Democratic Socialist Republic of Sri Lanka
Central Environmental Authority (CEA)

Democratic Socialist Republic of Sri Lanka Pollution Control and Reduction of Environmental Burden in Solid Waste Management (ReEB Waste)

Final Report

February 2019

Japan International Cooperation Agency (JICA)

EX Research Institute Ltd.
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Contents

Contents of Figure

Contents of Table

Photos

Kick off meeting (7th March 2017)

Discussion on pilot project sites (27th March 2017)

Sundarapola disposal site (KMC) (March 2017)

Compost plant at Kanadola site (RMC) (March 2017)

Galapitagalayaya site and Compost plant (KPS) (March 2017)

Discussion with a short term expart on Sundarapola disposal site KMC and Galapitagalayaya disposal site KPS

Leachate sampling at the disposal site in KMC

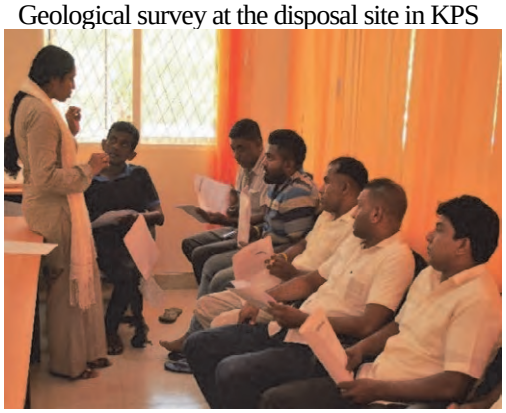
Groundwater sampling near the site in KMC

Preview of composition survey areas in RMC

Sorting yard in Kanadola site of RMC

Geological survey at the disposal site in KPS

Awareness rising by KPS during Kataragama festival



Explanation of POS at KPS and practice of the interview

Interview to public of KPS in survey

Project kick-off seminar (27 October 2017)

Discussion with a short term expart (RMC)

Cooperation with JOCV (KPS)

Meeting to explain to residents (KMC)

Start of windrow system compost in RMC (December 2017)

Construction of elephant fence at Galapitigalayaya disposal site (KPS)

Promotion of 3Rs - home compost - (KPS)

Construction of a Security Hut in theDumpsite in KPS

Sight Visit for the Tender at the Dumpsite in KPS

SWM awareness event (RMC)

Awareness rising at community meeting (RMC)

Material of PRB in the dumpsite of KMC

The location to install PRB in dumpsite of KMC

Study Tour of Shibushi City, Japan

Prof. Kawamoto visited the dumpsite in KMC

Progress of construction of disposal site in KPS

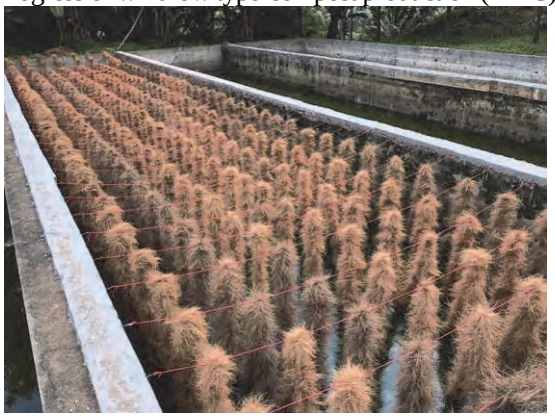
Construction of night soil treatment plant in KPS

Compost site visit by KPS Zone 4 community leaders

Meeting on monitoring system with guesthouse owners of Zone 3

Progress of windrow type-compost production (RMC)

Home compost monitoring by supervisor (RMC)



Rehabilitation of night soil and leachate treatment faicility in KMC (May2018)

Stocked PRB material at landfill site in KPS

Construction of the PRB at KMC

Completion of the construction of landfill site in KPS

Abbreviations

AMOH	Additional Medical Officer of Health
C/P	Counterpart
CBO	Community-Based Organization
CEA	Central Environmental Authority
CMOH	Chief Medical Officer of Health
CPHI	Chief Public Health Inspector
EDCF	Economic Development Cooperation Fund
EIA	Environmental Impact Assessment
JICA	Japan International Cooperation Agency
JOCV	Japan Overseas Cooperation Volunteers
KMC	Kurunegala Municipal Council
KPS	Kataragama Pradeshiya Sabha
MC	Municipal Council
MoH	Ministry of Health, Nutrition and Indigenous Medicine
MoLGPC	Ministry of Local Government and Provincial Councils
MoMDE	Ministry of Mahaweli Development & Environment
MoMWD	Ministry of Megapolis and Western Development
N/A	Not Applicable
NSWMSC	National Solid Waste Management Support Centre
PHI	Public Health Inspector
PP	Pilot Project
PRB	Permeable Reactive Barrier
PS	Pradeshiya Sabha
ReEB Waste	Pollution Control and Reduction of Environmental Burden in Solid W Management
RMC	Ratnapura Municipal Council
SWM	Solid Waste Management
UNESCAP	United Nations Economic and Social Commission for Asia and Pacific
UDA	Urban Development Authority
WMA	Waste Management Authority
WP	Work Plan

Map: Sri Lanka and pilot project sites

Source: Google Maps (https://www.google.lk/maps/@7.8860103,80.1473432,8z)

1 Outline of the Project

1.1 Background and Objectives

The Government of Japan, through Japan International Cooperation Agency (JICA), has been providing various assistances to the Government of Sri Lanka in the field of Solid Waste Management (SWM), since the National Strategy for Solid Waste Management was established in the year 2000. The Study on Improvement of Solid Waste Management in Secondary Cities (2002-2003) recommended an institutional system in which the central government assisted local governments, taking into account their limited capacity in this field. This recommendation established the National Solid Waste Management Support Centre (NSWMSC) and its capacity was enhanced through the JICA Technical Cooperation between 2007 and 2011. Meanwhile, the Central Environmental Authority (CEA) started up the Pilisaru Programme in 2008, which supported local governments in construction of waste disposal sites and composting facilities.

These efforts have improved sanitation problems such as uncollected wastes and clandestine dumping, which were recognized as issues in the abovementioned study on SWM in secondary cities, since its implementation in 2002/2003. In recent years, environmental improvement of waste disposal sites and waste minimization by composting are of growing significance, as waste generation amount is increasing in line with economic development.

To cope with these challenges, a technical cooperation program, “Science and Technology Research Partnership for Sustainable Development (SATREPS) - Pollution Control and Environmental Restoration Techniques for Solid Waste Landfills in Sri Lanka”, was carried out between 2011 and 2016, and several techniques were developed. These techniques were presented in scientific papers and international conferences. A guide for utilizing the techniques, hereinafter referred to as “SATREPS Guide”, was developed in a project by the Ministry of Higher Education, CEA, NSWMSC and others, is planned to be finalized in a stakeholder meeting on 13th June 2017.

This Project aims to verify the practical usefulness of the techniques presented in the SATREPS Guide in the field and disseminate the guide to improve the environmental situation of as many final disposal sites in Sri Lanka as possible by experts in Pollution Control and Reduction of Environmental Burden in Solid Waste Management

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1.2 Project Implementation Structure

1.2.1 Organizations Concerned

The Project is to be jointly implemented between the Sri Lankan side and the Japanese side. Organizations concerned are listed as below.

(1) Sri Lankan Side

The following are the organizations concerned of the Sri Lankan side. Each organization is to assign personnel for this Project.

- Government Agencies
  - Central Environmental Agency, CEA (responsible for project implementation)
  - Ministry of Local Government and Provincial Councils, MoLGPC
  - National Solid Waste Management Support Centre, NSWMSC
  - MoMWD, Urban Development Agency, UDA
  - Colombo Municipal Council, CMC
  - Waste Management Authority – Western Province, WMA
- Universities (SATREPS Partners)
  - University of Peradeniya
  - University of Ruhuna

(2) Japanese Side

- JICA Project Team (responsible for project implementation)
  - Long term Expert
  - Technical Advisors (SATREPS techniques, final disposal, composting, waste separation)
  - Consultants (Chief consultant/solid waste management, final disposal, composting, environmental education, environment and social considerations)
- JICA Sri Lanka Office
- JICA Tokyo Headquarters

1.3 Project Design Matrix

The following is the latest version of Project Design Matrix.

Pollution Control and Reduction of Environmental Burden in Solid Waste Management
Project Area: Whole country of Sri Lanka and pilot project sites Ver. 1
Duration: March 2017 – February 2019

1 March 2017

Narrative summary	Objectively verifiable indicators	Means of verification	Important assumptions
Overall goal Environmental hygiene is improved by introducing appropriate technologies to exisitng final disposal sites and strengthening appropriate solid waste management Project purpose The capacity of CEA will be strengthened through Project activities, namely verification of appropriate technologies for management of final disposal sites, and utilization of the existing SATREPS Guide and the newly developed manuals	1. Pilot project(s) involving CEA using appropriate composting techniques and SATREPS technology is implemented 2. CEA disseminates the SATREPS Guide and the manual which have the results of the pilot project reflected 3. Roles of CEA are defined in various manuals based on the actual interaction of CEA during the pilot project	1. Number of pilot projects implemented 2 . Number of mid-term reporting seminars and output dissemination seminars held and number of participants 3. Various manuals	
Outputs			
1 The usefulness of SATREPS Guide and appropriate technology for management of final disposal in Sri Lanka will be confirmed through pilot projects implemented in the Project. Manuals for such purposes will also be developed.	1. Pilot project(s) using SATREPS technologies are implemented (quantitative indicators will be decided after deciding on pilot project sites and receiving advice from JICA short-term expert) 2. Manual for improving final disposal site facilities with results of pilot project(s) reflected is developed	1 . Implemented pilot project(s) 2 . Manual for improving final disposal site facilities	1. Sri Lankan environmental legislation and policy does not change significantly. 2. Prices of materials and fuel does not increase dramatically. 3. Security and safety situation of pilot city(s) remains stable.
2 Appropriate operational methods for composting operations are confirmed through pilot project(s) in the Project. A manual for this purpose is developed	1. A pilot project using appropriate operational methods for composting operations is implemented (quantitative indicators will be decided after deciding on pilot project site and receiving advice from JICA short-term expert) 2. Manuals, reflecting pilot project results, are developed towards utilization of biogas and advancing composting technology	1 . Implemented pilot project 2 . Manual for adoption of technology towards utilization of biogas and advancing composting technology	
3 Outputs of SATREPS Guide is disseminated	1. Outputs of SATREPS technology implemented in pilot project(s) are reflected in the manual for improving final disposal site facilities. 2. Manual for improving final disposal site facilities is disseminated to stakeholders.	1. Manual for improving final disposal site facilities 2. Holding of mid-term reporting seminar(s) and output dissemination seminar(s)	
4 CEA furthers its understanding of SATREPS Guide and implements pilot project(s) utilizing the Guide	New pilot project(s) utilizing SATREPS technology are planned or implemented by CEA	Plans or implementation records of new pilot project(s) utilizing SATREPS technology	

Pollution Control and Reduction of Environmental Burden in Solid Waste Management
Project Area: Whole country of Sri Lanka and pilot project sites
Duration: March 2017 – February 2019

Ver. 1

1 March 2017

Narrative summary	Objectively verifiable indicators	Means of verification	Important assumptions
5 CEA furthers its understanding of appropriate composting operational methods and implements pilot project(s) utilizing such methods	New pilot project(s) utilizing appropriate composting operational methods are planned or implemented by CEA	Plans or implementation records of new pilot project(s) utilizing appropriate composting operational methods	
Activities	Inputs		Preconditions Stakeholders participate in the Project
1 Utilization of SATREPS Guide and greater dissemination of outputs	<u>Sri Lankan side</u> 1. Counterpart personnel from: − CEA − Other relevant organizations 2. Facilities − Office space for CEA experts − Utility costs − Data and information 3. Operational costs	<u>Japanese side</u> 1. Long-term expert (SWM) 2 . Short-term expert (in local government affairs) 3. Consultant expert 4. Costs of necessary surveys 5. Provision of equipment/materials (as necessary) 4. Support of operational costs	
2 (1) Development and implementation of pilot project(s) utilizing SATREPS Guide (2) Development and implementation of pilot project(s) utilizing appropriate composting technology			
3 (1) Advising on rehabilitation, operation and maintenance of existing landfills			
4 Promotion of development of new projects to upgrade, rehabilitate existing landfills or to construct new sanitary landfill disposal sites through discussions with counterparts, etc.			
5 Development and/or promotion of waste management projects in areas besides those abovementioned based on the results of the *Survey to research and collect information on waste management*			

Pollution Control and Reduction of Environmental Burden in Solid Waste Management
Project Area: Whole country of Sri Lanka and pilot project sites
Duration: March 2017 – February 2019

Ver. 2

1 March 2017

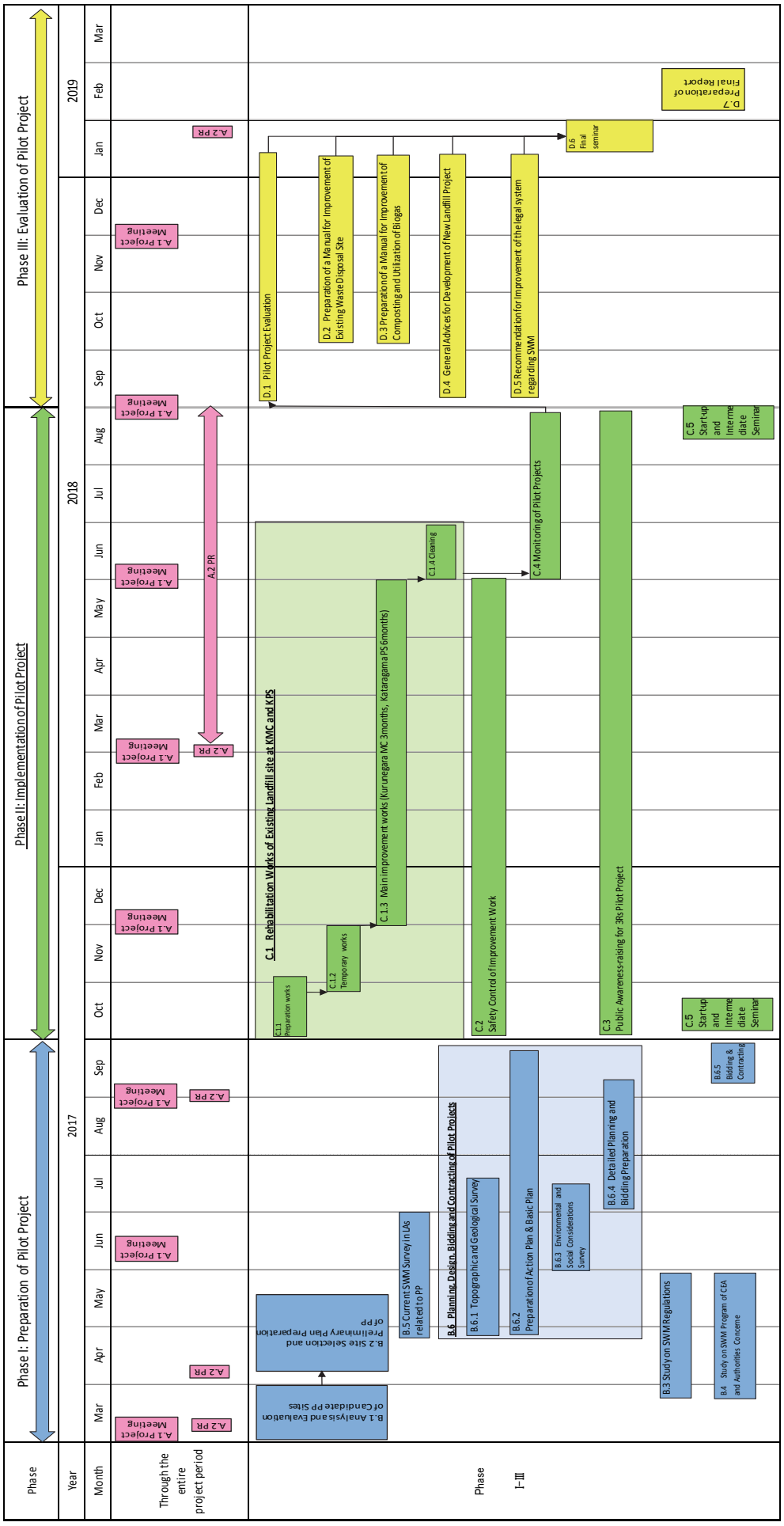
Narrative summary		Objectively verifiable indicators	Means of verification	Important assumptions
Overall goal Environmental hygiene is improved by introducing appropriate technologies to exisitng final disposal sites and strengthening appropriate solid waste management				
Project purpose The capacity of CEA will be strengthened through Project activities, namely verification of appropriate technologies for management of final disposal sites, and utilization of the existing SATREPS Guide and the newly developed manuals		1. Pilot project(s) involving CEA using appropriate composting techniques and SATREPS technology is implemented 2. CEA disseminates the SATREPS Guide and the manual which have the results of the pilot project reflected 3. Roles of CEA are defined in various manuals based on the actual interaction of CEA during the pilot project	1. Number of pilot projects implemented 2 . Number of mid-term reporting seminars and output dissemination seminars held and number of participants 3. Various manuals	
Outputs				
1	The usefulness of SATREPS Guide and appropriate technology for management of final disposal in Sri Lanka will be confirmed through pilot projects implemented in the Project. Manuals for such purposes will also be developed.	3. Pilot project(s) using SATREPS technologies are implemented (quantitative indicators will be decided after deciding on pilot project sites and receiving advice from JICA short-term expert) 4. Manual for improving final disposal site facilities with results of pilot project(s) reflected is developed	1 . Implemented pilot project(s) 2 . Manual for improving final disposal site facilities	1. Sri Lankan environmental legislation and policy does not change significantly. 2. Prices of materials and fuel does not increase dramatically. 3. Security and safety situation of pilot city(s) remains stable.
2	3Rs is promoted to properly operate composting facilities and material recovery facility through pilot project(s) in the Project. A manual for this purpose is developed	1. A pilot project promoting 3Rs to properly operate composting facilities and material recovery facility is implemented (quantitative indicators will be decided after deciding on pilot project site and receiving advice from JICA short-term expert) 2. Manuals, reflecting pilot project results, are developed towards utilization of biogas and advancing composting technology	1 . Implemented pilot project 2 . Manual for adoption of technology towards utilization of biogas and advancing composting technology	
3	Outputs of SATREPS Guide is disseminated	1. Outputs of SATREPS technology implemented in pilot project(s) are reflected in the manual for improving final disposal site facilities. 2. Manual for improving final disposal site facilities is disseminated to stakeholders.	1. Manual for improving final disposal site facilities 2. Holding of mid-term reporting seminar(s) and output dissemination seminar(s)	

Pollution Control and Reduction of Environmental Burden in Solid Waste Management
Project Area: Whole country of Sri Lanka and pilot project sites Ver. 2
Duration: March 2017 – February 2019

1 March 2017

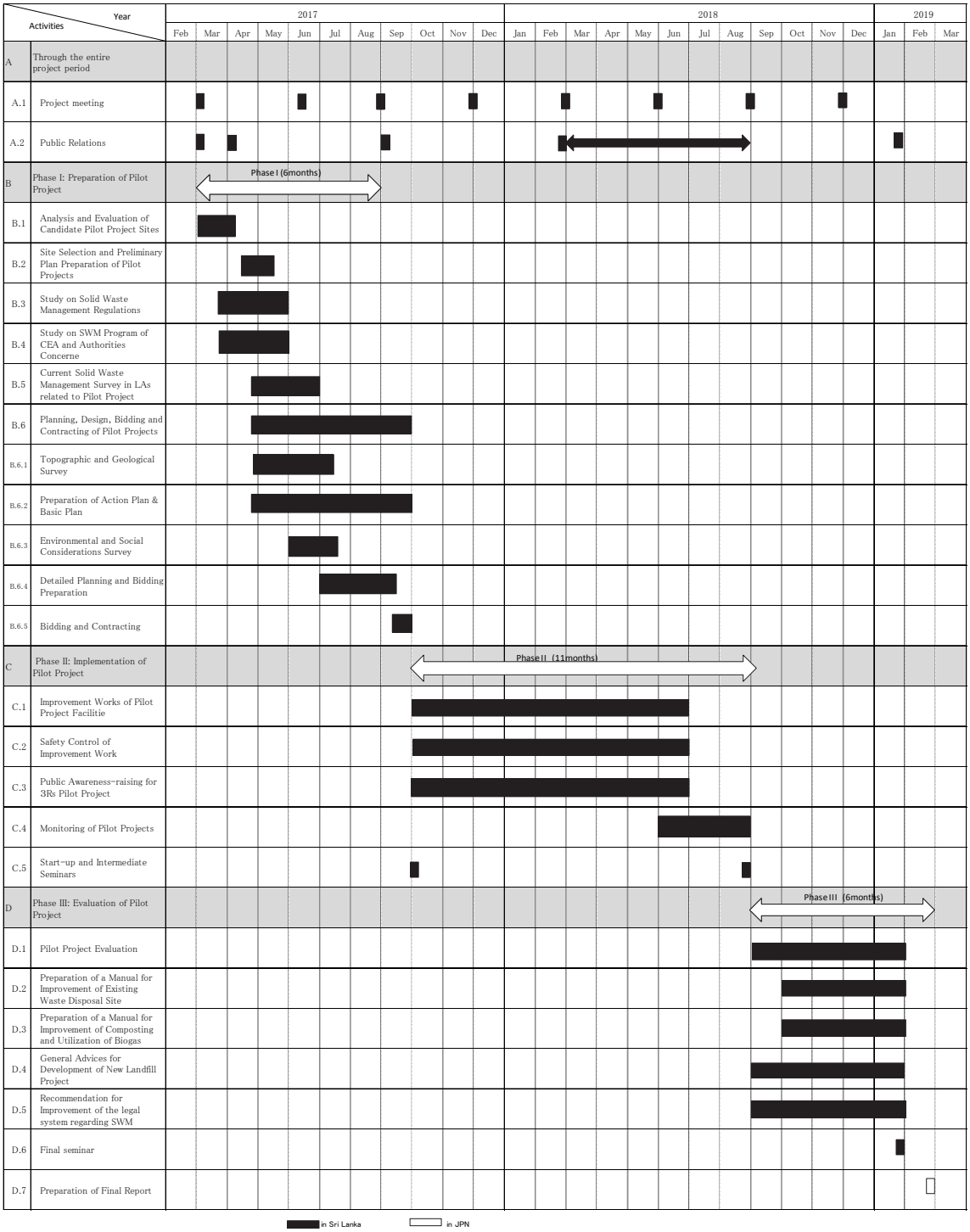
Narrative summary	Objectively verifiable indicators	Means of verification	Important assumptions
4 CEA furthers its understanding of SATREPS Guide and implements pilot project(s) utilizing the Guide	New pilot project(s) utilizing SATREPS technology are planned or implemented by CEA	Plans or implementation records of new pilot project(s) utilizing SATREPS technology	
5 CEA furthers its understanding of promotion of 3Rs to properly operate composting facilities and material recovery facility and implements pilot project(s) utilizing such methods	New pilot project(s) promoting 3Rs to properly operate composting facilities and material recovery facility are planned or implemented by CEA	Plans or implementation records of new pilot project(s) utilizing appropriate composting operational methods	
Activities	Inputs		Preconditions Stakeholders participate in the Project
1 Utilization of SATREPS Guide and greater dissemination of outputs 2 (1) Development and implementation of pilot project(s) utilizing SATREPS Guide (2) Development and implementation of pilot project(s) utilizing appropriate composting technology 3 (1) Advising on rehabilitation, operation and maintenance of existing landfills 4 Promotion of development of new projects to upgrade, rehabilitate existing landfills or to construct new sanitary landfill disposal sites through discussions with counterparts, etc. 5 Development and/or promotion of waste management projects in areas besides those abovementioned based on the results of the *Survey to research and collect information on waste management*	Sri Lankan side 1. Counterpart personnel from: − CEA − Other relevant organizations 2. Facilities − Office space for CEA experts − Utility costs − Data and information 3. Operational costs	Japanese side 1. Long-term expert (SWM) 2 . Short-term expert (in local government affairs) 3. Consultant expert 4. Costs of necessary surveys 5. Provision of equipment/materials (as necessary) 4. Support of operational costs	

1.4 Flow Chart



1.5 Plan of Operation

The following is the first plan of operation.



2 Detailed Activities

This chapter describes detailed activities of the Project.

2.1 Production and authorisation of Work Plan

Work Plan was discussed in the kick off meeting with relevant governmental agencies including a counterpart organisation on the 7th March 2017. On 7the April 2017 after circulation of the Work Plan to participants and absentees of the Kick off meeting, WP was approved by the counterpart and approval letter was issued. (Please see appendix 1).

2.2 Production of progress reports

Progress reports are made and updated every three months to explain progress of the project and discuss it in line with the date of project meetings shown below. This 2nd progress report is the update of the 1st progress report, adding the activities from June to August 2017.

2.3 A.1: Project meetings

Purpose of the project meetings is to provide opportunities of shared understanding on the indicators of project output and progress of the project, which will obtain an initiative of CEA.

2.3.1 Kick off meeting

Project kick off meeting was held with relevant governmental agencies including a counterpart organisation on7th March. Meeting agenda is shown below. ‘Minutes of the meeting’ is available in the appendix 2.

(1) Outline of the project (regarding Work Plan)

(2) Preliminary plans of pilot projects

(3) Selection of pilot project sites

2.3.2 1st project meeting

First project meeting was held combined with the meeting of finalization of SATREPS Guide in 13th June 2017. Participants included University of Peradeniya and University Rufuna. The minutes of meeting is available in project Appendix 3-1.

(1) Explanation of the progress of pilot project by Dr. Sato

(2) Explanation of the outline of the SATREPS Guide by Dr. Gamunu

(3) Discussion

2.3.3 2nd project meeting

Second project meeting was held on 25th October 2017. The minutes of meeting is available in project Appendix 3-2.

(1) Welcome and Opening Remarks by Chairman, CEA

(2) Project Progress of ReEB Waste and Progress of formulating new JICA SWM project and conducting Surveys by Dr. Onuma, Long term expert

(3) Progress of the pilot project by Dr. Sato, Consultant expert

(4) Reviewing any inputs from the stakeholders for Draft SATREPS Guide (Ver.1)

(5) Close

2.3.4 3rd project meeting

Third project meeting was held on 24th January 2018. Minutes of the meeting are available in the project Appendix 3-3.

(1) Welcome and Opening Remarks

(2) Project Progress of ReEB Waste
- Financial Progress
- Other activities progress and Activities plan for 2018

(3) Progress of the pilot project.
- Public Relations
- Detailed planning and bidding preparation
- Bidding and contracting
- Rehabilitation works of existing landfill site
- Safety control of improvement work
- Start up seminar on 27 October 2017

(4) Reviewing any inputs from the stakeholders for Draft SATREPS Guide (Ver.1)

2.3.5 4th project meeting

The 4th stakeholder meeting was held on 22nd March 2018 at CEA. The agenda of this meeting is shown as below and a handout was attached as appendix 3-4.

(1) Welcome and Opening Remarks (Acting Chairman/DG, CEA)

(2) Project Progress of ReEB Waste
- Financial Progress
- Other activities progress

(3) Reviewing any inputs from the stakeholders for Draft SATREPS Guide (Ver.1)

(4) Progress of the pilot project
- Public Relation
- Detailed planning and bidding preparation
- Bidding and contracting
- Rehabilitation works of existing landfill site
- Safety control of improvement work

(5) Review of study tour in Japan

2.3.6 5th project meeting

The 5th stakeholder meeting was held on 29th June 2018 at CEA. The agenda of this meeting is shown below. Meeting minutes are refered to in Appendix 3-5.

(1) Welcome and Opening Remarks (Acting Chairman/ DG/ DDG, CEA)

(2) Project Progress of ReEB Waste
- Financial Progress
- Other activities progress

(3) Distribution of SATREPS Guide (Ver.1)

(4) Progress of the pilot project
- Public Relations
- Rehabilitation works of existing landfill site
- Safety control of improvement work
- Public awareness-raising for compost pilot project
- Monitoring of pilot projects

(5) Schedule of upcoming activities

(6) Closing remarks

2.3.7 6th project meeting

The 6th stakeholder meeting was held on 23th October 2019 at CEA. The agenda of this meeting is shown below. Meeting minutes are refered to in Appendix 3-6.

(1) Welcome and Opening Remarks (DG/DDG(WM), CEA)

(2) Project Progress of ReEB Waste

2.1 Financial Progress

2.2 Results of RMC SWM Working Hour Utilization Survey

2.3 Progress of Waste Flow and Recycle Industry Survey

(3) Progress of the pilot project

3.1 Monitoring of pilot project

3.2 Evaluation of Pilot Project

3.3 Preparation of Manual

(4) Closing

2.3.8 Final project meeting

The final stakeholder meeting was held on 29th January 2019 at CEA. The agenda of this meeting is shown below. Meeting minutes are refered to in Appendix 3-7.

(1) Welcome and Opening Remarks (Chairman/DG/DDG(WM), CEA)

(2) Opening Remarks (JICA Sri Lanka Office)

(3) Project Progress of ReEB Waste

2.1 Financial Progress

2.2 Results of Waste Flow and Recycle Industry Survey and the Survey

(4) Result Dissemination Seminar on December 13th

2.3 Report on the result of the Japan study tour in January (Onuma & Ms. Sarojinie)

2.4 Presentation of Shibushi-city waste management policy introduction video translated into 3 languages (Sinhala, Tamil, English)

(5) Progress of the pilot project

3.1 Monitoring of pilot project

3.2 Evaluation of Pilot Project

3.3 Preparation of Manual

(6) Closing remarks

2.4 A.2: Public Relations

Public relations activities are designed to publicize, in a timely manner, the progress of the following activities:

Table 2-1: Plan of public relations

Implemented	Contents of publication	Media	Targeted population	Language	Timing
April 2017	Introduction of the outline of the project	CEA web site	Residents of Sri Lankan	English Sinhalese, Tamil	1st project meeting after deciding on the pilot project
September 2017		TV, radio, newspaper (national and local)			
November 2017		News letter			
November 2017 August 2018	Introduction of pilot projects -plan of pilot projects -progress of pilot project	TV, radio, newspaper (national and local) Newsletter	Residents of local authority implementing the pilot project and Sri Lanka	English Sinhalese, Tamil	At he beginning and completion of construction works under pilot project. After interim seminar
October 2017		CEA web site	Residents of Sri Lankan		On momentous occasions during implementation pilot projects
November 2017 Onward		Web site and SNS of local authority implementing the pilot project	Residents of local authority implementing the pilot project and Sri Lanka		
February 2018	Outcomes of pilot projects -evaluations of pilot project -final seminar	CEA web site	Residents of Sri Lankan	English Sinhalese, Tamil	At the time of final seminar
January 2018		Web site and SNS of local authority implementing the pilot project	Residents of local authority implementing the pilot project and Sri Lanka		
January 2018		TV, radio, newspaper (national and local)			

Mr. Indrarathna, Deputy Director General in Waste Management, issued a letter on 6 April 2017 to request to set up a portal for the Project within the existing CEA Website addressed to Deputy Director General in Human Resource Development, Administration and Finance, whose department is in charge of maintenance of the website. By the end of June, a link to the Project's portal has been set up on the front portal of the CEA website, and the page explaining project outline has been posted in three languages including English, Sinhalese and Tamil as shown below.

(http://www.cea.lk/web/?option=com_content&view=article&layout=edit&id=1057),

The updates to JICA website, which had been originally planned, has been cancelled because the site focuses on JICA's technical cooperation projects, while the Project is another scheme to dispatch experts. However, the Project is willing to provide information whenever it is necessary.

Project newsletter had not been planned to be issued because occasion requiring provision of information through a paper-media was expected to be limited while use of internet is prevalent. However, there have been cases where the counterpart institutions request for such, and the Project has now planned to issue the newsletter according to the plan below.

Table 2-2: Plan for project newsletters

Contents of Publications	Media	Targeted populations	Languages	Timing
Project outline and progress	Newsletter (A4-sized 4-page x 50 copies to be printed, PDF copy to be on CEA website as well as to be e-mailed to the relevant officials.)	Project counterparts and relevant officials, personnel in the field of waste management in relevant institutions, and officials involved in SWM	• English • Sinhalese • Tamil	1. Selection of PP sites 2. Start of PP 3. Mid-term of PP 4. End of PP 5. End of the Project

Table 2-3: Publications of Newsletter

Issue	Timing	No. of copies	Distribution	Language
No. 1	August 2017	50 200	Every C/P institution, visitors, at PP kick-off seminar	English, Sinhala, Tamil (3 languages in one copy)
No. 2	December 2017	500	Every C/P institution, visitors	English, Sinhala, Tamil (3 languages in one copy)
No.3	August 2018	500	All participants of 2nd Seminar	English, Sinhala, Tamill
No.4	February 2019	200	All participants of final Seminar	English, Sinhala, Tamill

Table 2-4: PR through Mass Media

Contents	Timing	Media	Language
KPS Logo & Slogan Contest Awarding Ceremony	October 24, 2017	Lakadeepa Katharagama issue	Sinhala
PP Kick-off seminar (held on October 27, 2017)	October 29, 2017	Nationalnetwork TV (1 station)	Sinhala
Project Outline	November 9, 2017	2 Katharagama local newspapers	Sinhala
Plastic Waste minimization during Kataragama Perahera	July 10, 2018	Press Conference inviting Newspapers, TV stations	Sinhala, Tamil English
Special Message for Plastic Waste minimization during Kataragama Perahera from CEA/ KPS/ReEB	July 10, 2018	Divaina Virakesari Daily News	Sinhala, Tamil English

The promotion video which consists of pilot projects activities of Kurunegala MC, Rathnapura MC and Katharagama PS was distributed to all participants of final seminar on 31st January 2019.

2.5 B.1: Analysis and Evaluation for Selection of Candidate Pilot Project Sites

A long list of candidate pilot project sites consisted of 10 local authorities in Data Collection Survey on Solid Waste Management in Democratic Socialist Republic of Sri Lanka (JICA and Kokusai Kogyo Co., Ltd., February 2016) and six local authorities (three disposal sites and compost plants each) recommended by CEA.

Screening of 13 pilot project candidate sites for rehabilitation of disposal site and 13 sites for improvement of compost plant was conducted. Eight candidate sites out of 16 sites are short listed.

Table 2-5: Basic screening criteria for long list

No land acquisition issue
No outsourcing operation of disposal site
No duplication of project
EIA is not required
SATREPS technics available

Table 2-6: Screening of PP sites for rehabilitation of disposal sites
(Short listed candidate pilot project sites are underlined)

No.	Candidate PP site	Screening Item				
		Land acquisition issue	Outsourcing operation	Project duplication/ Ongoing project	EIA	Applicability of SATREPS technics
1	Jaffna MC	No issues	No issues	On going	?	Available
2	Trincomalee UC	No issues	Outsourcing (German)	No issues	?	Available
3	Thamankaduwa PS	No issues	No issues	On going	?	Available
4	Kurunegala MC	No issues	No issues	No issues	No need	Available
5	Katunayake Seeduwa UC	?	No issues	On going	?	Not available
6	Nuwara Eliya MC	No issues	No issues	No issues	No need	Available
7	Dehiwala Mt. Lavinia MC	No issues (Karadiyana)	Outsourcing (WMA)	On going	N.A-	Available
8	Moratuwa MC	No issues (Karadiyana)	Outsourcing (WMA)	On going	N.A	Available
9	Kesbewa UC	No issues (Karadiyana)	Outsourcing (WMA)	On going	N.A	Available
10	Kataragama PS	No issues	No issues	No issues	?	Available
11	Puttalam PS	?	?	On going	?	?
12	Matale MC	?	?	?	?	?
13	Hambantota MC	No issues	No issues	No issues	No need	Available

Table 2-7: Screening of PP sites for improvement of compost plants
(Underline shows candidate pilot project sites in a short list)

No.	Candidate PP site	Screening Item			
		Existence of compost plant	Outsourcing operation	Project duplication/ Ongoing project	EIA
1	Jaffna MC	Exists	No issues	Ongoing (EDCF)	?
2	Trincomalee UC	None	N.A	N.A	N.A
3	Thamankaduwa PS	Exists	OK	Ongoing(EDCF)	?
4	Kurunegala MC	Exists	No issues	No issues	?
5	Katunayake Seeduwa UC	None	N.A	N.A	?
6	Nuwara Eliya MC	None	N.A	N.A	N.A
7	Dehiwala Mt. Lavinia MC	Exists (Karadiyana)	Outsourcing (WMA)	Ongoing	N.A-
8	Moratuwa MC	Exists (Karadiyana)	Outsourcing (WMA)	Ongoing	N.A
9	Kesbewa UC	Exists (Karadiyana)	Outsourcing (WMA)	Ongoing	N.A
10	Kataragama PS	Exists	No issues	No issues	?
11	Ratunapura MC	Exists	No issues	?	?
12	Kelaniya PS	Exists	?	?	?
13	Ja-Ela MC	Exists	?	?	?

Table 2-8: Possibility/ necessity of PPs for rehabilitation of disposal sites and improvement of compost plants in each candidate PP site

Candidate PP site		Possibility/ Necessity	
		Disposal site	Compost plant
1	Kurunegala MC	✓	✓
2	Nuwara Eliya MC	✓	
3	Kataragama PS	✓	✓
4	Matale MC	✓	
5	Hambantota MC	✓	
6	Ratunapura MC		✓
7	Kelaniya PS		✓
8	Ja-Ela MC		✓

2.6 B.2: Site Selection and Preliminary Plan Preparation of Pilot Projects

JICA Project Team visited all the candidate pilot project sites in the short list, conducted interviews and a questionnaire survey for commissioners, secretaries, (chief) public health inspectors ((C)PHI), medical officers of health (MOH), technical engineers and other officers in

the local authorities. Possibility and/or necessity of pilot project for disposal sites and compost plants were evaluated and applicable SATREPS techniques were suggested.

Table 2-9: Summary of the survey results and recommendation of PP sites

No	Candidate PP site	Survey date	Possibility / Necessity of pilot projects				Condition
			Disposal site		Compost plant		
1	Kurunegala MC	14th March	High	-Most of SATREPS techniques and landfill mining can contribute to improve the current condition.	Low	-Duplication of large scale compost project planned by MoLGPC	Budget allocation from the KMC is required.
2	Nuwara Eliya MC	23rd March	Low	Operation is good	-		
3	Kataragama PS	16th March	High	-Final disposal implementation of pilot projects by SATREPS techniques may be possible -Measures against elephants are indispensable for improving the current dumping site.	Mid	-More efficient composting techniques may contribute to further minimization of organic waste. -As a supplementary work, awareness raising of tourists and worshippers in waste separation may be efficient and effective in reducing plastic wastes.	Personnel resource may be insufficient and is required as condition of implementation. /Land lease agreement is necessary.
4	Matale MC	14th March	Low	-There is a need to close the current dumping site properly. However, there is no other place to dispose of waste. PP cannot be implemented. -It is recommended to close the current disposal site as early as possible. However, there is no option for the MC until a new landfill is constructed.	-		
5	Hambantota MC	16th March	Low	-Strong need for the SATREPS techniques is not found.	-		
6	Ratunapura MC	15th March	-		Mid	-It seems that the RMC has sufficient human resources for implementing	

No	Candidate PP site	Survey date	Possibility / Necessity of pilot projects			Condition
			Disposal site	Compost plant		
					pilot project(s) and is undertaking the pilot project(s) seriously. -There may be possibility in technical support for the new composting facility and citizen awareness raising in waste separation.	
7	Kelaniya PS	17th March	-	Low	-Duplication of Ministry or Megapolis project	
8	Ja-Ela MC	17th March	-	Low	-Duplication of Ministry or Megapolis project	

Survey results of eight local authorities and contents of pilot projects were discussed on 27th March 2017 with JICA Project Team and CEA. Out of eight local authorities, Kurunegala MC, Kataragama PS and Ratnapura MC were recommended and approved as candidate sites.

On 3rd April 2017, JICA Project Team and CEA invited and discussed with representatives of each of three local authorities regarding contents and conditions of the planned pilot projects and the responsibilities of the local authorities. All three local authorities showed their interest in the pilot projects.

As a result, Kurunegala MC and Ratnapura MC issued the commitment letters on 6th April 2017 (refer to *Appendix 4: Commitment letter from Kurunegala MC, Appendix5: Commitment letter from Ratnapura MC*). Kataragama PS has gotten the land use permission from Forestry Department and issued the commitment letter on 15th May 2017 (refer to Appendix 6: Commitment letter from Kataragama PS).

Final decision on pilot project sites is as stated in the table below.

Table 2-10: Decision of PP sites

	PP site	Pilot project		Discussion (3rd April 2017)	Commitment letter
		Disposal site	Compost plant		
1	Kurunegala MC	✓		✓	6th April 2017
2	Ratunapura MC		✓	✓	6th April 2017
3	Kataragama PS	✓	✓	✓	15th May 2017

2.7 B.3: Study on Solid Waste Management Regulations

(1) Policy

National Strategy for Solid Waste Management (NSSWM) was developed in the year 2000, which stipulates prioritization in waste reduction prior to recycling. In 2005, Sri Lanka Government formulated Mahinda Chintana: Vision for a New Sri Lanka, a Ten-year Horizon Development Framework (2006-2016) for the preparation of investment plan, followed by National Action Plan for Haritha Lanka Programme (2009 ~ 2016), in which SWM in identified as one of the priority issues. National Solid Waste Management Policy 2007[1] is available on the web site of Ministry of Mahaweli Development and Environment. President Maithripala Sirisena announced and emphasised the importance of waste segregation in November 2016.

[1] http://www.environmentmin.gov.lk/web/index.php?option=com_content&view=article&id=175&Itemid=291&lang=en

Moreover, momentum of waste reduction is being gained in response to the collapse of Meethotamulla disposal site on 14th April 2017.

(2) Laws and Regulations related to SWM are summarised in the table below.

From 1st of September 2017, production and sales of polythene or any polythene product which is twenty (20) microns or below in thickness have been banned. Since many restaurants use polythene lunch sheets for rice and curry In Sri Lanka, alternative organic resources such as banana leaf or routes leaf started to use. High density polyethylene except for the garbage bag of 600mm (Length) - 260mm (Width) – 900mm (Height) or above is also banned.

Table 2-11: Law and regulation related to SWM

Year	Policy & Regulation	Description
1939	Urban Council Ordinance No. 61 of 1939	■ Sections 118, 119, and 120 ■ Specify waste management responsibilities of UCs
1946	Nuisance Ordinance No. 62 of 1939 and No. 57 of 1946	■ Section 1-12
1947	Municipal Councils Ordinances No. 16 of 1947	■ Sections 129 Duty of council as to conservancy and scavenging ■ Sections 130 All refuse collected to be property of council ■ Sections 131 Places for disposal of refuse and keeping equipment (MC ordinance No 16 of 1947)
1979	Code of Criminal Procedure Act No. 15 of 1979 – Public Nuisances	■ Section 98
1980	National Environmental Act No.47 of 1980	■ Section 12 and 26 ■ Establishment of CEA ■ Amended by Act No.56 of 1988 (Introduction of EPL, IEE, EIA) ■ Amended by Act No. 53 of 2000, Gazette Extra ordinary No.1466/5 of 2006
1987	Pradeshiya Sabha Act No.15 of 1987	■ Sections 93 and 94 ■ Specify waste management responsibilities of PSs
1987	Provincial Councils Act No.42 of 1987	■ Amended by Act No.56 of 1988 ■ LAs contain provisions for waste management
1990	Gazette Extraordinary No. 595/16 of 1990	■ Regulation for water quality, Regulations gazetted in relation to EPL and waste water discharge standards.
1999	Waste Management Statute No: 9 of 1999	■ Western Province Waste Management Authority was established under the statute of Western Provincial Council
2006	Gazette Notification No. 1466/5 dated 10.10.2006	■ Regulation on Prohibition of Manufacture of Polythene or Any Product of 20 micron or below thickness
2007	North Western Province Environmental Statute	■ Waste Management Statute No: 9 of 1999 was amended to further strengthen of the legal status on waste management.

Year	Policy & Regulation	Description
	No 12 of 1990	■ North Western Province Environmental Authority was established.
2007	Prevention of Mosquitoes Breeding Act No.11 of 2007	■ Prohibition against creating conditions favorable to the breeding of mosquitoes.
2008	Gazette Notification No. 1534/18 dated 01.02.2008	■ National Environmental (Protection and Quality) Regulations, No. 1 of 2008.
2008	National Thoroughfares Act No. 40 of 2008	■ Section 64 (a), (b), (c) and Section 65
2009	Gazette Notification No. 1627/19 dated 10.11.2009	■ National Environmental (Municipal Solid Waste) Regulations, No. 1 of 2009. ■ General Rules on SWM discharge and collection of waste (Prohibition of waste dumping at national highway and at any place other than places designated for such purpose by the LA
2015	Gazette Extraordinary no 2015/53 dated 2017.04.20	■ Maintenance of the services essential to the life of the community
2017	Gazette Extraordinary No. 2034/33 of 2017	■ Prohibition of manufacture of polythene or any polythene product of twenty (20) microns or below in thickness ■ Prohibition of the sale, offer for sale, offer free of charge, exhibition or use of polythene or any polythene product which is twenty (20) microns or below in thickness
2017	Gazette Extraordinary No. 2034/34 of 2017	■ Prohibition of the manufacture of food wrappers from polythene as a raw material. ■ Prohibition of the sale, offer for sale, offer free of charge, exhibition or use of food wrappers manufactured from polythene as a raw material.
2017	Gazette Extraordinary No. 2034/35 of 2017	■ Prohibition of manufacture of any bag of high density polyethylene as a raw material. ■ Prohibition of sale, offer for sale, offer free of charge, exhibition or use of any bag manufactured from high density polyethylene as a raw material.
2017	Gazette Extraordinary No. 2034/36 of 2017	■ National Environmental (Prohibition of open burning of refuse and other combustible matters inclusive of plastics) Regulations No. 1 of 2017
2017	Gazette Extraordinary No. 2034/37 of 2017	■ Prohibition of the use of all forms of polyethylene, polypropylene, polyethylene products or polypropylene products as decoration in political, social, religious, national, cultural or any other event or occasion.
2017	Gazette Extraordinary No. 2034/38 of 2017	■ Prohibition of the manufacture of food containers, plates, cups and spoons from expanded polystyrene ■ Prohibition of the sale, offer for sale, offer free of charge, exhibition or use of food containers, plates, cups and spoons manufactured from expanded polystyrene within the country.

(3) Guidelines related to SWM

In addition to the previous guidelines, so called SATREPS Guide has been developed and plans to be authorised until the end of 2017.

Table 2-12: Guideline related to SWM

Year	Guideline	Relevant authority	Descriptions
2001	Healthcare Waste Management Guideline	Ministry of Health, & Indigenous Medicine	To provide evidence based recommendation to clinicians to manage hospital generated waste with minimum harm to the environment.
2003	Solid Waste Management Guideline for Local Authorities	Ministry of Home Affairs, Provincial Councils and Local Government	To support the SWM practice for LAs
2005	Technical Guidelines on Municipal Solid Waste Management in Sri Lanka	Central Environmental Authority (CEA)	To support the SWM and siting of engineered landfills
2005	Technical Guidelines on Used Tyre Management in Sri Lanka	Central Environmental Authority (CEA)	To prevent adverse impacts on health and environment caused by the emission from incomplete burning from used tyres as well as their improper disposal.
2005	Technical Guidelines on Management of Used Lead Acid Batteries	Central Environmental Authority (CEA)	To introduce safe handling of used lead acid batteries.
2007	Technical Guides on Solid Waste Management in Sri Lanka	Central Environmental Authority (CEA)	Update version of Technical Guidelines on Municipal Solid Waste Management in Sri Lanka 2005
2008	Guidelines for the Management of Scheduled Waste in Sri Lanka	Central Environmental Authority (CEA)	To manage the scheduled waste management
2017	Guide for Sustainable Planning, Management, and Pollution Control of Waste Landfills in Sri Lanka. 2011-2016 (SATREPS guide)	Ministry of Higher Education, CEA, NSWMSC	To introduce SATREPS techniques for pollution control and environmental restoration of solid waste landfills.
2017	Guideline for the island wide separate waste collection programme	Ministry of Provincial Council and Local Government, NSWMSC	As the 1st step of implementation of island wide source separated waste collection programme the ministry introduced the separate collection to all the Municipal Councils on 2016.11.01. The second step scheduled to initiate immediately from 2017.06.01 covering all the Urban Councils and Pradeshiya Sabha's island wide.

2.8 B.4: Study on SWM Program of CEA and Authorities Concerned

2.8.1 Pilisaru Program

Pilisaru Program started in 2008. So far, 134 composting facilities, one landfill and 12 bio-gas plants have been constructed. Total budget is approximately 50 billion LKR, and 30 billion LKR has been spent by 2016.

Total number of local government authorities is 335. Therefore, Pilisaru Program has covered more than one third of them. The implemented 134 composting projects were reviewed and various issues peculiar to respective projects were identified such as workers, waste collection systems and machines. These issues are currently addressed. Furthermore, 15 sites will be newly identified in 2017.

At the beginning of the programme, “hard” or physical aspects were focused on such as construction of facilities and procurement of machines. This tends to change. “Soft,” or non-physical aspects, such as training of public officers and workers, is also considered important. Furthermore, the program has recently been approaching recycling associations, hotel associations, schools, etc. for asking cooperation with the 3Rs.

Through implementation of the program, common issues, which are found in many project sites, have been identified. These include: difficulties of finding sites for waste facilities, citizens’ opposition to transboundary transport of waste, and inefficient old composting facilities (static box type compost).

Table 2-13: Pilisaru project (2015)

Province	District	No. of facilities	Capacity (ton/day)
Northern Province	Jaffna	3	11
North Central Province	Anuradhapura	18	48.5
	Polonnaruwa	3	16
	Sub total	21	64.5
North Western Province	Kurunegala	16	88
	Puttalam	5	30
	Sub total	21	118
Central Province	Kandy	4	17
	Matale	4	8
	Nuwara Eliya	2	5
	Sub total	10	30
Western Province	Colombo	6	48
	Kalutara	7	69
	Gampaha	10	46
	Sub total	23	163
Southern Province	Hambantota	9	32
	Matara	10	61
	Galle	9	63
	Sub total	27	156
Sabaragamuwa Province	Kegalle	6	34
	Rathnapura	5	39
	Sub total	11	73
Uva Province	Badulla	5	52
	Monaragala	3	6
	Sub total	8	58
Eastern Province	Ampara	6	18
	Baticaloa	1	9
	Trincomalee	1	3
	Sub total	8	30
Total	-	133	703.5

Note: The table shows the numbers as of Year 2015. Total number of composting facilities in 2017 is 134.

2.8.2 NSWMSC

A JICA project was launched in 2017 applying a special Japan made composting machine, called the Kawashima Compost[2].

Ministry of Local Government and Provincial Councils, to which NSWMSC belongs, secured budget for purchasing nine (9) composting machines based on its evaluation of the JICA project as being successful. NSWMSC mentioned the following reasons why the machine would be introduced.

[2] Pilot Survey for Disseminating Small and Medium Enterprises Technologies for Recycling Project of Organic Garbage and Agricultural Waste by Screw Type Composting Plant

- Manual composting requires many good quality of works. It is recently very difficult to secure such workers. Kawashima Compost can deal with a considerable amount of waste with less workers.
- Kawashima Compost operates in a vessel, preventing wild animals from accessing the waste.
- Kawashima Compost applies forced aeration, which accelerates aerobic digestion with less odour.

Meanwhile, NSWMSC pointed out its high cost: 120 million LKR for a machine purchase and 6 LKR per kg for operation.

Another important point is the capacity of Kawashima Compost, 50 ton/day feeding waste amount. Generally, each Local Government Authority (LGA) in Sri Lanka generates a small amount of waste. In order to collect 50 ton/day of organic waste, several LGAs have to work together. This may cause opposition among citizens against the transboundary transport of waste. Agreement among target LGAs is a prerequisite for a successful project.

2.8.3 KOICA and Korean Economic Development Cooperation Fund, EDCF

Korean Economic Development Cooperation Fund, EDCF, have been designing and constructing the landfills listed in the table below with a loan of 33 million USD from Korean Import and Export Bank. Among the landfills, Dompe funded by KOICA has been constructed and is being operated as of May 2017.

Table 2-14: KOICA and EDCF project sites

Name of Disposal Site	Province	Status	Area	Landfill area	Capacity	Life span	Service target LAs
Monriviawatte	Southern	Planning	8.1ha	3.4ha	37.8t/d	32 years	7 LAs including Rajgama PS
Keeramalai	Northern	Planning	15ha	4.6ha	50t/d	29 years	All LAs of Jaffna (17)
Keerikulama	North Central	Planning	9.7ha	4.6ha	15.2t/d	32 years	2 LAs including East Nuwaragampalatha PS
Meegaswewa	North Central	Planning	6ha	3.2ha	20t/d	32 years	All LAs of Polonnaruwa (7)

2.8.4 KOICA

(1) Construction of the Dompe Final Disposal Site

KOICA started the project for Sri Lanka's first sanitary landfill in Maligawatte in 2008 with the CEA as a counterpart. The construction started from 2014 and the operation started in April 2015. The Korea Kunhwa Engineering & Consulting Co., Ltd. was in charge of the design. KOICA and the Sri Lankan Government funded the project with 4.5 million USD and $ 1.5 million USD respectively[3]. It was designed for a cluster system in the beginning of the project but only accepts waste from the Dompe PS due to opposition from the community. In Sri Lanka, not only in the case of the Dompe landfill site but across the country, there is always strong public opposition towards the construction of such waste treatment facilities and many of the projects have been suspended. Therefore, careful consideration and consultation with residents are needed in this regard.

Table 2-15: Outline of Dompe final disposal site project

Name of Disposal Site	Province	Status	Area	Landfill area	Capacity	Life span
Dompe	Western	Operating	5ha	2ha	90t/d	6 years

(2) Pilot Project for Volume Based Bag (VBB) System

The KOICA planned to introduce the volume based bag (VBB) system with the WMA as a counterpart since 2013. They started the pilot project in October 2015 and sell plastic bags (20L) for mixed waste for 40Rs each.

