4.6	4.4	3.9	3.3
Grass and Wood	1.1	1.0	0.9	0.7	0.5
Plastic	22.4	22.5	22.8	23.5	24.4
Leather and Rubber	0.7	0.7	0.7	0.6	0.5
Combustibles	**74.2**	**74.3**	**75.0**	**76.3**	**77.9**
Metal	4.0	4.0	4.1	4.2	4.4
Bottle and Glass	12.4	12.5	12.6	13.1	13.4
Ceramic and Stone	4.4	4.3	3.9	3.0	2.0
Miscellaneous	5.0	4.9	4.4	3.4	2.3
Non-combustibles	**25.8**	**25.7**	**25.0**	**23.7**	**22.1**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5-25: Forecast on Composition of MSW in Summer for the Planned Area (2005-2020)

Waste Composition of MSW	2005 (%)	2006 (%)	2010 (%)	2015 (%)	2020 (%)
Kitchen Waste	35.7	35.9	36.4	37.7	39.2
Paper	21.7	21.8	22.1	22.9	23.8
Textile	4.1	4.0	3.9	3.5	2.9
Grass and Wood	5.3	5.2	4.7	3.6	2.41
Plastic	14.5	14.5	14.8	15.3	15.9
Leather and Rubber	0.4	0.4	0.4	0.4	0.3
Combustibles	**81.7**	**81.8**	**82.3**	**83.4**	**84.5**
Metal	1.8	1.8	1.8	1.9	2.0
Bottle and Glass	9.5	9.5	9.7	9.9	10.3
Ceramic and Stone	6.5	6.4	5.8	4.5	3.0
Miscellaneous	0.5	0.5	0.4	0.3	0.2
Non-combustibles	**18.3**	**18.2**	**17.7**	**16.6**	**15.5**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5-26: Forecast on Composition of MSW in Winter for the Unplanned Area (2005-2020)

Waste Composition of MSW	2005 (%)	2006 (%)	2010 (%)	2015 (%)	2020 (%)
Kitchen Waste	4.9	5.3	5.7	6.7	8.0
Paper	2.4	2.5	2.7	3.2	3.8
Textile	1.0	1.1	1.1	1.2	1.1
Grass and Wood	0.2	0.2	0.2	0.2	0.1
Plastic	2.2	2.4	2.6	3.1	3.7
Leather and Rubber	0.1	0.1	0.1	0.0	0.0
Combustibles	**10.8**	**11.6**	**12.4**	**14.4**	**16.7**
Metal	0.6	0.6	0.6	0.7	0.9
Bottle and Glass	3.0	3.1	3.6	4.2	4.9
Ceramic and Stone	0.9	0.9	0.9	0.8	0.6
Miscellaneous	1.8	1.8	1.8	1.6	1.2
Non-combustibles including ash	**6.3**	**6.4**	**6.9**	**7.3**	**7.6**
Other Weight (%)	17.1	18.0	19.3	21.7	24.3
Ash Weight (%)	82.9	82.0	80.7	78.3	75.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 5-27: Forecast on Composition of MSW in Summer for the Unplanned Area (2005-2020)

Waste Composition of MSW	2005 (%)	2006 (%)	2010 (%)	2015 (%)	2020 (%)
Kitchen Waste	30.4	30.5	31.1	32.4	34.0
Paper	13.9	14.0	14.2	14.8	15.5
Textile	6.2	6.2	5.9	5.2	4.4
Grass and Wood	3.9	3.8	3.5	2.7	1.7
Plastic	16.3	16.4	16.7	17.4	18.2
Leather and Rubber	0.8	0.8	0.8	0.7	0.6
Combustibles	**71.5**	**71.7**	**72.2**	**73.2**	**74.4**
Metal	6.4	6.5	6.6	6.8	7.1
Bottle and Glass	12.9	12.7	13.0	13.6	14.1
Ceramic and Stone	7.1	7.0	6.3	4.9	3.4
Miscellaneous	2.1	2.1	1.9	1.5	1.0
Non-combustibles including ash	**28.5**	**28.3**	**27.8**	**26.8**	**25.6**
Other Weight (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Ash Weight (%)	**-**	**-**	**-**	**-**	**-**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

5.3.3 Forecast of Industrial Waste Generation

The generation amount of industrial waste for the year 2010, 2015 and 2020 was estimated according to the economic growth in study area from 2005 to 2020. As shown in the following table, industrial waste (Non-HIW + HIW) generation is estimated at 84.0 ton/day in 2010, 109.7 ton/day in 2015 and 143.4 ton/day in 2020 respectively.

The amount of industrial waste also increases more than 2.2 times from 64.4 ton/day in 2005 to 143.4 ton/day in the year 2020.

Table 5-28: Forecast of Industrial Waste Generation Amount

Year	Non-HIW (ton/day)	HIW (ton/day)	Total (ton/day)
2005	64.3	0.1	64.4
2006	67.8	0.1	67.9
2010	83.9	0.1	84.0
2015	109.6	0.1	109.7
2020	143.3	0.1	143.4

5.3.4 Forecast of Medical Waste Generation

The generation amount of medical waste and general waste for the year 2006, 2010, 2015 and 2020 was estimated according to the population growth in study area from 2005 to 2020, and was thus calculated with the increase in the total number of beds proportional to the population increase. As shown in the following table, medical waste generation is estimated at 1.6 ton/day in 2006, 1.8 ton/day in 2010, 2.0 ton/day in 2015 and 2.2 ton/day in 2020 respectively.

The amount of general waste also increases more than 1.4 times from 14.8 ton/day in 2005 to 20.8 ton/day in the year 2020. In this connection, if we compare the amount of medical waste and the amount of general waste generated in the medical institutions, the amount of general waste is much more than that of medical, almost 9 times.

Following is the generation forecast using generation rate per bed.