2.9 B.5: Current Solid Waste Management Survey

Progress of current solid waste management survey in Kurunegala MC, Ratnapura MC and Kataragama PS is listed in the following table. Although Ratnapura MC is affected by the flooding in May 2017 and survey had been slightly delayed, it was completed by mid of July.

[3] JST-JICA SATREPS Project: Environment Business Survey in Sri Lanka (May, 2014)

Table 2-16: Progress of current solid waste management surveys

	Kurunegala MC	Ratnapura MC	Kataragama PS
Duration of site survey	From 15th to 21st of May 2017	From 20th May to mid-June due to heavy rain	From 9th June to 8th of July
Survey item	1. Waste discharge 2. Waste collection and transportation 3. Compost 4. Recycling/3Rs survey 5. Disposal site	1. Waste discharge incl. Public Opinion Survey (POS) 2. Waste collection and transportation 3. Compost 4. Recycling/3Rs survey 5. Disposal site	➢ Waste discharge ➢ Waste collection and transportation ➢ Compost ➢ Recycling/3Rs survey ➢ Disposal site
Progress	• The survey was conducted for a week to update Data Collection Survey on Solid Waste Management in Democratic Socialist Republic of Sri Lanka (JICA and Kokusai Kogyo Co., Ltd., February 2016) • Eight surveyors in total: three survey teams of two staff each; an assistant, and a manager. • POS was not conducted.	• POS of 200 samples (150 households and 50 commercial) was conducted from 20th to 24th May 2017. • 150 (POS) households consisted of high-, mid- and low-income households, selected randomly from the MC. • 12 surveyors in total: five survey teams of two staff each; an assistant, and a manager.	• The survey was conducted for a week to update Data Collection Survey on Solid Waste Management in Democratic Socialist Republic of Sri Lanka (JICA and Kokusai Kogyo Co., Ltd., February 2016) • Eight surveyors in total: three survey teams of two staff each; an assistant, and a manager. • POS was not conducted.

Orientation before POS survey in RMC

Role-play during the orientation in RMC

Waste discharge survey in RMC ①

Waste discharge survey in RMC ②

2.9.1 Kurunegala MC

(1) Waste generation sources (WGS)

Waste generation source of Kurunegala MC consists of household, commercial, school, office, market and so on. Main waste generation sources in Kurunegala MC are shown in below table.

Table 2-17: Main waste generation sources in KMC

Source	Description
Household	Kitchen waste, domestic waste such as cleaning house, garden waste.
Commercial	Restaurant, hotel, organic shop, non-organic shop and so on.
Institute	Schools, hospital, clinic, office, government institute, religion institute, police, military facilities and so on.
Industry	Waste generated from garment industries, agro-food industries and paper manufacture industries.
Others	Large scale mark called as “Pola” , small markets, slaughter house and so on.

(2) Waste generation amount (WGA)

Waste generation amount of Kurunegala MC is estimated based on the waste generation rate of NSWMSC SWM Action Plan (2008), SATREPS research reports (2011-2016) and JICA data collection survey (2016), and data collection survey under ReEB waste project. The result shows that waste generation amount of Kurunegala MC is 53.75 t/day and waste generation rate is 1,878.2g/day per capita (including instructional, commercial waste).

Table 2-18: Waste generation amount and waste generation rate of KMC

Category	Source	Generation rate	Units	Sources	Amount (MT/D)	Sub total	%
Residential	High, middle & law income	0.25	kg/person	28,618	7.15	7.15	13.3%
	Large size restaurants	69.2	kg/restaurant	8	0.55		

Category	Source	Generation rate	Units	Sources	Amount (MT/D)	Sub total	%
	Middle size restaurants	43.25	kg/restaurant	40	1.73		
	Small size restaurants	9.65	kg/restaurant	143	1.38		
	Large size hotel	51.9	kg/hotel	9	0.47		
	Medium size hotel	25.95	kg/hotel	59	1.53		
Commercial	Small size hotel	9.65	kg/hotel	75	0.72	27.82	51.8%
	Organic shops (large)	207.6	kg/shop		0		
	Organic shops (middle)	25.95	kg/shop		0		
	Organic shops (small)	9.65	kg/shop	98	0.95		
	Non-Organic shops (large)	43.25	kg/shop	2	0.09		
	Non-Organic shops (middle)	9.65	kg/shop		0		
	Non-Organic shops (small)	9.65	kg/shop	2,114	20.4		
	Schools	70.28	kg/school	17	1.19		
	Hospitals (government)	4650	kg/hospital	1	4.65		
	Hospitals (private)	202.85	kg/hospital	5	1.01		
	Health clinics	9.65	kg/clinic	90	0.87		
	Public office	19.04	kg/office	64	1.22		
Institutional	Bank/private office	19.04	kg/office	183	3.48	13.04	24.3%
	Buddhist temples	17.3	kg/temple	14	0.24		
	Hindu temples	17.3	kg/temple	6	0.1		
	Mosques	17.3	kg/mosque	6	0.1		
	Churches	17.3	kg/church	10	0.17		
	Navy/Police/ Army basses	9.65	kg/institute	1	0.01		
	Industries (large)	1490	kg/industry	1	1.49		
Industries	Industries (medium)	95	kg/industry	2	0.19	2.3	4.3%
	Industries (small)	9.65	kg/industry	64	0.62		
	Pola	1440	kg/pola	1	1.44		
	Public parks	150	kg/park	2	0.3		
	Public centers/halls	9.65	kg/center	52	0.5		
Other	Slaughter house	200	kg/shop	1	0.2	3.44	6.4%
	Fish market	200	kg/shop	1	0.2		
	Road/drain cleaning waste	600	kg (sum)	1	0.6		
	Hazardous (Special)	200	kg (sum)	1	0.2		
TOTAL					53.75	53.75	100%
Waste Generation Rate (g/day/capita)					1.878		

(3) Waste flow

Based on the survey of institution, recyclable waste, waste generation, Sudarapola and disposal site, the following waste flow is formulated.

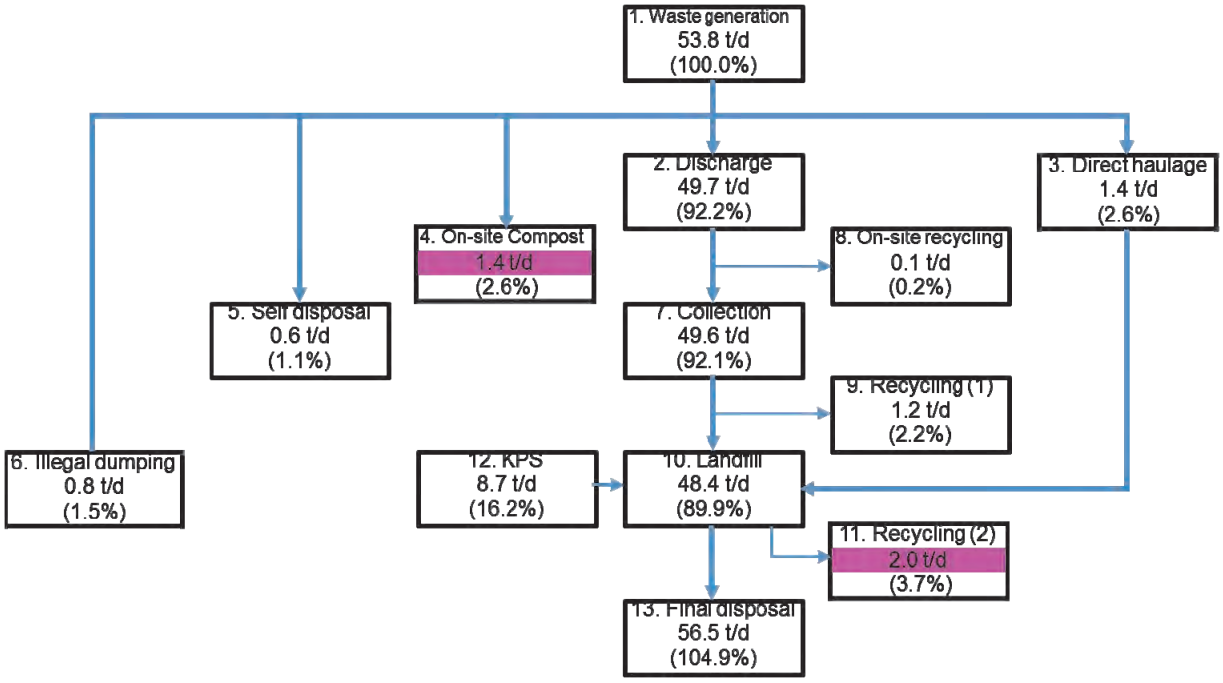


Figure 2-1: Current waste flow in Kurunegala MC

The amount of waste collection self-dispose, illegal dumping, onsite- recycling, on-site compost are 92.1%, 1.1%, 1.5%, 0.1% and 2.6% of waste generation amount respectively.

(4) Organisation of municipal solid waste management

The collection of municipal solid waste in Kurunegala town is executed by Kurunegala MC without involving any private sector or CBO (Community Based Organization). The slaughter house, some meat processing factories and households directly haul their waste to the Sundarapola disposal site by themselves.

Solid waste management of Kurunegala MC is management by Chief Medical Officer of Health (CMOH) under Health Department. The organization chart of solid waste management of Kurunegala MC is shown in below figure.

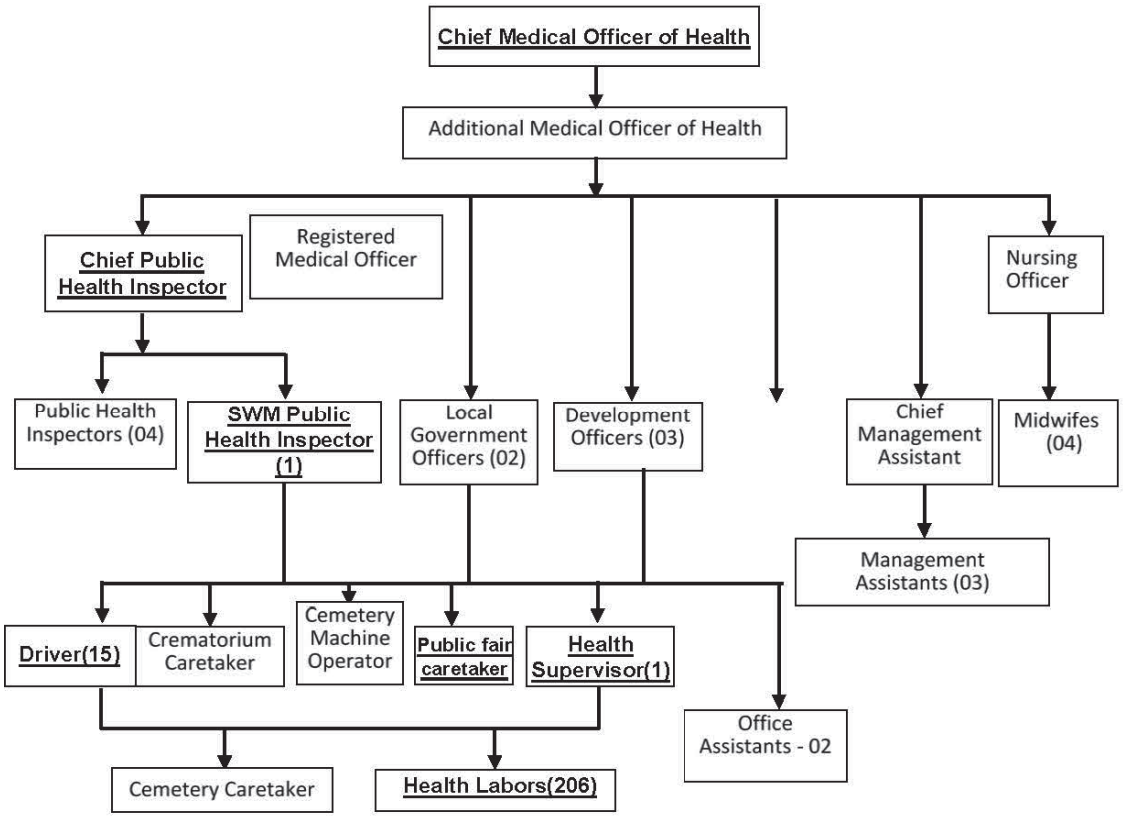


Figure 2-2: Organization structure of KMC (under bar part is in charge of solid waste management)

The solid waste management of Kurunegala MC consists of CMOH, Additional Medical Officer of Health (AMOH), Chief Public Health Inspector (CPHI), four (4) Public Health Inspectors (PHIs) and SWM- PHI. The main duty of PHI is not only solid waste management but also health care management, sanitary issue management, prevention of infectious disease, public awareness, operation of clinics and so on. Kurunegala MC appoints SWM-PHI to assign only solid waste management. The main duly of SWM-PHI is management of fifteen (15) drivers of collection vehicles, supervisors of regular market and health supervisors.

(5) Equipment for SWM (as of 2017)

The detail of vehicles and machineries for solid waste management is shown as below table.

Table 2-19: Detail of vehicles for collection of solid waste in KMC

Type of vehicle	Type	number of units	Condition
Handcarts	Steel handcart	38	All are good
4WL-Tractor	Tractor & trailer	13	Working
Compactor trucks (small)	ISUZU garbage truck (2T)	2	Working
Dump truck (small)	Leyland dump truck (3T)	1	Working
Compactor trucks (small)	ISUZU garbage truck (2T)	4	Under repair
Compactor trucks (small)	ISUZU garbage truck (2T)	1	Condemned
Dump truck (small)	Leyland dump truck (3T)	1	Condemned

Table 2-20: Detail of machineries and heavy machineries for the intermediate treatment and final disposal of solid waste in KMC

Equipment/ machinery	Model	Qty.	Repair & maintenance
Excavator	Sumitomo SH-130-5 (130)	1	Service after working 250 hrs
Skid steer loader	Bobcat S-450	1	Service after working 250 hrs
Screening machines (2)	Local n/a	1	No
4 WT & trailer	TAFE 45DI	1	Service after working 250 hrs

(6) Waste collection / disposal fees

The collection fee of solid waste is not charged from anyone.

(7) SWM bylaws

A draft bylaw prescribed six wastes segregations into (a) biodegradable waste, (b) paper and cardboard, (c) plastic and polythene, (d) ferrum and coconuts husk, (e) broken glass and bottle and (f) other, and was waited for being authorized by Northwestern Province until May 2017. However, after integrated island wide separation programme has been started since June 2017, KMC has changed its separation categories accordingly, which are (a) Biodegradable, (b) Glass, (c) Plastic and (d) Paper.

2.9.2 Ratnapura MC

(1) Waste Generation Sources (WGS)

The main sources of municipal solid waste (MSW) considered in this Study is households, commercial enterprises, institutions including schools, hospitals, public offices and religious places, and other including Pola, markets, slaughter houses etc. Each of these sources is briefly described below.

Table 2-21: Main waste generation sources in RMC

Source	Description
Household	Waste generated from domestic activities, including food processing, cleaning, fuel burning, yard sweeping, gardening and other miscellaneous household waste.
Commercial enterprises	Waste generated from restaurants, hotels, organic and non-organic shops.
Institutions	Waste generated from schools, hospitals, clinics, public offices, banks and private offices, religious places and navy/police/army bases.
Industries	No small, medium and big industries in RMC.
Other	Waste generated from Pola, markets, public parks, public halls, slaughter houses, fish market, road/grain cleaning waste and special hazardous wastes.

(2) Waste generation amount (WGA)

Measuring of waste generation rates and the estimation were done from a combination of quantitative data and interview surveys. Total Municipal Solid Waste (MSW) generation is 53.76 t/d, equivalent to 0.9346 person/kg/day. Compare to the survey conducted in 2009, total MSW generation (43.87t/d in 2009) and per persons generation (0.823 person/kg/day in 2009) increases 22.5% and 13.5% respectively. The following table illustrate estimated waste generation by each source in RMC area.

Table 2-22: Waste generation amount and waste generation rate of RMC (2017)

Source	Waste Generation Data			Waste Generation		
	WGR	WGR Unit	No. of Units	Amount (T/d)	Subtotal	%
Residential					14.38	26.75%
High, middle and low income	0.25	kg/person/day	51,193	12.8		
Non-collection (11%)	0.25	kg/person/day	6,327	1.58		
Commercial					18.9	35.16%
Restaurant (Large)	69.2	kg/restaurant	2	0.14		
Restaurant (Medium)	43.25	kg/restaurant	53	2.29		
Restaurant (Small)	9.65	kg/restaurant		0.00		
Hotel (Large)	51.9	kg/hotel		0.00		
Hotel (Medium)	25.95	kg/hotel	131	3.4		
Hotel (Small)	9.65	kg/hotel		0.00		
Organic shops (Large)	207.60	kg/shop		0.00		
Organic shops (Medium)	25.95	kg/shop		0.00		
Organic shops (Small)	9.65	kg/shop	99	0.96		
Non- organic shops (Large)	43.25	kg/shop	74	3.20		
Non- organic shops (Medium)	9.65	kg/shop		0.00		
Non- organic shops	9.65	kg/shop	885	8.54		

Source	Waste Generation Data			Waste Generation		
	WGR	WGR Unit	No. of Units	Amount (T/d)	Subtotal	%
(Small)						
Non-collection (2%)			25	0.37		
Institutional					10.99	20.44%
Schools	70.28	kg/school	22	1.55		
Higher education	250.00	kg/institute	1	0.25		
Hospitals (government)	4650.00	kg/hospital	1	4.65		
Hospitals (private)	202.85	kg/hospital	4	0.81		
Health clinics	9.65	kg/clinic	17	0.16		
Public office	19.04	kg/office	138	2.63		
Bank/private office	19.04	kg/office	22	0.42		
Buddhist temples	17.30	kg/temple	16	0.28		
Hindu temples	17.30	kg/temple	6	0.10		
Mosques	17.30	kg/mosque	6	0.10		
Churches	17.30	kg/church	2	0.03		
Navy/Police/ Army basses	9.65	kg/institute	1	0.01		
Industries					0.00	0.00%
Industries (large)	1490.00	kg/industry		0.00		
Industries (medium)	95.00	kg/industry		0.00		
Industries (small)	9.65	kg/industry		0.00		
Other					9.49	17.65%
Pola	7600.00	kg/pola	1	7.60		
Market	120.00	kg/market	1	0.12		
Public parks	150.00	kg/park	2	0.30		
Public centers/halls	9.65	kg/center	7	0.07		
Slaughter house	200.00	kg/shop	1	0.20		
Fish market	200.00	kg/shop	1	0.20		
Road/drain cleaning waste		kg (sum)	1	0.00		
Hazardous (Special)	1000.00	kg (sum)	1	1.00		
Total				53.76	53.76	100.00%

(3) Waste Stream

Waste stream is established based on the result of household survey and business/recycler survey, available records at Kanadola site, household waste discharge survey in 2014, and composition survey conducted in Ratnapura in 2009.

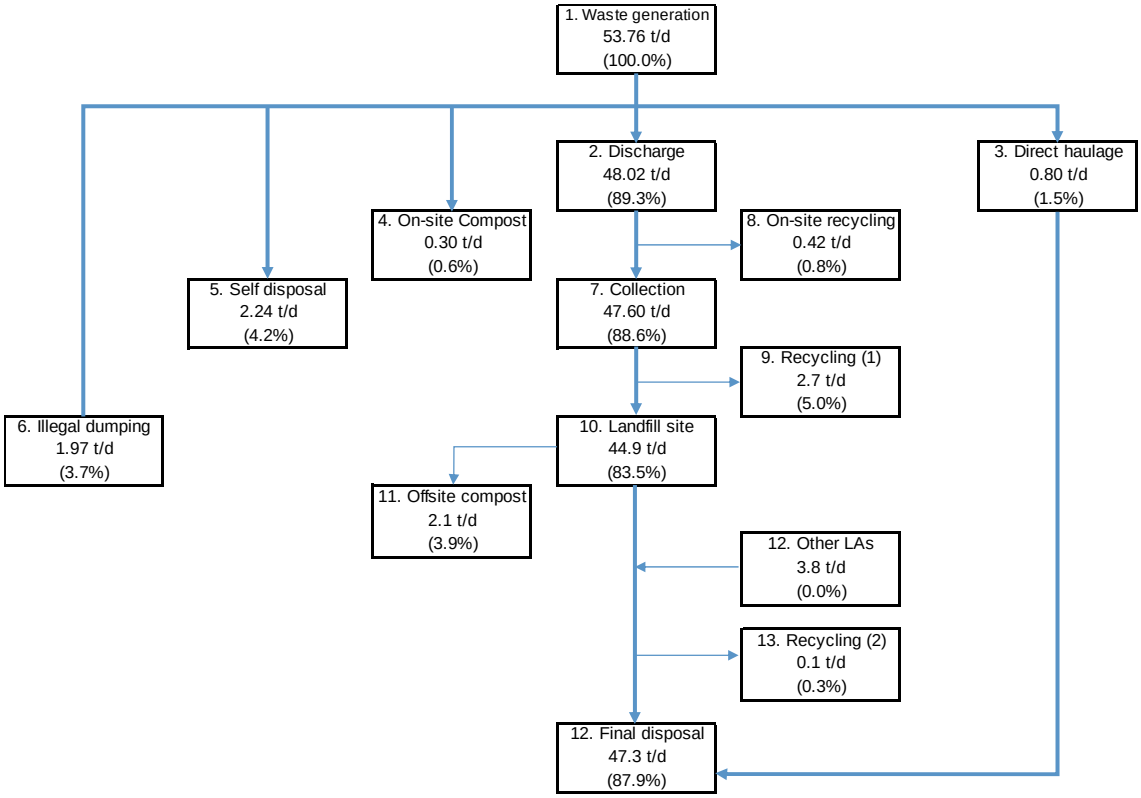


Figure 2-3: Current waste stream of RMC

From above mentioned waste stream, collection rate [4] achieves 90.8%, onsite discharge including burning and bury is 4.1%, illegal discharge is 3.67%, recycling is 0.78% and onsite compositing is 0.57%.

(4) Breakdown off Waste Discharge Amount

Breakdown of waste discharge amount is tabulated below.

Table 2-23: Breakdown of waste discharge amount in RMC

Source	On site disposal	On site composting	Discharge for collection	Recy cling	Illegal dumping	Generation (Tonne)
Residential						
Residential	1.55	0.27	10.49	0.21	0.27	12.80
Residential (Non-collection)	0.19	0.03	0	0.03	1.33	1.58
Commercial						
Restaurants	-	-	2.42	0.01	-	2.43
Hotels	-	-	3.38	0.02	-	3.40
Organic shop	-	-	Collected 0.65 Carried in	0.01	-	0.96

[4] (Discharge amount + Carried in wastes) / waste generation amount

Source	On site disposal	On site composting	Discharge for collection	Recy cling	Illegal dumping	Generation (Tonne)
			0.30			
Non-organic shop	-	-	11.67	0.07	-	11.74
Non collection	-	-	0	-	0.37	0.37
Institutional						
Schools	-	-	Collected 1.69	0.01	-	1.8
			Carried in 0.10			
Hospitals	0.5	-	4.96	-	-	5.46
Clinics	-	-	0.81	-	-	0.16
Offices	-	-	3.03	0.02	-	3.05
Religious places	-	-	0.51	-	-	0.51
Navy/Police /Army bases	-	-	0.01	-	-	0.01
Other						
Pola	-	-	7.55	0.05	-	7.6
Market	-	-	0.12	0.00	-	0.12
Public parks/halls	-	-	0.37	-	-	0.37
Slaughter house	-	-	Carried in 0.2	-	-	0.2
Fish market	-	-	Carried in 0.2	-	-	0.2
Hazardous (incl. Electronic waste)	-	-	1	-	-	1
Total	2.24	0.31	48.02	0.42	1.97	53.76

(5) Organization of municipal solid waste management

Medical Officer of Health is the main responsible officer in Health Department. The current organizational structure of SWM is described below.

Accordingly, the chief executive officer of the health department is Chief Medical Officer of Health (CMOH) and the CMOH is assisted by Additional Medical Officer of Health (AMOH). The both positions are held by officers of Government Medical Service (Medical Doctors). Under the preview of CMOH and AMOH, there is a chief Pubic Health Inspector (CPHI). There are four Public Health Inspectors working under the instruction of CPHI. Those officers are recognized as officers with authority (decision making powers at different levels). However, duties related to SWM are only part of their duties because several other duties such as maintenance of health and sanitation in the city, disease prevention, public awareness on health related issues, operation of health clinics and safeguard of worker's health.

In Sri Lanka in 2017, dengue fever outbreak has occurred, and number of cases have been counted reaching 151,330 since January 2017 (as of 15th September 2017). After the flooding

in May in Ratnapura, reported number of cases were 1,161 in May, 1,908 in June, 3,130 in July and 1,595 in August[5], where has the fourth biggest number of cases next to Colombo, Gampaha and Kandy within Sri Lanka.

Out of all PHIs, there is a PHI wholly assigned for activities related to SWM at Kanadola Waste Management facility and city centre waste collection. Other three PHIs assigned different zones of the MSW collection, in addition to other health department duties assigned for them by the Municipality. Under the PHIs, there are three (03) health supervisors, seven (07) health overseas and 15 vehicle drivers, public fair caretakers, and four watchers. The total labor cadre for the MSW section is 123 labors. In addition, two (02) office assistances are fully involved in MSW management activities Kanadola waste management facility.

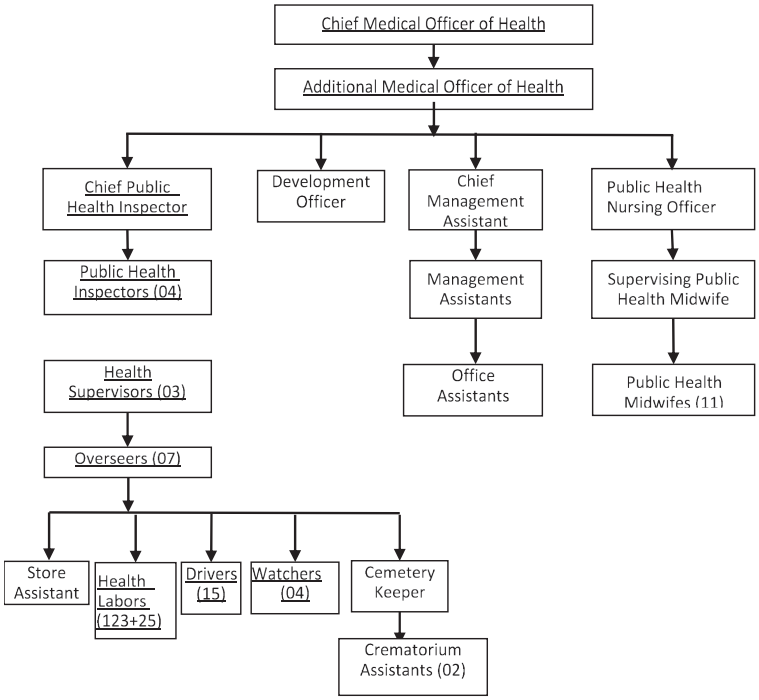


Figure 2-4: Organizational structure of Health Department in RMC

The waste collection within entire RMC area is handled by the Municipality and there are no privatization or other CBO involvement in waste collection. The transportation of waste to final disposal site and recycling center is also managed by the RMC. However, it was revealed that some amount of special wastes (slaughterhouse and fish waste from fish stalls), generated within the city are directly transported to dumpsite in small trucks by traders/venders.

[5] Epidemiology Unit, Ministry of Health, 2017.
http://www.epid.gov.lk/web/index.php?option=com_casesanddeaths&Itemid=448&lang=en

(6) Waste Management Services Labour Force

Labors allocation is as follows;

Table 2-24: Waste management labour allocation in RMC

Collection		Kanadola disposal site	
Shift	Number	Types	Number
Morning shift	11	Officers	3
Day shift (permanent)	72	Permanent Labour	11
Day shift (casual)	18	Casual Labour	15
Night shift (permanent)	19		
Night shift (casual)	6		
Bus stand	1		
Cemetery	20		
Total	148	Total	29

Following table shows the different activities performed at the intermediate treatment facility and Kanadola disposal site for a weekly working cycle. Highest number of labours are allocated for sorting of non-degradable waste at recycling centre. Then 3-6 labours are allocated for making composting piles in Box and window systems.

Table 2-25: Labour allocation for the different activities at Kanadola site in RMC

Activity	Number of labours allocated						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Waste unloading	1	1	1	1	1	1	1
Compost sieving	1	1	1	1	1	0	1
Compost mixing	0	0	1	0	0	0	0
Compost piling	4	6	6	3	3	4	4
Sorting non-degradable waste	11	9	5	8	9	6	11
Cleaning around stores	0	0	1	0	0	0	0
Sweeping	2	1	1	1	1	1	1
Office assistance	2	2	2	2	1	2	2
Total	21	20	18	16	16	14	20

(7) Equipment for SWM (as of 2017)

Vehicles use in waste management activities by RMC is as follows;

Table 2-26: Collection vehicles and machineries for SWM in RMC

Types of Vehicle	Type	No. of units	Status	Capacity (m3)	Way of using
For waste collection					
4WL-Tractors	Tractor & trailer	4	Working	7.02	Primary collection
4WL-Tractors	Tractor & trailer	7	Working	5.08	
Compactor trucks (small)	Hino ranger (2T)	1	Working	unknown	
Crew cab	JAC (2T)	1	Working	4.03	Non-biodegradable/recyclable waste collection
Three wheelers	Piaggio (0.5T)	3	Working	2.46	
For the operation in Kanadola site					
Skip Steer Loader	Bobcat, USA	1	Working	-	Composting, waste unloading and falling at the site
Screening machines	Local	1	Working		Composting
Multi-chopper	Jinasena, Sri Lanka	1	Working		
Hydraulic bailer	N/A. Chine	1	Working		
WT-tractors	Tractor & trailer	3	not working	5.08	-

Following table shows equipment and machinery in the compost plant.

Table 2-27: Machines available in the composting facilities of RMC

Equipment/ machinery	Brand	Country of origin	Model	Year of Manufacture	Repair & maintenance
Skid steer loader	Bobcat	USA	S-450	2015	Service after working 250 hrs
Screening machines (1)	Local	Local	n/a	2015	Changed the mesh in 2016
Multi-chopper	Jinasena	Sri Lanka	n/a	2015	n/a
Hydraulic bailer	n/a	China	n/a	2017	In stores

(8) Workshop

The vehicle maintenance, service and repairs are done by municipal workshop at the RMC. The municipal workshop is under the department of works headed by municipal engineer. The workforce and capacity of municipal workshop is shown in following Table.

Table 2-28: Workshop of RMC for vehicle maintenance

Item	Description
MC workshop	1
Place/address	MC COUNSIL, Ratnapura
Head	MC Engineer
Supervisors	Technical Officer -1
Mechanics	One (One assistant mechanic)
Labour (permanent)	8
Labour (casual)	3
Total area	90 m^2
Management of spare parts/ stocks	No Stocks, Purchase on demand
Outsourcing activities	On demand
Specific issue with brand/model	Air compressor, Welding plant, Tools, Grinders, Hydraulic jacks, Drilling tools

(9) Waste Collection / Disposal fees

At present, Ratnapura MC does not charge any waste discharge fee from any sources, including the large waste generated.

(10) SWM Bylaws

A draft bylaw prescribed five wastes segregations into (a) food waste and other bio-degradable waste, (b) re-usable and recyclable waste, (c) hazardous waste, (d) animal carcasses, body parts or dung and (e) dust and other dry waste collected after sweeping the premises, and was waited for being authorized by Sabaragamuwa Province until May 2017. However, after integrated island wide separation programme has been started since June 2017, RMC has changed its separation categories accordingly, which are (a) Biodegradable, (b) Glass, (c) Plastic and (d) Paper.

(11) Discharge, Collection and Transportation System

Ratnapura MC collects biodegradable and non-biodegradable separately by days of week by four-wheel tractor & trailers (4WT) and compactor trucks. Parts of non-biodegradable wastes are also collected by three wheelers. The waste collection within entire RMC area is handled by the Municipality and there are no privatization or other CBO involvement in waste collection. On the other hand, wastes from slaughterhouse and fish wastes are directly transported to the site by traders.

Table 2-29: Collection vehicles, collection method and discharge amount in RMC

Discharge ways	• The waste is usually packed in used glossary bags (called "shopping bags") or in garbage bags (20-30L, black). • Significant amount of traders, specially eating houses and restaurants directly empty the garbage bin to the larger collection vehicle.
Collection method	• The collection routes of RMC are divided into seven (07) for residential areas. Other than that, one tractor at the hospital and Pola premises collect daily. • Door to door collection is either curb side or directly collecting from residences/traders. • Large waste generators such as restaurants directly discharge wastes. • The collection vehicle in one route is having the bell collection system. • In addition to the daily collection from 6am to 2pm, RMC has night collection from 6pm to midnight in central commercial areas.
Collection vehicles	• Only larger collection vehicles; four-wheel tractor & trailers (4WT) and compactor trucks. • Parts of the non-biodegradable wastes are collected by three wheelers. • Handcarts are not used in RMC waste collection

(12) Intermediate Treatment

a. Composting

The composting system established by SEVANATHA in Ratnapura has previously been tested in Matale Municipal Council Area since 2007. The original technology was developed by Bangladesh Social Business Enterprise (SBE) which is also called "Waste Concern". This is also called "Box composting" method.

A series of (17 in parallel) large perforated clay brick-masonry box (7.5 m L, 1.5 m H, 1.5 m W) was constructed on top of a concreted floor, inside a roofed building. A perforated bottom grid and aeration pipes are fixed on waste pile to increase the aeration. Passive aeration is induced by perorations on the walls and through pipes. Perforated bottom also act as drainage to facilitate excess leachate draining. After manually filling about 15 tons of waste in to a box (it takes 1 to 1.5 weeks at RMC), waste is kept in box for 3 to 3.5 months. Then, waste in the box is manually turned in 3rd, 5th and 6th week. After 3 months of active composting, composting mass is transfer to maturing box where it is kept for 2-3 weeks for curing process. After curing and sufficiently dry, the cured compost screen through the 4 mm screen to grading and packaging.

In present configuration, the Box method of composting involve manual labor thus most labor complains about hardship. Also, the original system designer of the system, Waste Concern, recommend this system for small and medium scale operations. Therefore, scaling up to large amounts of waste is a challenge.

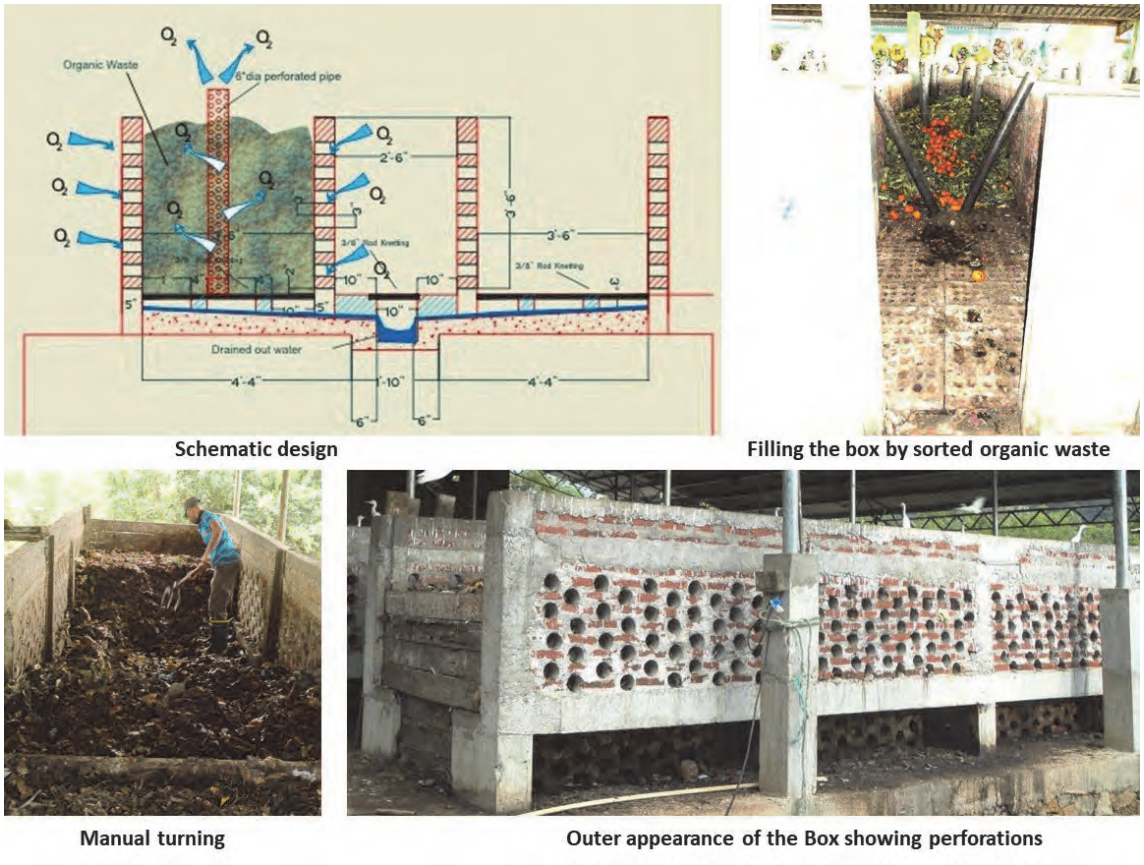


Figure 2-5: Schematic configurations of box system composting in RMC

The facility also conducts windrow composting in small scale due to limitation of space. Major part of the building developed for windrow composting is temporally used for storage of recyclable materials. However, there is a project to construct a recycling facility in an adjacent land, and the building works have been nearly completed. Therefore, the window system will be expanded in near future.

The current windrow composting is operating with 1-2 tons of waste per day. Most of the operations are manually conducted due to limited space availability for machine handling.

The collection from Market is having less amount of non-biodegradable waste, thus waste is directly unloaded on the open concrete floor. The larger plastic and non-degradable items are manually separated from the bulk waste by two labors. Then, waste is piled up in rectangular elongated piles (1-2m wide, 1-1.5 m height and 2-3m long).

As of September 2017, most of the compost yard is used for stock yard of recyclable wastes.

Figure 2-6: Windrow composting system in RMC

Table 2-30: Compost production and sales at the composting facilities in RMC

Date	Production	Stock at end of month	Sales	Unit Price	Income
2017	(kg)	(kg)	(kg)	(Rs/kg)	(LKR)
January	2,316	133	2,284	10	22,840.00
February	2,449	0	1,625	10	16,250.00
March	2,284	30	3,315	10	33,150.00

b. Resources recovery

The RMC is involved in recycling promotion through two main activities; collection of recyclable items through source-segregation activities and selection of recyclables through screening of non-degradable waste at Kanadola waste management facility. In addition, there are six (06) well established privet recycling businesses operate within the RMC area. The privet businesses also purchase recyclable items from citizens, vendors, middlemen, MC workers and also from any sources outside the MC limit.

The collected waste is unloaded at the sorting facility and recyclable that can be readily market is manually separated from non-degradable waste. The recyclable materials are usually sorted into 17 categories as shown in Table below. The recyclables are mainly sorted into cardboard, Box boards, newspaper, white paper, polythene, and polysack bags. The amount of other valuable recyclables (eg. Metal) is not much. Once a reasonable amount of materials is stored, recyclables are sold to buyers. Non-recyclable fraction is directly brought to disposal site and dispose of. Though the bailing machine is available, the machine has not been installed due to space limitation and issue with power supply.

Though records are not available, facility management explained that 3-5 loads of non-degradable waste is received from other local authorities; Nivithigala PS and Ratnapura PS.

Table 2-31: Different types recycling materials recovered at Kanadola site in RMC (Average Jan-Mar, 2017)

Category	Previous stock (kg)	Collection (kg)	Selling rate (Rs/kg)	Sold quantity (kg)	Revenue (Rs.)	Stock (kg)	Stock value (Rs.)
Polythene	903	811	5	1,169	5,469	545	2,379
Plastics	130	568	25	604	15,108	93	2,325
Cardboard	24	270	11	126	1,410	158	249
Box board	157	399	6	393	2,383	129	253
Cardboard pipe	9	25	2	25	50	69	1
Newspapers/ book	66	114	7	59	413	71	233
LDP mixed polythene	16	116	10	98	977	72	717
PET bottle	294	282	10	463	4,541	58	582
Glass (white)	3,931	804	6	5,227	25,765	935	1,725
Fe metal	11	1		0	0	16	0
Beer can	30	208	45	24	1,095	14	113
Aluminums	24	1		0	0	27	0
Saline bottle	22	24	25	28	692	8	200
Tin	100	224	4	183	733	315	380
Coconut shell	349	345	5	252	1,258	228	342
HDPE polythene	0	7		0	0	0	0
Glass (brown)	0	0		0	0	0	0

Result of interview for private recyclers is shown in the following table. Private recyclers collect 8.63 tons of recyclable wastes every month, whereas municipal council collects 4.19 tons of them.

Table 2-32: Collection amount of recyclable wastes in Ratnapura (unit: kg/month)

	Item	Private sector collector	Kanadola disposal site
1	Plastic	640	568
2	Polyethylene		952
3	Polysack	1,400	
4	Paper	1,500	114
5	Cardboard	2,150	694
6	White glass pieces	550	804
7	Metal	1,820	1
8	Aluminum	335	1
9	Copper	8	
10	Brass	23	
11	Coconut shells	200	345
12	PET bottles		282
13	Tin		224
14	Beer cans		208
15	Vehicle batteries		
	Total	8,626	4,193


RMC Recyclable collection


Recyclable collection from other LAs


Unloading Recyclable waste


Sorting Recyclable waste


Grading Recyclable waste


Storage of Recyclable waste

(13) Final Disposal

Final disposal site is located at Kanadola, at about 4 km away from the Ratnapura town. Kanadola waste disposal site is one of the largest dumpsite in Sabaragamuwa Province of Sri Lanka. The site is commonly shared by RMC and Nivitigala PS for MSW and toilet waste disposal since early 1900's. In addition, several government and privet organizations also use the site for MSW and non-hazardous solid waste disposal.

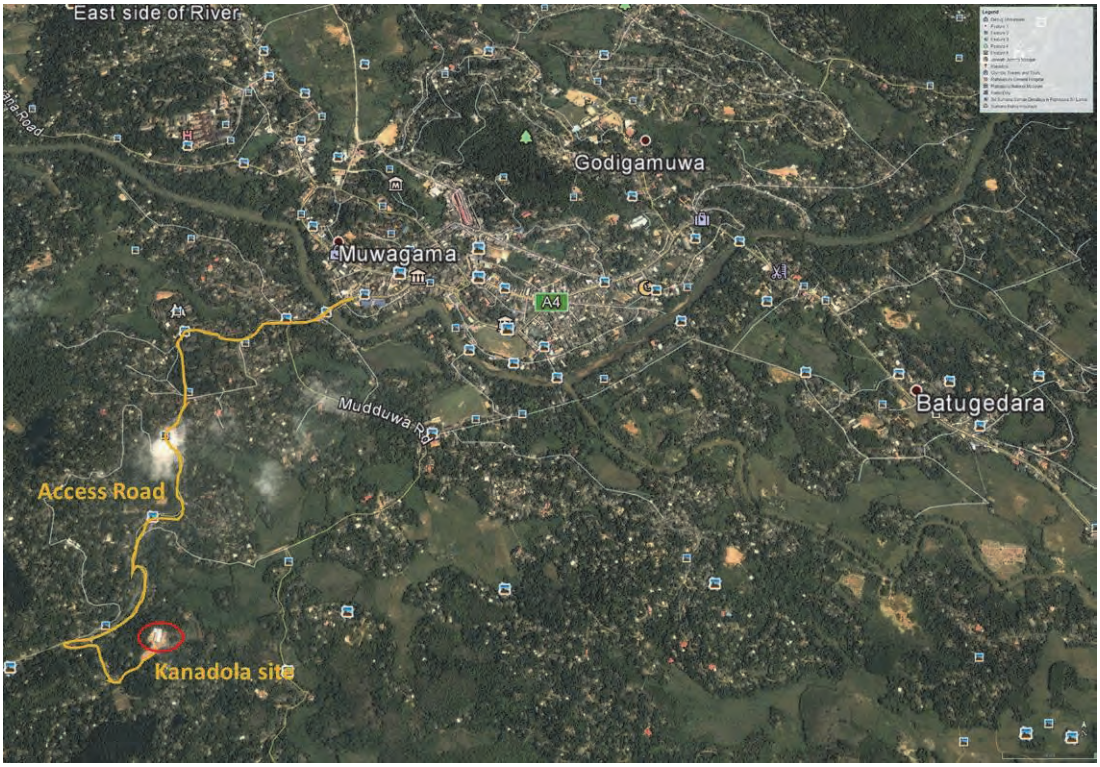


Figure 2-7: Location of Kanadola disposal site in RMC

As shown in the following Figure, there is an entrance to the site from the Ratnapura-Palawela-Kuruvita road. The entrance road divided to two sub-access roads running toward composting facility and residential areas on South-East. Internal access roads up to composting facility and disposal area have not paved. All other internal access roads are temporally constructed with soil.

As shown in the following figure, Kanadaola site consists of waste dumping area, two types of compost plant, recyclable waste sorting and stock yard and night soil treatment facility. Due to flooding occurs in May 2017, dumped wastes covered beyond the boarder, even across the road to east side. Also, probably due to the disaster wastes after the flooding, more than half of the original windrow system compost yard are currently used for recoveries of recyclable wastes and stocks of 17 materials after site separation. Although there are a bailing machine and crushing machine at the future recycling centre, they are still not ready to operate because of the electricity problem. Night soil treatment facility funded by NSWMSC is under construction as of September 2017.

Figure 2-8: Layout of facilities of Kanadola site in RMC

(14) Public opinion survey and interview

Public opinion survey was conducted for the following interviewees in May 2017. Household interviewees consists of 93 % Sinhalese, 2% Tamil and 4% Muslim.

Table 2-33: Categories and numbers of interviewees (RMC)

Category	No of households/ institutes
High income household	50
Middle income household	53
Low income household	53
Commercials	45
Large size dischargers	8
Market	2
Private recyclers	6

Result is shown below.

a. Household survey

- ✓ In Ratnapura MC, 91% of surveyed households are provided with a garbage collection service, of which 89% stated they use this service.
- ✓ 52% of surveyed households are "very satisfied" with present SWM service provision, while 36% are "somewhat satisfied". There are about 4% of households who are not satisfied at all, while 4% of households are less than satisfied with garbage collection service provided by RMC.
- ✓ Households' main methods of waste discharge are shown in the Figure. The most common methods are carrying garbage to collection truck (41%) and carrying to garbage collection point (33%) and discharging it outside their premises for house to house collection (13%).
- ✓ Only 10% of surveyed households receive a daily garbage collection service while 67% stated that they received the service 2-3 times/week.
- ✓ In general, adult females handle waste in about 62% of surveyed households.
- ✓ As shown in the Figure, 25% of households currently separate their garbage into organic and inorganic waste at the source of generation. Only 1% of surveyed households are not/less willing to cooperate with source separation for recycling. Rests of the household are very much willing (63%) and somewhat willing (6%) to cooperate in source separated garbage collection system.
- ✓ Further, 56% of surveyed households stated that there are recyclable collectors or someone who comes to collect their reusable or recyclable materials.

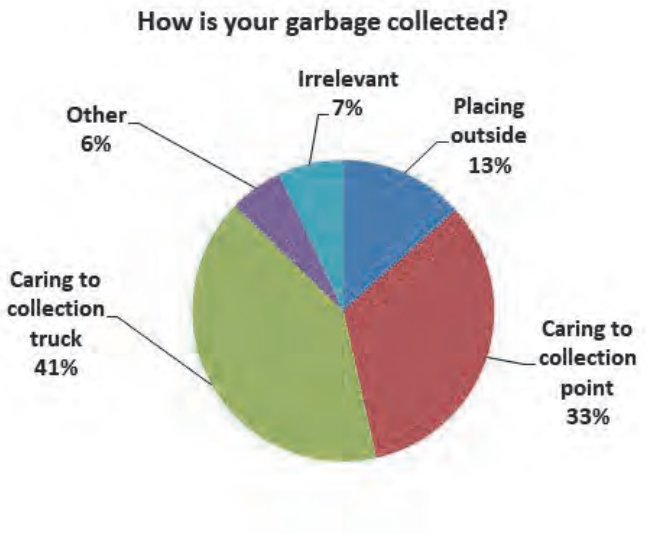


Figure 2-9: Methods of garbage discharge by residence in RMC area

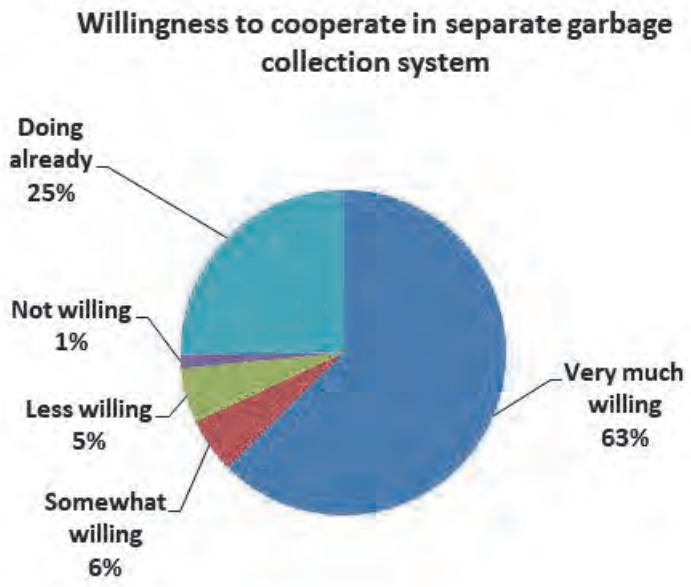


Figure 2-10: Willingness of residence for a source separated garbage collection system in RMC

b. Business institute

- ✓ In Ratnapura MC, 100% of surveyed businesses are provided with a garbage collection service, of which 98% stated they use this service.
- ✓ 69% of surveyed businesses are "very satisfied" with present SWM service provision, while 29% are "somewhat satisfied". There are about 2% of businesses who are not satisfied at all, while 2% of businesses are less than satisfied with garbage collection service provided by RMC.
- ✓ However, 56% of businesses in the view that the garbage collection service is not regular.
- ✓ 98% businesses stated that SWM awareness programmes are very necessary while only 2% stated "somewhat necessary". None of the surveyed businesses expressed that awareness campaigns are not necessary or not needed at all.
- ✓ Only 27% of businesses do not like to pay for SWM service mainly because of the revenue tax they paid for RMC. The average WTP (willingness to pay) for improved SWM services is 99 ± 154 Rs/month per business.
- ✓ Out of all surveyed businesses, 5% stated that they sale/give-off Glass & Bottle for recycling but none of the shops sale/give-off Plastics for recycling. Cardboard and paper recycling were 3% and 3%, respectively.

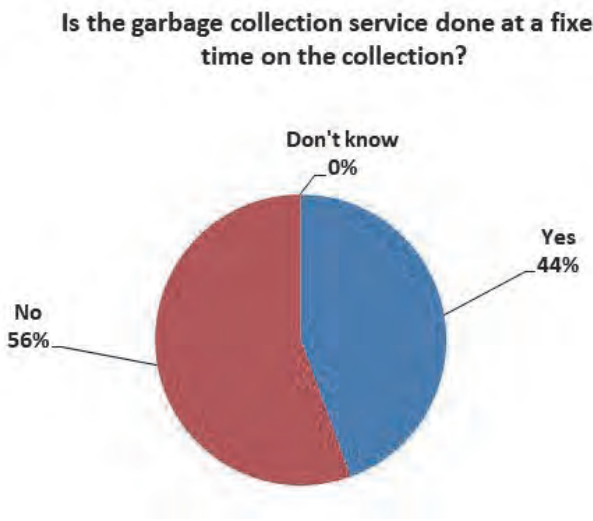


Figure 2-11: Punctuality of garbage collection service received by business community in RMC

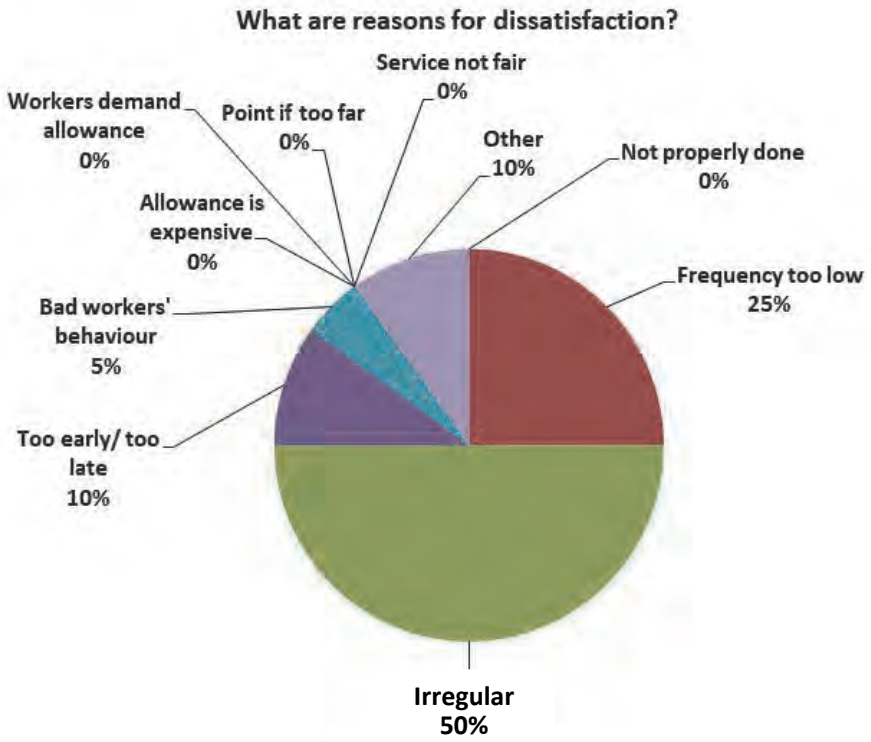


Figure 2-12: Reasons for dissatisfaction of business community

2.9.3 Kataragama PS

(1) Waste Generation Sources (WGS)

Waste generation source of Kataragama PS consists of household, commercial, school, office, market and so on. Main waste generation sources in Kataragama PS are shown in below table.