Table 5-29: Forecast of Waste Generation Amount from Medical Institutions

Year	Number of Bed Forecast**	Medical Waste (ton/day)	General waste (ton/day)	Total (ton/day)
2005	7,721	1.6	14.8	16.4
2006	7,937	1.6	15.2	16.8
2010	8,802	1.8	16.9	18.7
2015	9,852	2.0	18.9	20.9
2020	10,825	2.2	20.8	23.0

* Based on "Bed number"
** : The number of bed is increased in proportion to the increase of population.

5.3.5 Forecast of Construction Waste

The generation amount of construction waste for the year 2006, 2010, 2015 and 2020 was estimated according to the economic growth in study area from 2005 to 2020.

The construction waste generations in Study area are forecast as shown in the table below.

Table 5-30: Forecast of Construction Waste Generation

unit : ton/day

	2004	2006	2010	2015	2020
Winter season	54.5	60.6	75.0	98.0	128.0
Summer season	110.6	123.0	152.2	198.9	260.0

5.3.6 Future Waste Flow

In order to formulate a SWM master plan, it is necessary to know waste flows in 2020 without improvement. For the preparation of the waste flows we set the following conditions:

1. Collection service will cover whole population.
2. There will be no recycling and treatment facility operated by the public sector.
3. Sanitary landfill operation will be conducted. Therefore, waste picking at disposal sites shall be prohibited.

Based on the above-mentioned condition and future waste generation amount, future waste flows in the study area are prepared as shown in the figures below.

<All Study Area>

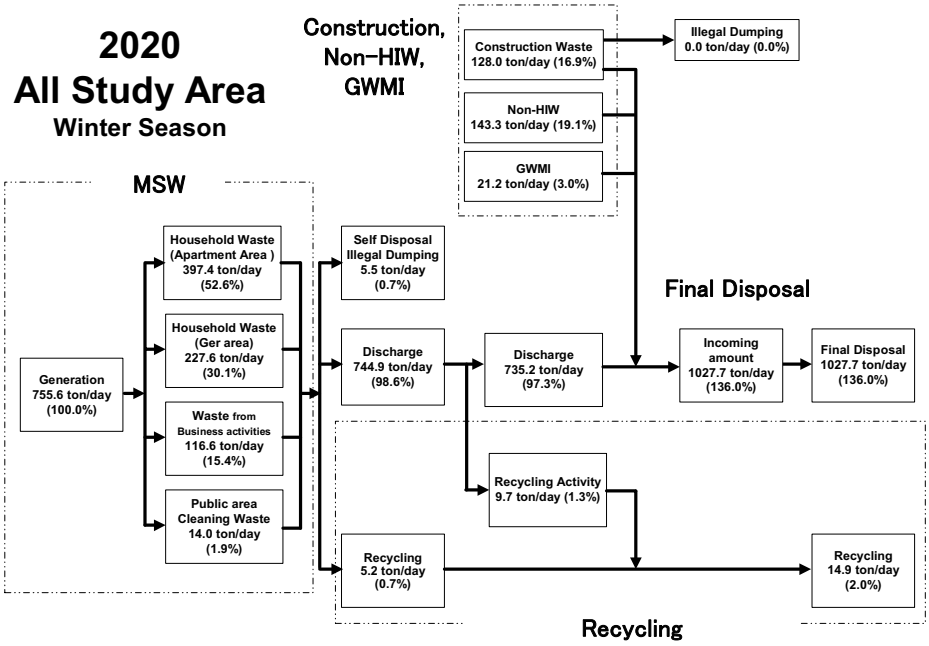


Figure 5-3: MSW Flow in Winter season in 2020 without M/P (All study Area)

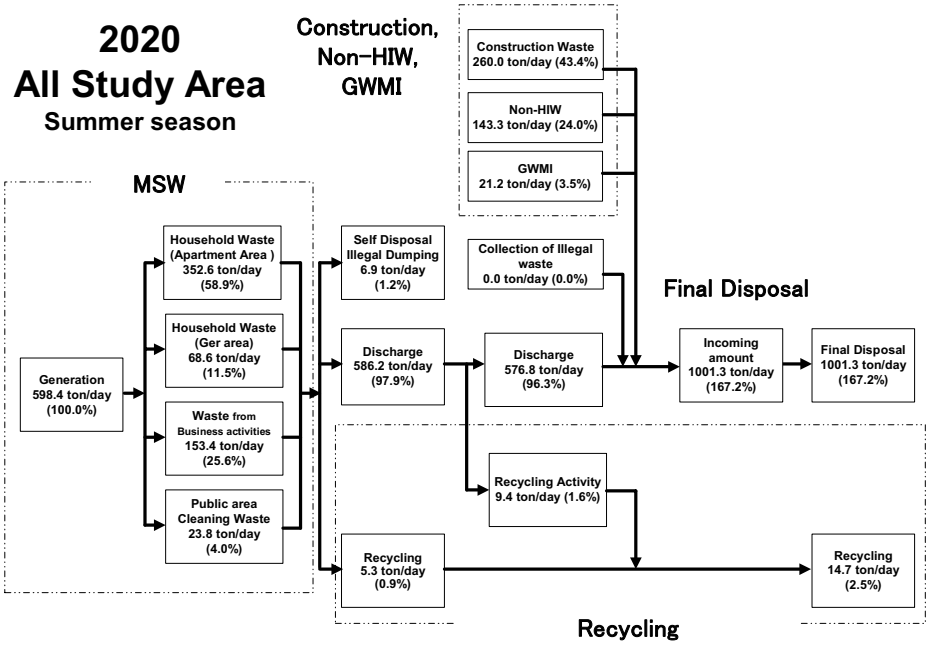


Figure 5-4: MSW Flow in Summer season in 2020 without M/P (All study Area)