Table 2-34: Main waste generation sources in KPS

Source	Description
Household	Kitchen waste, domestic waste such as cleaning house, garden waste.
Commercial	Restaurant, hotel, organic shop, non-organic shop and so on.
Institute	Schools, hospital, clinic, office, government institute, religion institute, police, military facilities and so on.
Industry	Grain factories and rice milling plants
Others	Large scale mark called as “Pola” , small markets, slaughter house and so on.

(2) Waste generation amount (WGS)

Waste generation amount of Kataragama PS is estimated based on the waste generation rate of SATREPS research reports (2011-2016) and JICA data collection survey (2016), and data collection survey under ReEB waste project. The result shows that waste generation amount of Kataragama PS is 16.38 t/day and waste generation rate is 723.5g/day per capita (including instructional, commercial waste).

Table 2-35: Waste generation amount and waste generation rate of KPS

Category	Source	Generation rate	Units	Sources	Amount (MT/D)	Sub total	%
Residential	High, middle & law income	0.41	kg/person	22,640	9.282	9.282	56.7%
Commercial	Large size restaurants	155	kg/restaurant	3	0.465	4.587	28.0%
	Middle size guesthouses	4.1	kg/restaurant	343	1.406		
	Small size restaurants	13.8	kg/restaurant	78	1.076		
	Large size hotel	155	kg/hotel	0	0		
	Medium size hotel	29	kg/hotel	10	0.29		
	Small size hotel	4.1	kg/hotel	28	0.115		
	Organic shops (large)	11.5	kg/shop	0	0		
	Organic shops (middle)	6	kg/shop	0	0		
	Organic shops (small)	11	kg/shop	57	0.627		
	Non-Organic shops (large)	7.25	kg/shop	2	0.015		
	Non-Organic shops (middle)	1.9	kg/shop	0	0		
	Non-Organic shops (small)	1.9	kg/shop	312	0.593		

Category	Source	Generation rate	Units	Sources	Amount (MT/D)	Sub total	%
Institutional	Schools	127.5	kg/school	5	0.638	2.35	14.3%
	Hospitals (government)	1087	kg/hospital	1	1.087		
	Hospitals (private/Ayurveda)	202.85	kg/hospital	1	0.203		
	Health clinics	9.65	kg/clinic	0	0		
	Public office	20	kg/office	14	0.28		
	Bank/private office	2	kg/office	11	0.022		
	Buddhist temples	2	kg/temple	32	0.064		
	Hindu temples	5	kg/temple	9	0.045		
	Mosques	1.1	kg/mosque	1	0.001		
	Churches	0.5	kg/church	0	0		
	Navy/Police/ Army basses	9.65	kg/institute	1	0.01		
Industries	Industries (large)	187.5	kg/industry	0	0	0.042	0.3%
	Industries (medium)	6	kg/industry	0	0		
	Industries (small)	6	kg/industry	7	0.042		
Other	Pola	120	kg/pola	1	0.12	0.12	0.7%
	Public parks	150	kg/park	0	0		
	Public centers/halls	9.65	kg/center	0	0		
	Slaughter house	200	kg/shop	0	0		
	Fish market	200	kg/shop	0	0		
	Road/drain cleaning waste	600	kg (sum)	0	0		
	Hazardous (Special)	200	kg (sum)	0	0		
TOTAL					16.381	16.381	100.0%
Waste Generation Rate (g/day/capita)					723.5		
**Waste generation from Kataragama Devala, Kirivehera & Abhinawarama are not included.*							
**Amount of waste generation from religious places is 6.3 MT/day							

(3) Organization of municipal solid waste management

Solid waste management of Kataragama PS is implemented by Kataragama PS, Kataragama Devala and Physidal Planning Department. Kataragama PS is in charge of collection of solid waste in the town, transportation, treatment and dispose waste at Galapitiyagala exising disposal site and Sellakataragama disposal site. On the other hand Physical Planning Department is execution body of solid waste management at Pooja Bhumi Area where is religion area, while Kataragama Devala is the execution body of collection and dispose the solid waste at Devalaya. The solid waste management of Kataragama PS is mainly managed by Technical Officer (TO) who supervises health Division. The organization chart of solid waste management of Kataragama PS is shown in below figure.

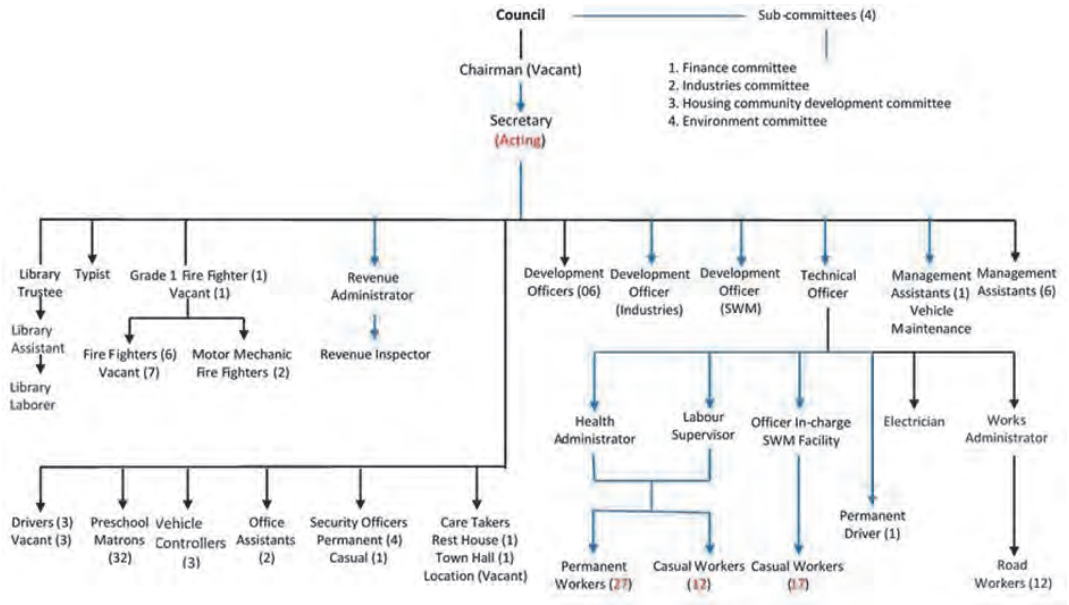


Figure 2-13: Organizational structure of KPS

The health division consists of health supervisor, labor/work supervisor, collection vehicle driver, one road worker and two sanitary workers. The duty of road worker and sanitary workers drive the collection vehicles as other post. There is no MOH and PHI at Kataragama PS, while they are assigned at Provincial Health Ministry.

(4) Equipment for SWM (as of 2017)

The detail of vehicles and machineries for solid waste management is shown as below table.

Table 2-36: Detail of vehicles and machineries for collection of solid waste in KPS

Type of vehicle	Type	# of units	Condition
Handcarts	Steel handcart	6	All are good
2WL-Tractor	Tractor & trailer	1	Working
4WL-Tractor	Tractor & trailer	6	Working
Compactor trucks (small)	IZUSU garbage truck (3T)	1	Under repair
Gully Bowser	Mitsubishi FUSO	1	Working
Gully Bowser	Tractor mounted	1	Working

(5) Cost of solid waste management

Any household is not charged the waste collection fee, however commercial and business institutes are charged by Kataragama PS in accordance with Pradeshiya Sabhas Act (9.3 article, No. 15 of 1987). The number of commercial and business institutes is approximately 950 numbers. The waste collection fee is charged by 10th day of every month. The detail of waste collection fees is shown as below table.

Table 2-37: Waste collection fees in KPS

No	Category	Tariff amount (LKR)/ Month
Shops		
1.1	Retail shops and other shops	150.00
1.2	Fruit shops	250.00
1.3	Canteens/ restaurants	1,000.00
Rest houses/ hotels		
2	1-5 rooms	500.00
3	6-10 rooms	1,250.00
4	11-20 rooms	2,500.00
5	21-50 rooms	5,000.00
6	50< rooms	7,500.00

(6) SWM Bylaws

A draft bylaw prescribed six wastes segregations into (a) biodegradable waste, (b) paper and cardboard, (c) plastic and polythene, (d) ferrum and coconuts husk, (e) broken glass and bottle and (f) other, and was waited for being authorized by Northwestern Province until May 2017. However, after integrated island wide separation programme has been started since June 2017, KPS has changed its separation categories accordingly, which are (a) Biodegradable, (b) Glass, (c) Plastic and (d) Paper.

2.10 B.6: Planning, Design, Bidding and Contracting of Pilot Projects

2.10.1 Topographic and Geological Survey

(1) Topographic Survey

The topographic surveys at the existing disposal sites at Kurunegala MC and Kataragama PS were carried out and the outline is shown as below table.

Table 2-38: Outline of topographic surveys at existing disposal sites in KMC and KPS

	Kurunegala MC	Kataragama PS
Survey period	11 May2017-9 June 2017	9 June2017-8 July2017
Survey company	NUN Engineering Pvt Ltd	NUN Engineering Pvt Ltd
TOR	Topographic survey at Sundarapola disposal site at Kurunegala MC : approx. 20ha	Topographic survey at Galapitagalayaya disposal site at Kataragama PS : approx. 3ha
Outcome	• Topographic map (scal:1/1000, contour interval :0.5m) : 3 sets • AutoCAD CD-R: 2 sets • Report: 2 sets	• Topographic map (scal:1/1000, contour interval :0.5m) : 3 sets • AutoCAD CD-R: 2 sets • Report: 2 sets

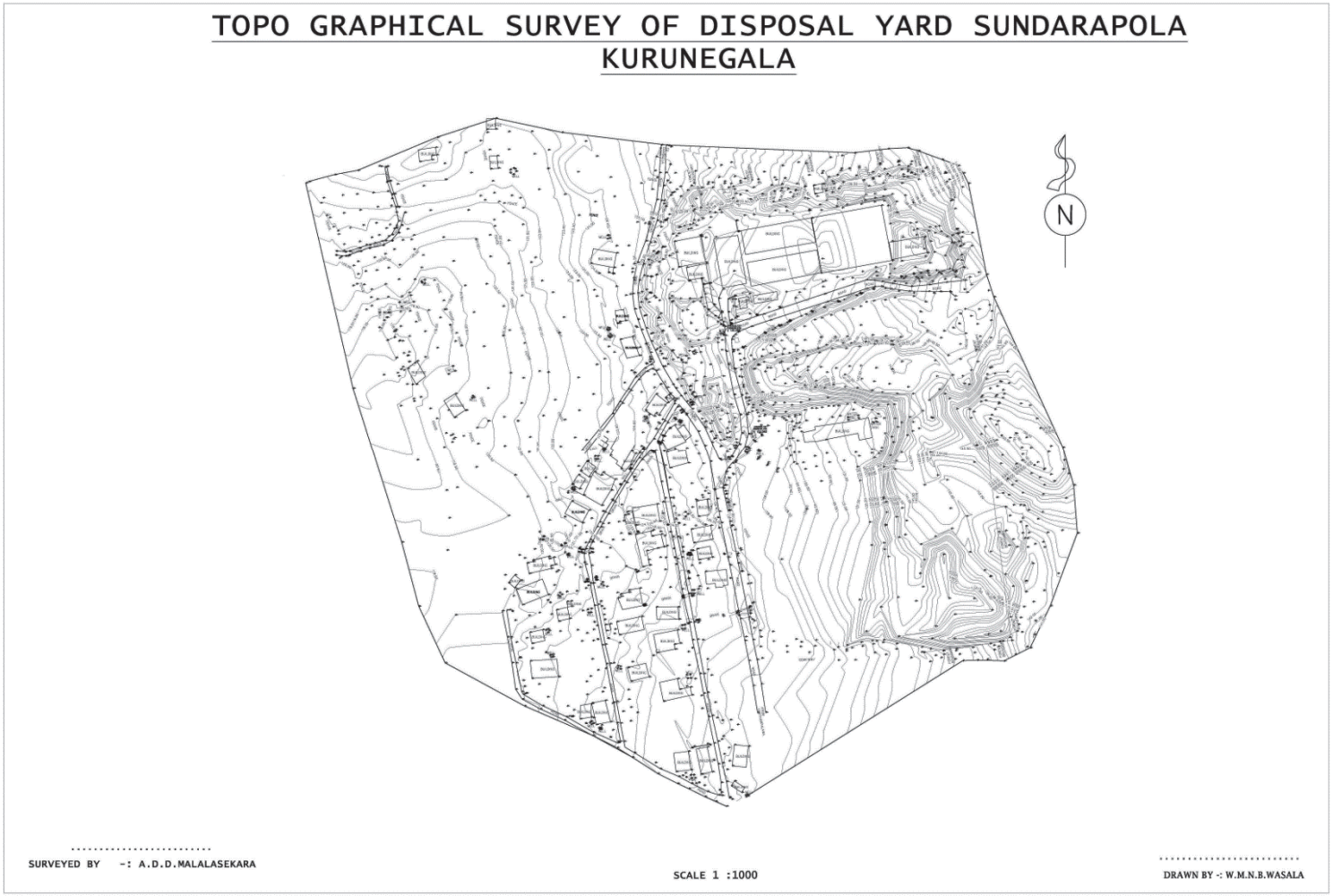


Figure 2-14: Topographic map of existing disposal site at KMC

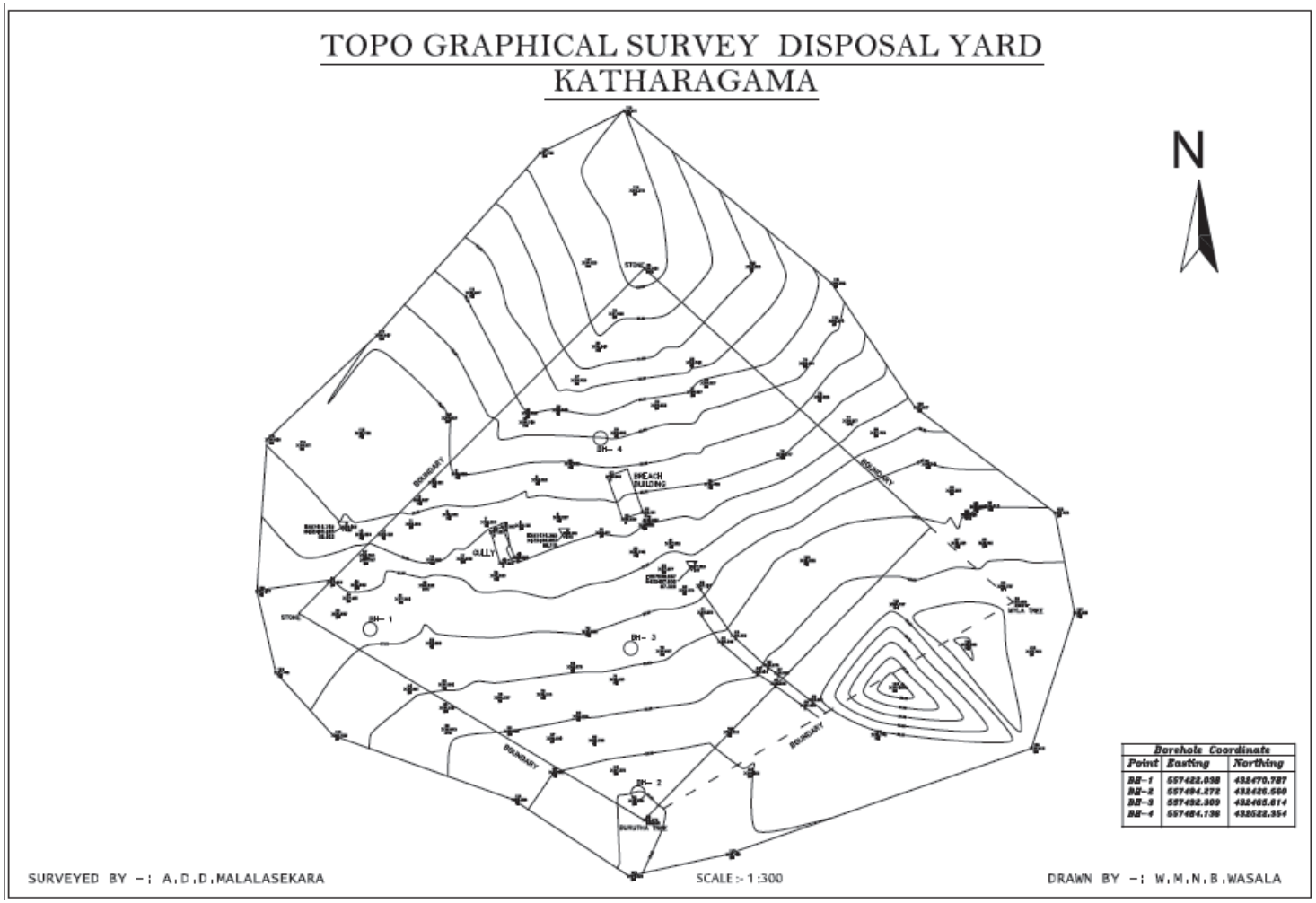


Figure 2-15: Topographic map of existing disposal site at KPS

(2) Geological survey

The geological surveys at the existing disposal sites at Kurunegala MC and Kataragama PS were carried out and the outline is shown as below table. Each geological survey report is attached as appendix 7.

Table 2-39: Outline of geological surveys at existing disposal sites in KMC and KPS

	Kurunegala MC	Kataragama PS
Survey period	5May2017-9June2017	17July2017-15August2017
Survey company	NUN Engineering Pvt Ltd	GEOTECH (Pvt) Ltd
TOR	Location : Sundarapola existing disposal site in Kurunegala MC 1. Borehole (15m, 5 places) 2. Monitoring well(3 places) 3. Sampling (5 places) 4. SPT (2places) 5. Permiable coefficient test(5places)	Location : Garapitigalayaya existing disposal site 1. Borehole (15m, 4 places) 2. Monitoring well(2 places) 3. Sampling (4 places) 4. SPT (4places) 5. Permiable coefficient test(4places)
Outcome	• AutoCAD CD-R: 2 sets • Report: 2 sets	• AutoCAD CD-R: 2 sets • Report: 2 se

2.10.2 B.6.2: Preparation of Action Plan and Basic Plan

(1) Action Plan

Creation of 5-year Action Plan in three pilot project local authorities were formulated which has four chapters below.

Table 2-40: Basic contents of Action Plan

Chapter	Title	Contents
Chapter 1	Introduction	• Purpose of Action Plan • Revision of Action Plan • Basic Information of LA • Applicable Bylaw and Policy on SWM
Chapter 2	Current SWM Condition	• Waste Stream and result of current SWM survey • Waste Management Institutional Setting • SWM System Components
Chapter 3	Assessment of Current SWM Condition	• Solid waste management • Night soil management
Chapter 4	Action Plan	• Outline i.e. Policy, Overall Goal, Scope, Target • Strategy of Action Plan • Detailed Technical System • Detailed Plan • Action Plan

a. Kurunegala MC

Based on the current solid waste management survey, current waste flow in 2017 and future waste flow in 2023 in the 5-year Action Plan (2019-2023) – which are predicted in accordance with GDP and population growth – were agreed with Kurunegala. The pilot project plays the role of the first year of the Action Plan.

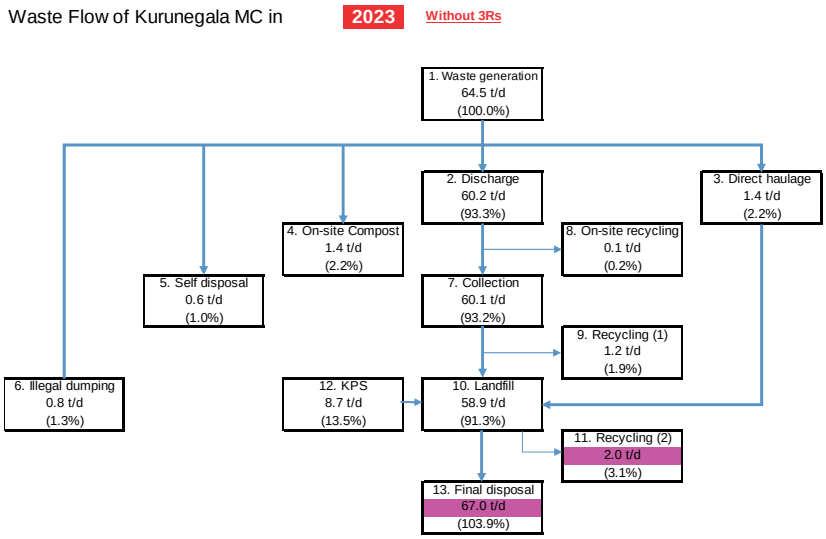


Figure 2-16: Future waste flow in Kurunegala MC (without 3Rs)

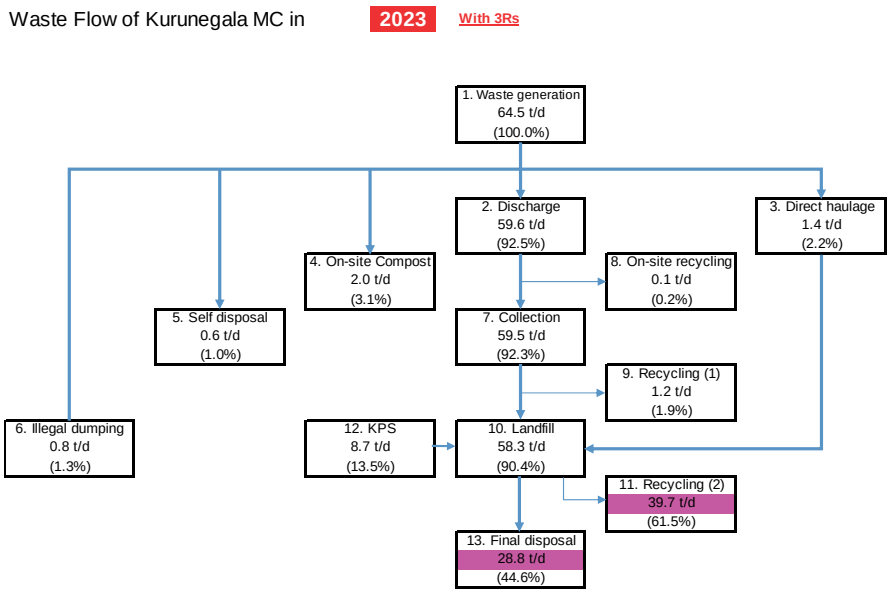


Figure 2-17: Future waste flow in Kurunegala MC (with 3Rs)

Table 2-41: SWM Target in Kurunegala MC (2019-2023)

	2017	2018	2019	2020	2021	2022	2023
Waste generation	53.8	55.4	57.0	58.8	60.6	62.5	64.5
Discharge	49.7	51.1	52.7	54.5	56.3	57.6	59.6
Direct haulage	1.4	1.4	1.4	1.4	1.4	1.4	1.4
On-site composting	1.4	1.4	1.4	1.4	1.4	2.0	2.0
Self disposal	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Illegal dumping	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Collection	49.6	51.0	52.6	54.4	56.2	57.5	59.5
On-site recycling	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Recycling (1)	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Landfill	46.4	49.8	51.4	53.2	55.0	56.3	58.3
Recycling (2)	2.0	2.0	35.0	36.2	37.4	38.3	39.7
KPS	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Final disposal	56.5	57.9	26.6	27.2	27.7	28.2	28.8

Table 2-42: Action Plan in Kurunegala MC

No	Activities	2018	2019	2020	2021	2022
1.1	Formation of SWM Department		X	XX	XXR	XX
1.2	Allocation of competent human resources at SWM managerial level		X	XX	XX	XX
1.3	Improved management	X	X	XX	XX	XX
1.4	Improved labourer management	X	X	XX	XX	XX
1.5	Improved financial management		X	XX	XX	XX
1.6	Enforcement of law	XX	XX	XX	XX	XX
1.7	Monitoring committee	X	XX	XX	XX	XX
2.1	Encouraging 3Rs through education/ awareness and enforcement	X	XX,R	XX	XX,R	XX
2.2	Support for recycling system	X	XX	XX	XX,R	XX
2.3	Promoting on-site composting	X	X	XX	XX	X,R
2.4	Promoting use of organic waste as animal feed	X	X	XX	X,R	XX
2.5	Special charging system for commercial/industrial enterprises		X	XX	X,R	XX
2.6	Separate collection system	X	X,R	XX	XX	XX
2.7	MCK SWM 3Rs Plan preparation/ implementation	X	X,R	XX	XX	X
3.1	Improved public-MCK communication	X	XX	XX	XX	XX
3.2	Implement education/awareness programme	X	XX	X	XX	X
3.3	Creation of “Shibushi Model Area”	X	XX,R	X,XX	X,XX	X,XX
3.4	Monitoring, evaluation and revision			R		R
4.1	Discharge, Storage, Collection and Transportation Improvements	X	X	XX	XX	X,R
4.2	Separate work category for street sweeping and drain cleaning	X	XX	XX	X	X,R
4.3	Clinical waste management	X	X	X	X	XX

No	Activities	2018	2019	2020	2021	2022
4.4	Improving vehicle/equipment system	X	X	X	X	X,R
5.1	Improving composting	X	X	XX	XX	XX
5.2	Compost process control	X	XX,R	XX	XX	XX
5.3	Quality assurance	XX	XX	XX	XX	XX
5.4	Processing polythene and plastic	X	XX	XX	XX	XX
6.1	Improved operation of current landfill site	XX	XX	XX	XX	XX
6.2	Closure of current landfill					X
6.3	Ongoing monitoring	XX	XX	XX	XX	XX
6.4	New Landfill Site		X			
6.5	Surveying, engineering and environmental investigations		X			
6.6	Construction			XX	XX	
6.7	Sanitary landfill operation at new site					X
6.8	Landfill Monitoring committee	XX	XX	XX	XX	XX

b. Ratnapura MC

Based on the current solid waste management survey, current waste flow in 2017 and future waste flow in 2022 in the 5-year Action Plan (2018-2022) – which are predicted in accordance with GDP and population growth – were agreed with Ratnapura MC. The pilot project plays the role of the first year of the Action Plan.

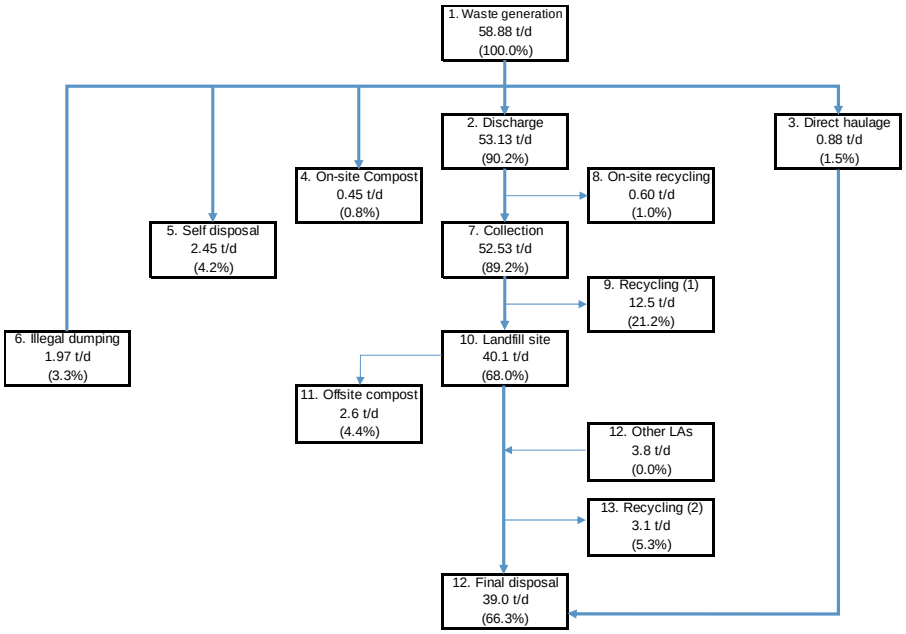


Figure 2-18: Future waste flow in Ratnapura MC (without 3Rs)

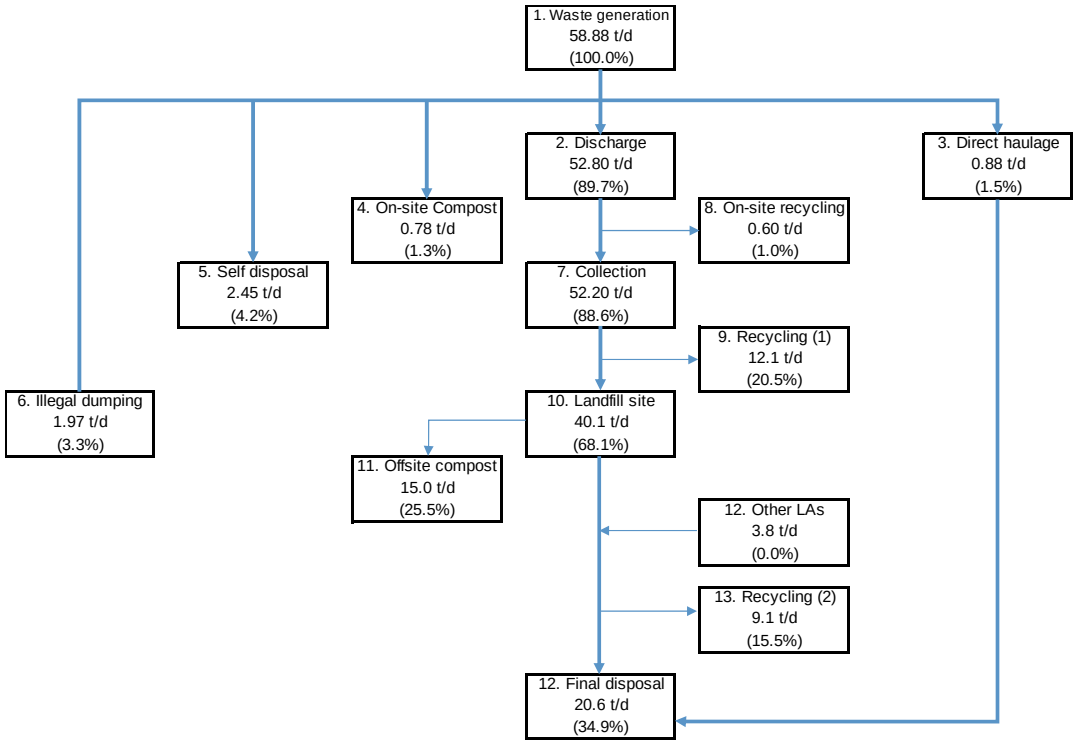


Figure 2-19: Future waste flow in Ratnapura MC (with 3Rs)

Table 2-43: SWM Target in Ratnapura MC (2018-2022)

	2017 (Current)	2018	2019	2020	2021	2022
No. of HH doing home composting (%)	6	6.9	8	9	10	10
Receiving amount of biodegradable waste at Kanadola (ton/day)	2.34	5.33	8.55	11.78	15	15
Compost production at Kanadola (ton/month)	2.3	5.33	8.55	11.78	15	15
Receiving amount of recyclable items (ton/day)	2.86	5.36	12.18	12.44	12.78	13.1
Sales amount of recyclable wastes at Kanadola (ton/day)	0.14	2.14	4.87	6.22	7.64	9.14
Sales amount/ Receiving amount (%)	4.9	40	40	50	60	70
Final disposal amount (ton/day)	35.76	33.77	28.58	24.81	21.16	20.56

Table 2-44: Action Plan in Ratnapura MC

No.	Description	18	19	20	21	22
1	Strengthening of institutional and organization system					
	Establish bylaw related to separate waste collection.	■				
	Create annual action plan.	■	■	■	■	■
	Request annual budget based on action plan for the following years.	■	■	■	■	■
	Monitor performances of SWM operation using actually measured data.	■	■	■	■	■
	Create (revised) action plan for next 5 years					■
	Conduct waste composition survey					■
2	Promotion of 3Rs (Reduce, Reuse, Recycle) system					
	Plan awareness programmes to promote 3Rs and source separation.	■	■	■	■	■
	Conduct awareness programmes to promote 3Rs and source separation.	■	■	■	■	■
	Promote onsite composting by providing compost bins or introducing “Jeewakotu”.	■	■	■	■	■
	Plan awareness programmes regarding hazardous wastes.			■	■	■
	Conduct awareness rising programmes regarding hazardous waste			■	■	■
	Procure necessary equipment for waste separation.	■	■	■	■	■
	Monitor separation practices at generation level, collection and transportation level and Kanadola site.	■	■	■	■	■
	Monitor the practice of home composting and Jeewakotu	■	■	■	■	■
3	Improvement of waste collection and transportation system					
	Schedule waste collection system and share with waste generators i.e. residents and businesses.	■	■	■		
	Monitor waste collection vehicles by GPS and regularly adjust waste collection and transportation system.	■	■	■	■	■
	Maintain collection vehicles	■	■	■	■	■
4	Improvement of compost production					
	Expand compost facility for windrow system.	■				
	Connect a pipe from compost yard to the night soil treatment facility.	■				
	Experiment producing compost using different biodegradable resources	■				
	Compare compost production and quality between two different compost systems	■				
	Find new land for composting and construct a yard	■				
5	Effective operation of the integrated intermediate treatment facility					
	Maintain machineries at the facility.	■	■	■	■	■
	Record sales and amount of recyclable stock and take action on it.	■	■	■	■	■
	Communicate with private recyclers regularly	■	■	■	■	■
6	Waste disposal system					
	Acquire a new landfill site.	■				

No.	Description	18	19	20	21	22
	Formulate a basic design of new sanitary landfill site facilities					
	Make consensus with local people					
	Design (detailed) the sanitary landfill site facility					
	Obtain environmental clearance					
	Construct the sanitary landfill site facility					
	Procure equipment.					
	Operate and maintain sanitary landfill site					
	Monitor the operation and maintenance					
	Close current disposal site					
7	Proper operation of night soil treatment facility					
	Operate night soil treatment facility					
	Replace coco-nut fiber biofilm media					
8	Multi stakeholder involvement					
9	Development of materials					
	Make/ revise leaflet for waste separation and collection system.					
	Make/ revise educational materials/tools for public					
	Make/ revise training materials for staffs of SWM					
	Provide training to the staff of SWM regularly					
10	Establish emergency management system					

c. Kataragama PS

An action plan was drafted based on the data collection survey and discussion with counterpart of Kataragama PS were started in April, 2018. The action plan covers the terms from 2018 to 2022 and it describes that efforts will be implemented in accordance with three overall goals. An outline of the action plan is shown below.

<The Overall Goals of the Action plan>

Goal A:
Develop a system of programs and facilities for effectively and economically managing solid waste, using 3Rs (reduce, reuse, recycling), composting, and landfill.

Goal B:
Utilize the elements of source reduction, recycling and composting to reduce the amount of waste being landfilled.

Goal C:
Develop Emergency Management Plans to assure that Authority facilities are properly prepared to respond to localized disasters.

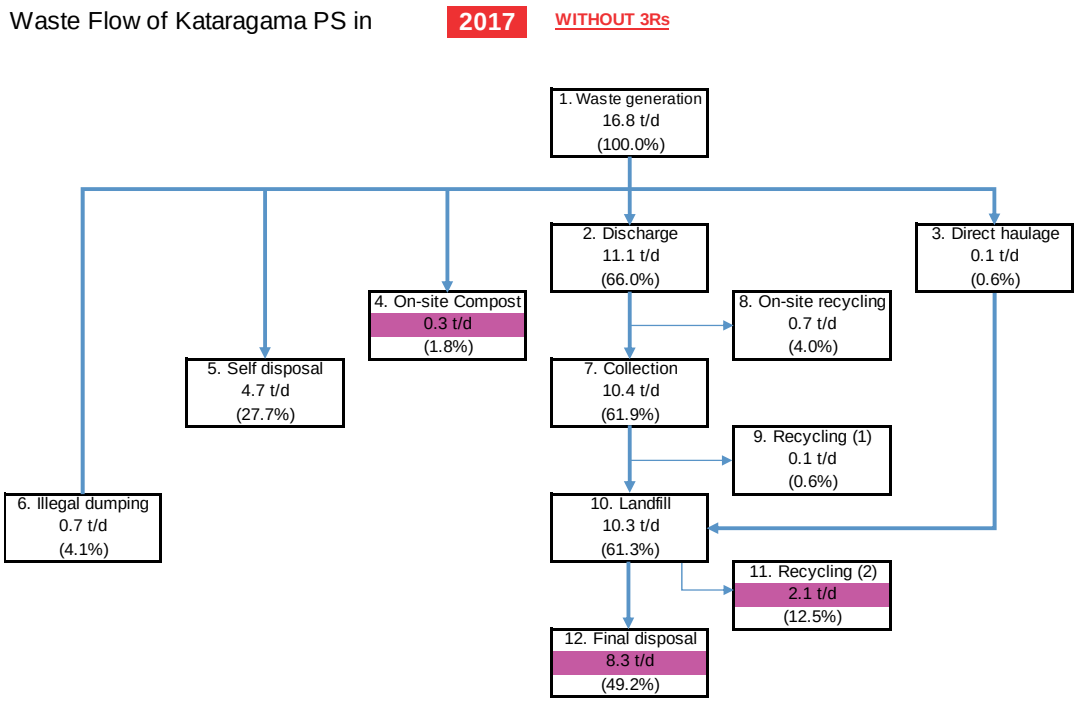


Figure 2-20: Current waste flow

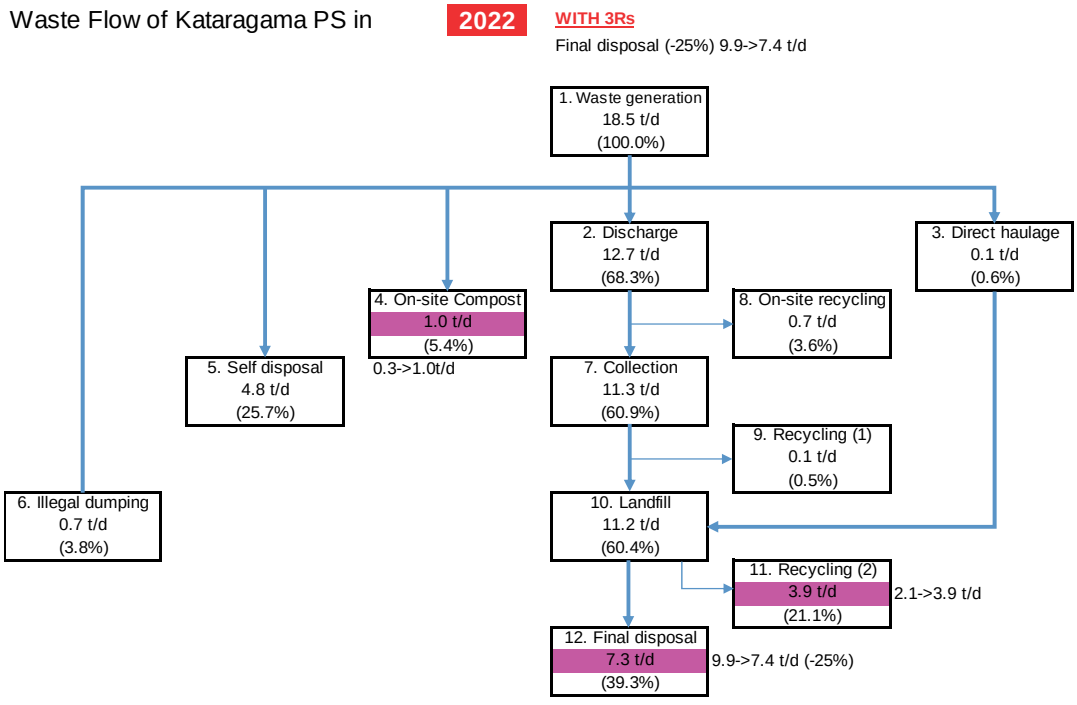


Figure 2-21: Future Waste Flow (With 3Rs)

Table 2-45: SWM Target in Katharagama PS (2018-2022)

	2017	2018	2019	2020	2021	2022
Waste generation	16.8	17.1	17.5	17.8	18.2	18.5
Discharge	11.1	11.2	11.4	11.6	11.7	12.0
Direct haulage	0.1	0.1	0.1	0.1	0.1	0.1
On-site composting w/3Rs	0.3	0.4	0.5	0.7	0.9	1.0
Self disposal	4.7	4.7	4.8	4.8	4.7	4.8
Illegal dumping	0.7	0.7	0.7	0.7	0.7	0.7
Collection	10.4	10.5	10.7	10.9	11.0	11.3
On-site recycling	0.7	0.7	0.7	0.7	0.7	0.7
Recycling (1)	0.1	0.1	0.1	0.1	0.1	0.1
Landfill	10.3	10.4	10.6	10.8	10.9	11.2
Recycling (2) w/3Rs	2.1	2.5	2.9	3.3	3.6	3.9
Final disposal w/3Rs	8.3	8.0	7.8	7.6	7.4	7.3

Table 2-46: Action Plan (Draft)

No.	Description	18	19	20	21	22
1	Strengthening institutional and organization system					
	To establish bylaw related to separate waste collection.	■				
	To create annual action plan.	■	■	■	■	■
	To request annual budget based on action plan for the following years.	■	■	■	■	■
	To monitor performances of SWM operation by actually measured data.	■	■	■	■	■
	To create (revised) action plan for next 5 years					■
	To conduct waste composition survey					■
2	Promotion of 3Rs (Reduce, Reuse, Recycle) system					
	To plan awareness programmes to promote 3Rs and source separation.	■	■	■	■	■
	To conduct awareness programmes to promote 3Rs and source separation.	■	■	■	■	■
	To promote onsite composting by providing compost bins.	■	■	■	■	■
	To plan awareness programmes regarding hazardous wastes.			■	■	■
	To conduct awareness rising programmes regarding hazardous waste			■	■	■
	To secure necessary number of staffs for waste separation.	■	■	■	■	■
	To monitor separation practice at generation, collection and transportation levels.	■	■	■	■	■
	To monitor the practice of home composting.	■	■	■	■	■
3	Improvement of waste collection and transportation system					
	To schedule waste collection system and share with waste generators i.e. residents and commercials.	■	■	■		
	To monitor waste collection vehicles by GPS and regularly adjust waste collection and transportation system.	■	■	■	■	■
	To maintain collection vehicles	■	■	■	■	■
4	Improvement of compost technology					

No.	Description	18	19	20	21	22
	To expand compost facility to make a windrow system.					
	To connect a pipe from compost yard to the night soil treatment facility.					
	To experiment producing compost using different biodegradable resources					
	To compare compost production and quality between two different compost systems.					
5	Effective operation of the integrated intermediate treatment facility					
	To maintain machineries at the facility.					
	To install a weigh bridge					
	To record sales and amount of recyclable stocks and take action on it.					
	To communicate with private recyclers regularly					
6	Waste disposal system					
	To construct the sanitary landfill site facility					
	To procure equipment.					
	To operate and maintain the sanitary landfill site					
	To monitor the operation and maintenance					
7	Proper operation of night soil treatment facility					
	To construct the night soil treatment facility					
	To operate night soil treatment facility					
	To replace coconut fiber biofilm media					
8	Multi-stakeholder involvement					
9	Development of materials					
	To make/ revise leaflet for waste separation and collection system.					
	To make/ revise educational materials/tools for public					
	To make/ revise training materials for staffs of SWM					
	To train staffs of SWM regularly					
10	Establishment of emergency management system					

(2) Basic Plan

a. Improvement of existing disposal site at Kurunegala MC

The basic plan and detail plan for improvement of existing disposal site at Kurunegala MC was formulated by Japanese expert and local consultant. The outline of basic plan and detail plan for the improvement of existing disposal site at Kurunegala MC is shown in below table.

Table 2-47: Outline of basic plan and detail plan for improvement of existing disposal site in KMC

Design period by local consultant	26July2017-8September 2017
Consultant	Waste to Energy Technologies Limited
Items of basic plan	• Installation of PRB to filter groundwater • Establishment of leachate treatment facility • Landfill mining

The basic plan of improvement of existing disposal site at Kurunegala MC is attached as Appendix 8.

b. Promotion of 3Rs in Ratnapura MC

b.1. Waste separation categories, discharge, collection & transportation, and disposal

Ratnapura MC provides biodegradable and non-biodegradable collection service. Household waste – normally discharged in grocery bags – is collected by tractors on certain days of the week. Part of non-biodegradable wastes is also collected by a three wheeler. To meet an integrated four separation categories started from 1st June 2017, the pilot project in RMC will introduce the six separation categories in selected pilot project areas within RMC. The biggest issue in Ratnapura MC is the dumping of large quantities of biodegradable waste without composting, most of which is partially separated at generation level. During the pilot project, dumping amount of biodegradable waste, which is a major cause of environmental impact, will be decreased by increasing the capacity of windrow compost production and training collection vehicle drivers and collectors, in addition to public awareness to promote separation of biodegradable wastes at a generation level.

Table 2-48: Transition of SWM situation and input

	Current (August 2017)	End of PP	Input by the project
Separation category	Two categories of biodegradable and non-biodegradable	Five categories of biodegradable waste, plastic and polythene, paper and cardboard, glass, metal and coconut shells and others.	Assistance in creating leaflet, poster, and notice board, promotion of public awareness programmes, establishment of monitoring system of separation.
Discharge	There is no specific announcement to public regarding way of discharge. At the moment, they discharge wastes with shopping bags.	Green separation bin is used for biodegradable wastes. Recyclable items including plastic, paper, glass & metal & coconuts shells are discharged in orange, blue and red coloured poly sacks respectively. Other wastes are discharged in varying ways.	Procurement of separation bins and poly sacks, and establishment of monitoring system of discharge behaviour.
Collection and transportation	Mainly tractor is used for wastes collection. Biodegradable wastes are dealt with as mixed wastes and non-biodegradable wastes are dealt with as recyclable wastes.	Collection area will be expanded by introducing a three wheeler. In household pilot project areas, biodegradable wastes will be collected by tractors, and recyclable items and other wastes will be collected by a three wheeler.	Procurement of a three wheeler. Creation of collection and transportation plan. Procurement of GPS. Establishment of monitoring system for daily collection coverage.
Treatment and Disposal	All mixed wastes are dumped directly at a disposal site. Only market wastes are used for boxed system compost yard. Recyclable items from non-biodegradable wastes are recovered and sold to recyclable items traders.	Dumped wastes are only what is categorised as 'other' in PP area. Biodegradable wastes are used for making compost in windrow system. Expectation of increasing resource recovery by promoting separation at generation levels.	Establishment of windrow composting system.

b.2. Pilot Project Areas

Each of four PHI areas, pilot project areas in the PHI areas and composition survey areas are shown in the figure below. Also, areas information are listed. Considering Ratnapura MC has a population of 54,373 and 12,931 households, the pilot project covers a quarter of households.

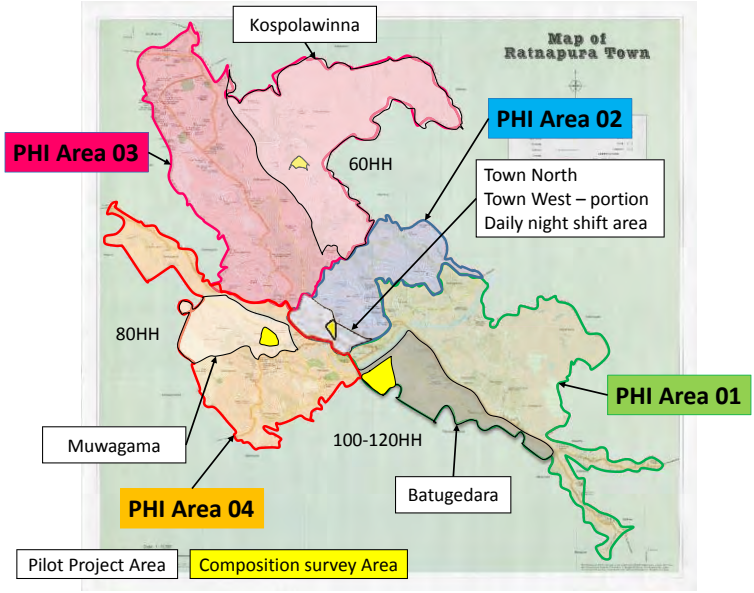


Figure 2-22: PHI areas, pilot project areas and composition survey areas of RMC

Table 2-49: Basic information of PHI areas, pilot project areas and composition survey areas of RMC

PHI area	Pilot Project			Composition survey	
	Area Name	Residents/ Commercial	No Household	No Household *	Expected waste generation amount (/week)
PHI-1	Batugedara	Residents	423	100-120	700kg
PHI-2	Part of Town north and Town West	Commercial	698[6]	165*	1650kg
PHI-3	Kospolawinna	Residents	1158	60	420kg
PHI-4	Muwagama	Residents	514	80	560kg
		Total	2,793		

Note * means number of commercials

b.3. Objectives of pilot project

- To reduce discharge amount of wastes
- To increase waste separation percentage
- To reduce disposal amount of wastes at dumping site

[6] PHI2 has 463 commercial dischargers in addition to 698 households.

- To cover the collection of inaccessible area
- To start formulating manual of intermediate treatment

b.4. Indicators of pilot project outcome

Indicators of the pilot project outcome and data sources are shown in the following table, which is the same as the 1st year target of the 5-year Action Plan described in 2.10.2.1 (2) Ratnapura.

Table 2-50: Indicators of PP outcome and data sources in RMC

Indicators of Pilot Project Outcome	Before and After PP	Data sources
Discharge amount of waste from households level	↘	• Questionnaire survey in the WACS areas • Number of compost barrels distributed • Monitoring results of distributed home compost barrels
Number of household doing home compost	↗	• Number of distribution of home compost bins
Percentage of separation	↗	• WACS • Questionnaire survey in the WACS areas • Monitoring results of waste separation to the residents by RMC supervisors
Production of compost at Kanadola	↗	• Data record of compost production at Kanadola
Sales of recyclable wastes at Kanadola	↗	• Sales record of compost production at Kanadola
Disposal amount of waste at dumping site (Non-valuable waste and residues from the compost yard)	↘	• Data record of disposal amount including residue from a compost yard at Kanadola site
Door to door collection service coverage	↗	• GPS tracking • Collection and transportation plan
Creation of 5-year Action Plan	NA	• Draft of RMC's Action Plan (2018-2022)

b.5. Improvement of existing disposal site at Kataragama PS

The basic plan and detail plan for improvement of existing disposal site at Kataragama PS was formulated. The outline of basic plan and detail plan for the improvement of existing disposal site at Kataragama PS is shown in below table.

Table 2-51: Outline of basic plan and detail plan for improvement of existing disposal site in KPS

Design period by local consultant	29September2017-early November (tentative)
Consultant	Selection procedure
Items of basic plan	• Leachate collection facility constructed by local available material • Leachate treatment facility • Improvement of access road • Installation of electric fence to avoid wild elephant • Covering soil • Night soil treatment facility • Installation of weigh bridge

The basic plan of improvement of existing site at Kataragama PS is attached as Appendix 9.

c. Promotion of 3Rs in Kataragama PS

c.1. Issued of Kataragama PS SWM:

Through the survey conducted for selection of PP target local governments, the following two issues have been identified:

- Waste generation amount largely fluctuate due to tourists and worshippers to temples;
- Waste amount sharply increases in festival, vacation seasons and weekends.

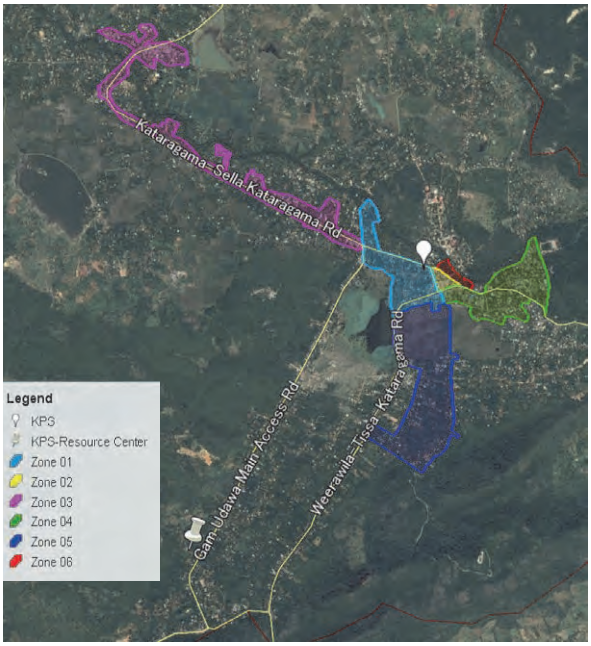
c.2. PP target areas in KPS

As a result of discussion with KPS, two areas have been selected as the target areas of the PP. The process of selection is as follows.

Primarily, it was decided to target hotels, guesthouses and restaurants who host the visitors, who are the major dischargers of the waste which KPS needs to tackle with.

i. Zones according to the on-going waste collection routes

Currently, Kataragama PS area has been divided in to six zones according to their waste collection routes as shown in the picture on left.



ii. Characteristics of each zone

Zone	Characteristics
Zone 1	• Mixed composition including government institutions, shops, residents, guesthouses, etc., too will require many inputs and resources, and difficult to measure the impact of PP. • KPS distributed a total of 200 compost bins in 2016 only to "half" of each of these zones. The rest of half has not been taken care of, thus require more attention.
Zone 2	• Market only
Zone 3	• Hotels/Guesthouses, 2 Markets near two major Dewales. • KPS distributed a total of 200 compost bins in 2016 only to "half" of each of these zones. The rest of half has not been taken care of, thus require more attention.
Zone 4	• Hotels/Guesthouses (including Government circuit bungalows), close to the centre of the town • KPS distributed a total of 200 compost bins in 2016 only to "half" of each of these zones. The rest of half has not been taken care of, thus require more attention.
Zone 5 Zone 6	• Mainly residential and less hotels/guesthouses and restaurants

c.2. Objectives of PP

A questionnaire survey was conducted from 10 July till 12 July, 2017, in cooperation with KPS, in order to understand the current status of public opinion and waste discharging practice, with targeting hotels, guesthouses and restaurants in Zone 3 and 4; the sizes of sample are 34 in Zone 3, and 21 in Zone 4, and in total 55.

i. Composition of the sample:

The compostion of the sample is shown as below table.