<Planned Area (Apartment + Business)>

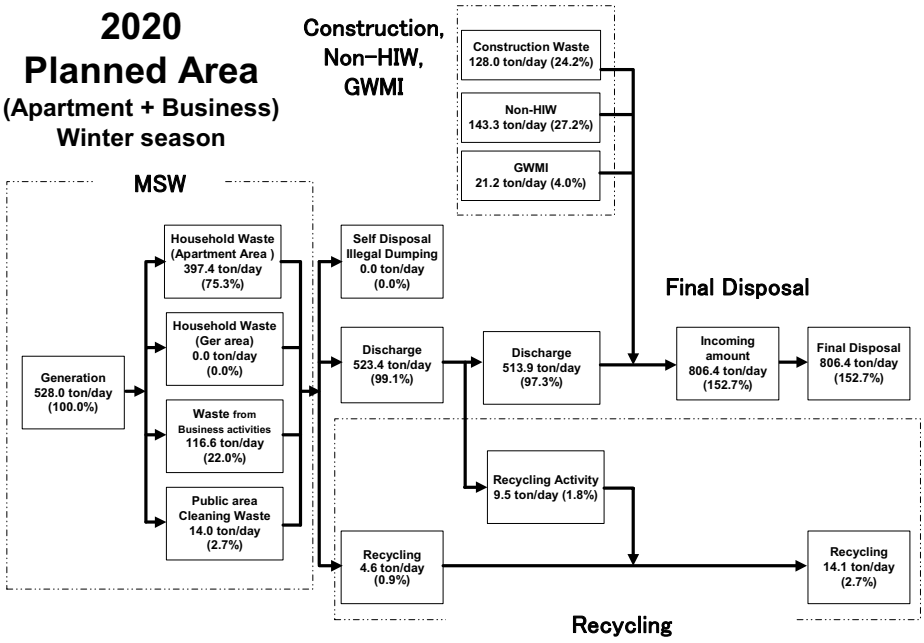


Figure 5-5: MSW Flow in Winter season in 2020 without M/P (Planned Area)

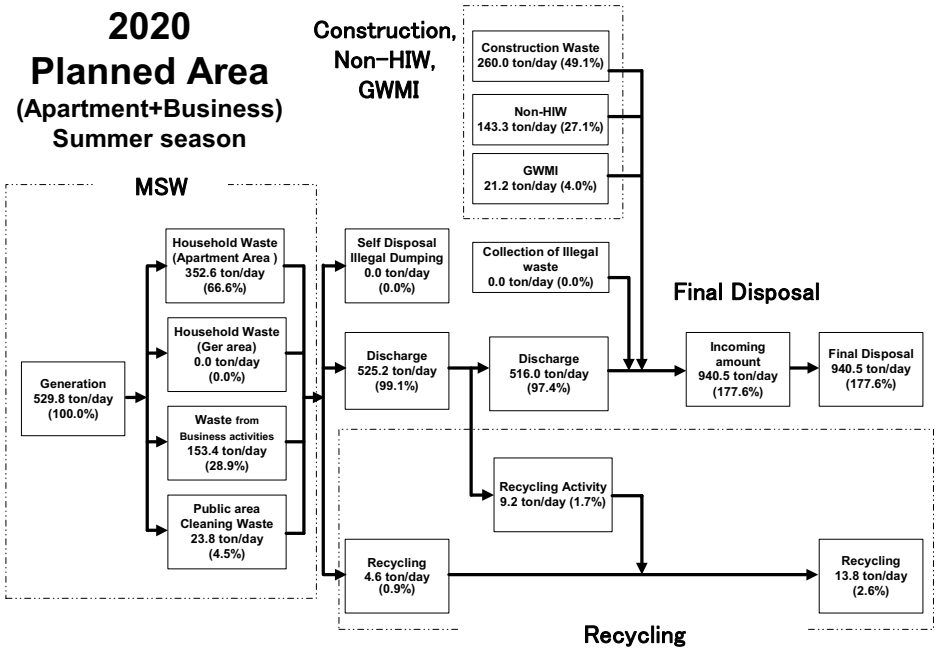


Figure 5-6: MSW Flow in Summer season in 2020 without M/P (Planned Area)

<Unplanned Area>

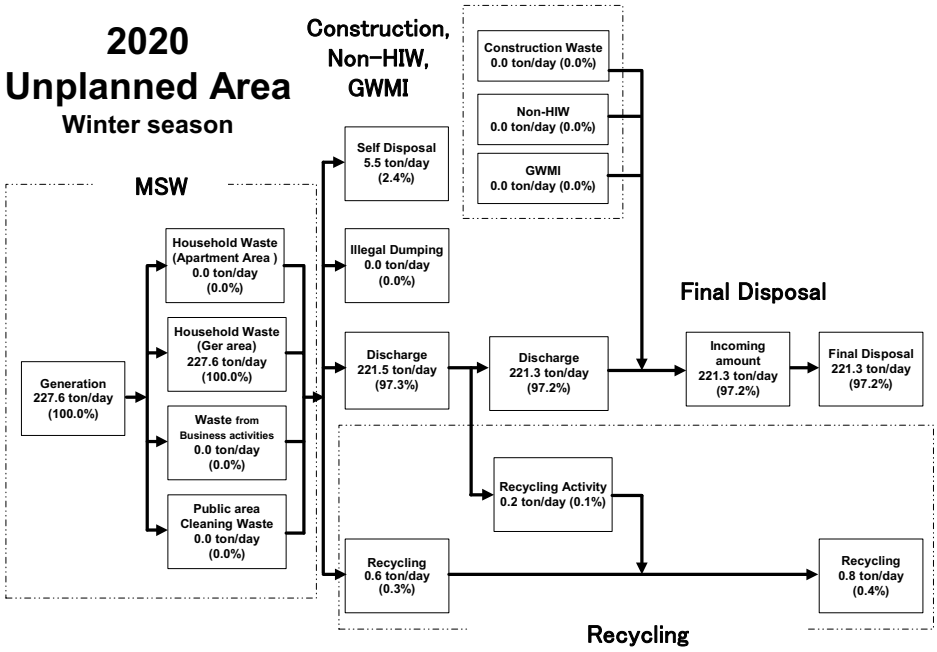


Figure 5-7: MSW Flow in Winter season in 2020 without M/P (Unplanned Area)

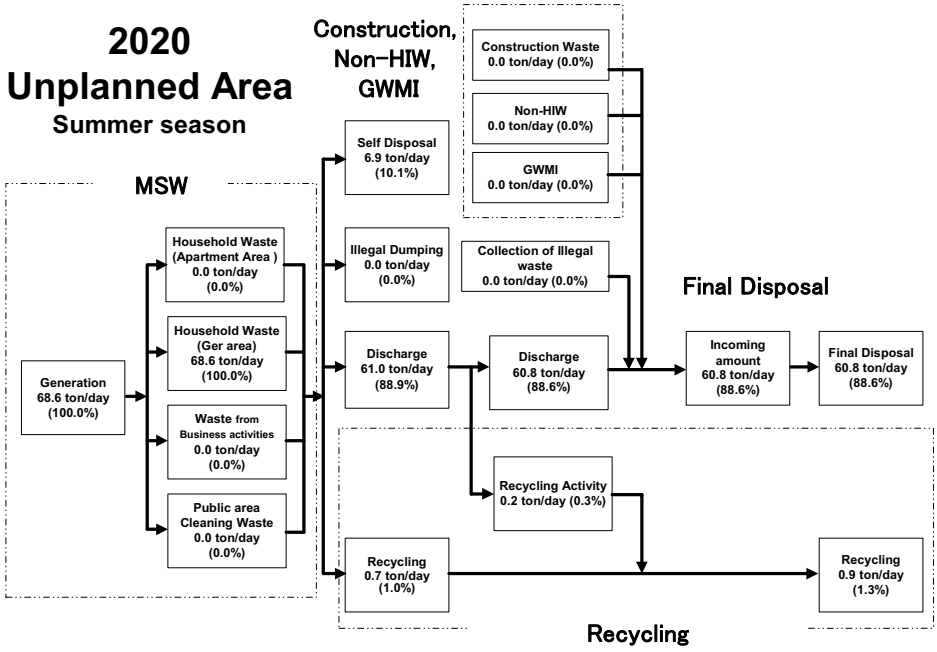


Figure 5-8: MSW Flow in Summer season in 2020 without M/P (Unplanned Area)

6. Selection of Optimum System

6 Selection of an Optimum System

6.1 Selection Method

6.1.1 Policy of Master Plan

An SWM technical system consists of various technical subsystems of a Discharge and Storage system, Collection and Haulage system, Public Area Cleansing system, Intermediate Treatment and Recycling system, Final Disposal system, and Maintenance system for Vehicles and Equipment. There are many potential technologies in each sub-system. Consequently, a number of alternatives can be formed for an optimum technical system from a combination of these various subsystems.

In order to screen the potential technologies and select an optimum technical system, the C/P and JICA Study team have set up the policies of the M/P as described below.

- Collection service will cover all residents by 2010. The waste collected will be disposed of at the final disposal site by sanitary landfill in order to minimize the negative effects on the environment.
- The fundamental goal of the M/P for SWM in MUB (Municipality of Ulaanbaatar) is to establish an environmentally sound SWM system in MUB by the target year 2020. To achieve this goal, the 3Rs (Reduce, Reuse, Recycle) will be actively promoted firstly to reduce waste generation, then to reuse and recycle generated waste as a resource as much as possible in order to reduce the amount of solid waste to be disposed of at the landfills.

6.1.2 Policies for Selection

Taking the current situation and background of SWM in the study area into account, the policies for the selection of an optimum technical system are as follows:

- Technical system proposals have to contribute to the implementation of the above-mentioned M/P policy.
- The implementation of technical system proposals have to be afforded by MUB and District governments and be justified in terms of national economy.
- The systems and technologies to be adopted should be simple so that operation and maintenance will be easy and inexpensive.
- The foreign currency requirements for the purchase, operation and maintenance of systems should be minimized. The use of locally available materials and services should be maximized.
- The proposed technical system should be consistent with the existing conditions and existing practices, in order to easily cope with the system.

6.1.3 Method of Selection

The SWM system consists of a collection and haulage system to remove generated waste from the living area and a final disposal system to suitably dispose the removed waste. Incinerating and composting is part of a processing system, called the intermediary system, between the collection and haulage system and final disposal system in order to ① reduce volume (to reduce the final disposal amount), ② stabilize (to stabilize the final disposal waste), and ③ detoxify (to make the final disposal waste non-hazardous) the waste. In the

event that sufficient capacity and a suitable location is secured for the final disposal site, it is possible to develop a sustainable SWM system even if there is no intermediary system.

An optimum discharge and storage system, and collection and haulage system are largely related in particular to the necessity of introducing separated collection and whether or not an intermediate treatment facility is introduced. Moreover, the necessity of introducing an intermediate treatment facility is greatly influenced by the capacity and location of the final disposal site. Therefore, the optimum system was selected in this study by the following process.

- Site selection work was carried out for the final disposal site and a disposal site was selected which can be used until the M/P target year of 2020. Accordingly, it was determined that the previously mentioned four disposal sites could be used until the year 2020.
- The necessity of introducing an intermediate treatment system was examined using the selected final disposal site as a base. Consequently, it was decided to plan the introduction of a valuables sorting yard and RDF production facility in order to promote the 3Rs for environmental conservation.
- As the introduction of a valuables sorting yard and RDF production facility was decided, optimum discharge and storage systems, and collection and haulage systems were examined for the introduction of separated collection necessary for the operation of the facility.

6.2 Identification of Potential Technologies

Each technical sub-system has potential technologies as shown in the table below.