Table 2-52: The number of sample at Zone 3 and Zone 4 in KPS

Zone	3	4
Hotels	2	4
Guest house	30	11
Restaurant	1	1
Others	1	5
Total	34	21

ii. Survey result

i) Treatment of kitchen waste

KPS has been promoting separation of organic waste even before the Project, and a certain number of the interviewed institutions does “separate and discharge bio-degradable waste”

■ Both in Zone 3 and 4, there are a certain number of institutions who claim to be discharging kitchen waste separately to the waste collection services.

Table 2-53: Manners of discharging kitchen waste in KPS

	a		b		c		d		e		Total	
Zone	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	0	0	1	1	0	1	1	2	0	0	2	0
Guest house	0	2	8	7	11	1	11	2	0	0	30	0
Restaurants	0	0	0	1	0	0	1	0	0	0	1	0
Others	0	0	1	2	0	1	0	2	0	0	1	0
Total	0	2	10	11	11	3	13	6	0	0	34	22

[a. discharged together with other waste to the regular collection service / b. discharged separately to the regular collection service /c. disposing together with other waste in own premises / d. disposing separately in our own premises / e. other]

■ On the other hand, those who are disposing kitchen waste in their own premises separately or together with other waste, almost all of them “burn” the waste, and only two guesthouses in Zone 3 were found to be composting their kitchen waste.

Table 2-54: Disposal manner of the institutions that are self-disposing kitchen waste with other waste in KPS

	Burning		Feeding to animals		Burying		Burying to use as fertilizer		Using compost bin		Other	
Zone	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	0	1	0	0	0	0	0	0	0	0	0	0
Guesthouse	9	0	1	0	3	0	0	0	0	0	0	0
Restaurants	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	1	0	0	0	0	0	0	0	0	0	0
Total	**9**	**2**	**1**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 2-55: Disposal manner of the institutions that are self-disposing kitchen waste separately from other waste in KPS

	Burning		Feeding to animals		Burying		Burying to use as fertilizer		Using compost bin		Other	
Zone	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	1	2	0	0	1	1	0	0	0	0	0	0
Guesthouse	7	2	2	0	1	0	2	0	0	0	0	0
Restaurants	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	2	0	0	0	0	0	0	0	0	0	0
Total	**8**	**6**	**2**	**0**	**2**	**1**	**2**	**0**	**0**	**0**	**0**	**0**

ii) Garden waste

■ Almost all institutions in both Zone 3 and 4 have own gardens, and the garden waste from their gardens are burnt in their own premises.

Table 2-56: Institutions with own gardens in KPS

	Yes		No		Total	
Zone	3	4	3	4	3	4
Hotels	2	3	0	0	2	0
Guesthouse	30	10	0	1	30	0
Restaurants	1	1	0	0	1	0
Others	1	5	0	0	1	0
Total	34	19	0	1	34	20

Table 2-57: Disposal manner of garden waste in the institutions with own garden in KPS

	a		b		c		d		e		n/a		Total	
Zone	3	4	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	1	0	0	0	0	0	1	3	0	0	0	1	2	4
Guesthouse	0	1	4	4	1	0	24	6	0	0	1	0	30	11
Restaurants	0	0	0	1	0	0	1	0	0	0	0	0	1	1
Others	0	0	0	1	0	0	0	4	0	0	1	0	1	5
Total	1	1	4	6	1	0	26	13	0	0	2	1	34	21

［a. discharged together with other waste to the regular collection service / b. discharged separately to the regular collection service / c. discharged separately to a garden waste collection service / d. disposing in own promises / e. Other］

Table 2-58: Disposal manner of the institutions that are <u>self-disposing garden waste separately from other waste</u> in KPS

	Burning		Burying		Burying to use as fertilizer		Using compost bins		Other		n/a		Total	
Zone	3	4	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	1	3	0	0	0	0	1	0	0	0	0	0	2	3
Guesthouse	0	6	4	2	1	0	24	0	0	0	1	0	30	8
Restaurants	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Others	0	3	0	0	0	0	0	0	0	0	1	0	1	3
Total	1	12	4	2	1	0	26	0	0	0	2	0	34	14

■ On the other hand, they purchase organic fertilizer preferring to chemical ones, and some pays more than Rs.3,000/month for fertilizer. (Although it is questionable that many say they use home-made organic fertilizer despite that there are few that are composting, it is still can be considered that they prefer organic waste.)

Table 2-59: Type of fertilizer used in their gardens in KPS

	Chemical fertilizer		Purchased organic fertilizer		Home-made organic fertilizer		cow dung		None		Other		n/a		Total	
Zone	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	0	0	1	1	0	0	0	2	0	1	1	0	0	0	2	4
Guesthouse	0	0	6	2	4	3	3	1	14	2	1	0	2	2	30	10
Restaurants	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1
Others	0	0	0	0	0	0	0	1	0	3	0	1	1	0	1	5
Total	0	0	7	4	5	3	3	4	14	6	2	1	3	2	34	20

Table 2-60: Type of fertilizer and expenditure for fertilizer (Rs. /month) in KPS

Type of Fertilizer / Expenditure (Rs./Month)	Purchased organic fertilizer		Home-made organic fertilizer		cow dung		None	
Zone	3	4	3	4	3	4	3	4
1~499	3	2	0	0	1	0	0	0
500~999	1	1	0	0	0	0	0	1
1000~1999	0	0	0	0	0	0	0	0
2000~2999	0	0	0	0	0	0	0	0
3000~ above	1	1	0	0	1	0	0	0
Total	5	4	0	0	2	0	0	1

There seems to be a large possibility for promoting home composting considering that having a space for burning waste could mean a possible space for composing, and that they have a garden where compost can be utilized and preference for organic fertilizer.

iii) Treatment of valuable wastes

In Sri Lanka it has been instructed since 1st of June, 2017 to collect waste separately to all local governments, and KPS follows the instruction and calls for separate discharge to their citizens.

Figure 2-23: Leaflet distributed by KPS to their citizens in June to promote separate discharge

Instructing to separate organic waste (green), paper/ cardboard (blue), plastic/ polyethylene (orange), metal/ coconut shell (brown), broken glass/ glass bottles (red)。（ ）indicate colours containers.

There was a confusion over the question about separate discharge of valuables, but it still revealed that the interviewed institutions discharge separately some kinds of valuables to some ones.

Table 2-61: Current status of separate discharge of valuable waste in KPS (Collectors are not limited to the PS)

	no recyclable discharged		I don't know		Not separating recyclables		Glass		PET		Other plastic		newspaper	
Zone	3	4	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	0	1	0	2	0	0	2	2	2	1	0	1	1	1
Guesthouse	2	3	0	3	8	0	16	7	5	2	3	0	2	2
Restaurants	0	0	0	0	0	0	1	1	0	1	0	0	0	0
Others	0	2	0	3	0	0	0	2	0	1	0	0	0	1
Total	2	6	0	8	8	0	19	12	7	5	3	1	3	4

	cardboard		other paper		iron		aluminum		other metals		others	
Zone	3	4	3	4	3	4	3	4	3	4	3	4
Hotels	1	0	0	0	0	0	0	0	0	0	1	0
Guesthouse	2	1	2	0	1	0	0	0	0	0	1	1
Restaurants	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0	0	1
Total	3	1	2	0	1	0	0	0	0	0	2	2

Mainly glass bottles, PET, newspaper and cardboards are separately discharged, but even PET which can relatively easily be separated is separated only by 5/21 (about 25%) in Zone 4, and 7/34 (20.6%) in Zone 3.

Regarding glasses, according to the interviewers, there are traditional glass collectors in Kataragama, and unbroken bottles are discharged to them. However, broken glass pieces are not discharged even though KPS has started collecting them.

iii. Conclusion

Based on the result of survey as described above, the targeted population have some kind of understanding about separate discharge, but they do not know sufficiently the rules and methods of separate discharge. Therefore, the objectives of PP in KPS has been set as “Separation of recyclables to be more neatly conducted” by hotels, guesthouses and restaurants where visitors and worshippers to temples are hosted.

c.3. PP implementation method

The secretary of KPS has assigned Development Officer in addition to field staff in charge of each target zone (fire brigades who had been co-assigned to waste management by KPS before the Project started) as main implementation counterparts of the PP

The PP will be implemented in the following manner in each zone.

Table 2-62: Method of PP implementation in KPS

	Zone 4	Zone 3
Separation Categories	i Step 1: 2 Categories (4 months as leading step for introducing 6 categories) ① Biodegradable , ② Non-biodegradable, with encouraging home composting (jeewakotu and bins) ii Step 2: 6 Categories ①Biodegradable, ② Paper & Cardboard, ③ Plastic & Polyethylene, ④ Iron & Coconut shells, ⑤ Broken glass & glass bottles, ⑥ Others, with with encouraging home composting (jeewakotu and bins)	
Transportation	 7 days/week  7 days/week	 7 days/week  3 days/week (reduce to 2 days/week)

i. Indicators of PP:

Three indicators for bio-degradable waste and two for valuable waste have been set as shown below. The amount and the composition ratio to be measured at the disposal site and the compost plant are to be measured with the incoming waste to the respective facilities by Waste Amount and Composition Survey (WACS) before and after the PP. The level of practice of composting is measured by Public Opinion Survey before and after the PP.

The anticipated scenarios for each indicator are shown below.

	Amount at Landfill	Ratio at Compost site	POS Composting Practice	conclusion
Case 1	↘	↗	↗	Separation – Successful Reduction at source - Successful
Case 2	↘	↘	↗	Separation – successful Reduction – very successful
Case 3	↗	↘	↘	Separation – unsuccessful Reduction - unsuccessful

Figure 2-24 : Indicators to measure the impact of PP on separation of bio-degradable waste in KPS

	Amount at Landfill	Ratio at Compost site	conclusion
Case 1	↘	↗	Separation – Successful Reduction - ??
Case 2	↘	↘	Separation – successful Reduction - successful
Case 3	↗	↘	Separation – unsuccessful Reduction - unsuccessful

Figure 2-25: Indicators to measure the impact of PP on separation of valuable waste in KPS

ii. PP implementation plan

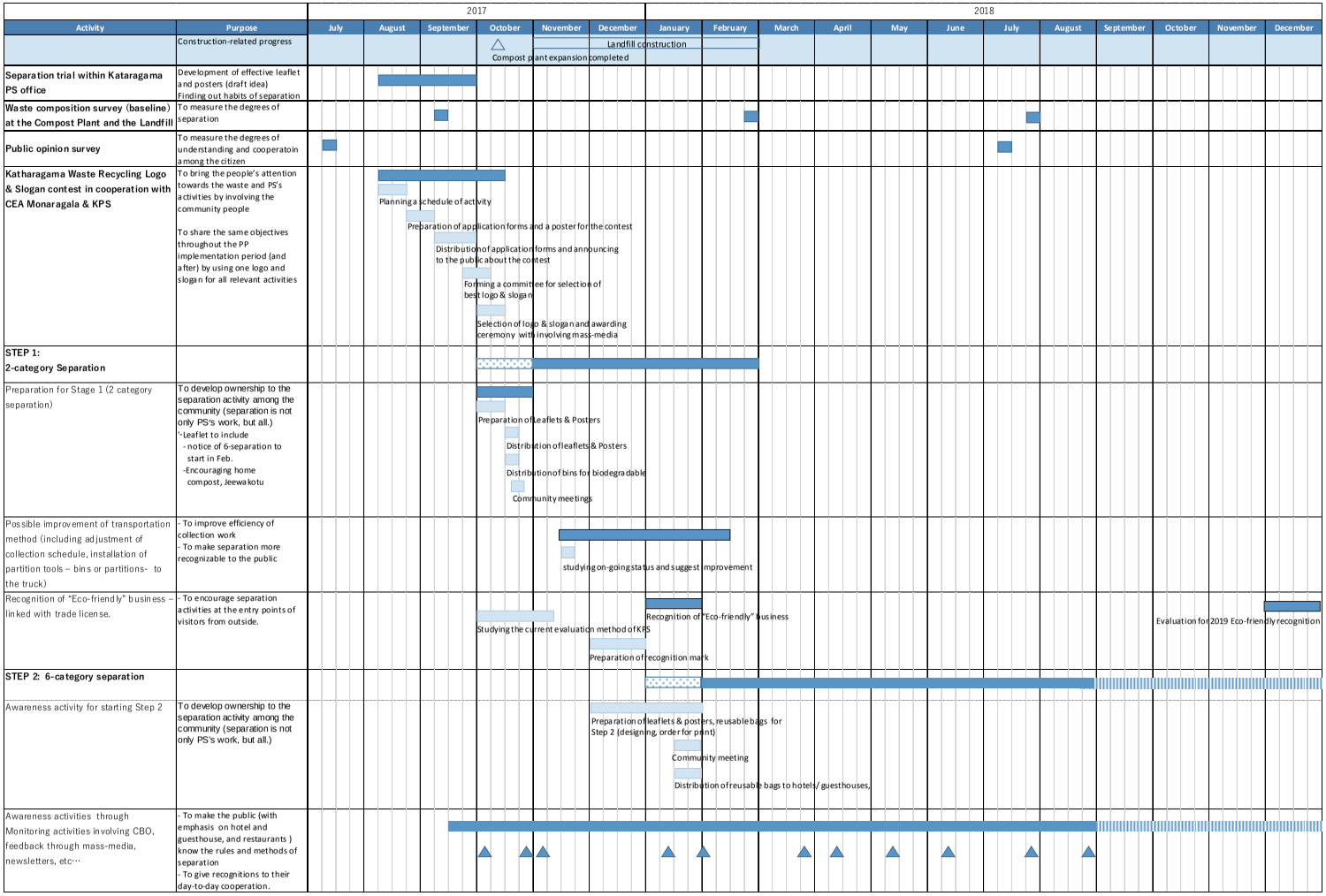


Figure 2-26: Implementation plan of PP in KPS

2.10.3 B.6.3: Environmental and Social Considerations Survey

(1) Scoping

According to EIA regulations in Sri Lanka as well as Ms. Shyamani Periyapperuma, the DDG of EIA department, since both Sundarapola disposal site in Kurunegala MC and Galapitagarayaya disposal site in Kataragama PS have already been used for solid waste disposal sites, neither EIA nor IEE were required. The projects are also classified as category C in the guidelines for Environmental and Social Considerations published JICA.

A municipality who handles a prescribed activity that may cause environmental issues must obtain an Environmental Recommendation. For Galapitagarayaya disposal site, Kataragama PS as a project proponent will plan to submit a project proposal and obtain an Environmental Recommendation from CEA.

On that basis, scoping was conducted for both disposal sites, and items to be addressed were assessed. The detailed screening results are referred to in *Appendix10: Screening result of Sundarapola disposal site*, and *Appendix 11: Screening result of Galapitagarayaya disposal site*.

Regarding the ratings for scoping, current dumpsite or disposal site is evaluated as baseline condition, and environmental impacts of during construction and after construction are evaluated by comparing baseline conditions.

(2) Environmental and social consideration survey method

Based on the results of the scoping, baseline surveys on environmental and social considerations are planned. The purpose of the surveys is to assess and monitor predictive important environmental and social considerations and to verify the effect of introduced technologies for rehabilitation of the disposal sites.

Table 2-63: Environmental and social consideration survey at Sundarapola disposal site in KMC

Survey item	Overview of the survey	Survey method
Water quality	• Check water quality of two (2) wells inside of Sundarapola disposal site and three (3) wells outside of the site (residential area). • Check water quality of three (3) boreholes and above mentioned five (5) existing wells to verify the effectiveness of Permeable Reactive Barrier (PRB) installed in PP. • Check quality of leachate, quality of existing night soil treatment plant and its outlet to verify the effectiveness of leachate and night soil treatment plant rehabilitated in PP. • The parameter includes heavy metal in three monitoring wells and groundwater.	• Water Quality survey conducted by an outsourcing company • Questionnaire survey for surrounding residents in the explanatory meeting before construction
Air quality, noise, vibration	• The survey will be conducted at the residential areas close to the disposal site. • Parameters are referred to in Gazette Notification No. 1562/22 dated 15 Aug. 2008.	• Air quality including noise and vibration surveys conducted by outsourcing company
Offensive odour	• Confirm the nearest climate station in Sri Lanka and wind direction at the station. • Questionnaire survey is also planned for the residences nearby.	• Meteorological data at the closest climate station available in Sri Lanka. • Questionnaire survey for surrounding residents in the explanatory meeting before construction
Condition of groundwater and its usage	• Kurunegala MC plans to have a questionnaire survey on the environment, groundwater usage and its quality for approximately 100 residents nearby the disposal site. Timing of this survey will be when Kurunegala MC explains rehabilitation of the disposal site and its possible impacts on the residents nearby.	• Questionnaire survey for surrounding residents in the explanatory meeting before construction

Table 2-64: Environmental and social consideration survey at Galapitagarayaya disposal site in KPS

Survey item	Overview of the survey	
Water quality	• Check the quality of leachate from current open dump site to verify the effectiveness of installed leachate treatment plant in PP. • Check the quality of existing night soil treatment facility to verify the night soil treatment facility.	• Water Quality survey conducted by an outsourcing company
Air quality, noise, vibration	• The survey will be conducted at the area near to the disposal site. • Parameters are referred to in Gazette Notification No. 1562/22 dated 15 Aug. 2008.	• Air quality including noise and vibration surveys conducted by outsourcing company
Biota	• As a number of elephants are confirmed around the disposal site, necessary measures are specified. Interviews to relevant ministries, NGOs and experts are planned if necessary.	• Interview to relevant ministries, NGOs and experts.

(3) Survey result

The result of the survey is shown below.

a. Sundarapola disposal site

a.1. Water quality survey

Water quality survey in Sundarapola disposal site was conducted in July 2017 dry season. The following table lists the result of the survey. Parameters were selected by referring to SATREPS guideline. Tolerance limits for discharge of industrial wastewater into island surface waters area in Gazette. No. 1534/18 is referred to check an environmental standard in Sri Lanka.

From the result, as suspected from visual examination, most of the parameters of the leachate did not meet the corresponding environmental standard. Two monitoring wells in the disposal site met the standard except for total suspended solid (TSS) and faecal coliforms.

On the other hand, an environmental standard for existing wells in residences near the site refers to Sri Lanka Standards for potable water SLS 614: 2013. Although results of the heavy metals were below the tolerance limits, three existing wells in households did not meet the standard in turbidity, COD and total coliforms.

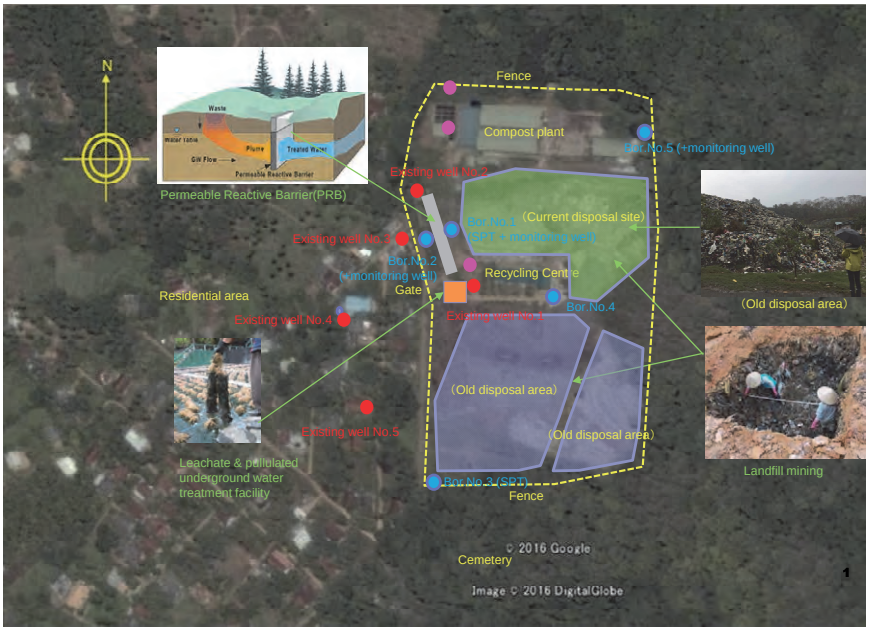


Figure 2-27: Sample points of water quality survey at Sudarapola disposal site in KMC

Table 2-65: Result of water quality survey in household wells near Sundarapola disposal site in KMC

No	Parameter	Month	(1)Disposal site						(2) Residential area			Tolerance limit
			Existing wells		Monitoring well**		Leachate					
			No.1	No.2	Bor. No1	Bor. No2	Influent	Effluent	No.3	No.4	No.5	
1	pH	July2017	7.4	7.1	6.5	6.8	4.85	-	6.5	6.8	7.	(1)(2)6.5-8.5
		Aug2018	7.0	6.8	6.9	6.7	8.0	9.6	6.4	6.6	6.6	
		Oct2018	7.2	6.9	6.7	6.7	7.2	8.1	7.2	7.2	6.6	
		Nov2018	6.6	7	6.8	6.8	8.0	8.2	6.5	6.7	6.2	
2	EC mS/cm	July2017	4.06	2.84	3.33	3.94	33.5	-	3.40	1.86	0.39	-
		Aug2018	6.67	3.41	3.88	3.29	20.6	1.17	3.77	2.23	0.38	
		Oct2018	2.63	2.65	4.52	4.16	4.81	1.87	3.24	1.80	0.25	
		Nov2018	4.82	5.73	4.99	4.53	10.10	2.43	4.25	2.19	0.34	
3	Temp	July2017	30.01	30.48	31.61	32.09	31.24	-	31.24	30.02	28.59	(1)No exceed
		Aug2018	29	30	30	32	29	30	30	29	28	40.0C
		Oct2018	29	28	30	31	29	28	29	28	27	(2)-
		Nov2018	28	30	30	31	30	28	30	29	28	
5	Turbidity (mg/l)	July2017	8	5	>999	>999	>999	-	2	4	2	(1)-
		Aug2018	24.7	2.2	1000	8	180	76	0.1	1.1	0.9	(2)<2
		Oct2018	5	35	113	157	132	164	8	6	10	
		Nov2018	4.9	3.8	21	144	150	175	4.5	1.7	1.6	
4	COD (mg/l)	July2017	30	50	80	80	10000	-	20	20	20	(1)<250mg/l
		Aug2018	696	33	98	49	6002	148	26	12	8	(2)<10mg/l
		Oct2018	76	41	64	44	9178	98	18	8	4	
		Nov2018	46	94	86	40	1512	363	19	10	4	
5	BOD_5 (mg/l)	July2017	1	6	4	5	348	-	3	1	1	(1)<30mg/l
		Aug2018	34	22	16	26	194	20	7	8	6	(2)-
		Oct2018	30	13	25	16	241	10	8	3	1	
		Nov2018	5	13	13	7	136	76	4	3	1	
6	TSS (mg/l)	July2017	25	2	432	268	212	-	2	1	1	(1)<50mg/l
		Aug2018	69	27	1352	67	254	60	19	12	1	(2)-
		Oct2018	52	34	547	235	936	88	32	10	7	
		Nov2018	24	13	2904	64	276	158	1	3	8	
7	Pb mg/l	July2017	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	(1)<0.1mg/l
		Aug2018	<0.01	<0.01	0.04	<0.01	-	-	<0.01	<0.01	<0.01	(2)<0.01mg/l
		Oct2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	
		Nov2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	
8	Fe (mg/l)	July2017	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	(1)<3.0mg/l
		Aug2018	9.36	<0.01	63.46	32.83	-	-	<0.01	<0.01	<0.01	(2)0.3mg/l
		Oct2018	0.17	<0.01	0.33	1.09	-	-	<0.01	<0.01	1.40	
		Nov2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	
9	Cr (mg/)	July2017	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	(1)<0.5mg/l
		Aug2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	(2)<0.05mg/l
		Oct2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	
		Nov2018	<0.01	<0.01	<0.01	<0.10	-	-	<0.01	<0.01	<0.01	
10	Cd (mg/l)	July2017	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	(1)<0.1mg/l
		Aug2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	(2)<0.003mg/l
		Oct2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	
		Nov2018	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01	
11	As (mg/l)	July2017	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	(1)<0.2mg/l
		Aug2018	0.002	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	(2)0.01mg/l
		Oct2018	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	
		Nov2018	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	
12	Total Coliforms	July2017	2400	260	940	5400	>16000	-	9200	330	18	(1)-
		Aug2018	>16000	9200	5400	4500	>16000	9200	78	790	20	(2)<10MPN/100
		Oct2018	>16000	2800	>16000	>16000	>16000	>16000	>16000	2200	<1.8	ml
		Nov2018	>16000	1100	82	110	>16000	>16000	2400	2400	<1.8	
13	Fecal Coliforms	July2017	1300	220	700	540	16000	-	240	170	18	(1)40MPN/100
		Aug2018	9200	5400	3500	3500	16000	5400	45	330	Absent	ml
		Oct2018	2200	40	16000	9200	16000	9200	2800	940	Absent	
		Nov2018	20	480	18	68	16000	3500	Absent	Absent	Absent	

a.2. Air quality survey

Baseline surveys regarding air quality, noise and vibration were conducted also in the dry season of July 2017, and results are listed in the following table. Rainfall was observed from March to June and October to November from the data throughout 2016 to 2017, and amount of rainfall was from 123 mm to maximum 738 mm (May 2016). As referred to Gazette No. 1562/22 August 15, 2008, all corresponding parameters were within their standard limit.

Table 2-66: Result of air quality survey in residential areas near Sundarapola disposal site

Parameter	Sampling Date	Time Ave.	Units	Collections at teach locations			Maimum Permisible Level(ug/m^3)
				L1	L2	L3	
SO_2	14July2017	1hr	Ug/m^3	14	16	18	200
	9Aug2018			14	13	10	
	29November2018			10	12	14	
NO_2	14July2017	1hr		35	40	31	250
	9Aug2018			26	28	22	
	29November2018			21	29	27	
CO	14July2017	1hr		<1000	<1000	<1000	30,000
	9Aug2018			<1000	<1000	<1000	
	29November2018			<1000	<1000	<1000	
TSPM	14July2017	3hr		192	160	162	450
	9Aug2018			32	28	27	
	29November2018			37	42	72	
PM10	13-14 July2017	24hr		55	36	37	100
	8-9Aug2018			16	13	29	
	28-29November2018			22	25	43	
PM2.5	13-14 July2017	24hr		30	20	20	50
	8-9Aug2018			19	17	16	
	28-29November2018			12	14	23	

Noise survey result is listed in the table below. Standard limit is referred to Gazette No.924/12, May 23, 1996. The maximum permitted level of vibration amplitude during operational time is 65 dB Leq (A) during daytime, therefore, the results were below this standard.

Table 2-67: Result of noise survey

Location	Time	Hourly averaged noise level leg(dB)	Background noise level L90 dB(A)
N1	14July2017	58	50
	8Augsut2018	60	58
	28November2018	60	58
N2	14July2017	62	54
	8Augsut2018	66	62
	28November2018	62	62
N3	14July2017	59	49
	8Augsut2018	59	59
	28November2018	59	59

Following shows the result of vibration survey.

Table 2-68: Result of vibration survey

Vibration	Sampling Date	Vibration Axis	Vibration levels ppv (mm/sec)	Maximum Vibration in ppv (mm/sec)	Frequency Range (Hz)
V1	14July2017	Transgenic	0.063		
		Vertical	0.102	0.141	10-50
		Longtical	0.11		
	8Augsut2018	Transgenic	0.166		
		Vertical	0.189	0.225	
		Longtical	0.205		
	28November2018	Transgenic	0.142		
		Vertical	0.087	0.182	
		Longtical	0.110		
V2	14July2017	Transgenic	0.063		
		Vertical	0.126	0.158	10-50
		Longtical	0.126		
	8Augsut2018	Transgenic	0.118		
		Vertical	0.221	0.239	
		Longtical	0.134		
	28November2018	Transgenic	0.150		
		Vertical	0.087	0.175	
		Longtical	0.102		
V3	14July2017	Transgenic	0.166		
		Vertical	0.205	0.235	10-50
		Longtical	0.150		
	8Augsut2018	Transgenic	0.063		
		Vertical	0.126	0.135	
		Longtical	0.102		
	28November2018	Transgenic	0.104		
		Vertical	0.095	0.154	
		Longtical	0.118		

According to CEA provisional vibration standard, spots to measure vibration are divided into four types based on structures of building, and environmental standard is regulated by maximum velocity amplitude (mm/sec) by the type of building. All three spots for vibration survey this time are categorised as Type 3 and its provisional environmental standard is shown below. As a result, vibration levels of all three spots were under the standard.

Table 2-69: Standard of vibration value

Type of Vibration	Frequency of Vibration (Hz)	Vibration in ppv (mm/sec)
Continuous	0-10	1.0
	10-50	2.0
	Over 50	4.0
Intermittent	0-10	2.0
	10-50	4.0
	Over 50	8.0

The result of water quality survey, air quality survey, vibration, and noise are attached as appendix 12,13,14 and 15 respectively.

a.3. Offensive odour

According to available wind direction data of nearest meteorological station to Sundarapola disposal site from 2011 to 2016, there is a tendency for an easterly wind from November to March, therefore residents living to the west of the disposal site are affected.

Planned questionnaire regarding offensive odour and groundwater usage in an explanatory meeting of the construction for nearby residents of Sundarapola disposal site could not be conducted due to sensitive issues. Residents might have been against the pilot project during the meeting, since some of them had complained about their living environment because of the disposal site and asked the chairman of CEA to improve the situation. In fact, it was a significant opportunity to obtain the understanding of residents towards the pilot project in the explanatory meeting held on 25th November 2017. However, the questionnaire still won't be conducted to avoid over evaluation of current polluted water and over expectation of improvement of the water quality soon after completion of the construction.

The following groundwater usage is confirmed in JICA experts' site visits and by water sampling.

- Among nearest housing group to the disposal site, a couple of residents who have wells in their premises are using the water as domestic water but not for drinking.
- At least one house located in the southern part of the above mentioned housing group is drinking groundwater from a well.

b. Galapitigalayaya disposal site

b.1. Water quality survey

Water sampling was completed in December 2017 during the rainy season. The result is shown in the table below. Parameters were selected by referring to SATREPS guideline. Tolerance limits for discharge of industrial waste water into island surface waters area in Gazette. No.1534/18 is referred to check an environmental standard in Sri Lanka. Water quality didn't meet the standard, especially the quality of No.2 monitoring well was worse than night soil, as suspected from visual examination and offensive odour.

Table 2-70: Result of water quality survey at Galapitigalayaya disposal site in KPS

No	Parameter	Bor		Night soil		Tolerance
		No.1	No.2	Gala	Sela	
1.	Total Suspended Solid	31	1988	5	84	<50 mg/l
2.	pH	7.0	7.3	7.3	7.5	6.0-8.5
3.	Biochemical Oxygen Demand	16	54	11	37	<30 mg/l
4.	Temperature	29.4	31.0	30.3	31.6	Less than 40
5.	Chemical Oxygen Demand	68	428	19	272	<250 mg/l
6.	EC (uS/cm)	0.49	2.26	0.24	2.62	None
7.	As (mg/l)	<0.001	0.009	-	-	< 0.2 mg/l
8.	Cd (mg/L)	<0.01	0.12	-	-	< 0.1 mg/l
9.	Cr (mg/L)	<0.01	<0.01	-	-	< 0.5 mg/l
10.	Pb (mg/L)	<0.01	0.79	-	-	< 0.1 mg/l
11.	Fe (mg/L)	1.72	147.4	-	-	< 3.0 mg/l
12.	Total Coliforms	>16000	>16000	>16000	>16000	None
13.	Fecal Coliforms	5400	9200	3500	2400	<40 MPN/100ml

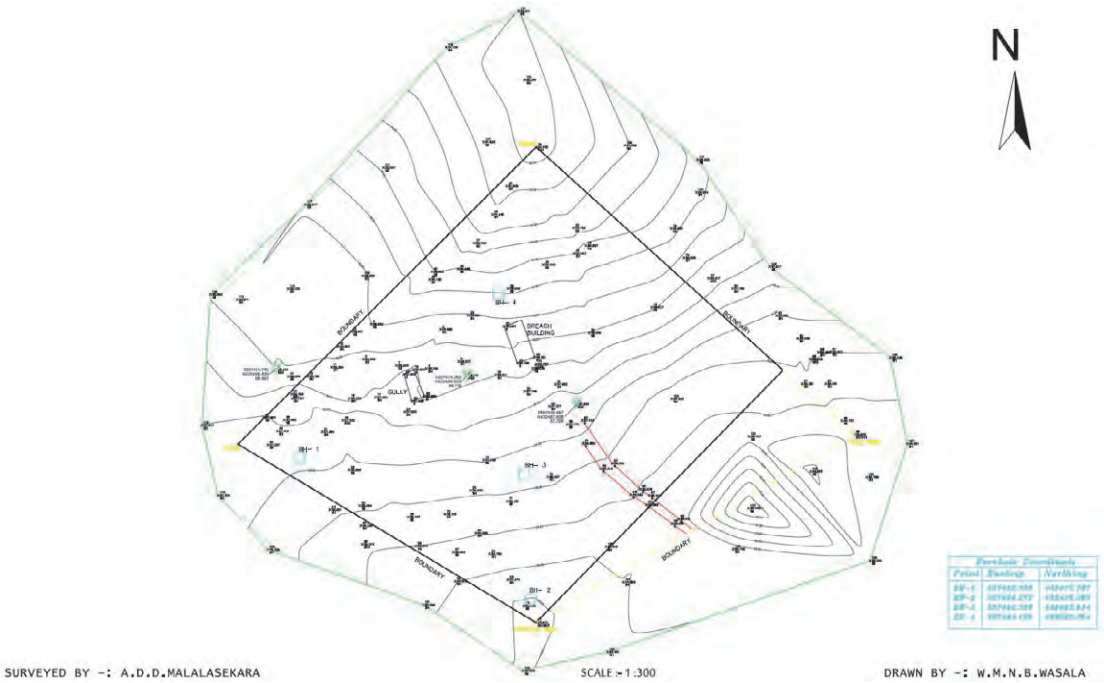


Figure 2-28: Sample points of water quality survey at Galapitigalayaya disposal site in KPS

b.2. Air quality survey

Baseline survey on air quality, noise and vibration was conducted in December 2017 during rainy season, and results are listed in the table below. The day before the survey conducted was a rainy day. As referred to Gazette No. 1562/22 August 15, 2008, all corresponding parameters were within their standard limit.

Table 2-71: Result of air quality survey in residential areas near Galapirigalayaya disposal site

Parameter	Sampling Date	Time Ave.	Units	Collections at teach locations L1	Maimum Permisible Level(ug/m^3)
SO_2	21Dec2017	1hr	Ug/m^3	14	200
	5June2018			21	
	26November2018			11	
NO_2	21Dec2017	1hr		35	250
	5June2018			30	
	26November2018			20	
CO	21Dec2017	1hr		<1000	30,000
	5June2018			<1000	
	26November2018			<1000	
TSPM	21Dec2017	3hr		42	450
	5June2018			47	
	26November2018			107	
PM10	20-21Dec2017	24hr		25	100
	4-5June2018			28	
	26November2018			64	
PM2.5	20-21Dec2017	24hr		14	50
	4-5June2018			15	
	26November2018			35	

The noise survey result is listed in the following table. Standard limit is referred to Gazette in No.924/12, May 23, 1996. The maximum permitted level of vibration amplitude during operational time is 55 dB L_{eq} (A) during daytime, therefore the results were below this boundary standard.

Table 2-72: Results of noise survey in Galapitigalayaya disposal site

Location	Time	Hourly averaged noise level leg(dB)	Background Noise level L90 dB(A)
N1	21Dec2017	54	47
	4-5June2018	47	*
	26November2018	54	54
N2	21Dec2017	47	39
	4-5June2018	47	50
	26November2018	47	47
N3	21Dec2017	47	39
	4-5June2018	47	58
	26November2018	48	47
N4	21Dec2017	50	42
	4-5June2018	50	53
	26November2018	50	50

Following shows the result of vibration survey.

Table 2-73: Result of vibration survey in Galapitigalayaya disposal site

Vibration	SamplingDate	Vibration Axis	Vibration levels ppv (mm/sec)	Maximum Vibration in ppv (mm/sec)	Frequency Range (Hz)
V1	21Dec2017	Transgenic	0.102		
		Vertical	0.102	0.224	10-50
		Longtical	0.213		
	5June2018	Transgenic	0.166		
		Vertical	0.173	0.198	
		Longtical	0.102		
	26November2018	Transgenic	0.158		
		Vertical	0.110	0.198	
		Longtical	0.118		
V2	21Dec2017	Transgenic	0.063		
		Vertical	0.158	0.209	10-50
		Longtical	0.158		
	5June2018	Transgenic	0.126		
		Vertical	0.079	0.146	
		Longtical	0.087		
	26November2018	Transgenic	0.150		
		Vertical	0.095	0.163	
		Longtical	0.110		
V3	21Dec2017	Transgenic	0.11		
		Vertical	0.11	0.145	10-50
		Longtical	0.142		
	5June2018	Transgenic	0.142		
		Vertical	0.079	0.180	
		Longtical	0.110		
	26November2018	Transgenic	0.134		
		Vertical	0.095	0.154	
		Longtical	0.118		
V4	21Dec2017	Transgenic	-		
		Vertical	-	-	10-50
		Longtical	-		
	5June2018	Transgenic	1.332		
		Vertical	0.607	1.807	
		Longtical	1.230		
	26November2018	Transgenic	0.110		
		Vertical	0.142	0.165	
		Longtical	0.071		

According to CEA provisional vibration standard, spots to measure vibration are divided into four types based on structures of building, and the environmental standard is regulated by maximum velocity amplitude (mm/sec) by the type of building. As a result, vibration levels of all three spots were under the standard.

b.3. Fauna

Galapitigalayaya disposal site in Kataragama PS is owned by the forestry department, from which Kataragama PS has obtained a land lease agreement for the pilot project purpose only, and surrounding areas also belong to the forestry department. As expected from this situation, JICA experts have observed more than ten elephants at one time, and staff of Kataragama PS also mentioned that elephants come to waste dumping areas to find food in the waste on a daily basis. According to those staff, elephants are smart enough to listen for the sound of tractors and appear after tractors have gone. Before starting the construction, monitoring wells were destroyed and a project assistant and staff from Kataragama PS were chased by elephants while they were sampling soil at the disposal site. Especially female elephants during times of breeding or child rearing are likely to be aggressive.

Elephant in a proposed disposal site

More than 10 elephants were confirmed

(4) Environmental impact assessment

The result of the survey is shown below.

a. Sundalapora disposal site

a.1. Water pollution and usage of underground water

The project is to rehabilitate the disposal site by installing a leachate treatment facility and a PRB (Permeable Reactive Barrier) and by conducting landfill mining; and aims to reduce the negative and increase the positive environmental impact of the site. Construction is planned during the dry season, however rainy season and dry season cannot be clearly differentiated and recently there has been cases of sudden rains. There is a short-term (during construction) possibility of leachate

flowing into the construction zone or a side gully in the event of heavy rain. Also, construction of PRB – the purpose of which is to mitigate pollution of groundwater – may have a negative impact on groundwater quality, which, as aforementioned, is being used by some nearby residents.

a.2. Air, noise and vibration

Although baseline air quality was within its standard level, landfill mining in a pilot project may increase dust pollution. Also, vehicles for construction and use of heavy machineries may cause air pollution and increase noise and vibration levels. In Sri Lanka, construction until late at night to meet the schedule constraints is common, however, it is not appropriate to have negative environmental impact at night time because the site is quite close to the residential areas.

a.3. Offensive odour

Offensive odour by digging old wastes is predicted during PRB construction. Also, there is a possibility to release offensive odour from water receiver tank of leachate treatment facility, where treatment reaction has not been completed yet. Therefore, construction of the facility to treat leachate from the disposal site and from the compost yard as well as the PRB are expected to have a positive impact on offensive odours at the site.

a.4. Accident

Driving vehicles and operation of heavy machineries may cause accidents during the construction phase.

Table 2-74: Impact assessment based on the survey result at Sundarapola site in KMC

	Item	Impact assessment during the scoping period		Impact assessment based on the survye result		Reason if changed
		Before and during construction	Implementation	Before and during construction	Implementation	
1	Water quality	Ground water: B[7] Surface water: C	Ground water:P Surface water:P	Ground water: C Surface water: C	Ground water:P Surface water:P	Baseline survey showed heavy metals are within the standard limit, therefore, little negative impact is expected.
2	Air quality	Dust/Exhaust gas/ Concentration of exhaust gas: C	Dust/Exhaust gas/ Concentration of exhaust gas: D	Dust/Exhaust gas/ Concentration of exhaust gas: C	Dust/Exhaust gas/ Concentration of exhaust gas: D	
3	Noise and vibration	By heavy construction equipment: C	By heavy construction equipment: D	By heavy construction equipment: C	By heavy construction equipment: D	
4	Offensive odour	From leachate/ water pollution: C	From leachate/ water pollution: P	From leachate/ water pollution: C	From leachate/ water pollution: P	
5	Condition of groundwater and its usage	Surface water pollution: C Groundwater pollution: B	Surface water pollution: P Groundwater pollution: P	Surface water pollution: C Groundwater pollution: B	Surface water pollution: P Groundwater pollution: P	
6	Accident	Increase of traffic accidents/ Accidents of equipment: C	Increase of traffic accidents/ Accidents of equipment: D	Increase of traffic accidents/ Accidents of equipment: C	Increase of traffic accidents/ Accidents of equipment: D	

b. Galapitigalayaya disposal site

b.1. Water pollution and usage of underground water

The project introduces and plans to install liner and leachate treatment plant at the Galapitigalayaya disposal site and night soil treatment in a backyard of a compost plant. Although there was no leachate on the day of water sampling, it is possible that negative ground water quality is affected

[7] A : Very serious impact is expected, B : Serious impact is expected, C : Little impact is expected, D : Impact is negligibly small/ no impact, U : Impacts are unknown, P : Positive impacts are expected

by polluted leachate. Also detected heavy metals in ground water from monitoring wells are possibly caused by night soil. If the proposed site faces heavy storm water during a construction phase, there is a possibility of leachate flowing into public water areas.

b.2. Air, noise and vibration

During the construction, air quality, noise and vibration may be affected by soil excavation and an increase of heavy machinery use or its traffic. However, other than a compost yard that is 2km away from the disposal site, there is no residents nearby so environmental impacts on public are negligible. Although traffic of waste vehicles is expected to increase a bit due to proper waste disposal, still environmental impacts on staffs working for a compost yard and supervisors in a safety hut of a disposal site are negligible.

b.3. Fauna

As mentioned above, destruction of monitoring wells was experienced, therefore protection and ensuring safety from wild elephants were the main challenges in the disposal site area. Other than a nearest compost building, which is 2 km away from the disposal site, there is no safe shelter in the site area. Also, neither three wheeler nor normal van can use the access road, so it is necessary to arrange access by a 4WD or tractor.

Even though elephants are visiting the area for organic wastes, non-organic wastes are also disposed. Health problems of elephants from eating organic and non-organic wastes in disposal sites have been reported in Sri Lanka.

b.4 Accident

Driving vehicles and operation of heavy machineries may cause accidents during the construction phase.

Protected monitoring well damaged by elephant

Electric fence[8]

[8] 2.11.2 Refer to Kataragama PS

Table below shows a summary of environmental impact assessment of Galapitigalayaya disposal site

Table 2-75: Impact assessment

No.	Item	Impact assessment during the scoping period		Impact assessment based on the survey result		Reason if changed
		Before and during construction	Implementation	Before and during construction	Implementation	
1	Water quality	Ground water/ Surface water: D	Ground water/ Surface water: D	Ground water/ Surface water: B	Ground water/ Surface water: P	Although groundwater exceeds environmental standards at the moment, positive improvement is expected by installation of leachate treatment and night soil treatment facility.
2	Air quality	Dust/Exhaust gas/Concentration of exhaust gas: C	Dust/Exhaust gas/Concentration of exhaust gas: D	Dust/Exhaust gas/Concentration of exhaust gas: C	Dust/Exhaust gas/Concentration of exhaust gas: D	
3	Noise and vibration	By heavy construction equipment: C By garbage truck: D	By heavy construction equipment: D By garbage truck: C	By heavy construction equipment: C By garbage truck: D	By heavy construction equipment: D By garbage truck: D	It turned out that number of waste collection vehicles will not increase significantly
4	Fauna	Animals: B	Animals: P	Animals: B	Animals: P	
5	Accident	Increase of traffic accidents/ Accidents of equipment: C	Increase of traffic accidents/ Accidents of equipment: D	Increase of traffic accidents/ Accidents of equipment: C	Increase of traffic accidents/ Accidents of equipment: D	

(5) Mitigation measure

a. Sundarapola disposal site

a.1. Water pollution and usage of groundwater

Regarding the leachate during heavy rain, construction of leachate retention facility prevents polluted leachate from releasing to public water. Leachate will be smoothly pumped up and

transferred to the treatment facility, especially during heavy rain after the construction, and only diluted leachate will be discharged from overflow weir to rain drainage.

Possible temporary deterioration of groundwater as a result of PRB construction will be announced to nearby residents in an explanatory meeting of pilot project construction. Necessary measures will be taken based on regular monitoring of water quality.

a.2. Air quality, noise and vibration

Sprinkling of water will be undertaken to mitigate expected increases of dust from land mining and PRB during construction phase.

In addition to adjustment of schedule, pre-cautions will be announced to residents regarding concentrated traffic of dump trucks. A guard is despatched during the construction for supervising vehicles and machinery. Effective operation of heavy machinery can even contribute to reduction of fuel consumption. Well-experienced constructor in terms of safety should be selected, and to avoid night time construction, construction is limited to daytime through the development of an optimum schedule.

a.3. Offensive odour

Decreasing open area and water sprinkling during boring for the construction of PRB will help to prevent offensive odours. Odour from leachate will be reduced by spraying air freshener.

a.4. Accident

To prevent accidents during construction, safety training will be conducted. A supervisor will be deployed to regulate traffic during construction.

b. Galapitigalayaya disposal site

b.1. Water pollution and usage of groundwater

Ground water quality is expected to be better by using proper leachate treatment and night soil. The volume of storm water should be considered in deciding capacities of water diversion and a leachate treatment facility. Construction is planned during dry season to avoid heavy rainfall, since concentrated rainfall has been recorded from October to December according to the available data in recent 5 years.

b.2. Fauna

To separate living area of elephants and the disposal site, electric fence will be constructed prior to the construction of the disposal site. After the construction of the disposal site, municipal wastes should not be disposed outside of the site/fence. Current waste dumping area will also be covered by soil to prevent elephants from eating the waste.

b.3. Accident

To prevent accidents during construction, safety training will be conducted. A supervisor will be deployed to regulate traffic during construction.

(6) Monitoring

a. Sundarapola disposal site

Daft monitoring plan of Sundarapola disposal site based on the environmental assessment is shown in the table below. Operation and maintenance including proper operation of leachate treatment facility, reduction of disposal amount of biodegradable waste and regular soil covering will contribute to reduction of environmental burden after the pilot project.

Table 2-76: Monitoring plan of Sundarapola disposal site (Draft)

No	Item	Location	Parameter	Frequency	Regulatory standard
1	Water pollution[9]	Groundwater well, monitoring well and leachate in the disposal site	pH, EC, TSS, temperature, BOD, COD, coliform, heavy metal (As, Cd, Cr, Pb, Fe) for groundwater	Once in construction phase, once just after the construction and once in operational phase during the project period	Gazette No. 1534/18, February 2008
		Leachate	pH, EC, TSS, temperature, BOD, COD, coliform and other necessity items to renew EPL	Once a year after the project	
		Groundwater well in residential area	pH, EC, TSS, temperature,	Once in a construction	SLS614-2013

[9] Usage of groundwater will be considered for the monitoring of water quality.

No	Item	Location	Parameter	Frequency	Regulatory standard
			BOD, COD, coliform, heavy metal (As, Cd, Cr, Pb, Fe)	phase, once just after the construction and once in an operational phase during the project period. Once a year after the project.	
2.	Air quality, noise, vibration	Disposal site, residential area close to the site	Dust (PM2.5, PM10), NO2, SO2, CO, SPM, Noise, Vibration	Once in construction phase and once in operational phase during the project period	Gazette No. 1562/22, August 2008, Gazette No.924/12, May 1996
		Disposal site, residential area close to the site	Necessity parameter to renew EPL	Once a year after the project	
3.	Weather, Temperature, Humidity, Rainfall	Disposal site	Temperature, relative humidity, rainfall	Everyday	-
4.	Wind, rainfall	Nearest meteorological station to Kurunegala	Wind direction, wind speed, amount of rainfall	Every month	-

a.1. Results of water quality survey during construction phase

The following tables summarise the results of the water quality survey in Sundarapola disposal site on 8 August 2018.

TSS, turbidity Fe, faecal coliform exceeded the tolerance limit of discharge of industrial waste into inland surface waters (Gazette. No. 1534/18) in borehole No.1 which is upper stream of PRB. Although effects of excavation of old wastes throughout the construction period at around installation place of PRB on the results of water quality are considered, final consideration as well as evaluation of effectiveness of PRB are planned after getting results of the operation phase. These information are described in 2.14.1 and 2.16.1.

Leachate from the landfill site is treated in a night soil treatment plant. Several parameters of water quality were improved through the treatment process, including BOD and COD.

Table 2-77: Result of water quality survey during construction phase in KMC

No.	Parameter	Existing wells inside disposal site		Monitoring well**		Leachate	Inlet of the plant	Outlet of the plant	Tolerance limit
		No.1	No.2	No1	No2				
1.	Total Suspended Solid	69	27	1352	67	254	3400	63	<50 mg/l
2.	pH	7.0	6.8	6.9	6.7	8.0	NA	9.6	6.0-8.5
3.	Temperature	29	30	30	32	29	NA	30	Shall not exceed 40.0 C in any section of the stream within 15 m downstream of the effluent outlet.
4.	Turbidity	24.7	2.2	1000	8	180	NA	76	2 max. (SLS614-2013)
5..	Chemical Oxygen Demand	696	33	98	49	6002	38376	148	<250 mg/l
6.	Biological Oxygen Demand	34	22	16	26	194	835	20	<30 mg/l
7.	EC (uS/cm)	6.67	3.41	3.88	3.29	33.5		1.17	NA, mS/cm
8.	As (mg/l)	0.002	<0.001	<0.001	<0.001	-			< 0.2 mg/l
9.	Cd (mg/L)	<0.01	<0.01	<0.01	<0.01	-			< 0.1 mg/l
10.	Cr (mg/L)	<0.01	<0.01	<0.01	<0.01	-			< 0.5 mg/l
11.	Pb (mg/L)	<0.01	<0.01	0.04	<0.01	-			< 0.1 mg/l
12.	Fe (mg/L)	3.66	<0.01	63.46	32.83	-			< 3.0 mg/l
13.	Total Coliform	>16000	9200	5400	3500	>16000	>16000	9200	NA, MPN/100ml
14.	Fecal Coliform	9200	5400	3500	3500	16000	9200	5400	<40 MPN/100ml

Table 2-78: Result of water quality survey in household wells during construction phase

No	Parameter	Existing wells nearby households			Tolerance limit
		No.1	No.2	No.3	
1.	Turbidity	0.1	1.1	0.9	<2
2.	Total Suspended Solid	19	12	1	NA, mg/l
3.	pH	6.4	6.6	6.6	6.5-8.5 (250C + 20C)
4.	Chemical Oxygen Demand	26	12	8	<10 mg/l
5	Biological Oxygen Demand	7	8	6	NA, mg/l
6.	EC (uS/cm)	3.77	2.23	0.38	NA, mS/cm
7.	As (mg/l)	<0.001	<0.001	<0.001	< 0.01 mg/l
8.	Cd (mg/L)	<0.01	<0.01	<0.01	< 0.003 mg/l
9.	Cr (mg/L)	<0.01	<0.01	<0.01	< 0.05 mg/l
10.	Pb (mg/L)	<0.01	<0.01	<0.01	< 0.01 mg/l
11.	Fe (mg/L)	<0.01	<0.01	<0.01	< 0.3 mg/l
12.	Total Coliform	78	790	20	<10 MPN/100ml
13.	Fecal Coliform	45	330	Absent	Absent

a.2. Results of air quality survey during construction phase in KMC

Air quality, noise and vibration surveys were conducted on 9 August 2018. The tables below describe results of the surveys. All corresponding parameters were within their standard limit.

Table 2-79: Results of air quality survey during construction phase in KMC

Parameter	Date of sampling	Time average	Units	Concentrations at each location			Maximum permissible level (ug/m3)
				L1	L2	L3	
SO2	09/08/2018	1 hr	ug/m^3	14	13	10	200
NO2	09/08/2018	1 hr	ug/m^3	26	28	22	250
CO	09/08/2018	1 hr	ug/m^3	<1,000	<1,000	<1,000	30,000
TSPM	09/08/2018	3 hrs	ug/m^3	32	28	27	450
PM10	08-09/08/2018	24 hrs	ug/m^3	16	13	29	100
PM2.5	08-09/08/2018	24 hrs	ug/m^3	19	17	16	50

Table 2-80: Results of noise survey during construction phase in KMC

Location	Time	Run time (min)	Measured noise level Leq (dB)	Residual noise level Leq dB (A)	Corrected noise level
N1	Day	5	60	58	*
N2	Day	5	66	62	64
N3	Day	5	59	59	*

Leq: Equivalent Continuous Sound Pressure Level

Table 2-81: Results of vibration survey during construction phase in KMC

Vibration	Vibration axis	Vibration levels ppv (mm/sec)	Maximum vibration in ppv (mm/sec)	Frequency range (Hz)
V1	Transgenic	0.166	0.225	10-50
	Vertical	0.173		
	Longitude	0.102		
V2	Transgenic	0.126	0.239	10-50
	Vertical	0..079		
	Longitude	0.087		
V3	Transgenic	0.142	0.135	10-50
	Vertical	0.079		
	Longitude	0.110		

b. Galapitigalayaya disposal site

A monitoring plan will be made based on discussion with CEA and Kataragama PS. Regarding the impact on water quality and wild elephants, it is essential to monitor daily to ensure separated biodegradable and night soil sludge are not dumped to the disposal site. In addition to instructing workers on operational management of the disposal site, it is also important to instruct workers not to dump municipal wastes outside of the disposal site.

b.1. Results of air quality survey during construction phase in KPS

Air quality, noise and vibration surveys were conducted on 5 June 2018. The tables below describe the results of the surveys. All corresponding parameters were within their standard limit.