Table 6-1: Technical Sub-systems and Potential Technologies

Technical Sub-systems	Items to be Examined	Potential Technologies
Discharge and Storage	Storage system	• Dust chute • Disposable containers • On-site waste storage • Small containers • Medium containers • Large containers
	Discharge system	• Mixed discharge • Separate discharge • Bring to the drop-off stations or buy-back stations
Collection and Haulage	Primary collection	
	Collection frequency	
	Mixed or separate collection	• Mixed collection • Separate collection
	Collection system	• Point collection • Communal container collection • Bell collection • Curbside collection • Door-to-door collection
	Collection Schedule	• Day collection • Night collection
	Collection equipment	• Compactor trucks • Non-compaction trucks • Tractors and trailers • Tipper trucks • Skip trucks • Railway transportation • Transfer of waste
Street Sweeping	Sweeping method	• Manual street sweeping • Mechanical sweeping • Vacuum sweeping • Flushing

Technical Sub-systems	Items to be Examined	Potential Technologies
Recycling	Material recycle	• Direct reuse • Raw materials for remanufacturing and reprocessing • Feedstock for production of biological and chemical conversion product • Land reclamation
	Thermal recycle	• Heat recovery • Fuel recovery
Intermediate treatment	Pre-treatment system	• Size reduction • Manual and mechanical sorting
	Treatment system	• Incineration • Refuse Derived Fuel (RDF) • Composting • Biogas Production • Size reduction • Manual and mechanical sorting
Final Disposal	Location of final disposal sites	• Mining pit, flat land or valley
	Landfill structure	• Anaerobic, Semi-aerobic or aerobic
	Level of sanitary landfill development and operation	• 4 sanitary landfill level
Maintenance of Vehicles and Equipment		• Preventive Service Workshop • Full Service Workshop

6.3 Screening Potential Technology

6.3.1 Collection and Haulage

The following systems are examined and the detailed screening work is available in the Annex report 5.3.

a. Storage System

Regarding storage system, the following systems were screened:

- Dust Chute
- Disposable containers (Sackcloth, paper sacks or plastic sacks)
- On-site waste storage
- Small containers (about 0.2 m^3)
- Medium containers (1 to 2 m^3)
- Large containers (5 to 10 m^3)

Conclusion of the screening works for the storage system is summarized in the table below.

	Residential waste in Planned Area	Residential waste in Unplanned Area	Other waste
Dust Chute	Unsuitable	Not applicable	Unsuitable
Disposable containers (Paper or plastic sacks)	Suitable	Suitable	Suitable
On-site refuse storage	Suitable	Unsuitable	
Small containers (about 0.2 m3)	Unsuitable	Suitable	Suitable
Medium containers (1 m3)	Unsuitable	Unsuitable	Suitable
Large containers (5 to 10 m3)	Unsuitable	Unsuitable	Suitable

b. Discharge System

The appropriate discharge system is closely related to the storage system and the collection system which is applied and in addition to the people's cooperation level. The following systems were examined:

- Mixed Discharge System

- Separate Discharge System
- Bring to the Drop-Off Stations or Buy-Back Stations by Dischargers

c. Collection and Haulage System

Regarding collection and haulage system, at first the need of primary collection are examined and then the following systems were screened:

- Collection Frequency
- Mixed or Separate Collection
- Collection System
- Collection Schedule
- Collection Equipment
- Railway Transportation
- Water Transportation
- Transfer of Waste

6.3.2 Public Area Cleansing System

a. Street Sweeping Methods

As practiced today, street sweeping methods may be grouped conveniently under these general headings:

- manual sweeping
- mechanical sweeping
- vacuum sweeping
- flushing

The above systems were screened in the Annex report.

b. Current Street Sweeping System

All TUKs currently employs the manual sweeping method. The sweepers collect and heap up litters with a broom and scrape it and put it into a wheel bin. The waste is later collected by waste collection vehicles. Sometimes after strong wind blow, water is sprayed with a water tanker onto roads to wash out dust.

c. Applicability

To use the flushing system is sometimes necessary because the strong wind carry lots of fine sands especially in spring and autumn; however the fully mechanical flushing system is not necessary because the frequency of the necessity of the flushing system is low.

The mechanical and vacuum sweeping systems are also not suitable for the study area because they require large capital, and incur high operational and maintenance costs.

Conclusively, the present manual sweeping is most suitable for the study area because of an abundant and inexpensive supply of labor force. The jobs that are produced by this sweeping system can contribute, albeit to a smaller degree, to the betterment of poor people. This system is also flexible and can cope with waste containing lots of sand.

6.3.3 Recycling

a. Alternatives

a.1 Government Related Recycling System

Government related recycling system is carried out as a means of economically controlling solid waste generation. This system obliges dischargers to conduct waste segregation and sorting, as well as separate discharge, collection and transportation. These activities incur additional costs and their success is heavily dependent on public cooperation. The government related recycling system is considered to be more productive and they reduce the amount of waste for final disposal.

a.2 Private Sector Centered Recycling System

The government has an indirect and limited role in the promotion of this recycling system that is the conduct of public education programs on recycling. This system does not impose separate collection and any risk encountered is solely the responsibility of the private entities involved.

b. Conclusions of Screening for Recycling Systems

Although the current recycling activities are limited due to the demand for recovered materials and the market value of the materials, the private sector is conducting material recycling as much as possible. Furthermore, in view of the limited financial capability of the MUB and Duureg governments, in principle SWM shall be as financially independent as possible and recycling is not exception though the promotion of 3Rs is the goal of M/P. The Team, therefore, sets the following policies for the recycling:

1. Recycling activities shall be conducted by the private sector in principle.
2. The role of public sector (MUB) shall be limited to:
   - Promote, support and regulate the recycling activities of private sector.
   - Develop technologies to recycle the wastes that the private sector can not deal with

6.3.4 Intermediate Treatment

a. Intermediate Treatment System

This section considers the possible options for:

- The treatment of wastes by improving or removing some of its undesirable characteristics (e.g., to reduce waste volume, to render waste inert)
- The recovery of some of the wastes either as energy (gas, steam or electricity) or as reusable materials (e.g., waste paper, ferrous scrap, compost)

Several criteria of prime importance in assessing the suitability and viability of any system of waste handling, treatment or recovery are as follows.

Technical feasibility

- **The degree to which the technology of the system is proven,** i.e., "are these plants actually in operation elsewhere?".
- **The reliability of the system and similar issues.** (These questions are particularly important when considering latest technologies since, for example, many recovery systems are of relatively recent development).
- **Its financial and economic implications**: how much will the system cost to construct and operate; what are the potential benefits from savings in transport and disposal costs and from the sale of recovered products; what other economic benefits does the system offer in terms of foreign exchange savings, employment, etc. Of

special importance here is the scope for actual selling and using any recovered products as this can frequently be less than is estimated.