Table 2-82: Results of air quality survey during construction phase in KPS

Parameter	Date of sampling	Time average	Units	Concentrations at each location	Maximum permissible level (ug/m3)
SO2	05/06/2018	1 hr	ug/m^3	21	200
NO2	05/06/2018	1 hr	ug/m^3	30	250
CO	05/06/2018	1 hr	ug/m^3	<1,000	30,000
TSPM	05/06/2018	3 hrs	ug/m^3	47	450
PM10	04-05/06/2018	24 hrs	ug/m^3	28	100
PM2.5	04-05/06/2018	24 hrs	ug/m^3	15	50

Table 2-83: Results of noise survey during construction phase in KPS

Location	Time	Run time (min)	Measured noise level Leq (dB)	Residual noise level Leq dB (A)	Corrected noise level
N1	Day	5	54	54	*
N2	Day	5	52	47	50
N3	Day	5	58	47	58
N4	Day	5	55	50	53

Table 2-84: Results of vibration survey during construction phase in KPS

Vibration	Vibration axis	Vibration levels ppv (mm/sec)	Maximum vibration in ppv (mm/sec)	Frequency range (Hz)
V1	Transgenic	0.166	0.198	10-50
	Vertical	0.173		
	Longitude	0.102		
V2	Transgenic	0.126	0.146	10-50
	Vertical	0..079		
	Longitude	0.087		
V3	Transgenic	0.142	0.180	10-50
	Vertical	0.079		
	Longitude	0.110		
V4	Transgenic	1.332	1.807	10-50
	Vertical	0.607		
	Longitude	1.230		

2.10.4 .B.6.4: Detailed Plan and Preparation of Bidding Documents

(1) Detailed Plan and Bidding Documents for Improvement Works at Kurunegala

The detailed plan and bidding document for improvement of disposal site at Kurunegala MC were prepared by local consultant “Waste to Energy Technologies Limited” based on the discussion with JICA team and Kurunegala Municipal council. The draft of detailed plan and bidding document were approved by management committee of Kurunegala MC on 23rd October 2017 (refer to Appendix 16). The items and outcomes of detailed plan are shown in the below table.

Table 2-85: The items and outcomes of detailed plan

Item	Detail
Items of basic plan	• Installation of Permeable Reactor Barrier (PRB)to filter underground water • Establishment of leachate treatment facility • Landfill mining
TOR of detail design	1. Data collection for basic design of PRB 2. Design of structure and cost estimation of construction of PRB and leachate treatment facility 3. Preparation of tender document and support of tender
Outcomes	1. Inception report consisting of list of collected data, site survey results, necessary conditions, and so on. 2. Main report consisting of basic plan, BOQ of construction cost, drawings, specifications and so on. 3. Tender document consisting of general specifications, technical specifications, drawings and so on.

(2) Detailed Plan and Bidding Documents for Improvement Works at Kataragama

The detailed plan and bidding document for improvement of disposal site at Kataragama PS were prepared by local consultant "Dakshina Cost Consultants (Pvt) Ltd." based on the discussion with JICA team and Kataragama PS. The draft of detailed plan and bidding document were approved by management committee of Kurunegala MC on 22nd December 2017 (refer to Appendix 17). The items and outcomes of detailed plan are shown in the below table.

Table 2-86: The items and outcomes of detailed plan of improvement work of Kataragama PS

Item	Detail
Items of detail plan	• Leachate collection facility constructed by local available material • Leachate treatment facility • Improvement of access road • Installation of electric fence to avoid wild elephant • Covering soil • Night soil treatment facility • Installation of weigh bridge
TOR of detail design	1. Data collection for basic design of Permeable Reactor Barrier (PRB) 2. Design of structure and cost estimation of construction of PRB and leachate treatment facility 3. Preparation of tender document and support of tender
Outcomes	1. Inception report consisting of list of collected data, site survey result, necessary condition, and so on. 2. Main report consisting of basic plan, BOQ of construction cost, drawings, specification and so on. 3. Tender document consisting of general specifications, technical specifications, drawings and so on.

2.11 C.1: Implementation of Pilot Projects

2.11.1 Improvement Works at Kurunegala

(1) Meeting to explain to residents

The meeting to explain the pilot project to residents was held near Sundarapora disposal site on 25th November 2017. The number of participants was approximately 40 residents and 10 people from Kurunegala MC and CEA.

Dr. Sato, chief consultant of ReEB waste explained the outline of construction, purpose, effectiveness, implementation schedule and so on. After the explanation by Dr. Sato, environmental issues during construction, the duration of efficiency of PRB and monitoring procedures were

discussed between residents and Kurunegala MC. After the discussion, residents agreed on the project.

(2) Tendering, contracting and starting the improvement project at disposal site of Kurunegala MC

The tender document was distributed to the below four tenderers recommend by the counterparts on 28 November 2017 and the site explanation was held on 5th December 2017. The tender was held on 19th December 2017 and a company called TN Construction was awarded priority negotiation rights.

- Asoka Construction
- Distinction Construction
- MSC Construction
- TN Construction

JICA consultant team immediately negotiated with TN Construction and made a contract on 22 December 2017. The improvement of Sundarapola disposal site started from 26 December 2017.

(3) Progress on the PP in Kurunegara MC

The following construction works were undertaken in accordance with drawings and construction plan .

- Preparation of Permeable Reactive Barrier (PRB) material
- PRB site clearance
- Construction of leachate collection pit
- Sampling of landfill mining (3 pits x 2samples=6samples）

Following the construction, regular meetings were convened appropriately, and efforts were made to develop mutual recognition among Kurunegara MC, CEA, contractors, and project participants.

Table 2-87: Regular Meetings

Date	Description
16 January, 2018	The First Meeting Submission of a construction plan was required to the contractor. Role sharing between the contractor and Kurunegara MC,was discussed.
13 February, 2018	The contractor reported the progress of the construction works The design of the sign board to inform the PP was discussed.
27 February, 2018	The contractor reported the progress of the construction works Role sharing on the preparation of PRB between the contractor and Kurunegara MC,was discussed. Site Observation was conducted.

a. PRB

PRB is formed by making a wall-like structure in a pit in the ground from a mixture of crushed brick and activated carbon (from burnt coconut fibres) as per Figure 2-29: Concept of PRB below.

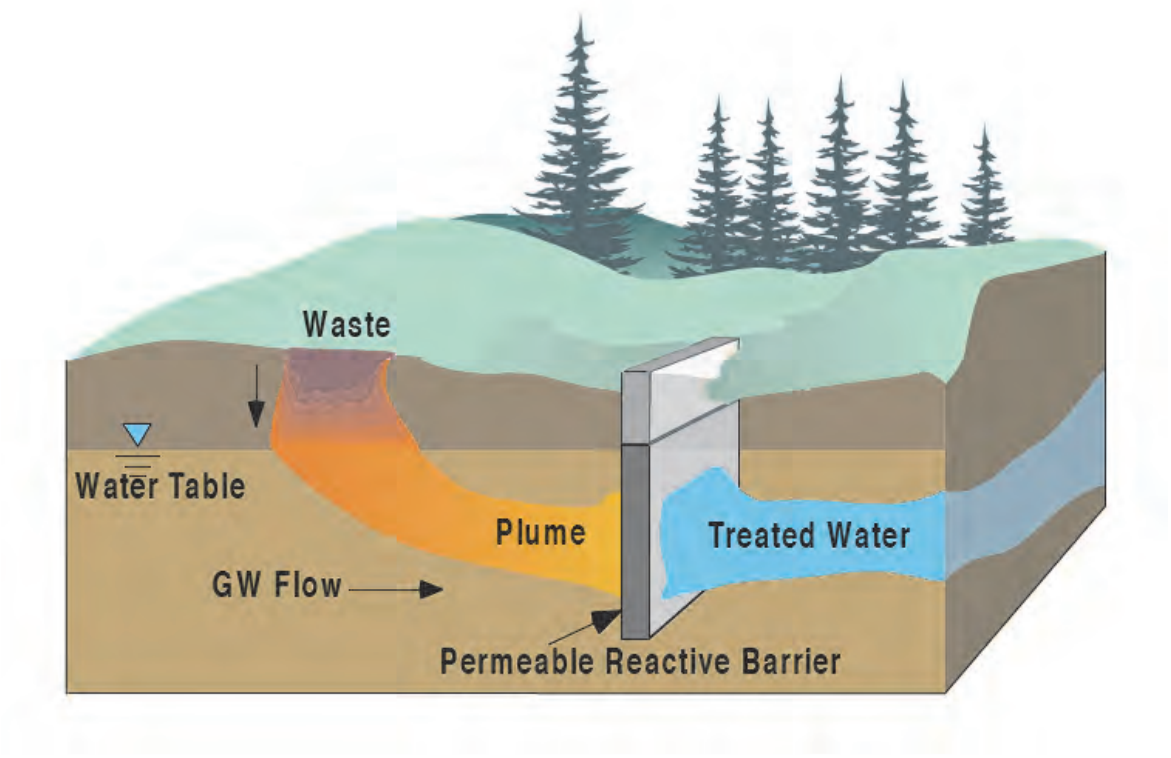


Figure 2-29: Concept of PRB

(http://www.powellassociates.com/PAServices/PAservices.html)

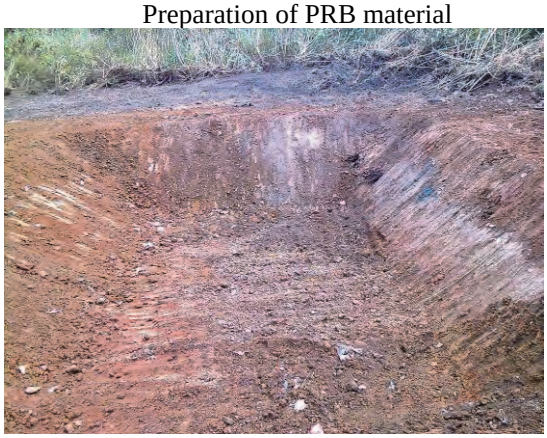
The material was brought in early March because it is time-consuming to procure and prepare this material. During the construction of PRB, several lessons were learnt - that need to be taken into account in the work schedule - such as reducing procurement time for materials and the period required for processing on site.

As of May 11, site clearance of land for PRB, levelling of the planned site, maintenance of work yards, loading of materials to the site, leachate pits, and landfill mining study and improvement of leachate treatment facility were implemented. Remaining work was to construct PRB, which has been delayed due to weather conditions.

PRB site clearance

Preparation of PRB material

The location to install PRB



Construction of the working yard

From 27th of July, site works of PRB installation was started. At first, a pre-compaction test was conducted. The compaction test was conducted with the cooperation of Dr. Anurudda, Peradenia University.

The PRB material should be compacted to meet optimum seventy-five percent (75%) standard Proctor density (BS 1377:1990 soil test series) at 27±3 % water content, which is equal to 1000 kg/m^3. Therefore, the required level of compaction is 1.0 – 1.1. kg/m^3. As per the results of the test, all samples met the above mentioned standards (table 2-76). Construction works started after confirmation of the laboratory test results and completed at the end of September 2018.

Sampling of the compacted PRB layer

On-site testing

Table 2-88: The results of the compaction test for PRB

Sample	Wt of wet soil (g)	Dry weight of soil (g)	Water content (%) (Wb)	Water content (%) (Db)	Core volume (m^3)	Wet Bulk density (kg/m^3)	Dry Bulk destity (kg/m^3)
S1	166.0	123.0	25.9	35.0	98.8	1,680	1,245
S2	126.0	110.0	12.7	14.5	98.2	1,283	1,120
S3	125.0	110.0	12.0	13.6	98.2	1,273	1,120
S4	118.0	104.0	11.9	13.5	98.6	1,197	1,055
S5	126.0	110.0	12.7	14.5	98.2	1,283	1,120
S6	123.0	107.0	13.0	15.0	98.2	1,253	1,090

Main parts of PRB construction were (1) material mixing process and (2) construction of PRB process.

Bangadeniya Soil 12.5% : Biochar 12.5% : Brick particles 75.0%

Mixture of the materials

Excavation

Filling the mixed PRB materials

Compaction for the PRB layer
Required level of compaction is 1.0-1.1 kg/m^3

The compacted PRB layer

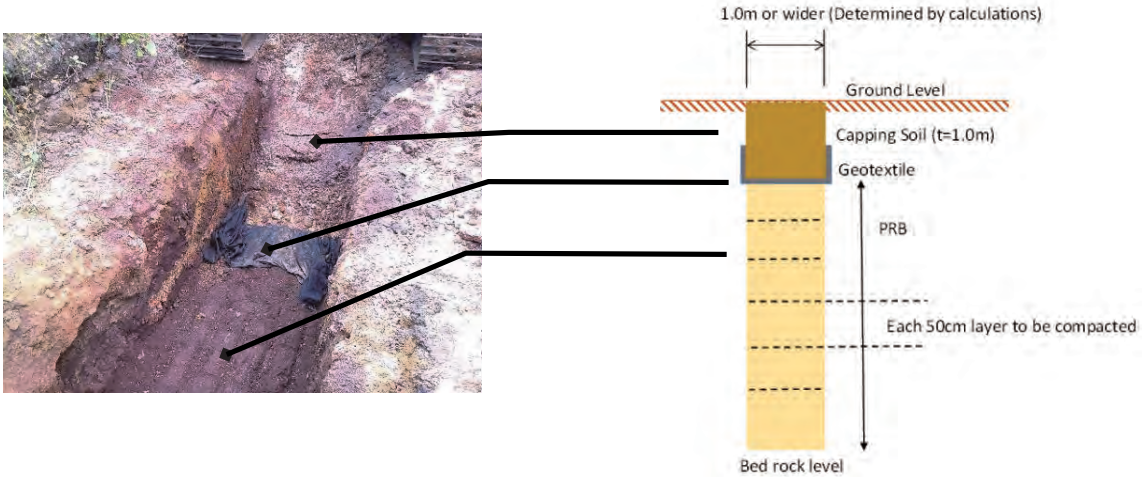


Figure 2-30: The Model of PRB installation

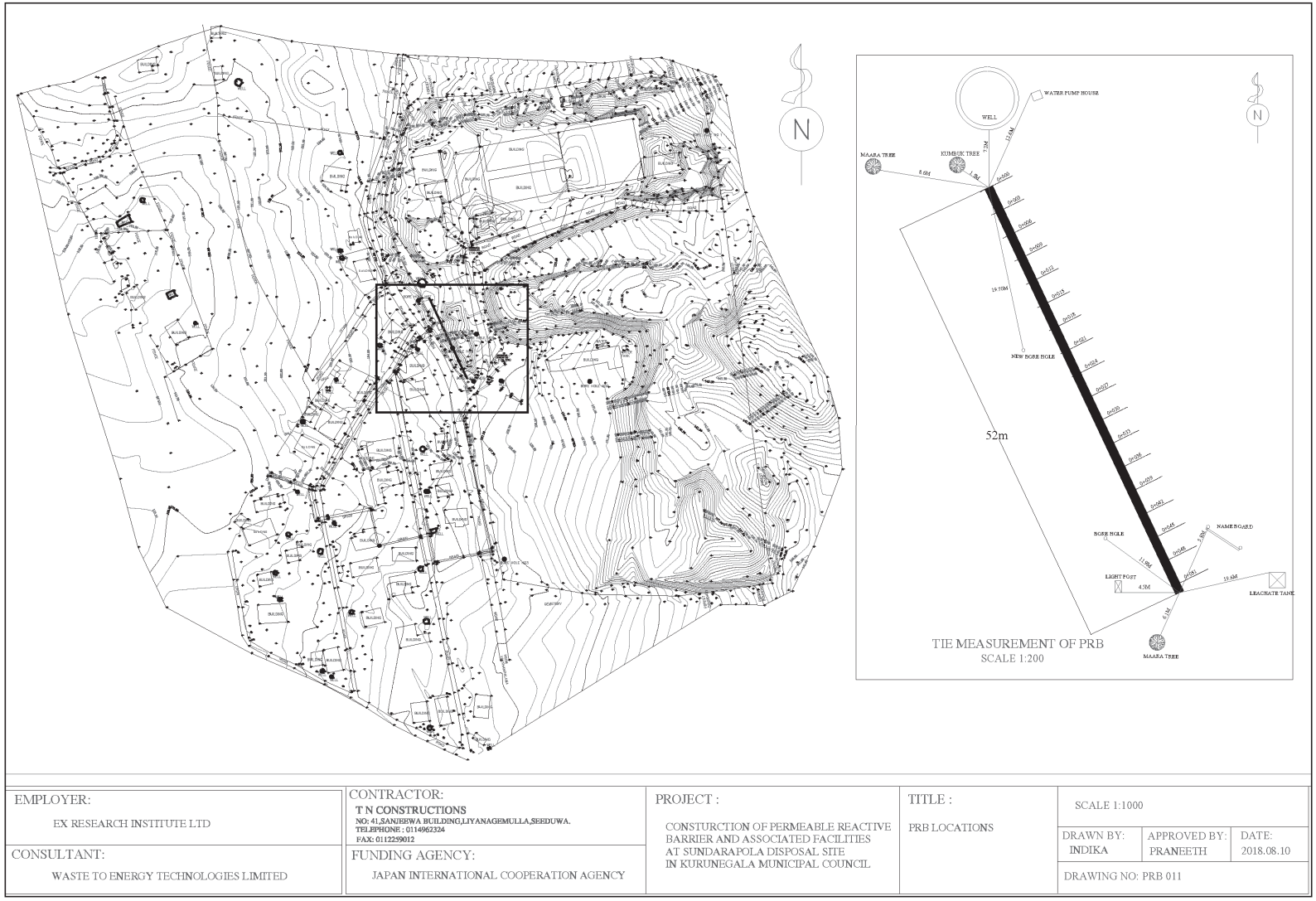


Figure 2-31: The plan of PRB installation

b. Construction of leachate collation pit

In order to minimize the contamination of surface and ground water by leachate, the quantity generated has to be collected and directed to an appropriate treatment facility.

From the present site conditions, it was considered suitable to install leachate interception drains and to collect overland flows.

Proposed leachate collection system consists of horizontal pipes, trenches and collection tank.

The leachate collection tank is equipped with automated pumping system where the collected leachate will be automatically delivered to leachate and gully waste co-treatment facility. Therefore, the tank capacity has been estimated to be 2.0 m^3.

As build drawings of PRB and leachate treatment facility are attached as appendix 18.

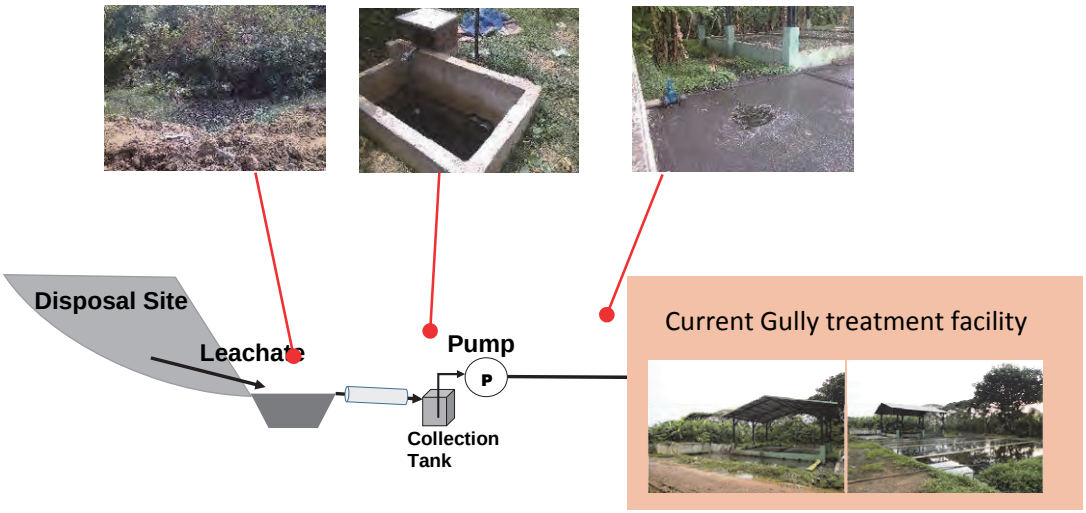


Figure 2-32: Flow diagram of the leachate collection, pumping and Leachate and gully waste co-treatment system

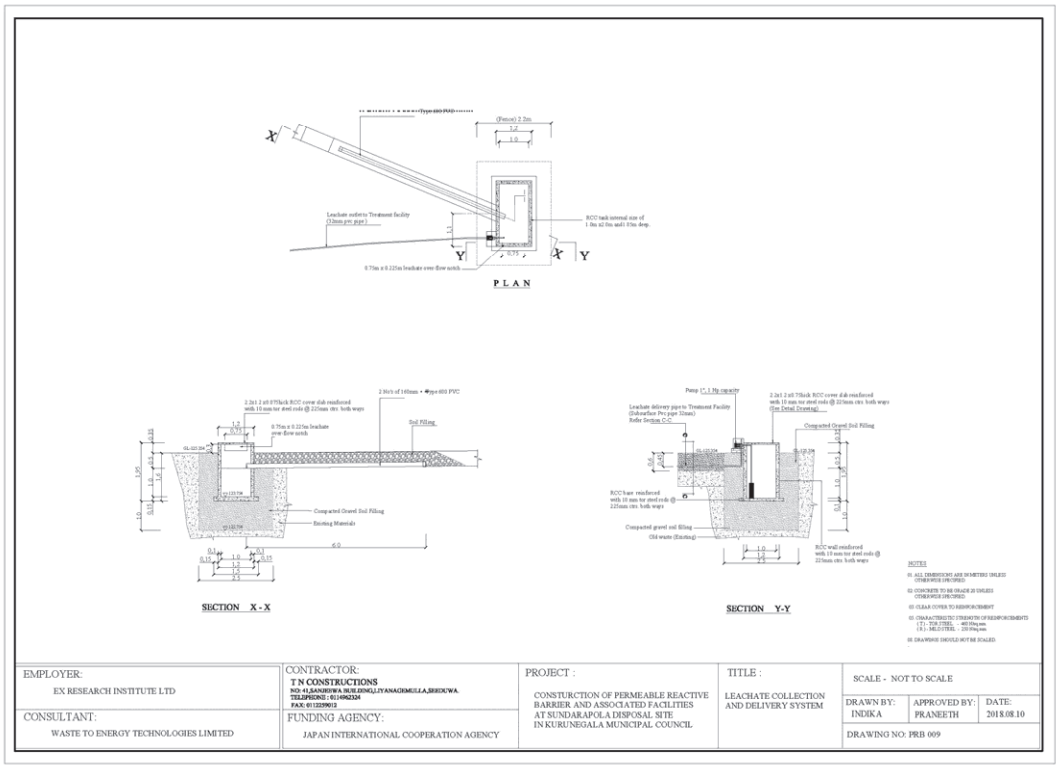


Figure 2-33: Structure of leachate collection facility

c. Sampling of landfill mining (3 pits x 2 samples = 6 samples)

c.1. Outline of landfill mining

Municipal solid waste (MSW) dumpsite (landfill) reclamation (also referred to as landfill mining) refers to the process of excavating previously disposed of materials from a dumpsite/landfill to recover metal, glass, plastic and other combustibles, soil, and the landfill volume itself. Landfill mining has been practiced to a limited extent at several locations in the word. As an auxiliary activity of the project, project-implementing agency seeks the feasibility of dumpsite/landfill mining, aiming to reclaim the available space, recyclable materials, and soil-like substances for land reclamation or, to be used as cover soil in the landfill itself.

The primary factors that have motivated landfill operators to consider and implement landfill mining at their sites are;

a) to address groundwater contamination problems posed by wastes in old unlined landfills by removing the source of pollution,
b) to create new capacity for future landfilling activities,
c) to reduce closure costs by reducing the footprint of the landfill,

d) to recover recyclables, particularly metals, for resale, and
e) to recover soil/compost-like material to be used in land reclamation or as cover soil.

The correct identification of composition and quantity of waste dumped in a disposal site is important to prepare site rehabilitation and a remediation plan, including the potential for resources recovery, especially recyclable items and usable products such as decayed organic matter. However, soil boring is not a practical method to examine the dumpsite as the mixed-waste, especially plastic residues, make it difficult to penetrate. Therefore, pit excavation is often recommended for examining dumpsite wastes.

c.2. Scope of Works

The specific tasks and objectives of the project were as follows:

a) Identify suitable locations to dig test pits for mined-waste sampling.
b) Excavate test pits on the garbage dump with approximate sizes of L= 3.0m, W=3.0 m and D=5.0 m using a crawler excavator.
c) Obtain considerably large mined-waste samples (~ 50 kg) in two profiles; from surface to 2.5 m depth and from 2.5 m to 5.0 depth.
d) Estimate moisture content of each waste sample.
e) Estimate particle size distribution of air-dried waste samples.
f) Determine composition of air-dried waste sample by separating waste into different categories.

c.3. Methodology Adopted

The exact location of the test pits were identified in order to extract representative samples from the old dumpsite. The sampling locations are shown in the following map (Figure 2-34).

Figure 2-34: Location of test pits

c.4. Mining process

The first step of the mining process was to identify suitable locations. As instructed by the Consultant, three locations were identified on the top of the old dumpsite (Figure 2-34). The scrubs and overgrown vegetation on each location were carefully removed to expose the ground surface. The area of the excavation was marked on the ground (3 m x 3 m).

Excavation was done using a crawler excavator. Excavated waste was pilled up adjacent to the pit and a sample of waste from each 0.5m depth of excavation (the approximate size of the excavator bucket) was placed on a plastic sheet. The excavation continued until the depth of the pit reached 2.5 m below the surface. The samples collected on the plastic sheet were thoroughly mixed and a representative sample was taken for further laboratory analysis. The same procedure was followed to grab the second waste sample from 2.5 to 5.0 m depth profile of the same pit. All samples were packed in large polythene bags, labelled, and delivered to the laboratory for further analysis.

As instructed in the Specifications, three pit excavations were conducted from 13/03/2018 to 14/03/2018. Two waste samples were collected from each excavation.

Table 2-89: Coding and description of mined-waste samples

Code	S_1N_1	S_1N_2	S_2N_1	S_2N_2	S_3N_1	S_3N_2
#	1		2		3	
Date	13/03/2018	13/03/2018	14/03/2018	14/03/2018	14/03/2018	14/03/2018
Time	11.00 am	2.27 pm	11.10 am	11.45 am	12.26 pm	12.55 pm
GPS	7°30″498′N 80°21″223′E	7°30″498′N 80°21″223′E	7°30″510′N 80°21″232′E	7°30″510′N 80°21″232′E	7°30″483′N 80°21″228′E	7°30″483′N 80°21″228′E
Depth (m)	Down to 2.5m below surface	Between 2.5 & 5.0 m	Down to 2.5m below surface	Between 2.5 & 5.0 m	Down to 2.5m below surface	Between 2.5 & 5.0 m

Field observation confirmed that flowing or stagnated leachate (water table) was not encountered in any of the excavations. No large obstacles (tree roots, boulders etc.), distinct soil layers, or bedrock were found during the excavations.

Figure 2-35: Mining of dumpsite and waste sampling procedure

c.5. Sample size received at laboratory

Sample size received at laboratory is shown as below table. The fresh sample size was larger than the minimum sample size (50 kg) specified in the specifications.

The fresh sample size was larger than the minimum sample size (50 kg) specified in the specifications.

Table 2-90: Sample size received at laboratory

Sample code	Bag 1 (kg)	Bag 2 (kg)	Bag 3 (kg)	Total sample size (kg)
S_1N_1	26.0	21.0	23.5	70.5
S_1N_2	23.0	22.5	26.0	71.5
S_2N_1	29.0	36.0	-	65.0
S_2N_2	28.5	29.0	-	57.5
S_3N_1	30.5	32.0	-	62.5
S_3N_2	30.5	30.0	-	60.5

c.6. Moisture content analysis

A sub-sample from each main sample was placed in an oven at 70 °C and dried until it reached a constant weight to determine the moisture content. Moisture content of the waste samples varied from 147 to 25%, with an average moisture content of 21%.

Table 2-91: Moisture content of mined-waste samples

Sample	Weight of empty container (g)	Weight of Container + fresh waste (g)	Dried weight of waste + Container (g)	Dry weight of waste (g)	Moisture Content (% db)	Moisture Content (% wb)
S_1N_1	248.0	1468.0	1294.0	1046.0	17%	14%
S_1N_2	540.0	1550.0	1312.0	772.0	31%	24%
S_2N_1	350.0	1300.0	1120.0	770.0	23%	19%
S_2N_2	40.0	590.0	484.0	444.0	24%	19%
S_3N_1	40.0	614.0	488.0	448.0	28%	22%
S_3N_2	40.0	444.0	342.0	302.0	34%	25%
		Average			26%	21%

c.7. Pre-processing of samples

The received samples were air-dried for two weeks to reduce dampness in order to conduct the composition study. This was practiced to reduce the amount of contaminants adhering to large particles such as plastic films and textiles.

1) Air drying of mined-waste samples prior to sieving and composition analysis

2) Sieving of air dried samples for different size fractions

3) Composition of mined-waste samples after separating to different catagaries

Figure 2-36: Air drying, sieving and composition analysis of mined-waste

c.8. Determination of particle size of mined waste

Particle size of mined-waste materials was determined by dry sieving the samples through a series of large sieves.

Table 2-92: Determination of particle sizes of mined-waste

Sample	> 50 mm (kg)	> 25 mm (kg)	> 4.0 mm (kg)	< 4.0 mm (kg)	Cumulative (kg)
S_1N_1	22.5	8.0	21.0	13.9	65.4
S_1N_2	22.4	11.0	21.0	10.1	64.5
S_2N_1	14.0	9.0	22.0	14.3	59.3
S_2N_2	16.5	7.0	16.0	12.3	51.8
S_3N_1	13.5	6.0	19.0	18.2	56.7
S_3N_2	22.5	4.5	14.5	12.9	54.4
Average (kg)	18.6	7.6	18.9	13.6	58.7
Average (%)	32%	13%	32%	23%	100%

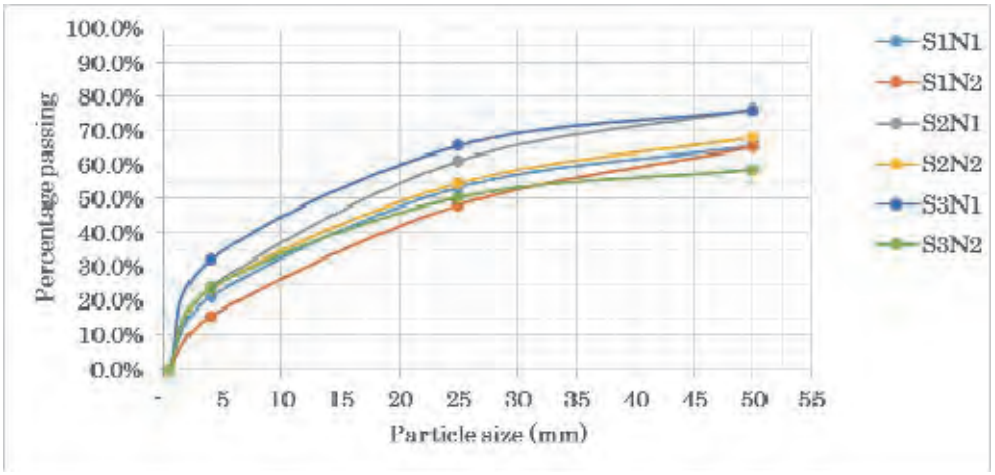


Figure 2-37: Particle size and distribution of mined waste

c.9. Mined waste physical composition

Each sample was separated to sieve size fractions (> 50 mm, > 25 mm, > 4.0 mm and < 4.0mm). The material in each size fraction were separated manually into the following categories and weighed. The weight of each material in the sample was recorded as follows. Any remaining material (< 4.0 mm) which could not be manually sorted into any of prescribed categories, was identified as compost-like substances. Similarly, a large fraction of waste having particle sizes in between 4.0mm and 25.0mm were also termed as compost-like substances, if further manual sorting is impossible.

Table 2-93: Mined-waste composition by weight

Categories	Weight of waste (kg)					
	S_1N_1	S_1N_2	S_2N_1	S_2N_2	S_3N_1	S_3N_2
Plastic (Hard)	1.552	1.645	1.050	2.246	0.801	1.669
Plastic (Soft)	9.500	10.750	7.488	8.000	6.949	6.000
Metal	0.105	0.523	0.300	0.216	0.045	0.490
Stones (X > 4.00 mm)	5.846	4.808	3.561	1.953	3.280	9.965
Paper	0.000	0.000	0.000	0.198	0.000	0.000
Textile	2.955	2.091	2.093	1.052	3.188	3.025
Glass and Ceramic	1.069	1.465	0.892	0.835	0.480	0.847
Rubber	1.765	0.613	0.000	0.000	0.000	0.000
Other inert (Organic)	1.541	2.242	1.330	2.390	0.875	2.072
Other inert	3.400	6.084	4.066	4.872	1.630	1.229
Compost like substances (25 mm > X > 4.0 mm)	21.000	21.000	22.000	16.000	19.000	14.500
Compost like substances (< 4.0 mm)	13.911	10.068	14.268	12.270	18.173	12.930
Total	62.644	61.289	57.048	50.032	54.421	52.727

Table 2-94: Mined-waste composition by weight percentages

Categories	Weight of waste (%)						
	S_1N_1	S_1N_2	S_2N_1	S_2N_2	S_3N_1	S_3N_2	Average (%)
Plastic (Hard)	2.5%	2.7%	1.8%	4.5%	1.5%	3.2%	2.7%
Plastic (Soft)	15.2%	17.5%	13.1%	16.0%	12.8%	11.4%	14.3%
Metal	0.2%	0.9%	0.5%	0.4%	0.1%	0.9%	*0.5%*
Stones (X > 4.00 mm)	9.3%	7.8%	6.2%	3.9%	6.0%	18.9%	8.7%
Paper	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.1%
Textile	4.7%	3.4%	3.7%	2.1%	5.9%	5.7%	4.2%
Glass and Ceramic	1.7%	2.4%	1.6%	1.7%	0.9%	1.6%	1.6%
Rubber	2.8%	1.0%	0.0%	0.0%	0.0%	0.0%	0.6%
Other inert (Organic)	2.5%	3.7%	2.3%	4.8%	1.6%	3.9%	3.1%
Other inert (inorganic)	5.4%	9.9%	7.1%	9.7%	3.0%	2.3%	6.3%
Compost like substances (25 mm > X > 4.0 mm)	33.5%	34.3%	38.6%	32.0%	34.9%	27.5%	33.5%
Compost like substances (< 4.0 mm)	22.2%	16.4%	25.0%	24.5%	33.4%	24.5%	24.3%

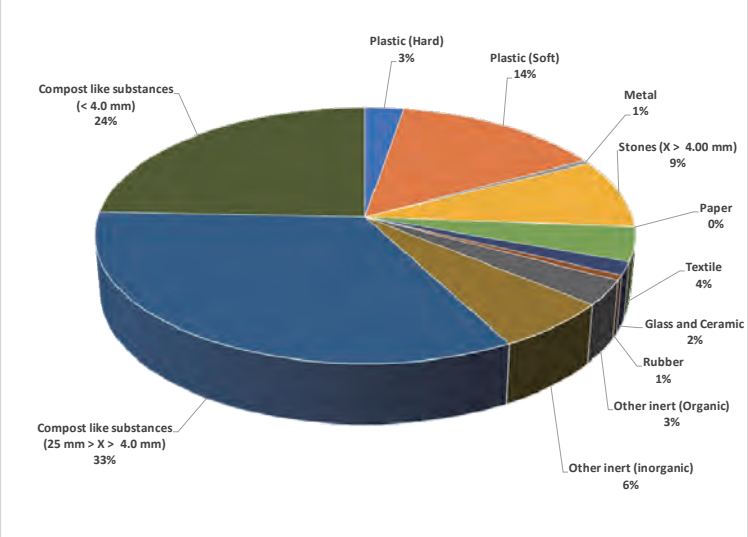


Figure 2-38: Average composition of mined-waste

The obtained data was further processed to determine the amount of material recovery, especially amount of plastics, textile, combustibles (plastics + textile), metal and compost size fraction, and shown in following table.

Table 2-95: Average composition of mined-waste

Fraction (%) by total fresh weight	S_1N_1	S_1N_2	S_2N_1	S_2N_2	S_3N_1	S_3N_2	Average (%)
Plastics	17.6%	20.2%	15.0%	20.5%	14.2%	14.5%	17.0 ± 2.9 %
Textile	4.7%	3.4%	3.7%	2.1%	5.9%	5.7%	4.2 ± 1.5 %
Combustibles (plastics + textile)	*22.4%*	*23.6%*	*18.6%*	*22.6%*	*20.1%*	*20.3%*	*21.3* ± 1.9 %
Metal	0.2%	0.9%	0.5%	0.4%	0.1%	0.9%	0.5 ± 0.3 %
Compost size fraction (< 4.00 mm)	22.2%	16.4%	25.0%	24.5%	33.4%	24.5%	24.3± 5.5 %

According to composition analysis and current waste amount at old disposal site, the approximately 7 years life time is expected to extend with landfill mining.

Table 2-96: Expected life time with landfill mining method

Items	Formula	unit	Qty.
Area of old disposal site	(1)	m^2	40,000
Average height of old disposal site	(2)	m	5
Waste mount at disposal site	(3)=(1)x(2)	m^3	200,000
Plastic (recyclable waste)	(4)=(3)x17.0%	m^3	34,000
Metal (recyclable waste)	(5)=(3)x0.5%	m^3	10,000
Compost	(6)=(3)x24.3%	m^3	48,600
Volume of plastic, metal and compost	(7)=(4)+(5)+(6)	m^3	92,600
Daily discharge waste amount (2019)	(8)	ton/day	26.6
Annual discharge waste amount(2019)	(9)=(8)x365	ton/year	9,709
Annual discharge waste volume	(10)=(9)x1.3	m^3/year	12,622
Life time of extended year	(11)=(7)/(10)	year	7

2.11.2 Improvement Works at Kataragama

(1) Installation of Electric Hanging Fence

Improvement of the existing dumpsite at KPS is underway. As a part of this improvement, an Electric Hanging Fence was installed at the Pilot Project Site in November 2017. Research into fences to prevent intrusion by elephants, on-site information gathering and through the recommendation of the counterparts, only one fence (Sri Lankan made) was found to be suitable for this purpose (difficult for elephants to destroy and capable of preventing elephant intrusion). Therefore, submission of a proposal was requested of the candidate by October 16, 2017. The candidate's proposal was assessed in a counterpart meeting (held the same day), and it was decided the amount was within the budget and the

content of the proposal was judged to be appropriate. Hence, a contract with the following candidate was concluded (also on the same day).

Contractor: Dr. S. Wijeyamohan (individual)

Field work to prepare for this was started the following day, the 17th of October. A detail description of the field work is included in 2.1.21. A conceptual image of the improvement of the dumpsite is shown in Fig. 2-23. Full-scale construction of the dumpsite improvement is planned to be started in January 2017.

(2) Construction of the security hut

On December 4, 2017, invitation of bidding was sent to the following three companies who received introduction from the counterpart organization to estimate the construction of the Security House. Bidding was opened on December 18th, 2017. Drawings of security hut is attached as Appendix 19

- Multy Engineers
- Sandamali Construction
- NUN Engineering Pvt Ltd

Since NUN Engineering Pvt Ltd submitted the lowest price estimate, contract negotiations were started immediately and the contract was concluded on 22nd December. Substantial construction began on 26th December. Construction of the security hut was completed by the end of March 2018.

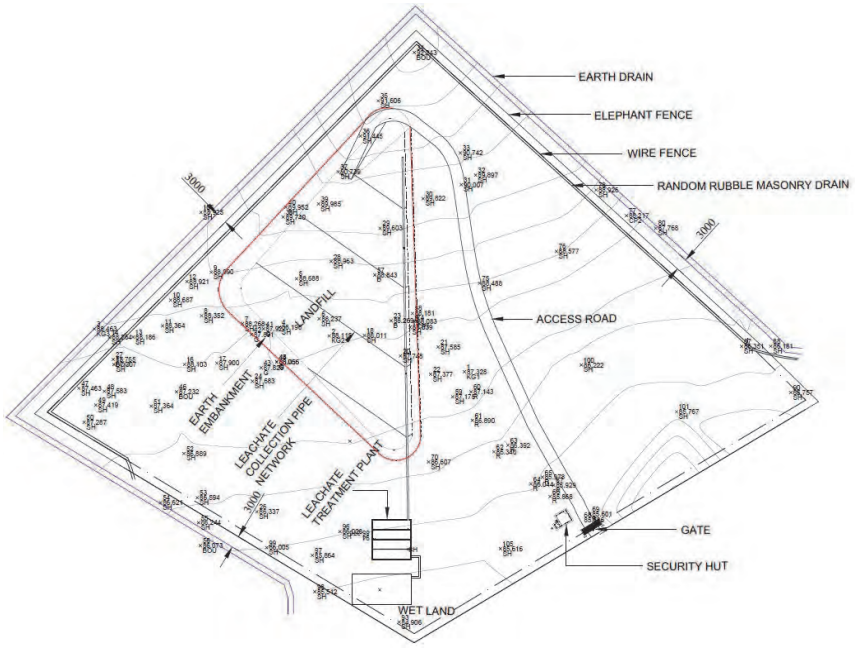


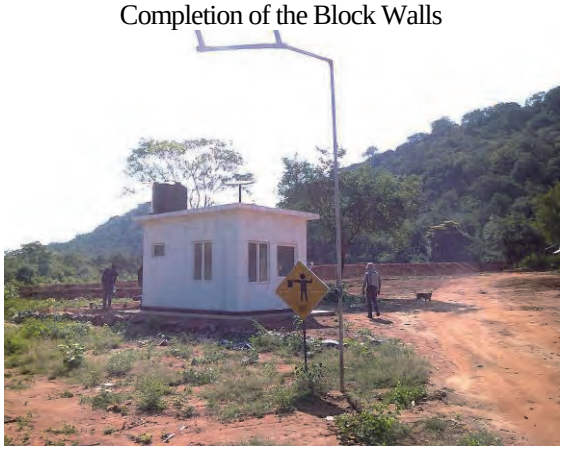
Figure 2-39:Layout of final disposal site at Katharagama PS

Construction of the Pillars

Construction of Block walls

Completion of the Block Walls

Form working of the roof



Completion of the Security hut (25th April)

Completion of the security hut (26th April)

Figure 2-40: Control house

(3) The PP in Kataragama PS

Tender documents were distributed to the below companies as recommended by counterparts on 23 January2018 and a site visiting was held on 27January2018. The tender was held on 6th March 2018 and 21st Century Property Development (Pvt) Ltd. was selected as the first company prioritised for

negotiations.

- 21st Century Property Development (Pvt) Ltd
- CCD Construction (Pvt) Ltd
- Rovel Constructions (Pvt) Ltd

After the negotiation, EX Research Institute made contract with 21st Century Property Development (Pvt) Ltd on 18March, 2018.

Site works were started by 26th March.. After the on-site construction was actually started, there were issues such as slight differences in contour lines from previous surveys, existence of hard rocks in the ground that could not be grasped by geological surveys. Amendments to these subject matters were proposed through meetings attended by experts, designers, contractors, local governments and CEA, therefore construction has continued since consensus was reached.

Site visit for the Tender on the PP in KPS

Site visit for the Tender on the PP in KPS

Earth works at the landfill site, before removal of hard rocks (May 2018)

Earth works at the landfill site, after removal of hard rocks (May 2018)

The photo after completion of earth works and leachate pipes were installed (August 2018)

Completion of the landfill site

Figure 2-41: Construction of final disposal site at Katharagama PS

By August of 2018, almost all construction works were completed. The results of the PP were as follows.

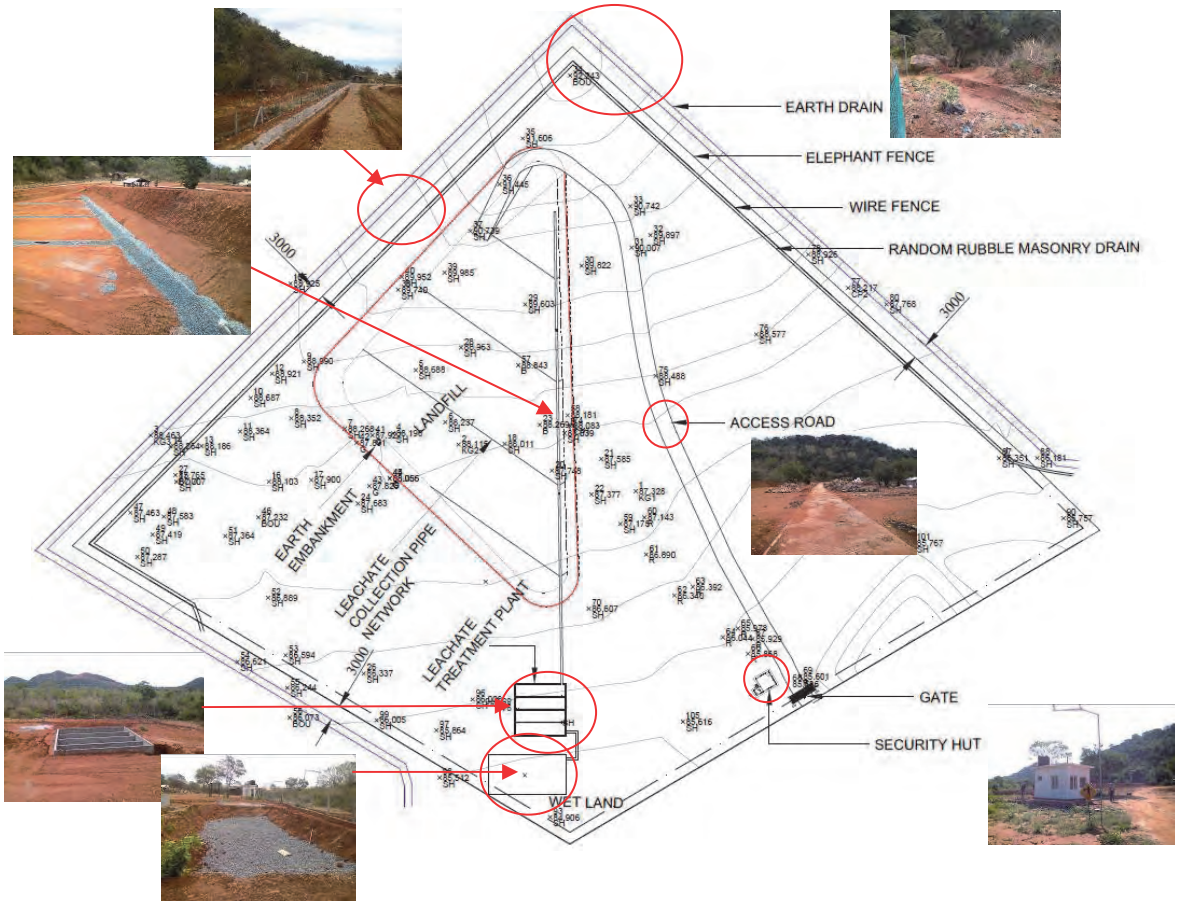
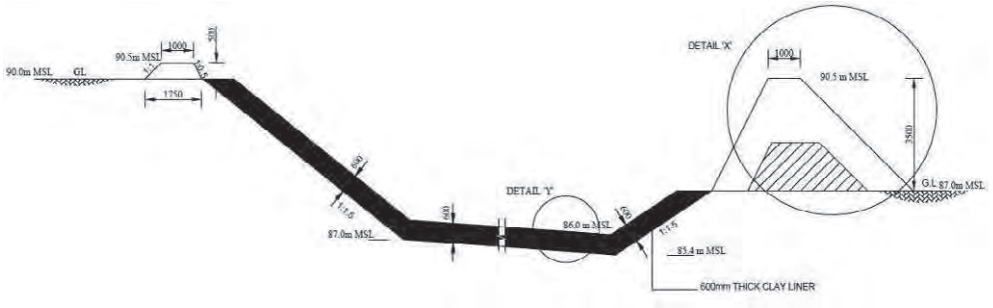


Figure 2-42: The image of the improvement of the dumpsite in KPS

a. Installation of Liner system

- The clay liner requirement with respect to hydraulic conductivity, i.e. 1×10^{-9} m/s, can be achieved with the addition of 10% of bentonite to the original soil.
- Soil-bentonite mixture with 5% coconut coir fibers by volume is a good measure to control the shrinkage cracks.
- 0.6 m thick soil + 10% bentonite + coir is determined to be adopted in the Kataragama pilot project in accordance with technical calculation results.



Bags of the bentonite at a site

Compaction for the liner

Compaction for the liner

Coconut coir fibers were mixed with the bentonite-soil layers

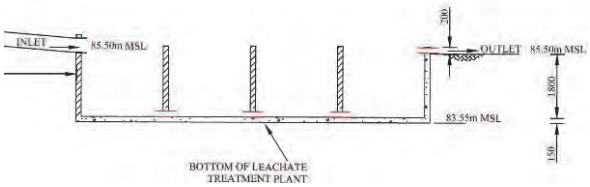
The bentonite-soil mixed liner was installed in the bottom of the landfill site

The bentonite-soil mixed liner on the inside slope of the landfill site

b. Installation of leachate treatment

The leachate treatment facility was installed under the ReEB waste project. The concept of the leachate treatment plan is shown as follows:

1. Leachate Pipes - HDPV or HDPE pipes were installed to pump the leachate up to the Leachate treatment facility. Dimension of the pipes were 60 mm. The pipes were installed either buried or above ground.
2. The flow rate will be measured with a triangular weir by installing notch tank.
3. Primary Oxidation Tank - Capacity of the tank shall be secured with a 14 days processing time to allow for the daily leachate generation amount. (11.2 m^3/day x 14 days = 156 m^3). It is better to include 12% margin rate; 160×1.12=180m^3.
4. The tank shall be separated to 4 sub-tanks - The size of each sub-tank: 10m Length, 2.5m width and 1.8, depth (Effective water depth) 45m^3/tank × 4 tanks = 180m^3.



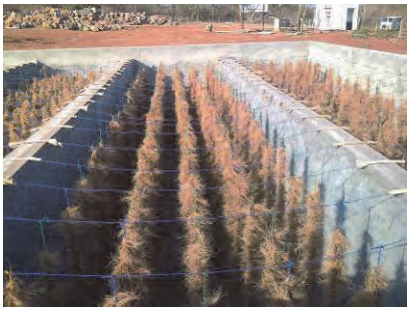
5. Coir-Fiber Biofilm Treatment System (COTS) shall be installed in the oxidation tank -

   The tank shall be composed of a concrete wall (t=200mm) and concrete base (t-150).

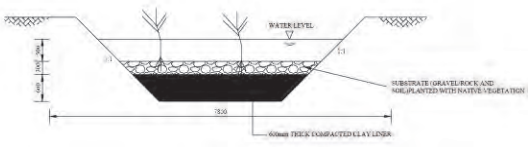
   Bars: D16, Single, pitch is 200 mm.

Bars: D16, Single, pitch is 200 mm.

Partition wall shall be masonry mortar finished with a wall thickness of 100 mm.



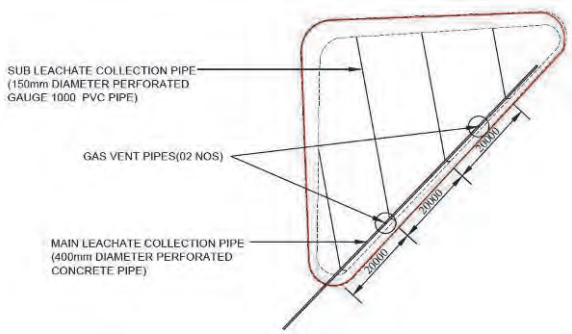
6. Vegetation Purification Process - Vegetation Purification Process shall be designed in accordance with "Case study on water purification measures" issued by Ministry of Land, Infrastructure and Transport, Japan. According to the Case Study, surface loading rates are 1g/m^2/day for T-N and 0.15 g/m^2/day for T-P.



7. Instead of installing a structure, it is constructed as a structure that naturally accumulates, and the treated effluent water from the oxidation tank flows naturally out of it.

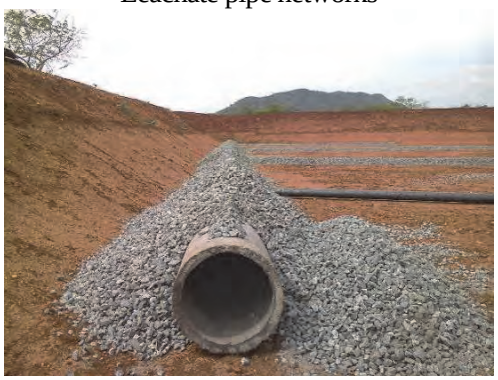
c. Installation of leachate collection pipe networks

In order to collect and drain leachate in the landfill cell, a leachate collection pipe networks were installed. The leachate collection pipe network was composed of (1) Main line pipe, (2) Branch line pipes and (3) Vertical gas vent pipes.

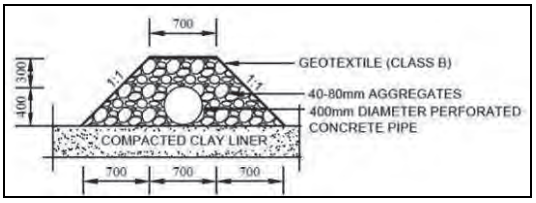


Leachate pipe networks

Percolated concrete pipes for the trunk line



Trunk line pipe

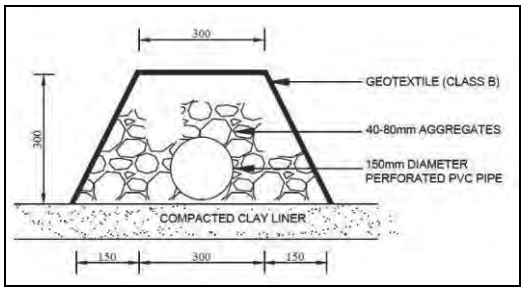


Cross section of the trunk pipe

Branch line pipe (covered by aggregates)

A percolated pipe for the branch line is connected to the trunk line pipe

Percolated pipes for branch line is covered by aggregates



Cross section of the branch line pipe

d. Weigh bridge

In order to improve data management for SWM in KPS, a weigh bridge system (Capacity: 30 tons) was installed to the compost site. The weigh bridge will be utilized to scale all incoming waste amounts and outgoing waste amounts from the compost site. The weigh bridge system is composed of a weigh bridge, management hut, and computers for data calculation and recording. Installation of the weigh bridge was completed by the end of July, 2018 and operation of the weigh bridge was started from the 1st of August, 2018. An operation manual for the weigh bridge was prepared under ReEB waste project.