- **Its management requirements**: how much qualified management and skilled labor will the system require to operate properly; how much co-operate will be obtained from the public, etc. Unless the necessary resources and skills are available, the system may be much less attractive than it initially appears.

Our assessment of the various operations below takes into account the prevailing conditions and problems in the target area, evaluating in broad terms the technical suitability and economic implications of different systems for handling, treatment and recovering solid wastes in the study area.

The following intermediate technologies are discussed in this section:

- Incineration
- Production of Refuse-Derived Fuel (RDF)
- Composting
- Biogas Production
- Size Reduction
- Mechanical and Manual Sorting

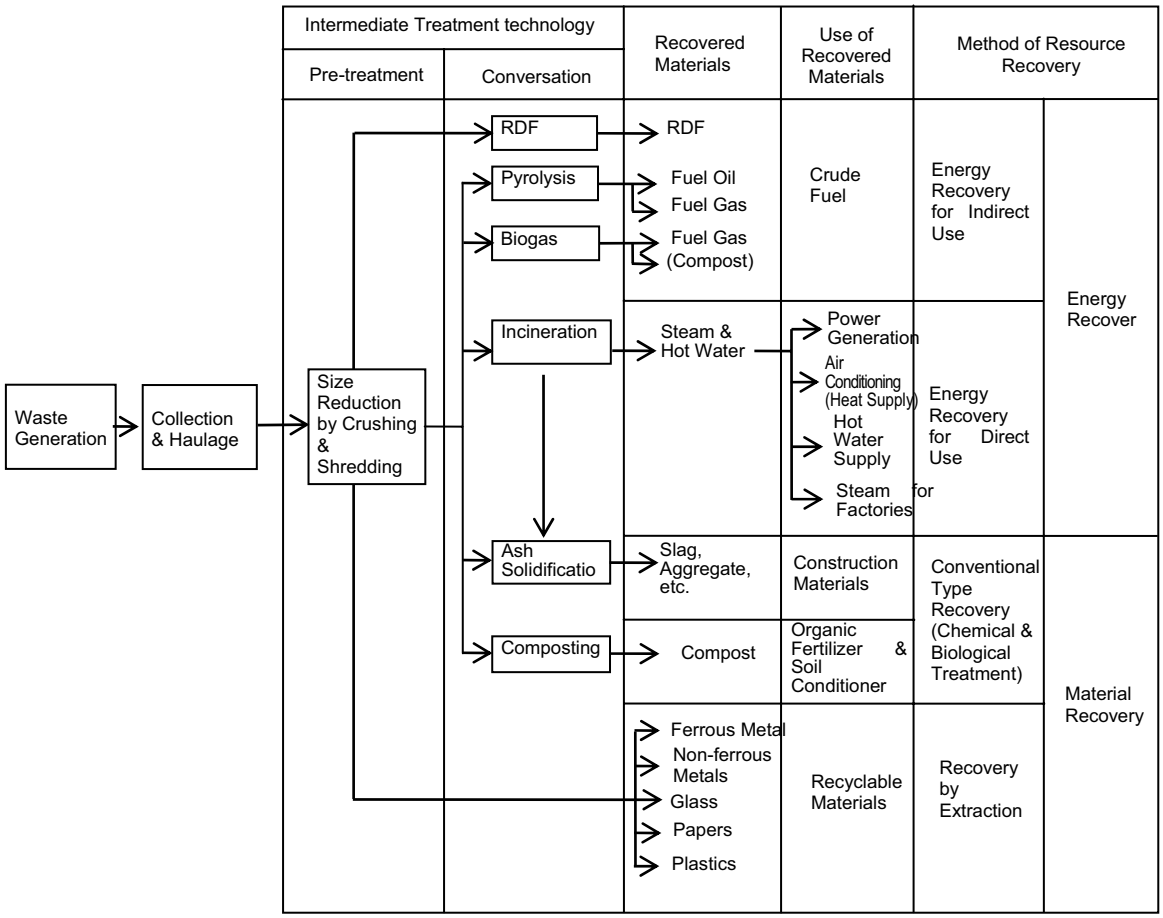


Figure 6-1: Intermediate Treatment Technologies and Resource Recovery Method

b. Summary of Screening Work for Intermediate Treatment Technology

The above-mentioned screening work for intermediate treatment technology is summarized in the table below.

Table 6-2: Characteristics of Possible Intermediate Treatment System

Intermediate Treatment Technology	Recovered Material	Main Target of System	Contribution to Landfill		Special Cautions							***Evaluation of Applicability***
			Volume Reduction	Stabilization	Stability of Technology	Pre-treatment	Rejected Substances	Acceptability of Refuse Quality	Construction Cost (US$/ton)	Marketability of recovered Material	Environmental Impact	
Incineration	Heat or Electric Power	Volume Reduction & Energy Conversion	A	A	A	Not Necessary	Non-combustibles (Ash)	A	High	B	B	It is not applicable because of • High initial/running cost and cheap sanitary landfill cost estimated by the Team
RDF	Solid Fuel	Conversion to Fuel	B	A	B	Necessary (size reduction, sorting)	Kitchen waste, Metal, Glass, Stone, Ash etc.	A	Low	A	B	It may be applicable if the following issues are cleared: • Stability of supplier and user • Measures to avoid air pollution
Biogas	Gas & Compost	Conversion to Fuel & Soil Conditioner	B	B	C	Necessary (size reduction, sorting)	Ash, Metal, Glass, Stone, Plastic, etc.	C	High	Gas : B Compost : C	C (Odor)	It is not applicable because of • Unproven technology • Requirement of strict segregation of waste and treatment of huge waste water
Composting	Compost	Conversion to Soil Conditioner	B	B	A	Necessary (size reduction, sorting)	Non-combustibles (Glass, Stone, Plastic, etc.)	B	Middle (Vessel type)	C	C (Odor)	It is not applicable because of • Lack of demands of the product (compost) • Unsuitable composition of waste, few compostable wastes
Size Reduction (Crushing & Shredding)	Ferrous etc.	Volume Reduction of Bulky Waste	C	A	A	Extraction of Explosive Object	Discarded Material	C	Low	B	C (Noise & Dust)	It is not applicable because of • No bulky waste
Sorting (Mechanical or Manual sorting)	Ferrous, Glass, Paper, Plastic, etc.	Recycling	B	A	A	Occasionally Necessary	Discarded Material	C	Low (Manual) Middle (Mechanical)	A	B	In addition to promotion of 3Rs, manual sorting system is recommended to provide job opportunities to waste pickers who will loose job when the new disposal site will open.

Note: A: Excellent B: Good C: Fair

6.3.5 Final Disposal Site

a. Final Disposal Methods

The final disposal methods can be divided into the following three types:

- open dumping
- controlled tipping
- sanitary landfill

Although the open dumping method is generally employed in the disposal sites in the study area, this operation shall be terminated in view of its adverse effects on landscape, public health and the environment.

Sanitary landfill should be adopted as it has been proven to be the most economical final disposal method in terms of controlling environmental impacts within the acceptable level.

b. Landfill Structure

There are five types of landfill structure as shown below.

- anaerobic landfill
- anaerobic sanitary landfill
- improved anaerobic sanitary landfill
- semi-aerobic sanitary landfill
- aerobic sanitary landfill

The semi-aerobic sanitary landfill or aerobic sanitary landfill methods are generally adopted aiming at the improvement of leachate quality. When the utilisation of biogas by using anaerobic digestion is planned in the region, the improved anaerobic sanitary landfill with liner is generally adopted.

The best landfill method depends on many factors such as the total solid waste management system, especially the type of processing and treatment method adopted, the climate, the natural condition of the disposal site, the available budget for solid waste management, etc. Therefore, these all factors have to be taken into account to select the best landfill method so that its own advantages can be effectively utilised.

In the study area, there is less precipitation and the wastes contain a lot of ash, therefore, the possibility of generating leachate is very low. Hence, the possibility of generating biogas also very low due to the composition of wastes that biodegradable wastes especially contents of kitchen wastes are very low. Therefore, semi aerobic sanitary landfill method is recommended as future landfill structure in the study area.

c. Level of Sanitary Landfill Development and Operation

The sanitary landfill development and operation levels are classified as follows:

- Level 1, Controlled tipping
- Level 2, Sanitary landfill with dike and daily soil covering
- Level 3, Sanitary landfill with primary leachate circulation system
- Level 4, Sanitary landfill with leachate treatment system

The above mentioned sanitary landfill development and operation levels are described and tabulated in the table below.

Table 6-3: Outline of Sanitary Landfill Development and Operation

Items	Level of Sanitary Landfill				Remarks
	1	2	3	4	
1 Site Development					
1.1 Main Facilities					
a. Enclosing Structures					
• Enclosing dikes		A	A	A	
• Dividers		B	A	A	B means a dike made of refuse and soil
b. Drainage System					
• Surrounding drains		A	A	A	
• On-site drains (surface water)		A	A	A	
• On-site drains (spring)		A	A	A	If necessary
• Drains for reclaimed area		A	A	A	
c. Access					
• Approach roads	A	A	A	A	
• On-site roads	A	A	A	A	
• Others	A	A	A	A	Improvement of existing road network to access the sites
1.2 Environmental Protection Facilities					
Buffer zones		A	A	A	
Litter control facilities		B	A	A	Movable fences, etc.
Gas removal facilities		B	A	A	
Leachate collection facilities			A	A	
Leachate circulation facilities			A	A	
Seepage control facilities			B	A	
Leachate treatment facilities				A	
1.3 Building and accessories					
Site office	B	A	A	A	
Weighbridge	A	A	A	A	
Store			A	A	
Safety facilities		A	A	A	Gate, fence, lights, etc.
Fire prevention facilities		B	A	A	Water tank, extinguisher, etc.
Monitoring facilities			A	A	Monitoring well, etc.
Car washer			A	A	
2 Equipment					
Landfill Equipment	A	A	A	A	
Others			A	A	Water truck, inspection vehicles, etc.
3 Operation and Maintenance					
3.1 Operation					
a. Personnel	A	A	A	A	
b. Cover material	B	A	A	A	B means insufficient soil cover.
c. Utility					
• Fuel tank	A	A	A	A	
• Water		A	A	A	
• Electricity	B	A	A	A	
d. Chemicals					
• Insecticide	A	A	A	A	
• Monitoring chemicals			A	A	
e. Others		A	A	A	Divider, drain for reclaimed area, leachate collection pipes, etc.
3.2 Maintenance					
• Main facilities		A	A	A	
• Environmental protection facilities		A	A	A	
• Building and accessories	A	A	A	A	
• Equipment	A	A	A	A	

A: necessary
B: necessary under certain conditions, or may be omitted when budget is not enough

In fact the sanitary levels of 3 existing disposal sites in UBC are worse than the first sanitary level which is the poorest.

Since it is difficult to improve the existing disposal site to fourth sanitary level in a short period, it is recommended that part of UCDS shall be improved through the pilot project and this improvement methods shall be applied to other disposal sites in a later stage.

New final disposal site is strongly recommended to be constructed and operated under forth sanitary level.

6.4 Selection of Optimum Technical System

6.4.1 Comparison of Alternatives

a. Selection of Final Disposal Site

The six potential disposal sites selected in the previously mentioned final disposal site selection work were presented in the St/C. Accordingly, the counterpart (C/P) and the study team compared the alternative six proposed disposal sites. In short, the waste collection and haulage including transfer station (T/S) and disposal cost was calculated for each site and the alternatives were assessed on how they fit in with the initial environment.