Weigh Bridge System

Weight of incoming waste

Weigh bridge data management system

e. Night soil treatment plant

A set of night soil treatment facilities were constructed at the compost site. The Coconut-fiber biofilm treatment system (COTS), a type of low-cost leachate treatment facility was installed.

The COTS has been introduced in Sri Lanka to treat collected sewage and leachate from a solid waste landfill. The COTS utilizes coconut-fiber as a biofilm support and is a kind of stabilization pond system. Besides, the COTS uses no mechanical devices or electricity, and so requires very little maintenance. The COTS facilities have been operating at Balangoda Urban Council (UC) and at Kuliyapitiya UC since 2009 and at Tangalle UC since 2012 for sewage treatment. On the other hand, at Nuwara Eliya Municipal Council (MC) site, the COTS has been operating since 2004 for treating the leachate from a solid waste landfill.

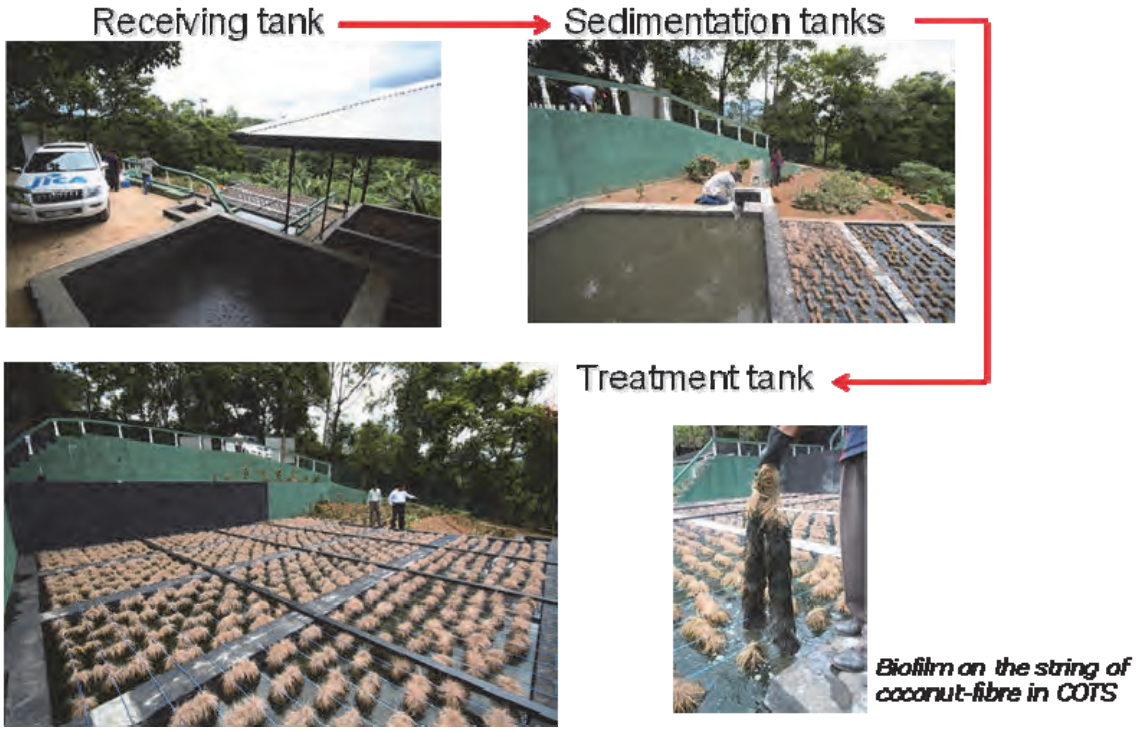
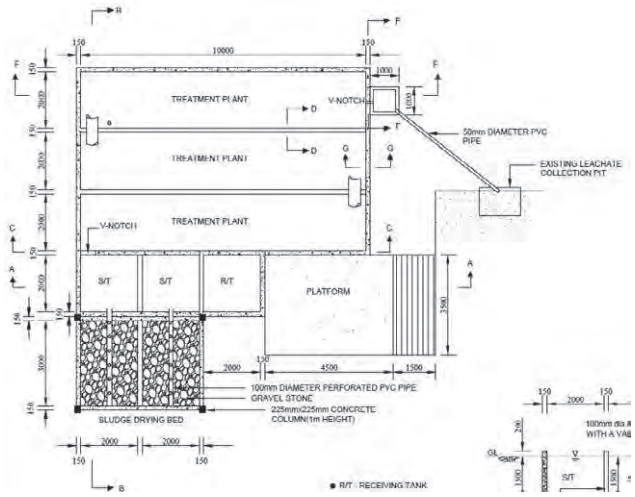


Figure 2-43: General process flow of the COTS system



Night soil treatment plant
(August, 2018)

Percolated pipe for the sludge drying bed

Sludge drying bed
(August, 2018)

The COTS is installed

As build drawings of landfill site compost plant are attached as Appendix 20.

f. Opening ceremony

The opening ceremony of the rehabilitated disposal site and compost plant was held on 17 September 2018. The number of participants was approximately 200 people from Uva province, KPS,CEA, NSWMSC and citizens. The list of main guests is shown as below table.

Table 2-97: The list of main guests for opening ceremony

No.	Name & title
1.	Hon. Parliament member Monaragala district Mr.Vijitha Berugoda
2.	Representative from the JICA. Ms. NEGISHI
3.	Deputy director General (Solid Waste). CEA Mr. Upali Indrarathna Director (Solid Waste).
4.	CEA Mrs. Sarojinee Jayasekara Director
5.	National Solid Waste Management Support Center. Mr. Madawalagama
6.	JICA volunteer Mr. INOUE SHINYA
7.	Dr. Najeed Priyankara. University of Ruhuna.
8.	Mr. Channa Ruberu. Chairman. 21st Centuries construction company.
9.	Mr. Mangala Vijenayake Commissioner of local government.
10.	Mr. D.M. Dissanayake. Assistant commissioner of local government.
11.	Mr. Nandasiri. District Secretary. Katharagama.
12.	Mr. Najeem. Provincial Director. Central Environmental Authority.
13.	Mr. Rukshan. Assistant Director. Central Environmental Authority.
14.	Mr. Nalin. Director. Pura Naguma project.
15.	Mr. Nandasiri Nikawaththa. Hon. Chaiman. Buththala Pradeshiya Sabha
16.	Mr. R. D. Haramanis. Hon. Chaiman. Wellawaya Pradeshiya Sabha
17.	Mr. Ranjan Silva. Hon. Chaiman. Bibila Pradeshiya Sabha


Weigh bridge


Night soil treatment facility


Separation of waste at compost plant


Unveiling event of signboard


Inspection of waste discharge area


Inspection of waste discharge area


Discharging of residue waste


Ceremony participants


Speech of JICA representative

2.12 C.2: Safety Management during Construction Phase for PP Implementation

2.12.1 Kurunegala MC

All staff and workers at the construction site are familiarized with the safety measures, such as putting on long rubber boots, helmet, safety jacket and so on at regular meeting. And the excavated pit should be strictly protected during construction to avoid anyone falling in.

2.12.2 Kataragama PS

(1) Circumstances of installation of electric fence

Countermeasures to protect the site from wild elephants' invasion and to prevent their feeding on disposed waste should be considered before starting the PP in KPS.

A. In KPS, some wild elephants have scavenged waste at the dumpsite because they eat kitchen waste.

B. The wild elephants invading the dumpsite are not necessarily of a calm disposition (temperament), and may be a threat to the dumpsite work as they threaten humans or sometimes chase people to protect what they perceive as their own territory. Also, facilities and embankment, etc. installed as part of dumpsite improvements are likely to be trodden on or destroyed by the elephants.

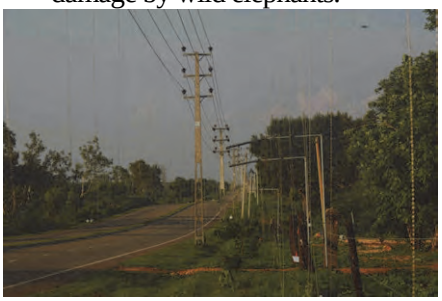
C. Since elephants should not eat human leftovers – and because they may also unintentionally eat plastic bags in the process – it is necessary to segregate the dumpsite from the elephants' habitat to protect the elephants.

In Sri Lanka, a method of installing an electric fence as a measure to prevent invasion of elephants onto national roads and so on is generally established in areas such as national parks. Conventional electric

fences, however, have proven unsuitable for such uses as intelligent elephants can easily mitigate their usefulness such as by laying logs on the wires. Therefore, the Project needed to find an electric fence able to successfully keep out elephants.

After researching this matter in the field and gaining the recommendation of the counterparts, it was found that only one vendor in Sri Lanka makes a fence – a hanging-type fence with a successful track record of excluding elephants.

Table 2-98: Comparative of types of electric fence

Item \ Type	Hanging Fence	Conventional electric fence
Technical features	i The structure of the fence is a series of inverted L-shaped support posts with electric wires hanging from these posts. This design overcomes conventional issues with elephant behaviour and intelligence, mitigating damage by wild elephants.  ii After establishing this type of fence at the Hambantota disposal site, the fence has a track record of keeping out elephants from the site. iii This fence has also proven effective at keeping out elephants from the compost facility of Kataragama since its construction..	Since the structure of conventional electric fences is electric wires stretched horizontally between a series of posts, it is prone to being damaged or destroyed by elephants as they can use their trunks to lay (large) logs on the wires, or step (stomp) on and break the posts.  Many existing electric fences are of this design, and as such have been destroyed by elephants, and are therefore not effective at keeping out elephants.

As a result of comparative consideration, it was decided that the hanging type electric fence had a proven track record and it was judged to be suitable for the project site, and the procedures for the local re-contracting were taken and completed. It was decided that the local sub-contractor would be Dr. S. Wijeyamohan, who is the inventor of this hanging-type electric fence and who was formerly a researcher at the Elephant Conservation Center, and who is also familiar with the behaviour and nature of elephants.

General description of the electric fence is shown below.

a	Aluminum pole and stainless steel wire
b	High-voltage pulse generator, manufactured by Speedlite (of New Zealand, generated voltage approx. 9,000 Volts
c	12 V battery powered with solar powered charger
d	Length of contracted fence: 544 m Contract amount: 1,112,800.00 LKR (801,305 JPY) unit price per 1 m approximately 2,046 LKR (1,473 JPY)

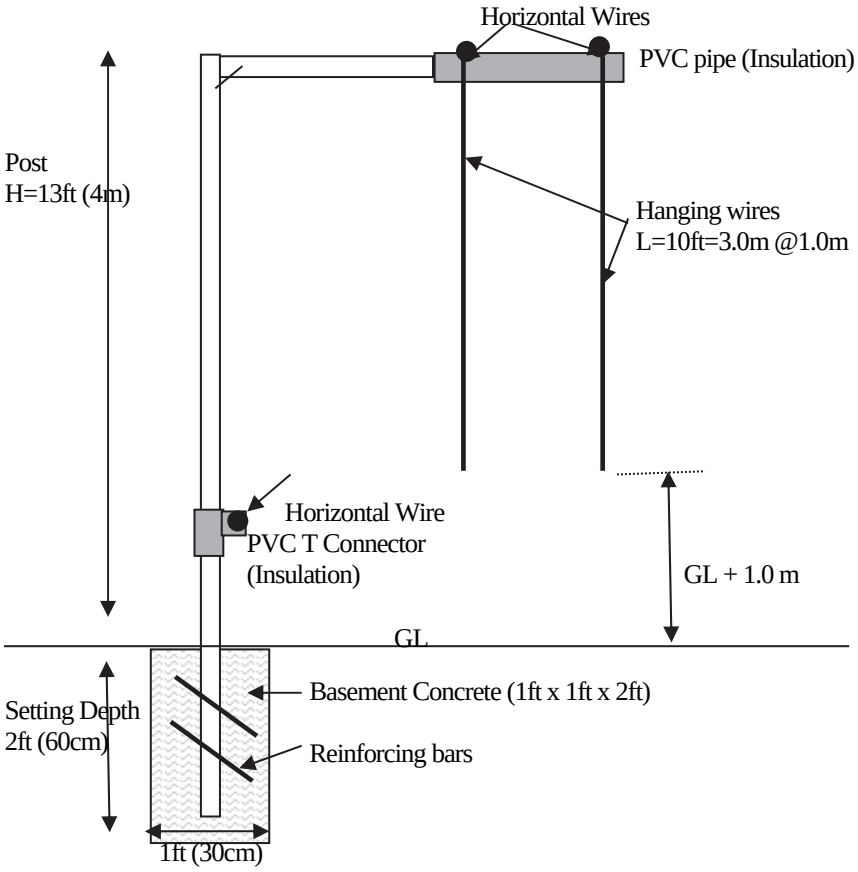


Figure 2-44: Standard structure of the hanging fence

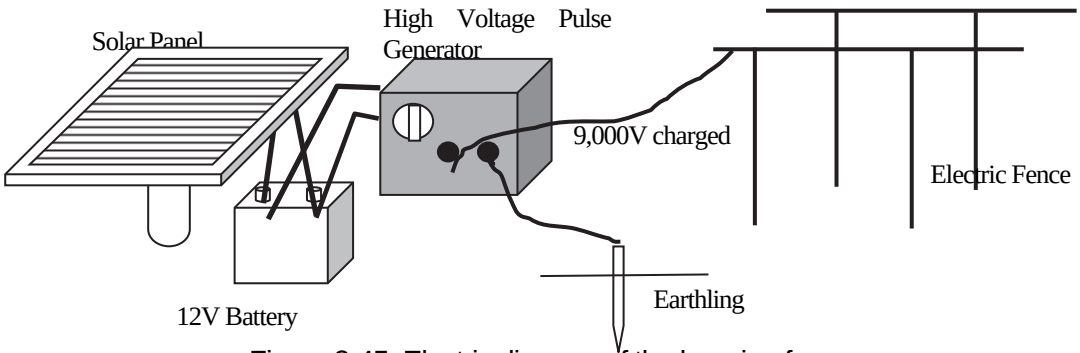


Figure 2-45: Electric diagram of the hanging fence

The standard structure is as shown in the figure. It is suitable for installation in developing countries because it is easy to manually construct and has a simple structure. In addition, PVC pipes are used for the contact part of the electric wires, which is a substitute for porcelain insulator, which is an idea in consideration of simplification of the structure, simple construction, and availability of materials.

Regarding the electric part, it is the same structure as the electric fence adopted for dairy farmers and measures against bears, wild boars, and deer in Japan. The high voltage generating part is a pulse generating type, only giving electric shock to animals, only current that will not cause death is allowed to flow, and even if a human erroneously touches it, there is no danger to life. Also, a battery that can be charged by a solar panel is a power supply, and it can operate even in places where commercial power cannot be secured. A voltage of about 9,000 V is charged in the electric fence.

(2) Construction works of the electric fence

It took nine days to conclude the preparatory work to install the fence. KPS prepared heavy machinery owned by KPS to prepare for fence installation and clearance of the site. The preparation work took three days. The initial installation plan was three days, but since the construction period was in the rainy season there were also interruptions due to rain and interruptions for safety assurance during the appearance of wild elephants on the site. Therefore, the installation took a total of six days. The assembly of the posts and fence, wiring of electric wires, and so on can all be undertaken manually. Therefore this conforms with the general recommendation for such donor projects in developing countries that general-purpose materials that do not require any special tools or equipment for installation or operation is appropriate.

The outline of the construction is as follows.

Table 2-99: Procedure of installation of electric fence

Date	Description
Oct-17, 2017	Preparation, clearance/logging in the site
Oct-18	Preparation, clearance/logging in the site
Oct-19	Preparation, clearance/logging in the site, preliminary survey, material loading
Nov-4	Installing (ramming in) the posts, wiring of the outside fence wires, turning on the current (of outside fence)
Nov-5	Installing (ramming in) the posts, wiring of the inside fence wires
Nov-6	Wiring, installation of solar panel, installation of electric power box
Nov-7	Wiring
Nov-8	Material loading
Nov-9	Finishing, checking, completion of the construction works
Nov-10	Instruction to KPS officers/workers

The site view after completion

The site view after completion

The solar panel and the power box

(3) Results of the works of electric fence

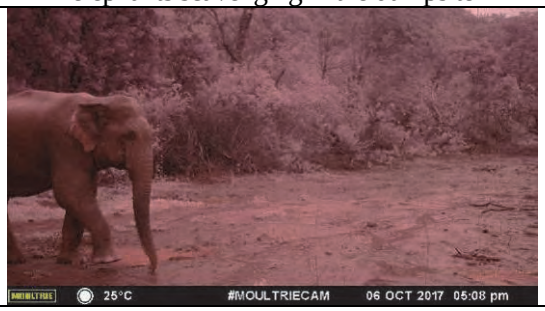
Before the installation of the electric fence, the dumpsite was a feeding place for wild elephants, and some groups of several elephants appeared daily, but after installation of the electric fence these elephants ceased to come inside the fenced area. Even with observation using fixed-point monitor

cameras set up by the subcontractor, no elephants were observed trying to enter the fenced area. Therefore, it could be confirmed that the fence is effective at preventing invasion by elephants. Moreover, as elephants were also frequently observed around the site, there is also sufficient evidence to support the need for such a fence.

Observation and monitoring of the fence was continued, and it was confirmed that both the operation of the fence and the charging of the battery have continued to work properly.

Before installation of the electric fence: elephants scavenging in the dumpsite

Before installation of the electric fence: elephants appearing during the construction works



After installation of the electric fence: Elephants no longer trying to enter the fenced area. (monitoring camera image)

After installation of the electric fence: same as left (monitoring camera image)

(4) Safety management during the PP

After the starting of PP works from the 26th of March, safety management was conducted by the local consultant and experts. Activities below were conducted as the safety management.

- Review of construction plans on the PP
- Patrol activities by the experts
- Providing safety advice during site visit

Although unsafe activity at the PP sites was not actually observed, based on a preventative approach, to prevent occupational accidents such as dropping/falls the following safety procedures were advised to contractors and stakeholders. In addition, the operation status of the electric fence was monitored and instructions to the KPS to grass reaping etc. leading to insulation decline of the electric fence (causing shortages, decreased effectiveness), thus, the electric fence maintained functional and effective.

2.13 C.3: Public Awareness Regarding 3Rs Promotion

2.13.1 Ratnapura MC

(1) Questionnaire survey

Questionnaire survey for households and commercial areas was conducted in October 2017. The survey areas were same as those for the waste amount and composition survey. The purpose of the questionnaire survey is shown below.

Table 2-100: Purpose of questionnaire survey in RMC

- To know about public knowledge and practice of waste separation, ways of self-disposal and number of households doing self-disposal, and ways of discharge.
- To know about public behaviour on recyclable items if they use RMC services or they sell them to private recyclable collectors.
- To understand satisfaction level of municipal council's solid waste management service.
- To know about public awareness programmes
- To understand public knowledge on solid waste management policy in Sri Lanka and 3Rs.
- To know about number of households and population from the questions regarding number of family members per households for the purpose of estimating per person's waste discharge amount in composition survey.

The survey method used was determined from an efficiency perspective, and because of the inclusion of questions regarding evaluation or satisfaction of RMC's services. Respondents either directly ticked multi-choice boxes or wrote down their own responses to questions, after getting an instruction from RMC staffs, and RMC then collected the responses the following day. Questionnaire survey for households was conducted on Sunday. The following shows the respondents information and some representative results.

Table 2-101: Respondents information of questionnaire survey in RMC

	Household	Commercials
Day of visit to instruct	22 October 2017, Sunday	23 October 2017, Monday
No. of household and commercials	Total No. of households: 252 Area 1 (Batugedara) : 100 HH Area 2 Town : 12 HH Area 3 (Kospalawinna) : 60 HH Area 4 (Muwagama) : 80 HH	Total No. of commercials: 165 Basically the shops are: small textile, food, grocery and book shops.
No. of respondent household and commercial	Total No. of households: 200 Area 1 (Batugedara): 56 HH Area 2 Town: 0 HH Area 3 (Kospalawinna): 48 HH Area 4 (Muwagama) : 96 HH	Total No. of commercials: 143
Age	50.46±12.44	
Gender	Female 44%, Male: 56%	
No. of family members on average	4.17±1.42	

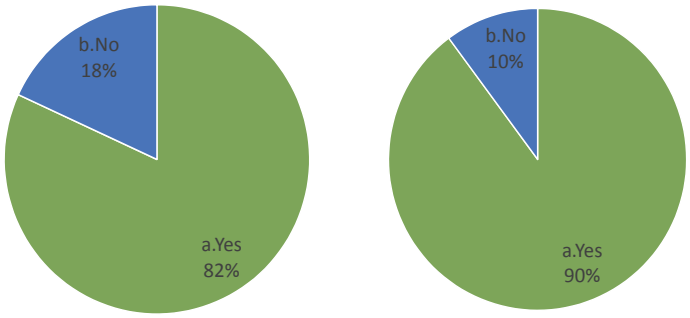


Figure 2-46: Are you separating wastes? (Left: 200 HHs, Right 143 Commercials)

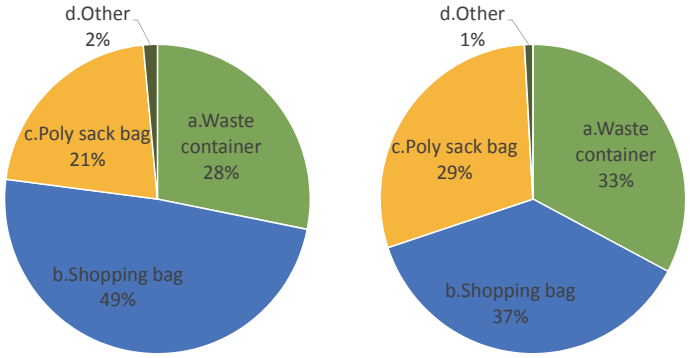


Figure 2-47: How do you discharge wastes? (Left: 200 HHs, Right 143 Commercials)

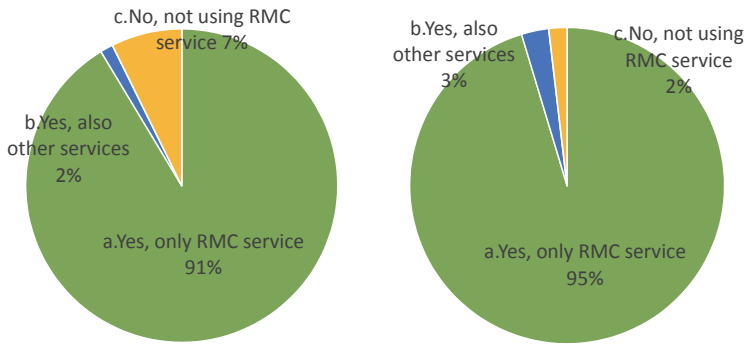


Figure 2-48: Collection service of recyclable items (Left: 200 HHs, Right 143 Commercials)

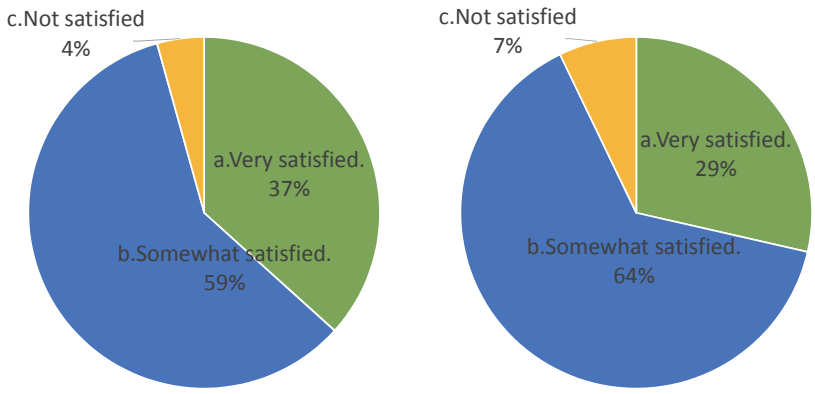


Figure 2-49: Satisfaction level of SWM service in RMC (Left: 200 HHs, Right 143 Commercials)

(2) Waste amount and composition survey (WACS)

Overview of WACS is highlighted in the following table.

Table 2-102: Overview of WACS

Date	28 October 2017, Saturday ～ 5 November 2017, Sunday 9 days in total due to WACS areas consisting night time collection
Place	Kanadola site (combination of compost, MRF and dump site)
Purpose	• To know about separation percentage of biodegradable wastes and non-biodegradable wastes before starting PP. • To know about collection amount in each composition survey area • To know about waste composition by type of waste in each composition survey area
Composition survey area	[Household area] Each of PHI1, 3, and 4 area has a composition survey area. Each area has approximately 60～100 HH. [Commercials] Approximately there are 200 shops, which have night collection services in the city centre.
Type of wastes	2 waste types, biodegradable and non-biodegradable.
Basic principle	• Households discharge designated type of wastes in designated dates as usual without getting special announcement for the survey. • WACS samples at the site are identified by checking vehicle (three-wheeler) number and an interview to driver about collection areas. • All WACS samples from three (3) residential areas are gauged basically. Regarding the wastes from commercial areas on the other hand, at least 500 L wastes are sampled by a consultant expert after measurement of capacities (m3) of collection vehicles (trailer or loading platform) and fill factor (%). • Wastes collected during night shift are sampled at night and analysis starts from following morning.
Collection method	[Household area] Three wheelers are specially arranged for three composition survey areas, and drivers are instructed to collect wastes only from the specific areas. [Commercials] Normal night time collection is conducted on a daily basis for biodegradable wastes (mixed waste), but collection points are observed and recorded by consultant to know about the number of dischargers.

Collection amount per week is shown in the table below. Waste discharge amount per household is estimated as 1.57 kg/ households/ day[10], and those amount per commercial shop is estimated as 6.72 kg/ shop/ day.

[10] From questionnaire survey described in (1), average number of family members per household is 4.17. Therefore, per capita discharge amount of waste is calculated as 0.38 kg/day.

Table 2-103: Discharge amount of wastes for WACS in RMC (29 Oct. – 4 Nov. 2017)

	Area1	Area2	Area3	Area4	Sum (kg)	Sum (%)
No. of household	99	0	54	72		
No.of shop	0	248	0	0		
1.Kitchen waste	340.55	5852.66	328.52	422.64	6944.36	49.38
2.Grass & wood	29.72	976.37	26.83	25.52	1058.44	7.53
3.Paper	109.40	2107.90	39.25	57.11	2313.67	16.45
4.Textile	35.83	203.08	6.54	10.96	256.42	1.82
5.Soft plastic	118.56	1390.61	43.62	52.43	1605.23	11.41
6.Hard plastic	15.51	85.81	16.43	36.05	153.79	1.09
7.Metal	11.19	89.85	21.08	27.41	149.53	1.06
8.Glass	115.65	172.65	69.65	33.92	391.87	2.79
9.Leather & Rubber	2.57	5.30	5.87	20.53	34.27	0.24
10.Ceramic & stone	11.93	17.56	4.68	20.70	54.88	0.39
11.Other	131.15	770.07	115.60	84.37	1101.18	7.83
Sum	922.06	11671.87	678.08	791.63	14063.64	100.00

Result of waste composition is described in the following pie chart. Biodegradable waste (kitchen wastes and garden wastes) consists of 57 %, followed by 17 % paper, 11% soft plastic and 3 % glass.

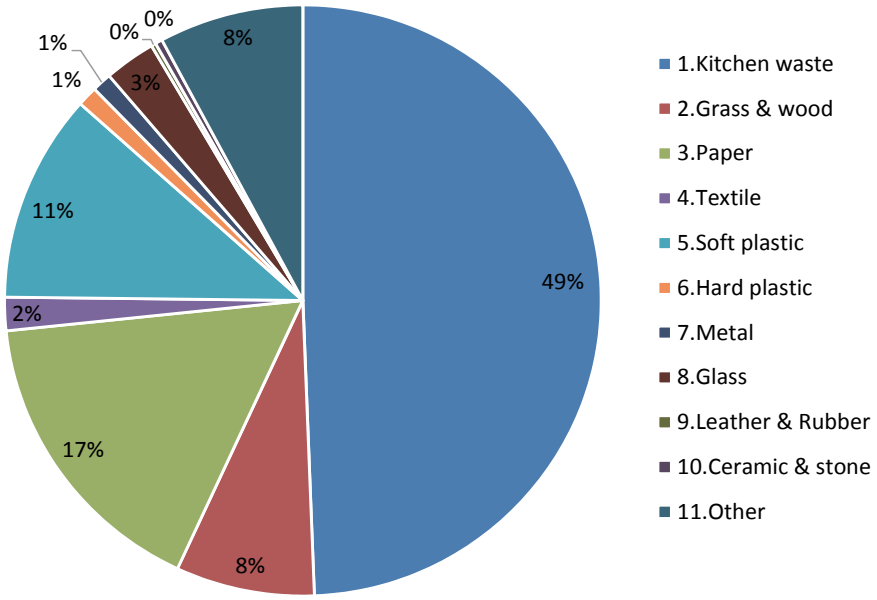


Figure 2-50: Result of WACS in RMC (1)

RMC practices two separation categories: biodegradable and non-biodegradable wastes. The following two pie charts show waste compositions of collected biodegradable wastes from households (right) and commercials (left).

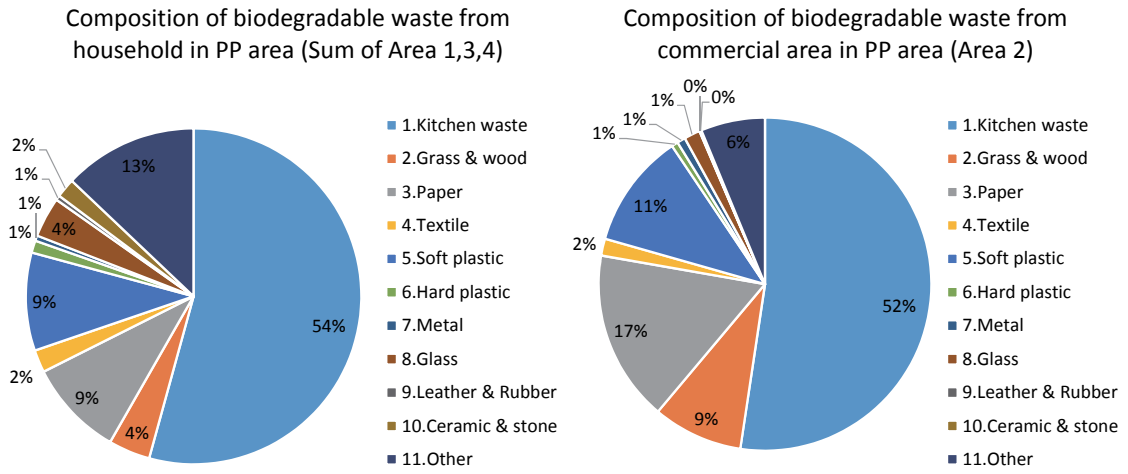


Figure 2-51: Result of WACS (2)

(3) Establishment of monitoring system of receiving amount, amount for intermediate treatment, dumping amount at Kanadola

Kanadola site in Ratnapura MC has a dump site, composting facility and MRF for recyclable items. The site had recorded the number of collection vehicles from RMC but had not recorded the number of private vehicles carrying in waste, the number of loads from other local authorities and night collection vehicles. Also receiving amount and dumping amount were not estimated. To establish monitoring method to find out about such essential waste amounts, the following survey was conducted for a week from 28 Oct. 2017.

- Measurement of capacity of all collection vehicles that transport wastes

- Measurement of bulk density by type of waste
- Measurement of fill factor (%) and training for site staffs for its measurement

Below table shows the result of capacities of collection vehicles and bulk density by type of wastes. Although a compactor was under repair during the survey period, the capacity has been measured and it has been already used at the end of December 2017.

Table 2-104: Capacity of waste collection vehicle and bulk density by waste type in RMC

Collection vehicle		Waste	
Type of vehicle	Capacity (m3)	Type of waste	Bulk density (kg/L)
Tractor (Daytime)	5.01	Mixed waste	0.29
Tractor (Night time)	5.30	Recyclable waste	0.18
Three wheeler	2.04	Biodegradable waste	0.51
Crew cab	2.32	Mixed waste from general hospital	0.49
Compactor		Fish waste and chicken waste	0.51
Tractor (Nivitigara PS)	4.82	Other	0.32
Private (Other than three wheeler)	6.59		

During the survey, bumpy surface was measured by a scale, and fill factor (%) by collection vehicle were recorded. Fill factor (%) was also measured visually by trained staff, so they can continue to measure and record it. However, there is no staff who can observe fill factors of night collection vehicles during the night. Therefore, a week-long survey of the average fill factor of night shift vehicles (6 tractor loads per day) was conducted. The result of which was 78.03 %.

Figure 2-52: Measurement of fill factor

(4) Development of leaflet

At the start of implementation of new separation categories, a leaflet was made. Five new separation categories were introduced by following a Sri Lanka-wide unified rule, and Ratnapupra MC added

'other' categories to minimise unnecessary site separations. The category of 'other' waste are directly dumped into the dump site. Also, the leaflet included information on 3Rs since the abovementioned questionnaire survey showed that many of the public don't know 'what is 3Rs'. Basic principles for the creation of a leaflet and a completed leaflet is shown below.

Basic Principle

- Draw simply with the use of pictures and photos as much as possible, for anyone to understand easily
- Prepare both in Sinhalese and Tamil languages
- Explain separation categories, and use island-wide-unified colour codes prescribed in the guideline.
- Explain the way of discharge, e.g. necessity of cleanliness, or dry condition, separation bins for biodegradable wastes and poly sack for recyclable wastes.
- Make space for descriptions of each wastes' collection date.
- Write down 'Organization' which is Ratnapura MC and 'Inquiry' which is phone number of health department of Ratnapura MC.
- Provide information on the 3Rs

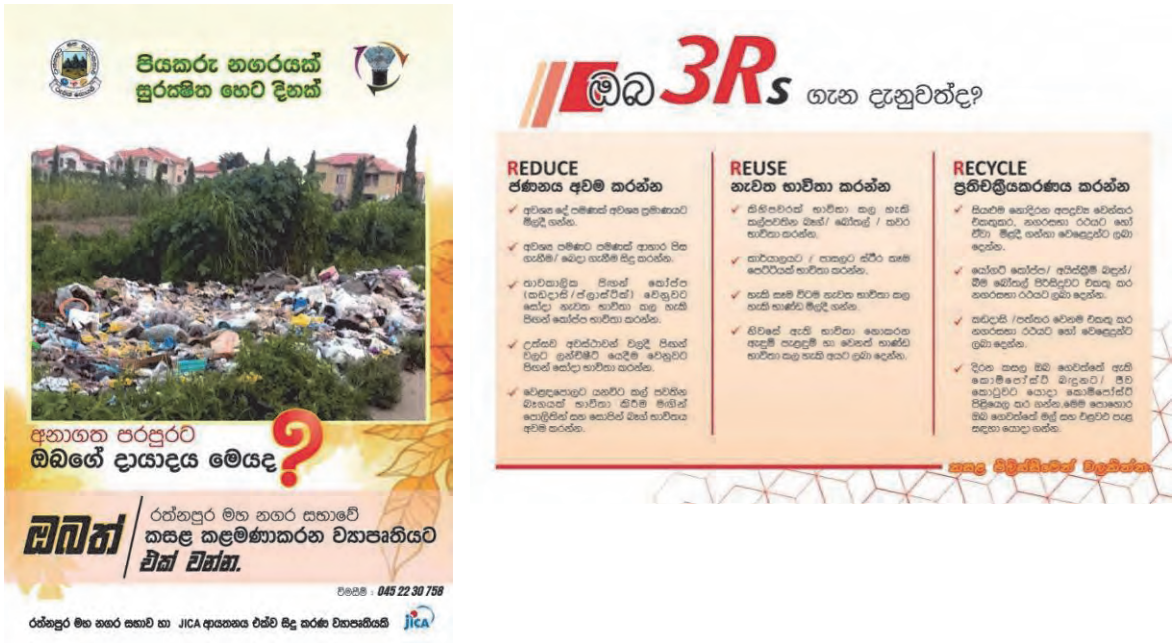


Figure 2-53: Front and back pages of the leaflet of Ratnapura MC

Figure 2-54: Main contents page of the leaflet of Ratnapura MC

(5) Procurement

Table below shows procured items.

Table 2-105: Procured equipment and machinery

	Separation bin	Poly sack bag	Compost bin	Three wheeler
Specification/ Required condition	Capacity: 20L, Colour: Green, Condition: Covered container and well-fitting lid	Size: 50cm x 70cm, Colour: Orange for plastic, Blue for paper, and Red & Brown for glass & metal & coconut shells, Print: Organisation and type of wastes in Sinhalese, Tamil and English.	Height: 1090mm, Diameter: 435mm, Weight: 6.5kg, Thickness:3.5mm, Material: LLDPE[11], No. of holes: 300, Volume: 160L, Condition: Durable	Body weight: 415kg Maximum load capacity: 560kg, Fuel efficiency: 36+/-4km/L, Colour: Green, Maximum power output: 8bhp, Rated speed: 3,600 rpm, Maximum speed: 50km/h
Photo		 Note: Red & Brown		

Progress of procurement is shown in the table below. Purchased three wheeler, for the purpose to expand waste collection of inaccessible areas, has been handed over to Ratnapura MC on 8 December 2017 and plans to be used after installation of a frame on the back.

Table 2-106: Summary of procurement, plan included in RMC

Tools and equipment	Quantity	Unit price (Rs.)	Total price (Rs.)	Suppliers
Separation bin (20L, Green)	3,000	302.50	907,500	Phoenix
Polysack bag (Orange)	3,000	26.18	286,379.24[12]	LN Polysacks (Pvt) Ltd
Poly sack bag (Blue)	3,000	26.18		
Poly sack bag (Red, Brown)	3,000	27.60		
Home compost barrel (160L, Green)	250	4,350	1,087,500	Wayamba Polymers
Three wheeler (Piaggio, Green)	1	540,000	540,000	Associated Motorways Limited
Leaflet	3,000	9.2	27,600	Image Maker
Notice board	35			Image Maker

[11] Linear Low Density Polyethylene

[12] In addition to NBT2% and VAT15%, this price included Rs.5,000 as a transportation fee

(6) RMC staff training

Continuous training for SWM staffs is a key to success of the project. Due to dengue epidemic that had more than 11,000 patients in 2017 in Ratnapura, all the staff working in the health department of RMC were preoccupied with response to dengue programmes and cannot handle the works or have training on solid waste management. To proceed with Ratnapura Action Plan as well as to start awareness programmes in the pilot project, trainings were conducted. Ratnapura MC plans to conduct continual trainings with available resources.

Table 2-107: Record and plan of training programme

Date and Time	Training programme	Trainer	Participant
20 November 2017, Monday, 14:00～16:00	Introduction of Shibushi city model	Mr. Masafumi Tomenaka, Shibushi city, Japan	MOH, CPHI, PHI, Supervisor
8 December 2017, Friday	Training on public communication	Officer, Communication department, RMC	Supervisor or
22 December 2017, Friday, 9:00～10:30	Waste flow, contents of the programme, project target, new separation category with leaflet, awareness programme and awareness record	Dr. Gamini (MOH), Ratnapura MC	Supervisor
22 December 2017, Friday, 10:30～13:30	Introduction of SWM	Ms. Nayana, Project coordinator (local consultant),	Supervisor
26 March 2018, Monday	Training on compost including 1. Basic information of home compost and 2. Monitoring form and monitoring method	Ms. Nayana, Project Coordinator (local consultant), Ms. Yuriko Honda, JOCV	Midwives
26 March 2018, Monday	Training on compost including 1. Basic information of home compost and 2. Monitoring form and monitoring method	Agriculture department, Agriculture Instructor	Supervisor
27 March 2018, Tuesday 7.00 am– 9.00 am	1. Three (3) stages of SWM, 2. Current situation of RMC, 3. Action Plan of RMC, 4. Important role of workers in SWM	Ms. Nayana, Project Coordinator (local consultant), Ms. Yuriko Honda, JOCV	Labour working for Kanadola that has dump site, compost yard and MRF
28 March 2018, Wednesday 9.00 am – 12.00 pm	1. Three (3) stages of SWM, 2. Current situation of RMC, 3. Action Plan of RMC, 4. Important role of workers in SWM	Ms. Nayana, Project Coordinator (local consultant), Ms. Yuriko Honda, JOCV	Supervisor
28-29 March 2018, Tuesday and Wednesday 7.00 am – 8.30 am, evening time for night shift collectors and drivers	1. Three (3) stages of SWM, 2. Current situation of RMC, 3. Action Plan of RMC, 4. Important role of workers in SWM	Ms. Nayana, Project Coordinator (local consultant), Ms. Yuriko Honda, JOCV	Labourers working as waste collectors and drivers


Training done by project coordinator (22 December)

Training on home compost monitoring done by Agriculture Instructor (26 March)

Training done by project coordinator and JOCV (27-29 March)

Training done by project coordinator and JOCV (27-29 March)


Training done by project coordinator and JOCV (27-29 March)

(7) Public awareness programmes

The below table shows the plan of awareness programme for the project.

Table 2-108: Plan of awareness programme

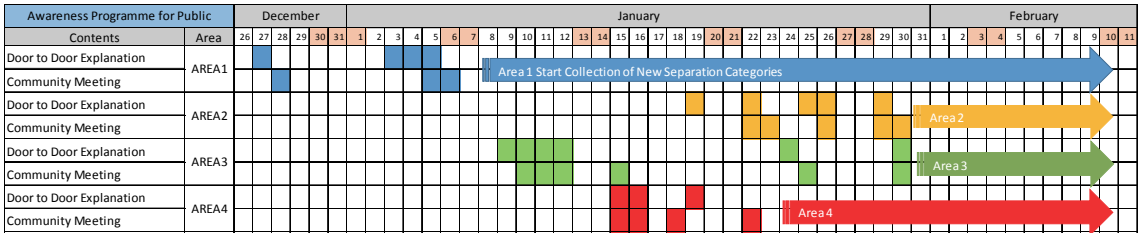
Method	Main player	Object group	Activity	Record
Door to door visit	Supervisors	All households in PP areas	• Explanation and provision of the leaflet • Simple questionnaire and its record in accordance with the checklist (described in "Record" on right). • Simple questionnaire on home compost for only suitable household to make the home compost provision list.	• Checklist consists of the contents if supervisors 1) explained the leaflet, 2) announced date, time and venue of community meeting, as well as understood possibility of their attendance, 3) understood regarding public's collection service usage of biodegradable wastes • Questionnaire on home compost to evaluate eligibility. • Record of questions, comments and complaints about SWM by members of the public.
Community meeting and distribution of necessary equipment	PHIs	All households in PP areas	• Further explanation of the leaflet. • Feedback from questions, comments and complaints regarding new separation or SWM in general from the same area of door to door visit. • Announcement of collection day. • Provision of separation bin and poly sack bags	• Attendance of the meeting • Name list, who received bins and three colour set of poly sacks
Community meeting	PHI, Agriculture Instructor (AI), ReEB Waste Project	Total 250 households in PP areas, who are willing to compost at home	• Explanation of way to use home compost barrel • Provision of home compost bin	• Attendance of the meeting • Name list, who received home compost bin
SWM Awareness Event	Commissioner of RMC, MOH, PHIs,	RMC staff, school children aged	• 1) Introduction of the project and the pilot project, 2) Action	• Attendance of the meeting • Comments sheet

Method	Main player	Object group	Activity	Record
	Supervisors, CEA, ReEB Waste Project	15-16	Plan, 3) Hand over of equipment provided by the project, 4) Awareness activity, 5) Award ceremony of logo and slogan competition • Explanation of new separation categories including group work (mainly contents of the leaflet)	
Workshop for commercial/business people	Commissioner of RMC, MOH, PHIs, ReEB Waste Project	1) Hotel and restaurants, 2) Textile shops, and 3) Grocery shop	• Introduction of ReEB Waste Project • Action Plan of RMC • Progress of the PP in household area of RMC • Waste separation category and waste discharge method • Collection method and time of collection	• Attendance of the meeting

Four (4) PHIs and all supervisors cooperated, starting door to door explanation as well as a community meeting and distribution of necessary equipment from one (1) PP area out of four (4) PP areas. These combination programmes have started since 28 December 2017. Normally 6-8 teams were available, each of which consisted two to three supervisors, visiting 20-30 houses per team per day, and explaining the aforementioned leaflet. At the same time, date, time and venue of community meetings were announced for the residents to receive separation bins and polysack bags in three colours. Four (4) PHIs conducted community meetings in 3-4 different places at the same time, they explained the leaflet again regarding waste separation and collection days for each type of waste. By conducting the awareness plan this way, each PP area was ready to start collection of new waste separation category after receiving necessary tools.

The following table summarises completed dates of door to door explanation and community meeting by PP area, and started periods of collection of 5 separation categories at a waste generation level. As for 16 March 2018, 2291 households have received separation bins and 2440 households have received polysack bags in three colours. Since RMC has already allocated budgets for necessary equipment to expand 5 waste separation categories in the latter half of 2018, the next program can be planned based on the experience.

Table 2-109: Door to door explanation and community meeting to launch new waste separation (From December 2017 to February 2018)



Orientation before starting door to door visit for RMC supervisor including ways for explanation of the leaflet

Explanation of the leaflet by door to door visit

Explanation of program in a community meeting by PHI

Distribution of necessary equipment by PHI and supervisors

Workshop for restaurant and hotel managers

Explanation regarding way of discharge by PHI

(8) SWM Awareness Event

The SWM awareness event was conducted on 20th February 2018. The program includes introduction of a PP in RMC, new waste separation category (5 categories), handover of a three-wheeler and necessary equipment for the project, and certification ceremony of logo & slogan contest. An agenda and contents of the event are shown in the following table. In total 166 participants joined the event, which consisted of 28 from a health department RMC, 26 from a divisional secretary office, 91 Grade8-13 students, 14 teachers and some others.

Table 2-110：Agenda and contents of SWM awareness event in RMC

Agenda	Presenter	Contents
1. Welcome and opening remark	Mr. A.S.J.Godallawatta Commissioner, RMC	• Highlighted following SWM issues in RMC ➢ Fire and smoke occurred early February 2018 ➢ Public awareness in waste separation • Explained the environmental pollution from dumpsite • Described challenges faced for city cleanliness i.e. dog problem, drainage cleaning
2. Current situation of SWM in Sri Lanka	Mr. K.G.P.N.Kiriella, Provincial Director (Sambaragamuwa), CEA office	• The way to manage our household generated waste • Environmental pollution from dumpsites • Effects of inappropriate dumping • 3Rs concept • Amount of waste generated by a person per day • Percentage of degradable to non-degradable waste generated from a household
3. Current situation of SWM in Ratnapura MC	Dr. N.B.Gamini, MOH, RMC	• Current situation of health section in RMC and service provided • Proposed/Upcoming project in RMC • Completed project in Kanadola • Donated buildings, projects from different organizations • Night soil treatment plant • Issues occurred with the fire in Kanadola – health, manpower used and cost spent to control the situation • Composition of generated waste in Ratnapura • Importance of educating students with regards to waste separation • Explanation of how RMC health section is doing their best to manage the waste generated
4. Plan and progress of a pilot project	Ms. Chiharu Iida, JICA ReEB Waste Project	• Creation of a 5-year Action Plan of RMC and explanation of numerical target at the end of the 5-year PP • WACS conducted in 2017 and the result • Preparation to start new waste separation categories, such as procurement, making the leaflet, training, door to door explanation, community meeting and distribution of equipment. • Progress of new waste separation practice at a generation level
5. Handover ceremony	Ms. Rie Tomita, Representative,	• Handover of a key to a three-wheeler, separation bin, polysack bag and compost barrel from JICA to a

Agenda	Presenter	Contents
	JICA Sri Lanka Office	commissioner of RMC
6. SWM Technical System in Ratnapura MC	Mr. Pathirana, PHI, Health department, Ratnapura MC	• Leaflet made by RMC and 3Rs concept • Video – how environment especially flora and fauna is affected by pollution. • Earnings for RMC by selling separated wastes • Amount of wastes separated at Kanadola • Ways to use waste as resources • Current situation in Kanadola site
7. Provision of certification		• Certification ceremony of Logo & Slogan contest conducted in September to November 2017.
8. Waste separation work in Kanadola	PHIs, Supervisor	• Introduction of activities conducted at Kanadola by PHI (which is in charge of the site) • Waste separation group work in accordance with the leaflet under supervision of PHIs and supervisors.

Presentation regarding SWM situation in Sri Lanka by Mr.Kiriella (CEA)

Handover of equipment from JICA to RMC

Provision of certification for Logo & Slogan contest

Explanation regarding function of Kanadola by PHI

Evaluation of the event from other than students is shown below.

Table 2-111: Evaluation of SWM awareness event in RMC

[Suggestion on the event]
- Get support from the media to increase awareness
- Evaluate the households who are doing proper waste separation
- Continue this kind of event in future too
- Give this knowledge to students, government officers and public.
- Conduct awareness programs for private sector, hotel owners, bus stand related officers and private tuition class teachers.
- Give this knowledge to women's associations (female societies).
- Conduct this program under the government sector and volunteer organizations too.
- Increase the number of participants (students) from schools (2).

[Opinion/Request in regards to SWM]
- Give waste separation bins to every institute.
- Arrange a general discharging place for each and every division.
- It's better to collect waste 5.30pm onwards from households. Then RMC can find the responsible person to notify, if there is any problem with the waste separation (most of the people will be available in houses after 5.30pm).
- Conduct awareness for rural areas
- Frequent inspection of road sides
- Take legal actions (fines) against the public and institutes those who are not doing the proper waste separation (2).
- Need a proper collection system for degradable waste in commercial areas and from temples.
- Install CCTV in problematic areas.

[Next topic request if any]
- E-waste management and need to know what will happened to collected e-waste (2)
- Identified problems when conducting a project like this and how to avoid them
- Important to share ideas from a farm family who has succeeded using compost.
- How to do the recycling within the household?
- How to do the waste separation practically, in schools?
- How to do the composting in schools?

[Other comments]
- Need to improve waste separation in schools according to this method.
- Need to conduct a practical session in each and every school.

(9) Distribution of home compost barrels and decision of monitoring plan for home compost

One of objectives of the project is to reduce waste discharge amount, so that RMC wants to increase percentage of home compost from a current rate of 6% to 10%. RMC identified 250 households in four (4) PP areas and distributed 250 compost barrels, to those who are willing to compost at home with sufficient space, and/or households for whom it is difficult to receive waste collection service due to inaccessibility of collection vehicles.

Table 2-112: Distribution of Home compost barrel

Area	Area1	Area2	Area3	Area4
Name of PP area	Batugedara	Town	Kospalawinna	Muwagama
No. of distribution	48	32	90	80

Following information was given by Agriculture Instructor (AI) to households who received home compost barrels.

Table 2-113: Information given to households who received home compost

Items	Information
Installation place	• It is better to install away from a kitchen to avoid bad smell and insects. • Shaded area is better to avoid rain
Layout of wastes	• Make layers of food waste: dry leaves = 3: 2 in volume. • Add animal manure if it's available.
Size of the waste	• It is better to make it small • Chopping or cutting of food waste or dry leaves are not needed.
Bad smell	• Large amount of coconuts powder may cause bad smell from coconuts oil. Oil also damages microorganism. • Initially it smells, so try to avoid close to a kitchen. *Check 'Installation place'.
Insect	• Always close a lid not to attract fly. • Sufficient temperature* is a key to avoid insects. *In case it does not have enough temperature, check 'Layout' and 'Moisture level'. Also, check if halls are open to get aeration.
Moisture level	• Use a stick to check moisture level. If the stick is wet when going down to the bottom, it is fine because water is going out from the barrel anyway. If the stick is dry, water has to be added. *Check 'Installation place'.
Demarcation with Jeewakottu	• Since decomposition is helped by soil microorganism, decomposition speed is higher in using a Jeewakott than a compost barrel. • Recommend to use a Jeewakott for dry leaves mainly, and a compost barrel for kitchen waste and dry leaves*. *Refer to 'Layout'
Safety	• Convey positive perception of the benefits of organic compost such as using it to grow plants instead of chemical fertiliser.
Economic efficiency	• Save around Rs.20 / kg if compost is made from the waste.

Explanation of home compost by AI

Discussion regarding monitoring method

	
Register for the use of home compost barrels	Distribution of home compost barrels

Monitoring form was decided based on discussion with AI and PHI At the beginning, once a month monitoring is planned, gradually reducing this to every two months or every three months. On the other hand, it is necessary to monitor frequently for those who have trouble.

(10) Collection and transportation plan

Creating collection and transportation plan is one of the most important and careful changes under this project. Basically, since no additional collection vehicle is available, remodelling of trailer such as installation of petitions or big collection bins and adjustment of the collection routes are required. Figure below shows the example of current tractor coverage route on daytime Monday. Currently collection and transportation is planned not by PHI area, but by covering whole MC area, and is mainly managed and maintained by three supervisors. The four areas surrounded by black lines (in the following map) are the four pilot project areas, from which routes of some tractors have to be changed to collect designated wastes only from pilot project area or non-pilot project area. Creation of a collection and transportation plan is currently under discussion.

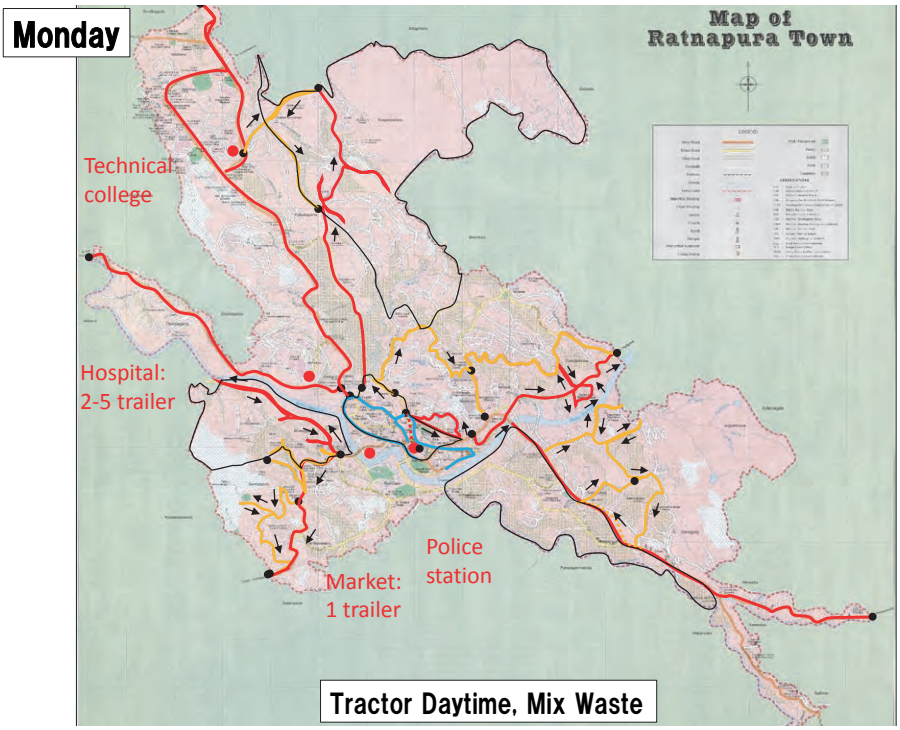


Figure 2-55: Mixed waste collection route map (tractor, Monday)

Figure 2-56: Recyclable waste route map (one three wheeler)

Frequency of waste collection and type of vehicle for biodegradable and non-biodegradable wastes are summarised in the table below.

Table 2-114: Frequency of waste collection and type of collection vehicle

	Biodegradable waste	Non-biodegradable waste
Collection frequency	3 times /week due to the necessity	Once a week (Twice a week in town area only) • Week 1 & 3: Plastic, Glass and Metal in Area 1-3, Plastic and paper in Area 4 • Week 2 & 4: Paper and other wastes in Area 1-3, Glass and Metal and other wastes in area 4
Type of collection vehicle	Tractor/ Compactor/ Three wheeler	Crew cab/ Three wheeler

Collection amount by type of waste in each PP area is expected from WACS result.

Table 2-115: Expectation of waste collection amount per collection in each PP area

			Batugerdara Area 1	Town Area 2	Kospalawinna Area 3	Muwagama Area 4
Biodegradable waste		Amount (kg)	360.5	2346.3	2292.0	1590.1
		Type of vehicle	Tractor, Three wheeler	Tractor Three wheeler	Tractor Three wheeler	Tractor Three wheeler
Non-biodegradable waste	Week 1 & 3	Amount (kg)	1524	6671	5835	2126
		Type of vehicle	Three wheeler	Crew cab Three wheeler	Crew cab	Crew cab
	Week 2 & 4	Amount (kg)	1699	3706	4087	1780
		Type of vehicle	Three wheeler	Crew cab Three wheeler	Crew cab	Crew cab

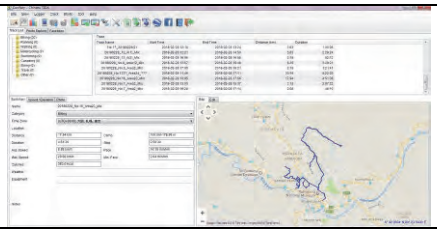
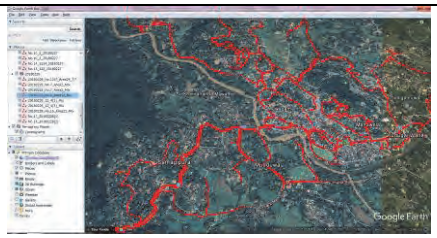
As shown in the previous section, collection and transportation routes are not managed by unit of area, so it was necessary to revise collection and transportation plan for drivers and collectors in a less confusing manner.

Although currently waste is not collected from 100 % of households, there are areas in the PP areas, where RMC has newly started waste collection service. Three wheelers were dispatched to parts of the pilot project area 1 and 4 to collect biodegradable wastes, where a tractor could not access because the areas do not face main streets or are located in a hilly area. Monitoring result of waste collection and transportation is described in the monitoring section.

(11) Establishment of monitoring system of waste collection and transportation by GPS.

Monitoring of waste collection and transportation with the use of GPS was established for the purpose of improving the collection and transportation plan and to find out and take action on pocket areas which had not received waste collection services for a while. At the moment, 17 collection vehicles working during day time are monitored once a week and evaluated if those vehicles are going to designated routes and collecting waste from each designated area, and also if a collection and transportation plan made by RMC is sufficient to cover the necessary areas. This monitoring system is planned to be conducted twice a week, so that action is smoothly taken for identified non-collection areas. Also, GPS monitoring finds out that some three wheelers which are collecting wastes far away from Kanadola site take a long time to transport, although waste load capacity is not that big. Therefore establishment of a waste transfer station is potentially discussed for efficiency of waste collection and transportation in RMC.

Table 2-116: GPS monitoring system

Person in charge	Operation	Photos
Three (3) supervisor	• Tick the attendance sheet of drivers (Form 1) for confirmation of waste collection areas and types of wastes. • Submit Form 1 to Data handling officer on Monday after morning registration.	
↓		
Drivers	• Record collection route by trip • Pass a GPS to Data handling officer at the office on Monday evening or Tuesday morning.	
↓		
Data handling officer	• Download GPS data and return a GPS to driver. • Rename and export the data to Google Earth • Waste type must be added in the file name, so that Data evaluator (PHI) can understand if the collection services are properly covered.	
↓		
Data evaluator (PHI)	• Check if waste collection service was provided as planned in a previous week. • Check if there is no issue in a route plan. • Categorise issues if urgent actions are required or mid and long term actions are required. • Take action for urgent matter. • Take action for mid and long term actions.	

(12) Making notice board

A notice board was created responding to the following matters. Therefore, the notice board will be maintained by each area supervisor every month, and has to be updated to show actual collection dates by inserting 'collection date' cards. The notice boards will be installed in the following locations.

- There are households in PP areas, of which waste collection days have been revised.

- It is not easy for most of the public to understand the description of 'week 1 & week 3 of day'

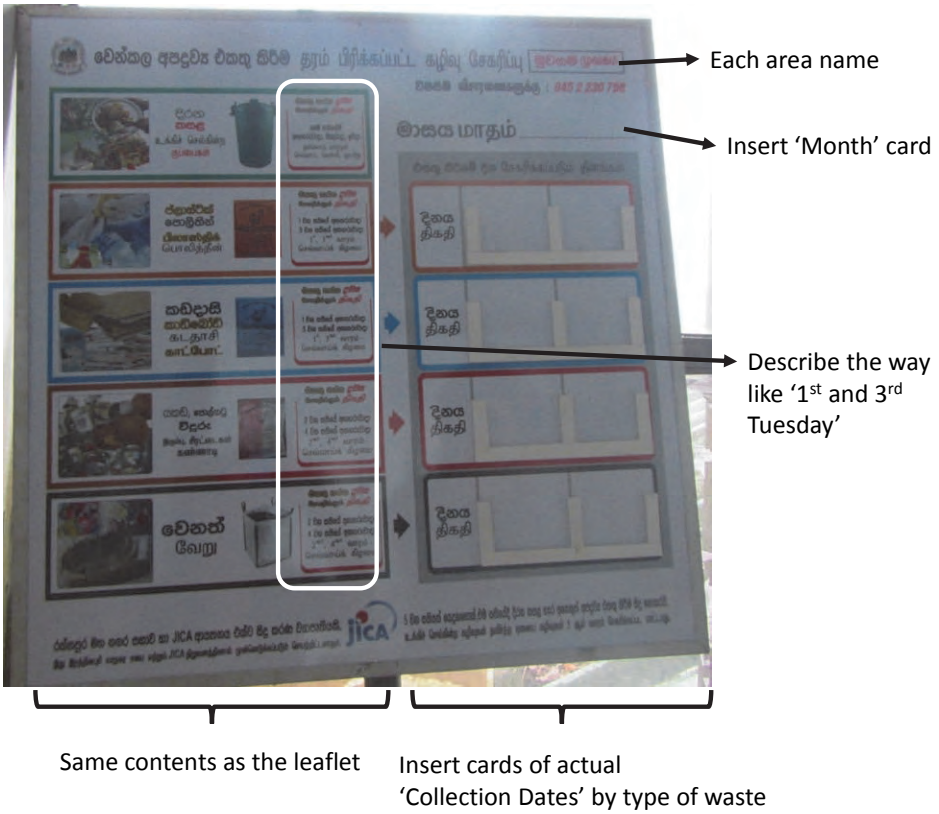


Figure 2-57: Notice board (bigger size: 90 cm x 120 cm, smaller size: 60 cm x 60 cm)

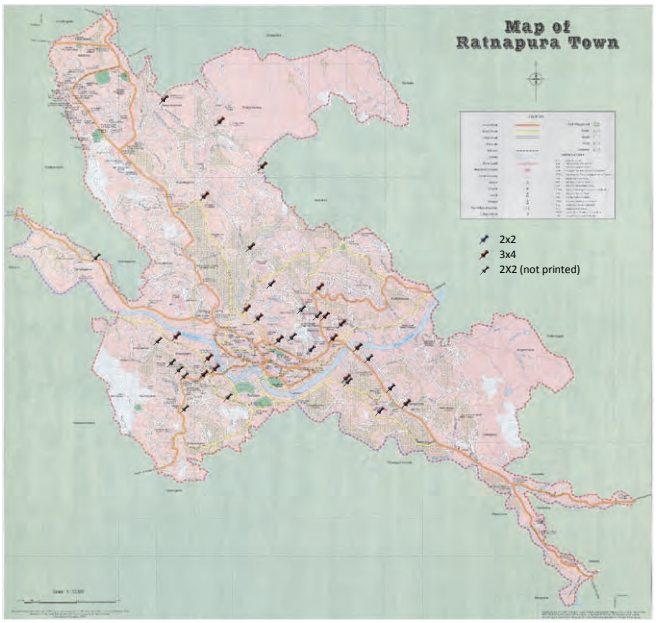


Figure 2-58: Location of notice boards installed (Bigger size: 3 x 4, Smaller size: 2 x 2)

(13) Improvement plan for intermediate treatment facility

Although Kanadola site had two windrow compost yards that had been expanded by Pilisaru fund in 2016, the yards were being used as a material recovery place and stock yard of those recovered items as of October 2017.

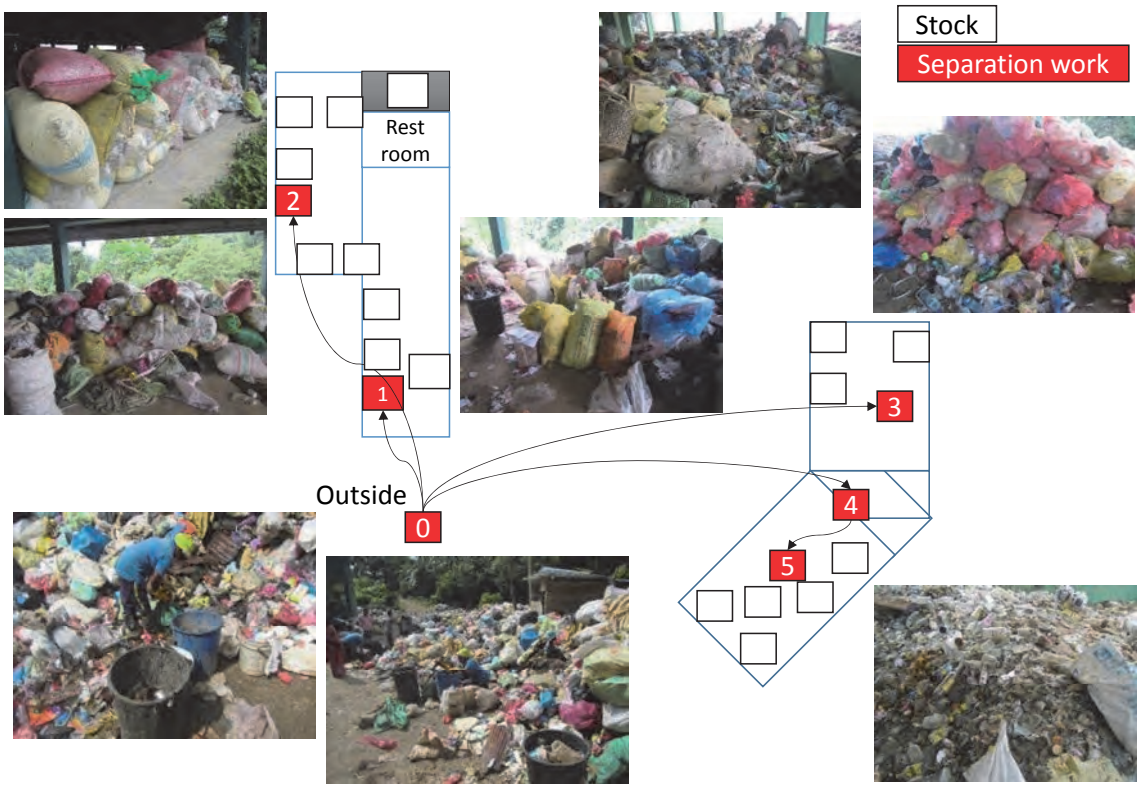


Figure 2-59: Utilisation situation of windrow compost yards and MRF (October 2017)

Ratnapura MC collects approximately 20 tons of biodegradable wastes every day. However, out of the 20 tons, only about 2 tons per day of biodegradable wastes from a market are used for composting in a boxed compost system. Since Skid-Steer Loader, Bobcat, is available in Kanadola, compost production in windrow system is an urgent issue.

Below shows the size of windrow and plan of facility usage. Volume of the windrow is 11.2 m^3, which accommodates 5.71 tons of biodegradable wastes if bulk density of biodegradable wastes is estimated as 0.51 kg/L. Decomposition speed and turning schedule need to be investigated, but basically the two

windrow yards will accommodate 3.5 tons of biodegradable wastes every day, which is then shifted to the maturation yards after at least two months of composting.

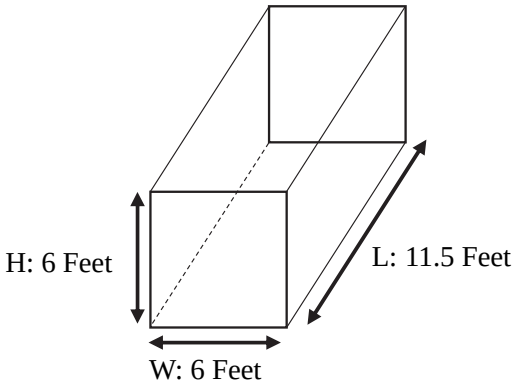


Figure 2-60: Size of windrow

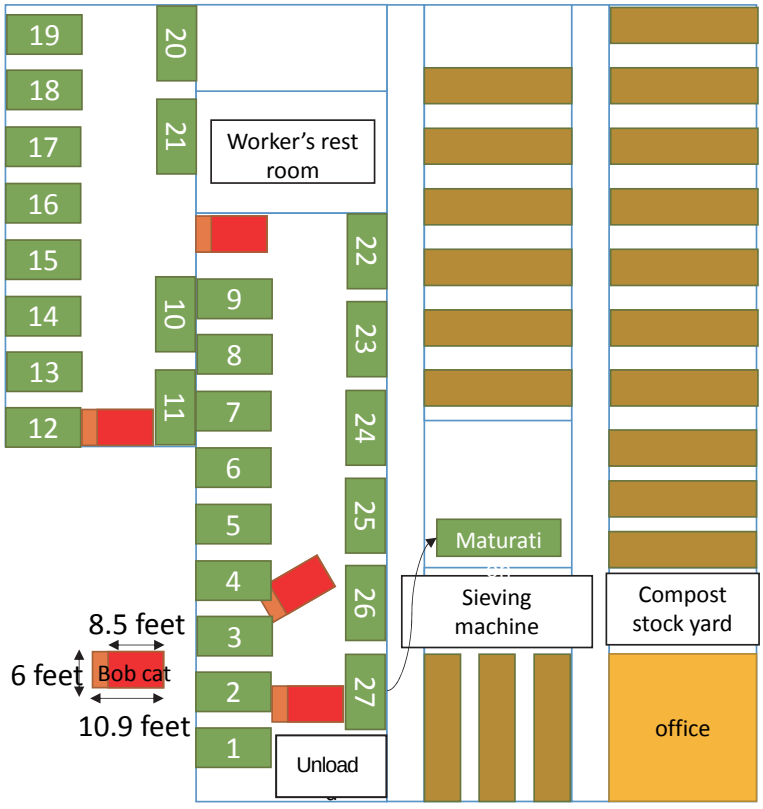


Figure 2-61: Design of windrow compost yard (Right: Boxed system, Left: Windrow system)

(14) Information board installed in Kanadola site

An information board installed in Kanadola site which consists of compost site and MRF was made in September 2018. Following figure shows the design of information board.

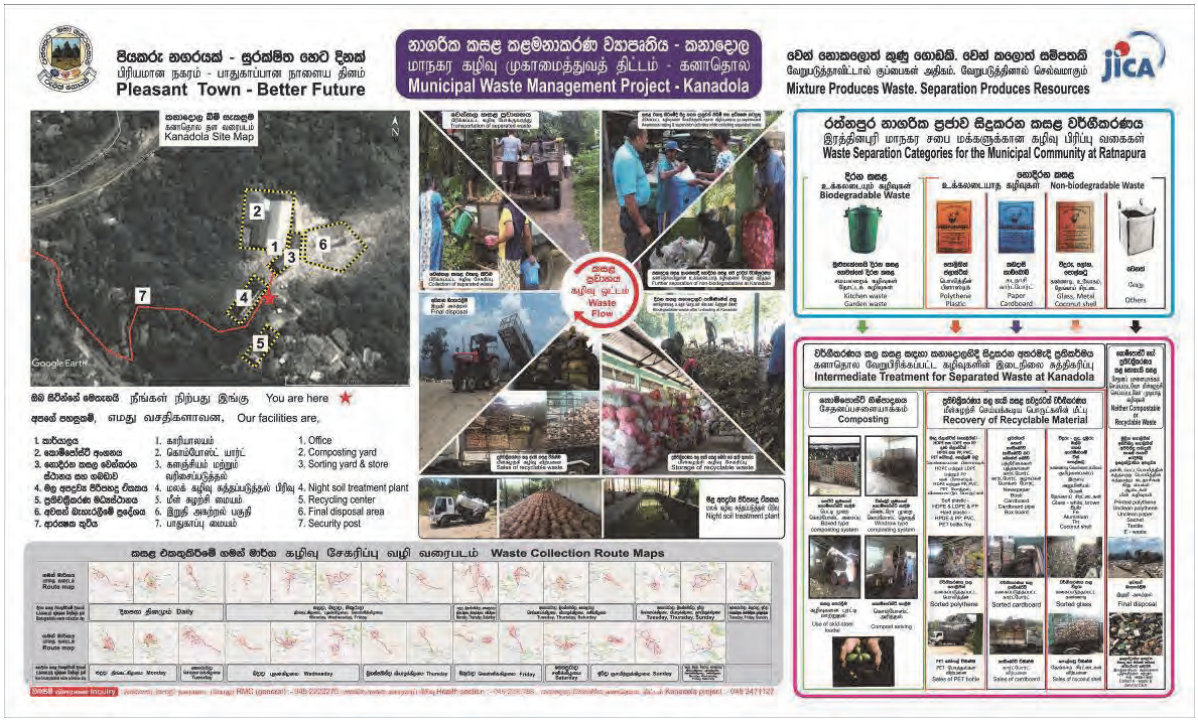


Figure 2-62: Information board installed in Kanadola

2.13.2 Kataragama PS

(1) Objectives of PP in KPS

As described earlier (2.10.2.2 Basic Plan), the objectives of the PP to be implemented during this Project is "Separation of recyclables to be more neatly conducted" at hotels, guesthouses and tourist places that are entry points for tourists and pilgrims.

(2) PP target areas

Zone 3	• Hotels/guesthouses, 2 markets near two major dewales. • KPS distributed a total of 200 compost bins in 2016 only to half of each of these zones. The other half are yet to receive bins, thus, the remainder will need distributing in future.
Zone 4	• Hotels/guesthouses (including government circuit bungalows), close to the centre of the town • KPS distributed a total of 200 compost bins in 2016 only to half of each of these zones. The other half are yet to receive bins, thus, the remainder will need distributing in future.

(3) PP Implementation method

a. Method

As Step 1 of PP, the period of 4 months starting from September 2017 was planned as a time to fully establish the 2-separation system where organic waste and other wastes would be separated. After the 2-separation system had become established in the target community, Step 2 was to start introducing separation of recyclable wastes, materializing fully the 6-category separation which has been once informed to the public by KPS through distribution of leaflets and other activities. Meanwhile, from the time of Step 1, composting at discharge sources will also be promoted.

However, as of December 2017, there has been a great delay due to the emergence of various challenges (described later) since the start of the 2-separation system. Therefore, the implementation period of Step 1 will be changed to end in later half of April 2018 after Sinhala & Tamil New Year, from the initial "4 months" ending in December 2017.

Furthermore, 6-category separation in Step 2 is currently under review, and there is a possibility to make it 3-category separation, namely: "Organic waste", "recyclable waste (which KPS can deal with)" and "other waste".

On the other hand, a burden on waste transportation schedule has become noticeable if organic waste collection would be carried out 7 days a week as initially agreed during the planning of PP, while the actual status of waste collection services in the entire KPS service area becomes more and more evident. The collection schedule will also need to be reconsidered after examining the collection routes in the entire KPS area.

b. Indicators

- Indicator to measure impact of PP on separation of bio-degradable waste

  i. Amount of bio-degradable waste measured at landfill site

  At the time of planning of PP in July 2017, our understanding was that only the waste separated and discharged as "bio-degradable waste" and "recyclable waste" by the dischargers were collected to

KPS Resource Centre and other wastes were transported to the final disposal site without any treatment. However, KPS revised their collection method on their own after the PP planning and all collected waste transported by all KPS vehicles are now first transported to the Resource Centre and offloaded for separation of bio-degradable and recyclable wastes before the "residue" is transported to the final disposal site.

Therefore, to maintain this separate transportation of "(compostable) bio-degradable" and "other waste" in Step 1 of this PP, the indicator will be the ratio of "bio-degradable waste" included in "other (mixed) waste"

The data of pre-PP is as shown below (Refer to *(4) d iv*).

Table 2-117: Ratio of bio-degradable waste included in "other waste"

Zone	%
Zone 3	44.1
Zone 4	45.06
Total of Zone 3, 4	44.44

ii. Amount of bio-degradable waste measured at the Compost Site

The ratio of the "compostable bio-degradable waste" separately transported to KPS's Resource Centre (in relation to the entire collection amount) will be measured.

The data of pre-PP is as shown below according to the WACS conducted in October (Refer to *(4) d iv*.).

Table 2-118: Ratio of the waste amount separately brought in as "bio-degradable waste" included in the entire collection waste amount

Zone	%
Zone 3	18.0
Zone 4	34.3
Total of Zone 3, 4	24.5

iii. Ratio of residents practicing composting measured by POS

In the POS conducted in May 2017, 26 dischargers out of 34 in Zone 3 were practicing home composting, while in Zone 4, there was no dischargers among the 21 surveyed who were doing so.(Table2-52)

- Indicators to measure the impact of PP on separation of recyclable waste

i. Amount of recyclable waste measured at the landfill site

As per the baseline data, the ratio of recyclable waste amount included in the waste brought in to the Resource Centre as "other waste."

ii. Amount of recyclable waste measured at the Resource Centre

The ratio of "recyclable waste" correctly separated as "recyclables" and brought in to the Resource Centre.

(4) Implementation activities of PP

a. Waste separation within KPS office

In cooperation with JOCV attached to NSWMSC, the waste separation was firstly undertaken within KPS office.

i. Objectives

KPS staff themselves would find out possible ways of clearly describing the process and concept of separation in the leaflet (to be distributed to residents) or in methods of notification necessary to make people put the 5-category separation (5 recyclable wastes excluding the "other waste") into a practice. This leaflet was distributed by KPS in June 2017 (Figure2-18).

ii. Method of implementation

The JOCV explained the contents of the leaflet to the entire KPS staff, and placed two sets of waste bins for 5-category separations in and outside of KPS office building.

From left, "paper", "plastic", "metal", "degradable", "glass", "food waste"

Figure 2-63: the set of separation bins placed outside of KPS office building (near its entrance)

iii. Considerations

Table 2-119: Problems and Improvements regarding 3Rs of KPS

	Problems	Improvements
1	It was difficult to find within Kataragama the bins in all colors designated in the leaflet（KPS used the bins in colors which could be found in Kataragama market, with labels attached with the category of waste)	Necessary to plan thoroughly how to deliver the bins in colors, shapes, and sizes that are difficult to find in nearby market.
2	Some people may not be able to understand/read the labels written in Sinhalese.	ReEB presented an example of Japanese waste bins placed in public places, which often indicate the separation categories with illustrations  KPS will also use illustrations on labels to visibly indicate waste category for a separation bin.
3	Waste discharged outside of the building were seldom discharged to separation bins nor separated well, even though the citizens coming to the building were also encouraged to do so.	In a public space, waste bins suitable for the specific kinds of wastes that are likely to be discharged in the particular location should be installed.
4	Confusion over the duplicated categories among ”degradable” “food waste” and “paper” (it is commonly understood in Kataragama that paper is “degradable”)	Definition of each category of waste should be clearly indicated.
5	Instructions given in the leaflet uses different colors in illustration from what is indicated in the written labels, or color coding indicated in the leaflet is different from the actual colors of bins.	Rules should be discussed well during planning process so that the informed contents and the implemented contents will not differ from each other.
6	The function of KPS building is more for administrative works, and the “degradable” waste generated there includes only paper or the leftover from lunches. (As for drinks, it is a common practice in Sri Lanka that each individual has their own bottle filled with water ready at their desk.) Therefore, for the inside of the office building of KPS, separate waste bins only for food waste are eventually placed.	It is more efficient to place separation bins suited to the kinds of waste discharged at the location.
7	At the compost site of KPS, currently paper (except for cardboard), food waste, and garden waste are all composted. Therefore, even if these wastes are separately discharged, they are eventually combined for processing.	Considering the treatments provided at the intermediate and final disposal facilities, categories of waste separation should be decided so that the citizens and KPS both will not take steps in vain.

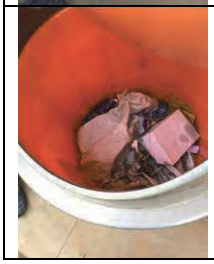
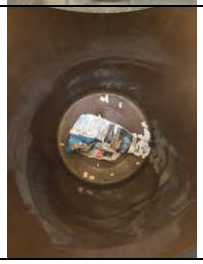
Paper	Polythin* (*referring to Plastic)	Metal	Degradable	Food waste
				
				No food waste discharged on this day.

Figure 2-64: Contents of separation bins placed outside of the KPS building (Oct. 2, 2017)

b. Logo & Slogan Contest

i. Objectives

- To disseminate knowledge, create buy-in and bring attention to the issue of 3Rs and to the Project, in order to make 3R a participatory activity,
- To visualize the relevancy of a series of 3R activities to be implemented under the PP by using a common logo and slogan.

ii. Method of Implementation

The JOCV made a presentation at four schools in KPS and Sunday religious class at temples to explain the background of the project and 3R, and called for participation in the contest.

To the general citizens, participation in the contest was called for through posting on the notice board at KPS. Government institutions within KPS were also informed.

The leaflet on the contest was distributed at the above-mentioned meetings, but the number of copies previously printed was not sufficient and it was instructed to the children to come and collect a copy from KPS.

iii. Result of the Contest

In response to the distribution of about 200 copies of application forms, 22 applications were received. The selection was conducted at CEA head office in Colombo upon request from KPS out of fairness to all applicants. The Director of Waste Management, Assistant Director from CEA Monaragala, and a local staff and a Japanese consultant of ReEB participated in the selection. Five best works were selected for logo and slogan respectively. The best ones (shown below) were the logo submitted by a 13-year old student, and the slogan submitted by a KPS staff. The logo illustrates a town where people are collaboratively carrying out waste separation, surrounding circles in colors indicating different religions and ethnicities, is embraced by a peacock symbolizing Kataragama. The Tamil and English translation of the slogan originally in Sinhalese were done by ReEB and agreed by KPS.

කදදෙවි පුරවරයට
සුපිරිසිදු හෙට දිනක්

கந்தனின் நகரம்
தூய்மையின் சிகரம்

Clean Tomorrow
for the City of God Skanda

Figure 2-65: Selected logo and slogan

iv. Awarding ceremony

On 19th October, about 400 students were gathered at the City Hall in KPS and the awarding ceremony was conducted for the logo and slogan contest. The ceremony was attended by a Japanese consultant and the JOCV from ReEB. Certificates, plaques and books were awarded to all runners-up, while all applicants were also recognized with a certificate for participation.

c. PP-Step 1: Preparation for implementation of 2-separation (separation of bio-degradable waste)

i. Development of a leaflet

In KPS, separation of bio-degradable waste had been initiated even before the start of the Project, and their collection trucks are equipped with a partitioned loading bed. However, separate discharge by dischargers had not been fully practiced. Therefore, a leaflet was developed to make dischargers aware of "what are categorized as bio-degradable waste" and "how the separated bio-degradable waste is utilized" once again, and distributed to the discharges in the targeted Zone 3 and Zone 4. The number of copies printed was 400, and about 200 copies have been distributed.

For developing the leaflet, ReEB prepared the first draft and had discussions over it with the manager of the compost site and KPS officials to finalize it.

Figure 2-66: Awareness leaflet for Separation of Bio-degradable waste prepared by KPS

A4 folded into three. (First page (left) Waste to be discharged as "bio-degradable", (middle) Waste not to be included in "bio-degradable" (indicating those that are not composted at the KPS compost

site), (right) Waste to be discharged as recyclables. Second page (left) introduction of home-compost, (middle) "Composting and Separation of Bio-degradable waste", (right) Introduction of processes at the Compost Site, explaining that the waste brought in needs to be separated for better work efficiency and quality of compost.)

ii. Discussion for procurement of waste bins by cost sharing with citizens

Picking up the momentum of the awarding ceremony of the logo and slogan contest, a discussion was held to explain the current status of bio-degradable waste separation and planned activities based on the contents of the new leaflet with participation of 10 dischargers from Zone 3 and 4 (owners of hotels and guesthouses) on October 25, 2017. During the meeting, an experiment was done to make the participants aware of the merits of waste separation. This involved a group of participants being asked to separate waste that they had discharged without separating and another group were asked to separate their waste and discharge to waste bins separately categorized by waste kinds.

The participants voiced their cooperative opinions for separately discharging waste to the waste collection services, while pointing out the challenge of enforcing the separation rule and gaining the cooperation of guests for separating waste. During the discussion, there was a unanimous proposal from the participants "to use standardized colour coding of waste bins throughout Kataragama to make it more recognizable to all visitors from outside including pilgrims and tourists, and that they are prepared to purchase the waste bins designated by the PS for the purpose."

Following this proposal, discussions were carried out with KPS on "procurement of waste bins by sharing cost with citizens (dischargers)", and another meeting with about 50 residents from Zone 3 and Zone 4 was held on November 14, while KPS secretary, DO, and their field staffs were present. The participants included about 10 residents from households in Zone 4 other than business owners.

At the meeting, after explaining the separation of bio-degradable waste, the samples of waste bins in different sizes of 20L, 40L, and 60L with lids were shown to help identify the necessary sizes of their waste bins and to ask their willingness to pay for purchasing one.

	
Community meeting held on 25th October	Community meeting held on 14th November

The owners of hotels and guesthouses have a willingness to pay up to 500 rupees per a 40L-durable waste bin with a lid (a commonly available one would cost about 800 rupees and a durable one would be about 1500 rupees in market prices), while household residents have a willingness to pay up to 250 rupees per 20L waste bin with a lid (a commonly available one would be about 800 rupees).

		
40L bin available at about 800 rupees	45L bin available at about 1500 rupees	20L bin available at about 800 rupees

iii. Procurement of separation bin for bio-degradable waste

In Progress Report (3), it was reported in detail that there has been a delay in procurement of about 150 separation bins to be purchased by KPS, which were supposed to have been distributed to Zone 3 and 4 before the end of December. By mid-March, they remain undelivered. The progress so far is summarized in the following figure.

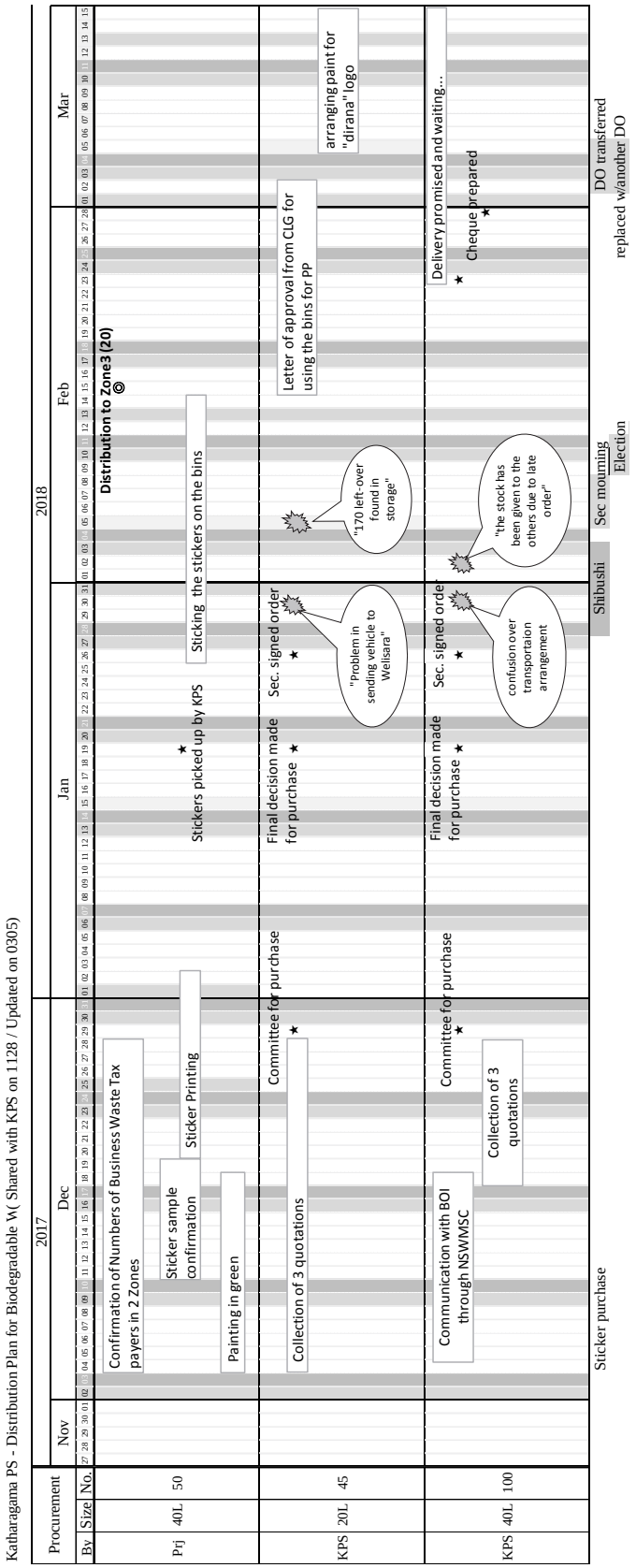


Figure 2-67 Progress of Bio-degradable waste separation bins procurement in KPS

Fifty 40L bins which ReEB Waste had procured in early December were prepared with necessary stickers by early February, and they were distributed to businesses in Zone 3, one of the PP targeted zones.

On the other hand, 20L bins are still to be procured by KPS and distributed to general households in Zone 4. In early February, it turned out that KPS had 170 of the same kind of bins in the storage of KPS. They were the bins provided by the Commissioner of Local Government (CLG) in 2014. KPS requested to utilize these bins for the current PP, and CLG gave their approval to do so. By mid-March, they were prepared with stenciled illustration of "degradable waste" and PP logo sticker, and were ready for distribution. The delivery of the 40L bins to be procured by KPS had been postponed repeatedly by the supplier, however, they finally arrived on 6th April. The supplier was not charged any penalty for this delay in delivery.

d. PP-Step 1 : Introduction of 2-Separation (separation of bio-degradable waste)

i Distribution of Bio- degradable Separation Bins to Zone 3

Out of Zone 3 and Zone 4 targeted under the PP, Zone 3 has about 50 business holders as the targets of our PP including hotels, guesthouses, and restaurants. On the other hand, Zone 4 targets include general households, and they will be provided with a smaller 20L separation bin for bio-degradable waste. Moreover, business entities in Zone 4 exceeds 80 in number. Therefore, they've given up trying to distribute all separation bins to both zones at the same time, and it was decided to distribute the 50 40-L bins procured by ReEB Waste firstly to Zone 3 on 15th February 2018.

As agreed previously, KPS would receive 500 rupees per bin as the discharger's share of cost, issue a receipt in return, and record the beneficiaries' information. For carrying out these tasks, the appropriate venue of distribution was decided to be KPS. This explanation was included in an invitation letter for the distribution day prepared by KPS, and their field coordinator and ReEB Waste members handed it over to each target business entity on 13th February.

On the day of distribution on 15th February, the Secretary of KPS and ReEB Waste explained the

background of the PP, the current status of waste management in Kataragama and its resulted necessity for separation of "bio-degradable waste". Zone 3 has hotels, guesthouses and restaurants as the PP targets. The list of the targets prepared earlier by KPS included 48 business entities that are subjected to waste tax, and they were given the invitations. However, the number of business holders that showed up on the distribution day was only 20.

Through the monitoring activity being carried out by KPS field coordinator and ReEB Waste, two more businesses came to KPS to purchase the separation bins. KPS hopes that once the initial few businesses utilize the bins effectively, further cooperation might be obtained.

	
Field coordinator (2nd from right) and ReEB explaining the purpose while handing out the invitation for separation bin distribution.	Separation bins painted in green, placed with "degradable" illustration and logo stickers.
	
KPS secretary explaining the background of the PP and his observation about community cooperation in Japan.	ReEB Waste shared the result of WACS to explain only a half of available bio-degradable waste is being separately collected and the rest is merely dumped without being composted.

	
Business owners paying Rs.500 per bin and receiving a receipt.	KPS official and ReEB Waste handing over the bin to a business owner (center on the right).

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ii Distribution of Bio- degradable Separation Bins to Zone 4

For Zone 4, the plan was to distribute 45-L bins to guesthouses and restaurants and 20-L bins to general households. Both types were to be procured by KPS, but it was found that many 20-L bins of the same type had been kept unused in KPS' storage, and they were going to be utilized for the PP with permission from ACLG (Assistant Commissioner of Local Government) who initially distributed them to KPS. Initially one third of the price to purchase a bin was to be born by the discharger, but it was decided to ask for only 150 rupees per bin because the product to be given had been kept in storage for several years.

Distribution of them was organized on 29th March at a preschool of Mallikarama Buddhist temple located in Zone 4. Thirty –nine (39) bins were handed over on the day, and five (5) more bins were handed over at KPS afterwards to the residents of Zone 4. At the time of distribution held at the temple, an awareness programme was conducted for the residents as well as to preschool children and their parents. As an awareness programme, a simple game was conducted by preschool teachers to teach the kinds of waste using picture cards, following a prior discussion conducted with the teachers. There are many non-Zone 4 residents among the parents of the children, but the waste discharged at the temple (which is within Zone 4) had not been separated well. The parents being among the dischargers of such waste would need to be informed about separate discharge to change the manner of waste discharge at the temple. KPS also facilitated painting of the temple's existing waste bins green and affixing "degradable" illustrations on them, to help ensure the discharge of

waste at the preschool follows the rules.

KPS Development Officer opened the event at the preschool's hall filled with parents and children.

ReEB Waste members introducing the newly painted and "degradable" labelled waste bin at the temple.

Preschool teacher explaining the rules using "degradable waste" picture cards.

Resident of Zone 4 receiving 20L bin for bio-degradable waste from KPS' field coordinator for Zone 4.

Meanwhile, the procurement of the 45-L bins to be distributed to guesthouses and restaurants in Zone 4 took time as described earlier, and were finally delivered to KPS on 6th April. Sinhala-Tamil New Year and Vesak Poya holidays followed this and issues with purchasing paint by KPS meant the bins would not have been ready for distribution until the 28th May. After informing the targeted recipients about the bins and conducting an awareness programme, the distribution was re-scheduled for the 7th June and 15 businesses received the bins on that day.

Table 2-120: Distribution of KPS Bio-degradable waste separation bins (Distributed number/prepared number)

Targeted Recipients / Type of Bin	Zone 3	Zone 4	
	Hotels/Guesthouses/ Restaurants	Hotels/ Guesthouses/ Restaurants	General Households
45 L	25/50	15*/32	0
20 L	0	0	41/45

* As of 7th June 2018

iii Forming community-based monitoring system

In Zone 3, hotels and other business holders are the target of the waste collection services, and any form of their local association was looked for in order to utilize it for monitoring purpose, but it was found out that no hotel association or tourism association exist in Kataragama specifically, but a general business association for all kinds of business. Therefore, for the purpose of monitoring the PP activity in the target area for the targeted business holders, it will be necessary to start developing a participatory monitoring system from scratch.

On the other hand, Zone 4 includes a portion of general households. Existing organizations found to have networks in this area include a funnel association, Sanasa Bank, and women's association, and a meeting with the representatives of the organizations was proposed to them. The representative of Sanasa Bank of the area agreed to meet us and a meeting was held on 28th February with their members in Zone 4 to discuss with KPS' Development Officer, the field coordinator for Zone 4, and ReEB Waste. The 27 participants of the meeting, while requesting improvements in their zone's waste collection services, showed willingness to cooperate in separate collection of bio-degradable waste and reacted positively toward the monitoring by the community themselves. Therefore, while consulting with the participants, nine groups of five to ten households living in one neighbourhood for each group were formed, and a leader for each group was selected. Hereafter, understanding toward the waste collection by KPS will be promoted through these leaders and KPS will explain discharge rules and monitoring method to them and use them as a channel of communication to gain insight on resident opinions.

A site visit to the compost site was conducted for these leaders on 23rd March. Eight leaders participated and deepened their understanding about the necessity of separating wastes. The participants appreciated it saying "I came and saw to understand the real necessity of separation. It was worth coming." And they promised to promote separation among their neighbours. The driver and collection workers of the compactor in charge of Zone 4 have found that more people from the general households in Zone 4 have come to separate the bio-degradable waste better.

On the other hand, it has been difficult to gain cooperation from the guesthouses and restaurants in

the Zone to whom the distribution of 45-L bins have been delayed. In the compost site visit organized for them on 18th May, only two participated although 30 had been invited.

As for Zone 3, a meeting was held with thirteen representatives from hotels and guesthouses with participation of an environmental police on 27th March to discuss about their monitoring method. They found it difficult for anyone particular to become a leader to take on a role of instructing other neighbouring hotels, and thus selected four people to become mere "contact persons" with KPS. Regarding the monitoring of the hotels, KPS will continue with their field coordinator and Development Officer. The participants of this meeting were also invited to a visit to the compost site on 4th of April, and nine of them participated. So far KPS has received good cooperation from Zone 3 in separation of bio-degradable waste.

Separately from the above meeting, a meeting was organized to meet shops in Zone 3 (shops in two areas in front of temples) but the participation was very low (80 were invited and only three showed up in time and ten showed up right before the end of the meeting). The participants gave information that they have an association that meets regularly. Another meeting was organized using their regular meeting and met with 21 shops on 22nd April. A problem with waste in the two areas of these shops is the scattering of waste thrown by visitors to the temples. Moreover, each of their shops is a small shed with no space for placing individual waste bins within their shop. Therefore, they requested a large communal waste bins to be placed. KPS had been provided three sets of four-colour categorized 120-L bins by CEA through ACLG (Assistant Commissioner of Local Government), but they had not yet decided where to place them and how to maintain them. KPS decided to utilize them at these shop areas, and requested the support of a local company, Kohomba, to make metal frames to securely place the bins. Once the frames are made, the bins will be set up in the areas and their association will be responsible for maintaining them.

	
Leaders from Zone 4 listening to the compost site manager explaining the process of separation.	After hearing the process of composting, the participants put their hands in the pile of compost to feel the heat of it.
	
Visits of hotels from Zone 3 to the compost site.	The four-color categorized bins distributed to LGs by CEA for public areas.

iv Result of Step I – Waste Composition Survey at the Resource Center

In order to see the impact of Step 1 (bio-degradable waste separation), the second waste composition survey was conducted in the end of June 2018.

The 9-day survey period covered four days of bio-degradable waste collection and another four days of non bio-degradable waste collection.

As seen in the summary of the result shown below, almost no non-kitchen waste is included in the waste collected on the days of "bio-degradable waste" collection, and only 2 % of the waste collected as "non-bio degradable waste" was kitchen (The details of the survey is described in 2.16.4).

The non-bio-degradable portion found on "bio-degradable waste" collection days included plastic and paper that is used for wrapping the kitchen waste. The "non-bio-degradable waste" still included a significant portion of grass and wood, but this is expected to be reduced after introduction of a chipping machine which

will enable them to collect "hardly bio-degradable waste" such as bulk tree branch, banana branch and hard-shell of fruits.

This result is very encouraging: it has shown that 3 community people are capable of separating waste very well once they are well informed about the method (by leaflet and house visit), purpose (by meeting), and the outcome of their contribution (by compost site visit).

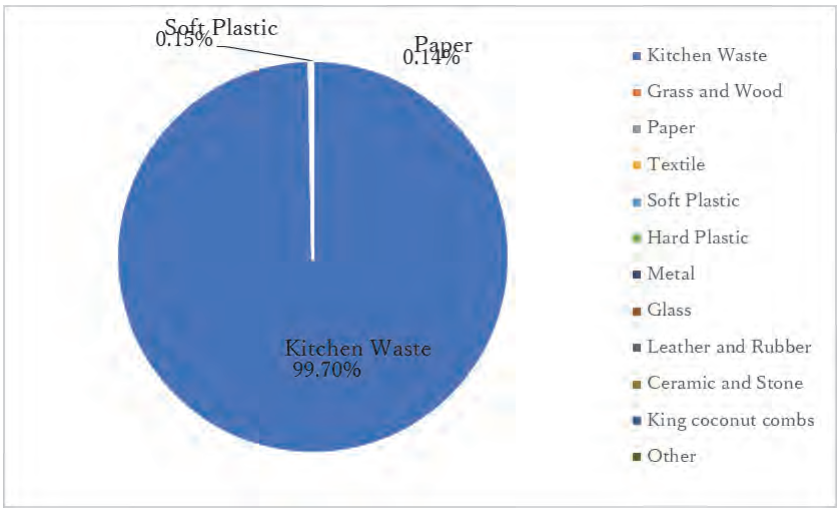


Figure 2-68: Composition of waste collected as "bio-degradable waste" in PP area

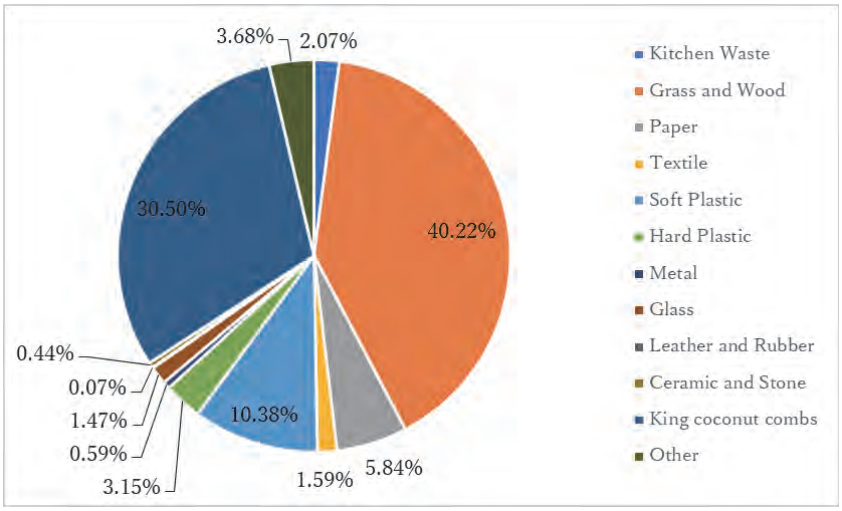


Figure 2-69: Composition of waste collected as "non-bio degradable waste" in PP area

e. Stage 2: Preparation for implementing 3-category separation (bio-degradable waste, recyclables, other waste)

i Preparation to shift to Step 2

Initially shifting to Step 2 from Step 1 was planned much earlier, but implementation of Step 1 was largely delayed due to the time taken in procuring the waste bins, thus delaying the transition to Step 2. However, it has been about three months since Zone 3 received the bio-degradable waste bins, and about two months since the general households in Zone 4 received their bins. Therefore, it is now planned to shift to Step 2 in early July.

It was also planned to separately collect recyclables by their kinds and collect all waste in six categories, but considering the burden and the expected confusion, a simpler three-category separation of bio-degradable, recyclables, and other waste will be introduced. The recyclables to be collected by KPS will be the recyclables sorted and sold by KPS' Resource Centre, which means to include plastic, polyethylene, iron, coconut shells, broken glass and glass bottles.

Furthermore, it has been decided that a chipping machine will be purchased by ReEB Waste to increase the recycling rate by composting such bio-degradable waste as banana branches, pineapple stems, sugar canes, king coconut shells that require a long time for decomposition and were excluded from bio-degradable waste collection during Step 1.

ii Preparation to deal with the Kataragama Perahera Festival Season

The biggest issue in KPS' waste management is the treatment of the waste discharged by the visitors coming from all over the country, and especially the waste management during the season of Kataragama Perahera Festival (from 13 to 27th July in 2018) when the largest number of visitors come to Kataragama.

At the time of the festival last year, their Perahera Committee carried out activities to set up waste bins and distribute fabric bags to replace plastic bags at the entrances to the sacred area around the Kirivehara Temple in order to stop plastic products (plastic shopping bags and PET bottles and others) from being brought in to the area.

Similar activities were planned for this year as well by the committee. KPS, being a member of the Perahera Committee, and ReEB Waste, in conjunction with shifting to Step 2 in their town areas, will support the PR campaign related to the above activities.

The support is planned to include the following:

- Press conference at the Colombo level in cooperation with CEA Head Office,
- Distributing news about the above through national TV networks, radios, and newspapers
- Newspaper advertisement in three newspaper (1 for each of Sinhala, Tamil, and English) to prevent bringing in plastic to Kataragama on 10th July (See Figure 2-68: Composition of waste collected as "bio-degradable waste" in PP area).
- Cooperation with civic groups to make t-shirts for attendants of waste collection points and fabric bags.
- Setting up ten (10) signboards in relation to Step 2 of the Pilot Project at seven (7) locations in KPS town areas (See Figure 2-69: Composition of waste collected as "non-bio degradable waste" in PP area).
- Following up the operation, ReEB summarized their recommendation for the future operation to be shared with the Perahera Committee. (See 2.13.2 g. v.)

Divaina (Sinhala) Virakesari (Tamil) Daily News (English),

Figure 2-70: Newspaper Ads published on 10th July 2018 in three newspapers

Figure 2-71: Signboard to request cooperation for 3-category (bio-degradable, recyclables, and others) separation

iii Implementation of Step 2

In July 2018, prior to Kataragama Perahera Festival, transition from Step 1 to Step 2 took place.

A leaflet was developed to explain the three categories of separation, namely bio-degradable, recyclables, and others. At this point, it had been decided to install a chipping machine so that hardly-degradable waste could also be composted. Therefore, the leaflet also included the explanation that hardly-degradable waste would also be accepted as bio-degradable. However, procurement of the machine took far longer than expected because of searching for the most affordable one, and it caused confusion and required re-explaination to exclude them until further notice (until the end of September when the machine finally became operational.)

The leaflet also explained the “destination” of each separated recyclable waste and bio-degradable waste, in order to help people understand better what impact their separation activity could make. The information gained through the recyclable survey conducted earlier by ReEB was incorporated in this part of the leaflet.

KPS reviewed their entire waste collection vehicle arrangement, not only for the PP target area, but for the entire waste collection area in order to send vehicles more efficiently and more conveniently to the community.

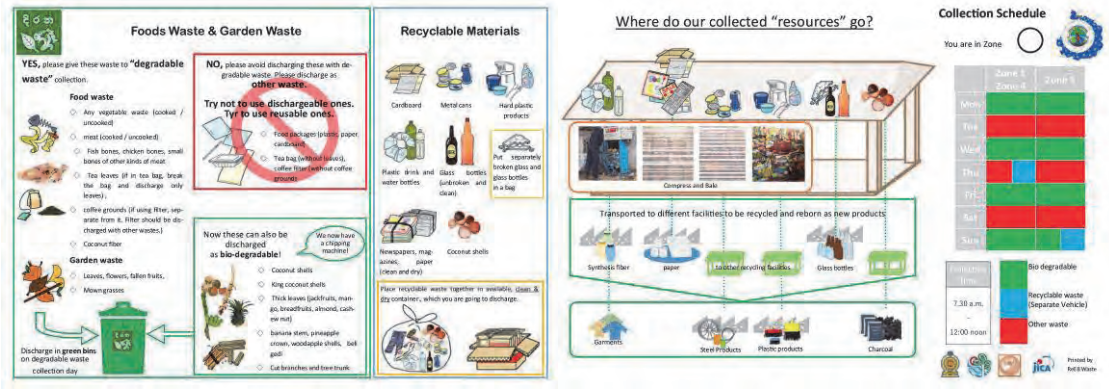


Figure 2-72: Leaflet for Step 2 (3-category separation) in KPS

Figure 2-73: Recyclables waste collected on a day of recyclable collection

iv Progress of and Development from Step 2

a) KPS continued their monitoring activities after implementing the above-mentioned awareness activities, in order to get the practice of separation rooted in the community.

b) In Zone 3, the market areas near Hindu Temples in Sellakatharagama, hand-carts and workers (one worker per cart) were assigned to make sure the waste would be discharged after separation according to the KPS rules.

c) The field coordinators named by KPS had been responsible for disseminating the rules of separation to the community, but they have now entrusted the responsibility to the collection workers (3 workers in Zone 3, and 2 in Zone 4.)

d) Chairman, Secretary, DO, a council member of KPS in charge of SWM, and ReEB Waste's local

staff called for a meeting with all collection workers of KPS in order to start expansion of separate collection to the areas other than PP target areas. In this meeting, the council member explained about the separation collection and the principle of "no separation, no collection", while the local staff explained the contents of the leaflet indicating the three categories of separation. Furthermore, at the same timing, KPS reviewed and revised once again the collection schedule to allocate collection vehicles and workers for accommodate separate collection in all other areas, and the new schedule was also explained at the meeting. The new schedule is as shown below.