Table 6-4: Six Alternative M/P Technical Systems

Alternative (Site)	System
Alternative 1: Narangiin Enger disposal site (NEDS)	6 Districts => NEDS Nalaikh District => Nalaikh Coal Mining disposal site (NCMDS)
Alternative 2: XMK disposal site (XMKDS)	6 Districts => XMKDS Nalaikh District => NCMDS
Alternative 3: Morin Davaa disposal site (MDDS)	6 Districts => MDDS Nalaikh District => NCMDS
Alternative 4 : Tsagaan Davaa disposal site (TDDS)	6 Districts => TDDS Nalaikh District => NCMDS
Alternative 5: Bayangiin Khonkhor disposal site (BKDS)	6 Districts => Transfer Station (T/S) => BKDS Nalaikh District => BKDS
Alternative 6 BCMDS: Baganuur coal mining disposal site (BCMDS)	6 Districts => T/S => Railway => T/S => BCMDS Nalaikh District => NCMDS

From the results of the comparison of the alternative sites, the workshop participants assessed the pros and cons of the alternatives, based on the six proposed final disposal sites. The St/C decided upon the proposed Narangiin Enger site as the future disposal site for the main six districts of Ulaanbaatar City based on the results of the workshop investigation.

Therefore, waste generated in Ulaanbaatar City in 2020 is scheduled to be disposed of at the following four disposal sites.

Table 6-5: Final Disposal Site and Disposal Amount in 2020

Landfill site	Ratio (%)	Final Disposal Amount (ton/day)	
		Winter season	Summer season
NEDS	91	935.4	911.2
MDDS	5	51.3	50.1
NDS	3	30.8	30.1
KH21DS	1	10.3	10.0
Total	100	1027.8	1001.4

b. Introduction of Intermediate Treatment System

Comparative work for the intermediate treatment system was carried out in accordance with the selection policies and the details are described in the Annex Report. Introduction of a valuables sorting yard and RDF production facility was decided based on the results of the study and the main reasons for this decision are listed below.

b.1 Valuables Sorting Yard

- Waste Picker (WP) activity will be prohibited because sanitary landfill will be conducted at the new Narangiin Enger disposal site (NEDS). Therefore, the WPs who are making a living at the current Ulaan Chuluut disposal site (UCDS) will lose their livelihoods. Thus it is essential for securing their workplace.

- It will be possible to utilize the RDF production facility as a pre-processing facility.

b.2 RDF Production Facility

- Plastic and paper waste is a significant obstacle to the conservation of the environment of the final disposal site (waste scattering) and smooth operation (compaction).
- The proportion of plastic and paper waste in the municipal solid waste (MSW) of Ulaanbaatar City is extremely high. The combined percentage of plastic and paper waste in household waste in the Apartment area, which does not produce ash, is 36.1% in all year average and in the summer season it accounts for 34.1% of all MSW. As the density of this waste is low, the volume becomes several times higher than that of food waste and the above problems occur at the disposal site.
- On the other hand, the percentage of food waste which is generally a main cause of the deterioration of disposal site environments (generation of leachate and bad smells) is very low. It accounts for 37.3% of the household waste in the Apartment area, which does not produce ash, and in the summer season it does not account for more than 33.8% of all MSW. Furthermore, as cattle manure is discarded at the disposal site if the disposal fee is paid, it was decided that there is almost no demand for compost made from the MSW.
- There is extremely low domestic demand for plastic and paper waste materials and recycling and because most of the consumers are in China which is thousand of kilometers of transport away, it is limited to high cost PET bottles. Moreover, strict separation is essential for ensuring a prescribed quality for material recycling but it is difficult to implement separation.
- There is significantly high demand for waste to be used as fuel because the calorific value plastic and paper waste is extremely high (9,000 and 5,000 kcal/kg) and it is a cold climate. However, it is necessary to homogenize the size in order to use it as fuel, and the RDF production facility is an essential to do this.
- If the size is homogenized and it is possible co-combust with coal, it is possible to use the RDF produced from using plastic and paper waste at existing power plants or large-scale heat supply plants thus there is an enormous demand for it.

6.4.2 Selection of an Optimum Technical System

The optimum technical system was selected, as shown below, in accordance with the results of the comparison of alternatives.

Table 6-6: Optimum Technical System

Sub-system	Plan System
Discharge and Storage	● **Source Separation:** Waste will be separated into recyclable and non-recyclable waste in the Apartment area but it will be mixed discharge in the Ger Area. ● **Storage Container:** Public containers for bulk dischargers and other individual containers (generally, plastic bags)
Collection	● **Collection Frequency:** Twice a week in the Apartment Area (non-recyclable waste), once a week (recyclable) and twice a month in the Ger area. ● **Collection Method:** Point collection (Entrance Collection) and curb sude collection in the Apartment Area. Door to door collection in the Ger Area. ● **Collection Time:** Daytime collection ● **Collection Vehicle:** Compactor truck in the Apartment Area and dump truck in the Ger Area. ● **Haulage Method:** Directly transported to each disposal site.

Sub-system	Plan System
Public Area Cleansing	Combination of manual and machine use. Revised taking into consideration future costs and manpower from the viewpoint of the cost benefit of the proportion of manual labour and machinery.
Recycling	The following public participation recycling systems will be established. ● A plan will be established to promote and develop private sector recycling activities. One plan for this is to construct a recycling complex adjacent to NEDS in order to attract private enterprises. ● A separate discharge system will be established at the source and recycling of the separately discharged waste will be promoted.
Intermediate Treatment	A valuables sorting yard and RDF Production facility will be constructed and will operate within the Narangiin Enger Recycling Complex (NERC) to recycle the recyclable waste discharged separately from the Apartment Area.
Final Disposal	Suitable landfill will be carried out at the following 4 disposal sites. ● NEDS: Sanitary landfill ● Morin Davaa disposal site, Nalaikh disposal site, Khoroo 21 disposal site: semi-sanitary landfill.
Maintenance for Vehicles	● Carry out preventative maintenance and establish a small-scale repair shop and entrust large-scale repairs to private companies.