Vehicle Type	Vehicle No.	Belong to..	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Compactor	LM-5617	PS	Z01, Z04	Z01, Z04	Z01, Z04	Z01, Z04	Z01, Z04	Z01, Z04	Z01, Z04
						Z04			
Tractor	RA-2880	PS	Z 03	Z03	Z 03	Z03	Z 03	Z03	Z 03
					Z03				
Hand cart (02 Nos)		PS	Z 03	Z 03	Z 03	Z 03	Z 03	Z 03	Z 03
Tractor	RC-6954	PS	Z 02 / Z02	Z 02 / Z02	Z 02 & 06 / Z 02 & 06	Z 02 / Z02	Z 02 / Z02	Z 02 & 06 / Z 02 & 06	Z 02 / Z02
Hand cart (01 No)					Z 06			Z 06	
Tractor	RC-1117	PS	Z 07 / Z07			Z 05	Z 07 / Z07		

7.30 a.m. 4 days	Bio degradable
7.30 a.m. 3 days	Non bio degradable
7.30 a.m. 1 day per week	Recyclable waste
7.30 a.m. 7 days	waste from sweepings
	Mixed Waste

Figure 2-74:: The revised collection schedule of KPS.

f. Waste Amount and Composition Survey of Transported Waste as Baseline Survey

i. Objectives of the survey

To understand the composition of the waste before starting the implementation of PP in the zones targeted under the PP.

ii. Survey period

From Friday 13th October 2017 until Friday 20th October 2017 (including a holiday of Deepavali on 18th October, when many pilgrims and visitors are expected in Kataragama)

iii. Method of Survey

The amount and the composition of the waste, which are collected separately as "bio-degradable" and "non-biodegradable (mixed)" wastes and transported to the Resource Centre on the collection service vehicles collected separately from Zone 3 and Zone 4, were measured.

Regarding the waste amount, the "mixed waste" was measured with the fill-factor calculated with the vehicle's loading capacity and loading ratio, multiplying it with the weight of ten 100 litter bins

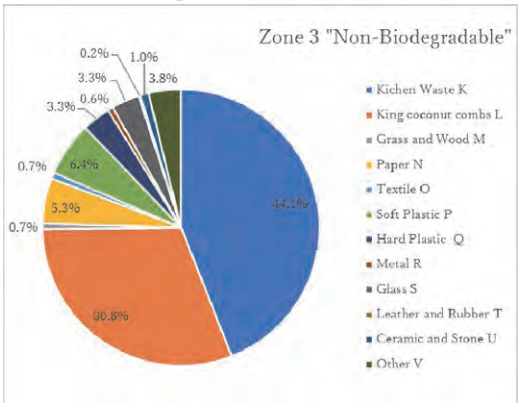
of waste. The "bio-degradable waste" was weighed fully.

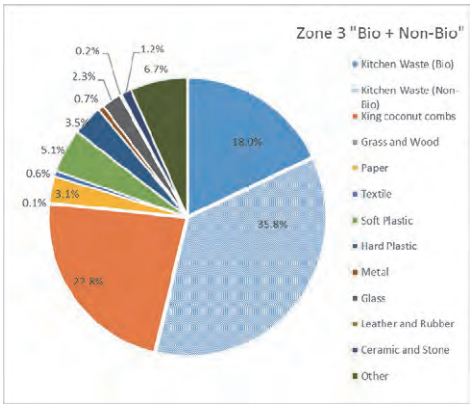
In terms of waste composition, "bio-degradable waste" was not measured (100%, for the collection workers separate apparently unsuitable waste out while loading), and "mixed waste" were cut into small pieces if they were large in size, mixed evenly, and about one 100-L bin full of waste was taken out through fractional sampling to examine the composition.

iv. Result of the Survey

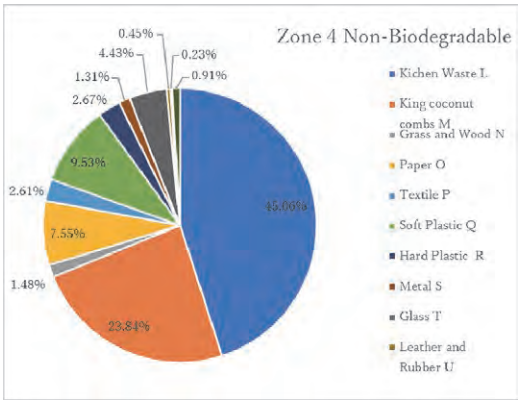
In the figures shown below, "Non-Biodegradable" (or "Non-Bio") indicates the "mixed waste"; "Bio+non-Bio" indicates the total of the waste collected in each Zone. In the "Bio+Non-Bio" figures, "Kitchen Waste (Bio)" means the waste transported in after being separately discharged as "bio-degradable waste" and "Kitchen Waste (Non-Bio)" means the bio-degradable waste included in the waste brought in as "mixed waste."

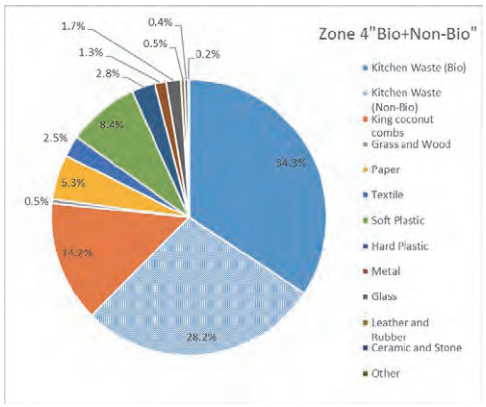
- Waste compositions of “mixed waste” and the total waste in Zone 3



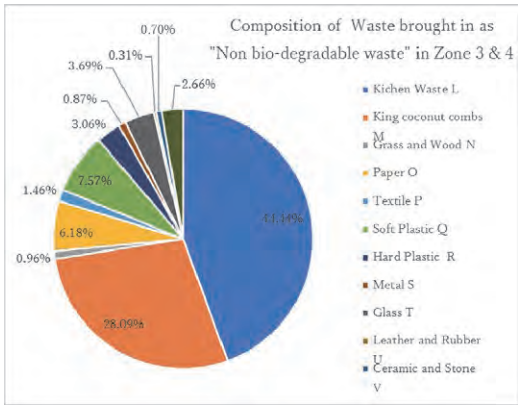


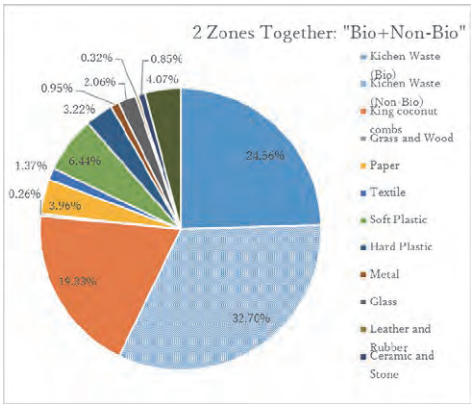
- Waste compositions of “mixed waste” and the total waste in Zone 4





- Waste compositions of the “mixed waste” and the total waste in a total of Zone 3 and Zone 4





g. Survey on Use of Home Compost Bins Distributed by KPS

i. Background of the Survey

In both Zone 3 and Zone 4 targeted under the PP, home compost bins have been distributed by KPS before 2017, but it is said that the level of usage among the recipients is very low. It is planned to

encourage composting at discharge sources under the PP in the future, but if there is any decisive reason for home compost not to be accepted, the plan itself needs to be reconsidered. On the other hand, if any supportive efforts could encourage usage, future distribution should be conducted after considering such supportive activities.

ii. Objectives of the Survey

The objectives are 1) to know the reasons that the recipients of a compost bin have not used it or have stopped using it, and 2) to check the conditions of compost bins which are being used. Based on an understanding of such reasons, supportive activities for home compost users will be considered to increase the number of regular users of compost bins.

iii. Target of the Survey

The recipients of the compost bins that have been distributed by KPS within the PP target area.

Out of the distribution list kept by KPS, the target recipients in Zone 3 and Zone 4 were picked up by checking their addresses, and 48 recipients in Zone 3 and 27 in Zone 4 are listed.

iv. Survey period and method

From October until December 2017, a field staff assigned by KPS to Zone 3 and Zone 4 respectively visited each recipient with a survey sheet (see appendix 21).

The first two days of the visits were accompanied by the local staff of ReEB in order to show the way of interviewing and recording, as well as to give those recipients using their compost bins advice on improving their composting techniques. The field staff were thus also able to further their knowledge of composting using the bins through this activity.

v. Survey Result

Table 2-121: Level of use of home compost bins distributed by KPS

Items / Zone	No. of Targets	Current use		Experiences of "not in use" recipient	
		In use	Not in use	Never used	Stopped using
Zone 3	48	46	2	1	1
Zone 4	27	13	13	8	5

*Zone 4 has one recipient left to be visited.

There is an apparent difference observed between Zone 3 and Zone 4. It is assumed that explanations upon distribution or conditions for selecting recipients may be different, but the official in charge of the activities is no longer available, and detailed information about the situation at the time of distribution was not available. On the other hand, a leaflet that explains how to use the bin was given to each recipient, and some users in Zone 3 still had this leaflet.

Table 2-122: Reasons for never using or stopped using

Never used	I do not understand how to use it. I have not tried using it. I did not need it. There is no space for using it.
Stopped using	Bad smell and worms increased Not sufficient waste generated Guests discharged unsuitable wastes

Smell and worms were predictable answers as reasons, while "no space for using it" or "I did not need it" pose questions needing asking before distribution. It is necessary to well define the preconditions for distribution in any future distributions.

Table 2-123: Willingness of restart using compost barrels

	Willing to use	Unwilling to use
Zone 3 (out of 2)	2	0
Zone 4 (out of 13)	4	2 (no response: 7)

Among those who do not have a will to use, it is noteworthy that there was a response: "no space to use it." On the other hand, in Zone 3, there were a few residents who "could not receive one even

though they wanted to use" which also highlights the necessity to clearly set the standards for selection of recipients.

Table 2-124: Problems found in compost bins in use and advised countermeasures

Problems	Countermeasures
Too much moisture in compost	
- Insufficient sunlight (in many cases, only 1-2 hours of sunlight a day)	To move to sunnier place (where it will get morning sun of about 3-4 hours)
- Only moist garden wastes are discharged.	Discharge after drying and mix with wet layer. Add rice husks or similar to control moisture.
- Garden waste and kitchen waste clogged separately to form layers.	When discharging, mix with layer below.
Many worms	It is caused because the temperature does not rise enough. Proper ventilation and moisture control (by methods mentioned above)
Non bio-degradable waste are mixed.	Not only they are not degraded, but they block other waste from degrading, so as soon as noticed, they should be removed.
- Paper waste is noticeable.	Since paper takes longer to degrade, and blocks ventilation of other wastes, should avoid discharging paper.
Too dry	
- Too strong sunlight	Make shade or move to shadier place.
- Only dried leaves are discharged	Mix with kitchen waste or undried garden waste and discharge.
No kitchen waste discharged (this itself is not a problem, but it is necessary to encourage composting kitchen waste in order to reduce waste amount by the use of compost bins)	
- Worried about bad odor	Mix with garden waste and prevent kitchen waste from getting clogged and forming a layer.
- More worms and rats are anticipated.	They emerge due to high moisture and strong smell. Prevent them by the methods mentioned above.

KPS・ReEB staff monitoring a compost bin

Many bins are found with "compost" too wet.

It was also observed that every user has difficulties controlling moisture in rainy season, while the visits for this survey were made during the season with the highest rainfall in Kataragama. It will be necessary to distribute further compost bins after considering countermeasures especially for the rainy season.

Some of the users were re-visited, and were found to have made improvements following the advice provided during the first visits. For example, a family which started discharging kitchen waste to their compost bin testifies "it did not make any smells. I can continue discharging kitchen waste." These episodes make it clear that monitoring and providing advice after distribution are required to encourage recipients to continue using their compost bins.

vi. Lessons Learnt for future promotion of use of compost bins

- To set clear standards for selection of recipients. (To distribute after indicating what conditions are necessary for setting a compost bin and calling for applicants, and other methods should be considered.)
- Monitoring and providing advice after distribution to find and respond to problems at an early stage to prevent the recipient giving up and to encourage continuous usage.
- Method to control high moisture in rainy season to be presented prior to starting use.
- To compile a leaflet of "frequently asked questions" found in this survey, and to distribute to users.

vii. Development of Compost User's Guidebook

In KPS, where the climate is harsh with heavy rain during a rainy seasons and strong driness in a dry season, it is very difficult to manage a compost bin well. However, KPS is scarce of human resources and it is very difficult to conduct close follow up of each compost user. Under such circumstances, the number of compost users had not been increased and a good number of compost bins previously provided to KPS remain undistributed in their storage. Considering the situations, the Project decided not to provide yet more compost bins to KPS, and developed a small booklet summarizing "problems and solutions" which have been identified during the above-mentioned monitoring activities, in a hope

that the current users and future users of the existing compost bins would be able to utilize the bins better.

Figure 2-75: The front cover of the booklet “How to use your compost bin better?”

2.14 C.4: Support on Monitoring and Maintenance Activities for Pilot Projects

2.14.1 Kurunegala MC

The Draft of Operation and Maintenance manual for Sundarapola disposal site including monitoring was formulated based on the discussion between Krunegala MC and JICA team. The Draft of Operation and Maintenance manual is attached as “appendix 22”.

2.14.2 Ratnapura MC

(1) Monitoring of collection amount, amount composted, amount of materials recovered and amount of dumping

As described in 2.13.1, waste amount monitoring at Kanadola site has been started. Amount of wastes are calculated based on capacities of collection vehicle and densities of each type of wastes as well as measurement of fill factor (%) in each vehicle. Below figure summarises daily receiving amount, final disposal amount, amount for composting and amount for material recovery in November 2017.

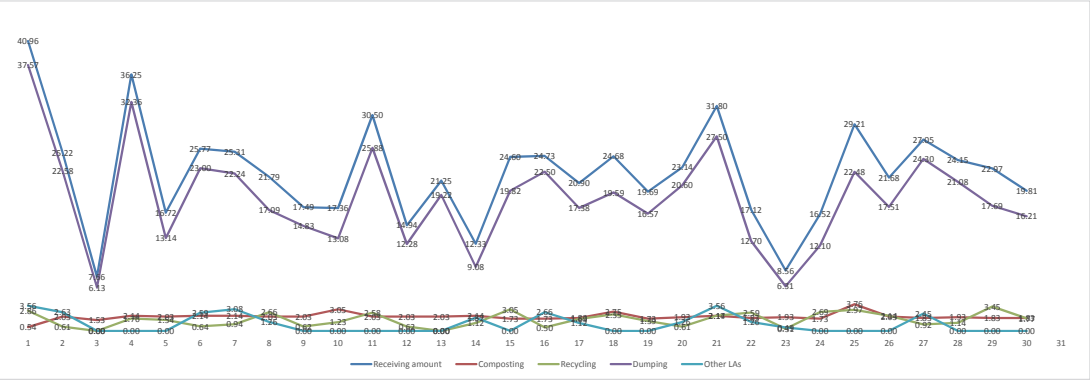


Figure 2-76: Monitoring of waste amount at Kanadola site in RMC

This data is very important to check progress of targets of Action Plan developed in the project and to revise the waste flow data in the future. Although the data sheet has to be revised at the start of the new 6 separation categories at generation level in the pilot project and when introducing new collection vehicles, data records and data input by site staff of RMC will contribute to capacity development on SWM. Available data will also be used for evaluation of the pilot project in RMC.

(2) Monitoring for waste separation at a generation level

Monitoring results of source separation for biodegradable waste and non-biodegradable waste are shown below.

Table 2-125: Monitoring result of source separation

Biodegradable waste	Non-biodegradable waste
• Most of the separation bins distributed by the project were properly covered by biodegradable waste although small amount of paper and polythene are founded.	• It seems that it is not easy to differentiate 'polythene' category and 'other waste' category.
	
Easily separated biodegradable waste	All 'polythene' items that were discharged as 'other wastes'

Each PHI has a different idea for the monitoring plan of source separation as summarised in the following table.

Table 2-126: Monitoring plan of source separation by PHI (4 PHI, 4 PP areas)

PP Area No.	Monitoring plan of source separation
Area1	• A PP area supervisor follows collection vehicles on collection dates, checks source separation at discharge points and instructs public about waste separation. • PHI visits house by house and inspects waste bins and polysack bags for improvement of waste separation during dengue control program.
Area2	• Supervisors visit as a team, and house by house, record biodegradable and non-biodegradable separation by using checklist, and instruct waste separation.
Area3	• Supervisors visit as a team, and house by house, check biodegradable separation and usage condition of the equipment, record them in a checklist and instruct proper waste separation. • RMC issues warning letters in the cases where waste separation is not in practice. • Bins are forced to be retuned and distributed to households in need and can use, in case of not using the necessary equipment.
Area4	• PHI monitors waste separation practice by visiting households for the purpose of dengue program or health related program • Supervisors go as a team and visit waste generators in a daily manner and check biodegradable and non-biodegradable waste separation.

(3) Monitoring of collection and transportation of waste

Monitoring of collection and transportation for biodegradable waste was conducted as follow.

Table 2-127: Results of collection and transportation monitoring for biodegradable waste

Observation	Counterplan/ Instruction
• Biodegradable waste is collected only from households who have received waste separation bins in Area 1, 3 and 4	NA
• In one area Area 2, a driver has to modify a route since the original one route has households that received separation bins and households that don't have bins.	• Route plan has to be revised and should add types of wastes to collect.
• Bins with some big non-biodegradable fraction (polythene and paper) are observed.	• Keep non-biodegradable fraction separately when separating them during the collection by waste collectors without disturbing waste collection work.
• Some households are discharging their rubbish into shopping bags set within the separation bins.	• Instruct not to collect shopping bags together with biodegradable wastes. Only if a resident is available at a collection point asking collectors to collect their shopping bag, then collectors are to collect it separately to biodegradable waste.
• There are residents who receive a leaflet that does not describe proper collection days	• As Soon as RMC staff know about the situation, they correct proper collection days

Observation	Counterplan/ Instruction
	by type of waste.
• A bin without a lid may cause odour, dog attraction and effluent from rain water.	• A lid should be used by the public when emptying a bin. • Close lids of waste separation bins when collectors finish waste collection.
• There are areas inside PP areas, where tractors cannot access.	• Three wheelers are dispatched for inaccessible areas of tractors. • Newly dispatched three wheelers in some areas cannot go and collect waste in the same day as with tractors, so notice boards are built for those areas.
• There are some households on mixed-waste collection routes that have received separation bins from RMC	• Route of collection and transportation should be fixed and confirmed prior to the door to door explanation and distribution of necessary equipment, for next time.

Big polysack bag for visible non-biodegradable waste during collection used by collectors

Waste separation bin with shopping bag

Instruction of waste separation by a supervisor on biodegradable collection day

Collection of biodegradable waste by a three wheeler with installation of large bins

Monitoring of collection and transportation for non-biodegradable waste was conducted as follow.

Table 2-128: Result of collection and transportation monitoring for non-biodegradable waste

Observation	Countermeasure / Instruction
• It is not easy for most residents to understand the description 'Week 1 & week 3 of days'.	• Intense instruction should be provided by area PHIs and supervisors. • Notice board includes the information not only waste separation category, but also collection days. As shown in the previous section, actual 'collection date cards' will be inserted into a notice board every month.
• Most of the paper waste is paper fraction or a kind of cookie box, and there is not a lot of cardboard, newspaper or magazine. • Due to the light paper materials, action should be taken to not drop and to not let fly away during transportation. It is necessary to prepare containers with lids or stone/tyre.	• Polysack bags* size of 70 L have started to be used for paper waste collection. As it is stretchy, paper can be compacted Big size polysack bag (70 L or larger) is used by workers in *Kanadola
• Plan is to collect 2 items of non-biodegradable waste every week. As there is neither partition nor a container/ a bin in collection vehicles, public may see and think that separated wastes are collected together.	• A big container, separation bin or partition should be installed in collection vehicles. • Single items should be collected by a collection vehicle.
• Collection of separated wastes are not limited in PP areas.	• Collection and transportation route should be revised and maintained to meet the current situation.
• Instruction to residents who have collection service on Sunday is limited because not so many residents are at home during the weekend.	• Make a warning sticker and attach it in cases where separation is not well practiced, or if collection days are incorrectly understood.
• In the case where not many residents use distributed polysack bag for putting out rubbish, waste collectors need to check inside the bags. • Some public in PP areas want to keep distributed bags only inside houses.	• It is better for public in PP areas to use distributed polysack bags in three colours for the purpose of collection services efficiency. • Ask residents to use those distributed polysack bags as much as possible.
• The hone is continuously used during collection so residents know that the waste collection vehicles are coming.	• Speaker should be installed and music should be prepared without continuous use of vehicle horn.
• Contents which speaker announce and wastes which collectors collect are not corresponding with each other. i.e. Speaker announces to collect 'Glass, PET bottle, paper, cardboard and metal' when actually glass, PET bottle and metal are the only items to collect.	• Speaker announcement and waste collected should be same. • Announcement should be modified or sound only is also fine.
• Illegal discharge points are identified.	• Take action e.g. installation of sign board of 'Prohibition of illegal dumping', identified areas surrounded with black and yellow tapes.

Checking type of waste to collect from several waste bags by a collector and a driver

The three orange bags left are not the designated waste to collect, only blue bag is the correct waste to collect on the day

Vehicle (three wheeler) for paper collection

Instruction by PHI on waste collection day

Each PHI has a different idea of the monitoring plan for collection and transportation of waste, which is summarised in the table below.

Table 2-129: Monitoring plan of collection and transportation of waste by 4 PHIs in 4 PP areas

Area No.	Monitoring plan for collection and transportation of waste
Area 1	• Have a supervisor follow collection vehicles at least twice a week (one is for biodegradable waste collection and the other is non-biodegradable waste collection) • Submit the monitoring report to MOH.
Area 2	• Have a supervisor follow collection vehicles still under discussion regarding how to feedback findings of monitoring.
Area 3	• Check if collection route is as planned by supervisor, and monitoring result written in a designated form is submitted to PHI.
Area 4	• Collection points for non-biodegradable wastes are decided based on the responsible persons of the collection points. A couple of cooperative residents are gathered prior to collection days and asked to send messages of non-biodegradable waste collection to their neighbour. • On non-biodegradable collection days, one area supervisor as well as a Kanadola site labourer are despatched to collection points approximately one hour each, so that further manual sorting supposed to be done in Kanadola can be conducted in parallel at the collection points. • Supervisor and collectors/drivers are monitored by PHI who do spontaneous visits on both biodegradable and non-biodegradable wastes collection day.

(4) Monitoring of windrow compost

Windrow typed compost system has been started since 26 December 2017 before starting source separation in PP areas. The following table shows progress of windrow compost as of 13 March 2018, resulting 10 windrows have started compost process. The biggest issue at the moment is frequent break down of bobcat and a long process for its repair.

Table 2-130: Progress of windrow compost system in RMC

No. of Windrow	Date started	Date end	1st Turning	2nd Turning
1	26 Dec 2017	5 Jan 2018	5 Feb 2018	24 Feb 2018
2	6 Jan 2018	15 Jan 2018	6 Feb 201	24 Feb 2018
3	16 Jan 2018	26 Jan 2018	2 March 2018	
4	27 Jan 2018	29 Jan 2018	2 March 2018	
5	30 Jan 2018	4 Feb 2018	6 March 2018	
6	5 Feb 2018	13 Feb 2018	9 March 2018	
7	14 Feb 2018	19 Feb 2018	8 March 2018	
8	20 Feb 2018	24 Feb 2018		
9	25 Feb 2018	5 Mar 2018		
10	6 Mar 2018			

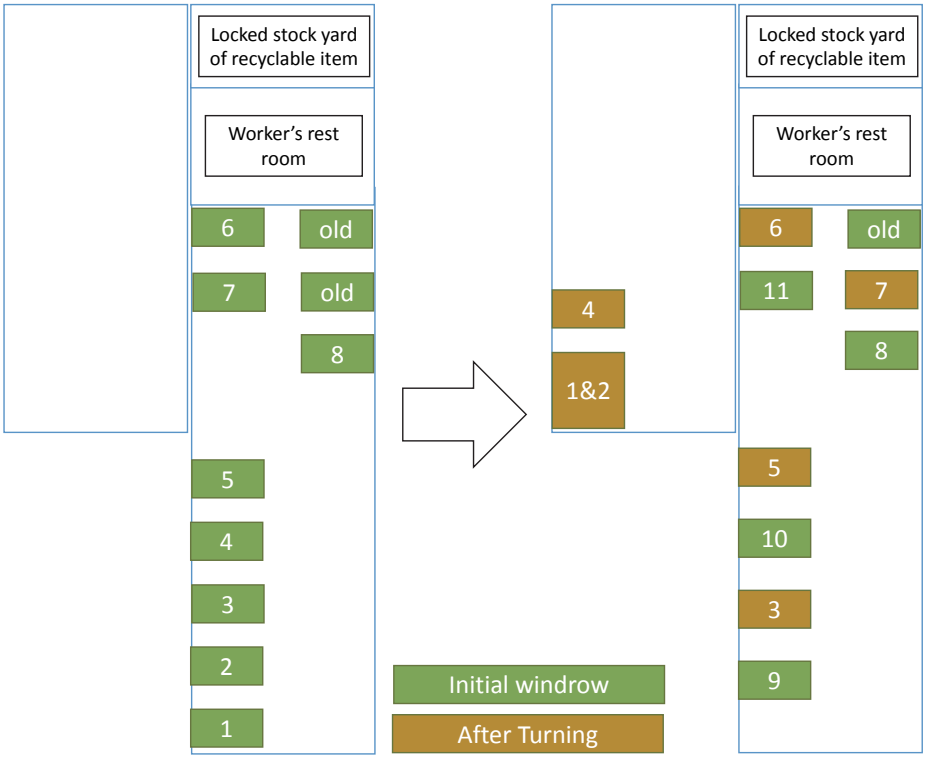


Figure 2-77: Progress of windrow compost in RMC

Types of biodegradable waste for windrow compost are summarised in the following table, whereas a boxed compost system accommodates biodegradable wastes from a market as before.

Table 2-131: Types of biodegradable waste and outcome and future expectation

Types of biodegradable wastes	Outcome and future expectation
Kitchen waste and garden waste from PP areas	• Segregated biodegradable waste from households in PP areas, which is the outcome of implementation of PP.
Biodegradable waste in shopping bags from small areas outside of PP areas, where residents separate and discharge, but do not receive waste separation bins.	• Degradable waste from planned expanded areas for bin distribution. • Manual sorting work in Kanadola can be reduced if the bins are distributed. • It is possible to shift sorting work for wastes from other areas to accommodate more biodegradable wastes.
Wastes from a shrine named Saman Devalaya	• Trailer from Saman Devalaya is taken in to Kanadola once a week. • Main waste from Saman Devalaya is offering to god, which is biodegradable wastes. • It is possible to use boxed compost system, however, high workloads are demanded to handle waste even from one tractor.
Saw dust	• Saw dust is laid out at the bottom of each windrow to reduce leachate from food wastes. • Saw dust is expected to take a role of moisture regulator.
Fish waste and chicken waste e.g. legs and feathers that are directly carried into the site daily	• Although fish and chicken residues have been dumped into the site, those are nitrogen rich resources for compost. • Since turning in boxed compost system has been done manually, it was difficult for workers to bear odour and gas from the process in spite of wearing a mask. • A pit is made in a windrow that keeps the temperature higher than 50 degree celsius for fish and chicken waste.

It is important to monitor the temperature of windrows with the purpose of knowing when to input fish and chicken wastes as well as to obtain evidence to revise turning plan. The following figure shows the monitoring result of temperature for windrow compost.

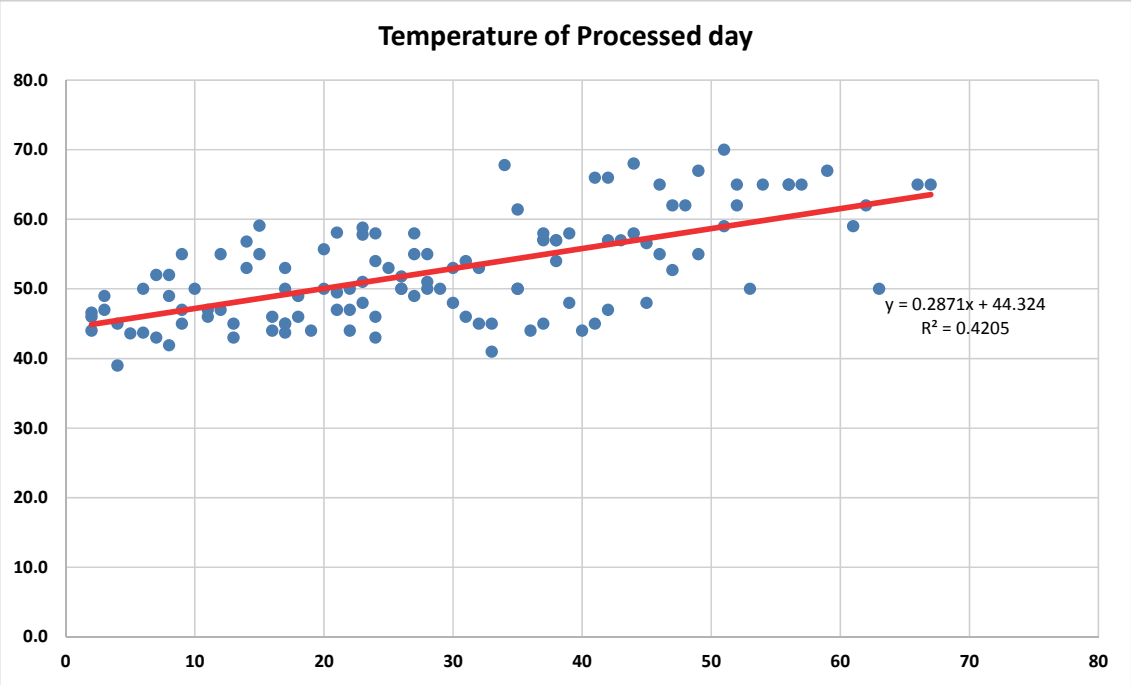


Figure 2-78: Relationship of process days and temperature of windrows as of 14 March 2018

	
Kitchen waste and garden waste from households in PP area	Manual sorting of wastes from Saman Devalaya

(5) Home compost monitoring

As written in 2.13.1 (9), monitoring of home compost bins, 250 of which have been distributed to household under the project, is ongoing by RMC supervisors. An individual monitoring sheet is used for for one user (bin) can be used for 18 monitoring entries.

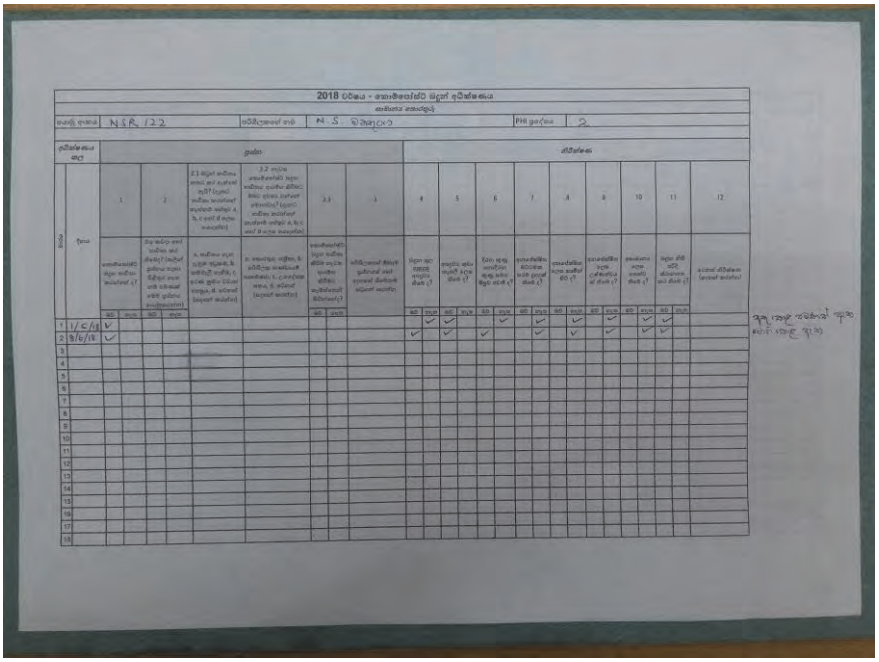


Figure 2-79: An example of home compost monitoring sheet

The table below summarises monitoring results of distributed home compost barrels by PHI' four area, which has been conducted by RMC supervisors from September to October 2018. As a result of the monitoring for 211 households, 5 households had not been using the barrels, and total of 57 home compost related issues were identified (Some households have multiple issues). For those non-users and problematic households, RMC decided to conduct the monitoring frequently. As shown in 2.13.1, RMC supervisors took training for home compost including the tips to solve the issues, so that they have sufficient knowledge to manage issues and provide instruction.

Table 2-132: Monitoring results of distributed home compost barrels (Sep – Oct, 2018)

PHI area		# of compost bins	# of monitored	# of users	# of non users	# of users who have problems on								# of users whom RMC has to visit frequently
No	Name					4.Inappropriate waste	5.Waste size	6.Mixing	7.Bad smell	8.Insect	9.Heat	10.Wet	11.Installation place	
1	Batugedara	47	44	44	0						1	3	1	5
2	Town North	47	22	20	2	5	4	4	1	3	3	2	2	24
3	Kospalawinna	76	76	74	2	8	3	8						19
4	Muwagama	80	69	68	1	1	3		1	1		2	1	9
	Total	250	211	206	5	14	10	12	2	4	4	7	4	

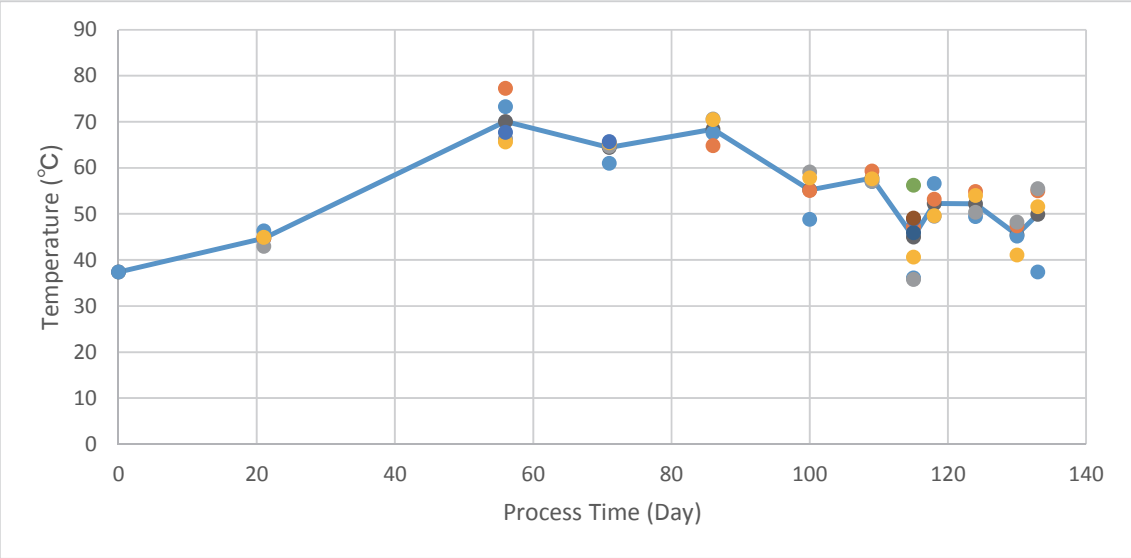
2.14.3 Rehabilitation of a final disposal site in Kataragama PS

The Draft of Operation and Maintenance manual for Galapitagalayaya disposal site including monitoring was formulated based on the discussion among KPS, Uva province, CEA and JICA team. The Operation and Maintenance manual is attached as “appendix 23”.

2.14.4 Promotion of 3Rs in Kataragama PS

(1) Survey on temperature of Compost

A series of surveys were conducted to measure the temperature inside the compost providing basic data to obtain hints for improving the compost manufacturing process and the relationship with the length of process time was considered. The internal temperature of each windrow and each stage of compost was measured. Changes over time in temperature were studied for items that show time series data from date tags. The results are shown in the figure below.



At the Compost yard in KPS, 1st February, 2018
Plotted: Each Actual data, Blue Line: Average

Figure 2-80: Result of temperature and process time

	
Windrow (Whole view)	Measuring temperature Indicated: 68℃

Although the standard procedure of the facility is set as every 15th day in the process of returning compost and moving to the next stage. It actually only happened every 20 to 30 days, depending on work records and listening. Due to a lack of personnel, delays in turning over the compost at regular intervals were observed. It was observed that the turnover in Figure 2-52 is the 20th day for the first time and the 30th day for the second time. The number of days is a factor required in raising the temperature, deteriorating the efficiency and prolonging the necessary number of days. The maximum temperature is 70°C or higher, and it was observed that the fermentation progresses. However, reaching the range from 60°C to 70°C took about 50 days or more after ripening started, which is comparatively similar behaviour in Ratnapura measurement case (Fig. 2-51). The temperature of the compost rises to 70°C or higher in the peak period, but then gradually decreases with the passage of days. The number of days over 60°C was be about 90 days. Temperature distribution is due to a lot of variables, a difference in content components, variation in work content and/or interval, etc. Because there are differences in conditions, it is necessary to take more measurement results, in addition to those taken at Ratnapura, but it is also presumed that there is a limit to the efficiency because the current windrow method is reliant on manual labour.

(2) Survey on work flow line in the Compost Yard

Works in the compost yard are mainly carried out manually. Survey on work flow line in the Compost Yard was conducted to observe and record how much time was spent on what work. The record was calculated by multiplying the number of persons engaged and the time spent and calculating the unit of person x hour.

Table 2-133: Survey results on work flow line in the Compost Yard

Day of observation: 2nd February, 2018 , Time: 9:00am – 16:00pm, Total Number of Workers: 12		
Work Activity	Person x Hour	General Descriptions
Clean up at the Yard	1.00	Clean up at the yard
Repairing of the Water Tank	11.92	Implemented as maintenance work on the day Officers are carrying out on-site maintenance and repair at the site.
Segregation of unloaded waste	12.42	Four to six workers took over 2 to 3 hours. This day was one tractor and one compactor car. This work is necessary according to the loading amount.
Transporting the compost in the Yard Windrow >> Open floor	7.92	Three workers took over 2 hours more. (One for scoop, one for transport and one for levelling)
Stocking biodegradable waste up to the first box of compost	0.67	This work is to stock biodegradable waste up to the first box of compost. One workers took over less than 1 hour.
Transporting the compost in the Yard Open floor >> Trommel	1.17	One or two workers took over one hour by a cart.
Compress Cans and PET bottles	2.17	One worker dedicated on the process. This process is light work to compress Cans and PET bottles by using machine. One worker took over about 2 hours.
Loading waste Compost Yard >> Dumpsite	1.25	Three workers took a tractor to transport and dump waste. One round trip took 30 minutes.
Daily Check-up for the electric fence	0.42	Daily Check-up for the electric fence was conducted daily on the way of dumping waste to the dump site.
Post shaping	5.25	Five to six workers took over one hour.

Manual transportation of compost (Using a Cart)

Manual Segregation of mixed waste

Based on these flow line surveys, ideas on improving work efficiency were considered. Two major works to consume time are (1) segregation work of waste and (2) transportation of the compost / turnover work. (Since

maintenance work does not occur every day, it is regarded as an irregular task and is excluded from consideration.)

■ Segregation of waste in the yard

Issues	Proposed measures
・ Currently it is collected as mixed waste, so the operator must manually collect valuables (such as cardboard, cans, plastic bottles, glass bottles, etc.) after loading. Moreover, there is a time and effort to reload the dumped dust again on the trailer after sorting. ・ Sorting accuracy is limited due to manual separation.	If separated discharge is adapted, it is possible to eliminate or reduce the work of reloading on the trailer, which separates manually after loading. If this work can be omitted, it will ideally have the effect of increasing the time spent on turning compost etc.

■ Transportation and turning the compost

Issues	Proposed measures
・ Because of manual work, you have to work while taking a break and efficiency is not good. ・ Compost which must be processed has 6 lines as a box, and it is not keeping up switching frequently each stage. ・ Because of manual labour, there is a limit to the amount and level of consistency of agitation and turnover.	・ If saving labor in the above separation process is possible, more people and time can be devoted to movement and turnover of compost. ・ Moving process: Improvement in efficiency, time reduction and improvement in working accuracy can be expected by introducing mechanization for even part of the turnover. Mechanization means, for example, Bobcat, small backhoe, etc.

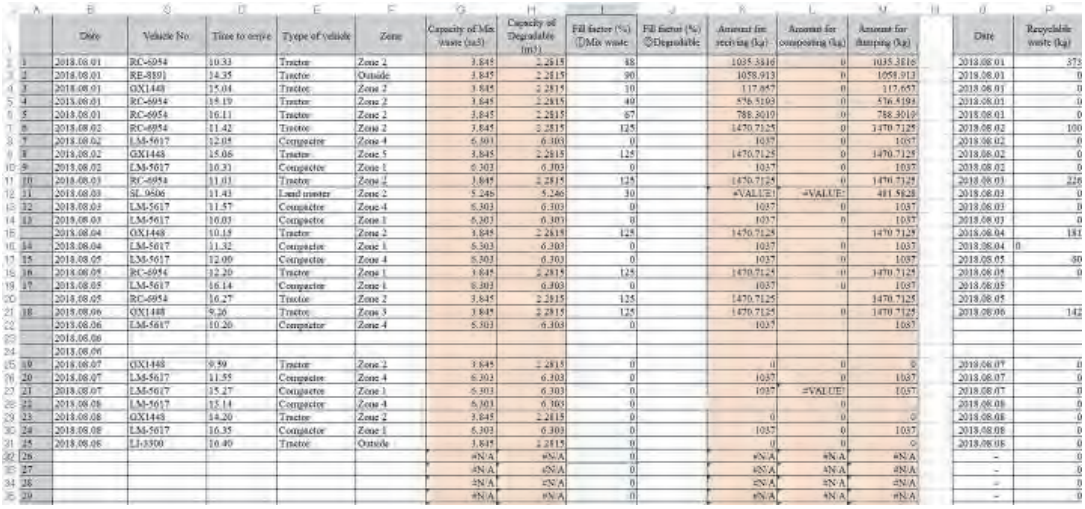
■ Composting process

Issues	Proposed Measures
・ In the manual, the frequency of turnover is once in 15 days, but it is once in 20 to 30 days as a matter of fact, which directly leads to a decrease in manufacturing efficiency. ・ Temperature rise is slow and takes about 50 days to reach peak temperature (about 65 to 70). (Here, 50 days is an estimate from the record of turnover) ・ Compost after aging has large grain.	・ As above mentioned, there is a possibility that the manufacturing process can be improved if work efficiency is improved by optimizing personnel allocation, mechanization, etc. ・ Promote reaction by raising oxygen concentration by introducing aggressive aeration method by blower. (As an example there are cases of Shibushi city in Japan) ・ Mechanical turning process is recommended for grinding effect (achieving smaller particle sizes).

An improvement of the sorting process and composting process including optimization of personnel allocation in consultation with counterpart will be proposed.

(3) Weigh bridge operations

A weigh bridge system was installed at the compost yard and experimental operation of the weigh bridge was started from 1st of August. Recording of the weighting data also started. A staff of KPS has been allocated at the weigh bridge control hut and she has been weighing the incoming and outgoing waste, data recording and other related work using the system. The data is accumulated and used for the monitoring activities of the project.



	Date	Vehicle No.	Time to arrive	Type of vehicle	Zone	Capacity of Mix waste (m3)	Capacity of Degradable (m3)	Fill factor (%) ①Mix waste	Fill factor (%) ②Degradable	Amount for receiving (kg)	Amount for composting (kg)	Amount for dumping (kg)		Date	Recyclable waste (kg)
2	1	2018.08.01	RC-6954	10.33	Tractor	Zone 2	3.845	2.2815	48		1035.3816	0	1035.3816		2018.08.01	373
3	2	2018.08.01	RE-8891	14.35	Tractor	Outside	3.845	2.2815	90		1058.913	0	1058.913		2018.08.01	0
4	3	2018.08.01	GX1448	15.04	Tractor	Zone 2	3.845	2.2815	10		117.657	0	117.657		2018.08.01	0
5	4	2018.08.01	RC-6954	15.19	Tractor	Zone 2	3.845	2.2815	40		576.5193	0	576.5193		2018.08.01	0
6	5	2018.08.01	RC-6954	16.11	Tractor	Zone 2	3.845	2.2815	67		788.3019	0	788.3019		2018.08.01	0
7	6	2018.08.02	RC-6954	11.42	Tractor	Zone 2	3.845	2.2815	125		1470.7125	0	1470.7125		2018.08.02	100
8	7	2018.08.02	LM-5617	12.05	Compactor	Zone 4	6.303	6.303	0		1037	0	1037		2018.08.02	0
9	8	2018.08.02	GX1448	15.06	Tractor	Zone 5	3.845	2.2815	125		1470.7125	0	1470.7125		2018.08.02	0
10	9	2018.08.02	LM-5617	16.31	Compactor	Zone 1	6.303	6.303	0		1037	0	1037		2018.08.02	0
11	10	2018.08.03	RC-6954	11.01	Tractor	Zone 2	3.845	2.2815	125		1470.7125	0	1470.7125		2018.08.03	226
12	11	2018.08.03	SL-9606	11.43	Land master	Zone 2	5.246	5.246	30		#VALUE!	#VALUE!	481.5828		2018.08.03	0
13	12	2018.08.03	LM-5617	11.57	Compactor	Zone 4	6.303	6.303	0		1037	0	1037		2018.08.03	0
14	13	2018.08.03	LM-5617	16.03	Compactor	Zone 1	6.303	6.303	0		1037	0	1037		2018.08.03	0
15		2018.08.04	GX1448	10.18	Tractor	Zone 2	3.845	2.2815	125		1470.7125		1470.7125		2018.08.04	181
16	14	2018.08.04	LM-5617	11.32	Compactor	Zone 1	6.303	6.303	0		1037	0	1037		2018.08.04	0
17	15	2018.08.05	LM-5617	12.09	Compactor	Zone 4	6.303	6.303	0		1037	0	1037		2018.08.05	80
18	16	2018.08.05	RC-6954	12.20	Tractor	Zone 1	3.845	2.2815	125		1470.7125	0	1470.7125		2018.08.05	0
19	17	2018.08.05	LM-5617	16.14	Compactor	Zone 1	6.303	6.303	0		1037	0	1037		2018.08.05	
20		2018.08.05	RC-6954	16.27	Tractor	Zone 2	3.845	2.2815	125		1470.7125		1470.7125		2018.08.05	
21	18	2018.08.06	GX1448	9.26	Tractor	Zone 3	3.845	2.2815	125		1470.7125	0	1470.7125		2018.08.06	142
22		2018.08.06	LM-5617	10.26	Compactor	Zone 4	6.303	6.303	0		1037		1037			
23		2018.08.06														
24		2018.08.06														
25	19	2018.08.07	GX1448	9.59	Tractor	Zone 2	3.845	2.2815	0		0	0	0		2018.08.07	0
26	20	2018.08.07	LM-5617	11.55	Compactor	Zone 4	6.303	6.303	0		1037	0	1037		2018.08.07	0
27	21	2018.08.07	LM-5617	15.27	Compactor	Zone 1	6.303	6.303	0		1037	#VALUE!	1037		2018.08.07	0
28	22	2018.08.08	LM-5617	15.14	Compactor	Zone 4	6.303	6.303	0			0			2018.08.08	0
29	23	2018.08.08	GX1448	14.20	Tractor	Zone 2	3.845	2.2815	0		0	0	0		2018.08.08	0
30	24	2018.08.08	LM-5617	16.35	Compactor	Zone 1	6.303	6.303	0		1037	0	1037		2018.08.08	0
31	25	2018.08.08	LI-3300	10.40	Tractor	Outside	3.845	2.2815	0		0	0	0		2018.08.08	0
32	26						#N/A	#N/A	0		#N/A	#N/A	#N/A		-	0
33	27						#N/A	#N/A	0		#N/A	#N/A	#N/A		-	0
34	28						#N/A	#N/A	0		#N/A	#N/A	#N/A		-	0
35	29						#N/A	#N/A	0		#N/A	#N/A	#N/A		-	0

Figure 2-81: Screen shot of the log sheet of collection waste (Manual calculation)

2.15 C.5: PP Kick-off and Intermediate Report Seminars

2.15.1 PP Kick-off Seminar

At start of the pilot projects, a kick-off seminar was held for the purpose of introducing the project and the pilot projects to Sri Lankan counterparts and officers working in SWM in local authorities. Not only CEA and Dr. Gemunu, representative of SATREPS from Peradeniya University, made presentations, but also representatives from three pilot project local authorities introduced each of the pilot projects by themselves to the audience; which is considered to have developed their sense of ownership of the pilot projects. Overview of the pilot projects will be described in the following table.

Table 2-134: Outline of PP kick-off seminar

Date	27 October 2017, Friday 9:00～14:00
Venue	Conference hall of CEA, 3F
Participants	Total 185 participants including representative from CEA, NSWMSC, SATREPS. Representatives of SWM departments from three PP local authorities, SWM relevant officers from other local authorities.
Contents of presentations and presenters	1. Introduction of ReEB Waste project, Dr. Naofumi Sato (ReEB Waste Project leader) 2. Present status of Solid Waste Management and Challenges for Change, Dr. K.H Muthukuda Arachchci (Deputy Director General Environment Pollution Control, CEA) 3. Guide for sustainable planning, management and pollution control of waste landfills in Sri Lanka., Dr. Gamunu Herath (Uiversity of Peradeniya) 4. Pilot project of Promotion of 3Rs in Ratnapura Municipal Council., Dr N B Gamini (MOH, Ratnapura Municipal Council) 5. Pilot Project at Kataragama Pradeshiya Sabahas for ReEB Project., Mr. K.L.A.L.Jayathilaka (Kataragama Pradeshiya Sabahas) 6. The Pilot Project at Kurunegala MC for ReEB Waste Project., Dr. Ratnakaya (MOH, Kurunegala MC)
Language	Sinhalese, Tamil and English

The table below shows questions and answers from the seminar.

Table 2-135: Questions and answers of PP kick-off seminar

Question	Answer
How to manage the medical waste? Is there any mechanism to solve the medical waste problem?	The total responsibility of management of solid waste is on the health ministry. They have their mechanisms to address this issue. If somebody needs information, could contact the health ministry.
What is the mechanism or procedure to collect and treat e-waste adopted by central environmental authority?	Already, the CEA implemented a program to collect e-waste through local authorities. Those collected by this program were taken to the CEA later on. There are plans for such future programs to be implemented through local authorities and to go for realistic treatment procedures.
There are some facilities done by NSWMSC and PILISARU programmes. But, there are some difficulties associated with these facilities on operation. Mainly the equipment and labour. What sort of solutions could you, CEA can give for these issues?	The responsibility for the provision of technical support for such kind of facilities are mainly on the NSWMSC. For further assistance on this kind of matters, you could contact NSWMSC director. Anyhow, the careful implementation and efficient management of available resources could overcome such problems to a certain level. Therefore, better to try with available resources for the sustainability of the process.

2.15.2 PP Intermediate Report Seminar

The PP Intermediate report seminar was held on 30 August 2018 at the auditorium of Central Environmental Authority. The presentation of SATREPS technics by Prof. Kawamoto Saitama University and progress of the PP at three local authorities was given to the participants. The number of participants consisted of approximately 200 people from 122 organizations. The agenda and the summary of attendance is shown as below table.

Table 2-136: The agenda of the PP intermediate report seminar

Time	Activity	
08.00- 9.00	Registration of participants & Tea	
09.00-09.15	Welcome and opening remarks	Director General of CEA
09.15 - 09.45	Key note	Chairman of CEA
9.45 – 10.15	Present Pollution Aspects of Solid Waste Management in Sri Lanka	Director MSW, CEA
10.15-10.50	"Shibhushi Model" & Future of Solid Waste Management in Sri Lanka	Deputy Director General, Waste Management, CEA
10.50 - 11.30	Concept of SATREPS Guide	Professor Ken Kawamoto, University of Saitama, Japan
11.30 - 12.00	Utilization of Draft 3Rs Manual & Landfill Site Operational Manual	Chief Consultant -ReEB Waste Project
12.00 - 13.00	Lunch	
13.00- 13.30	Introducing Pilot Projects Kurunegala MC	MOH, Kurunegala MC
13:30- 14.00	Rathnapura MC	MOH, Rathnapura MC
14.00-14.30	Katharagama PS	Secretary, Katharagama PS
14.30-14.55	Discussion	
14.55-15.00	Closing Remarks	Deputy Director General, Waste Management, CEA

Table 2-137: the summary of participants

Province	PS	UC	MC	Total
Southern	13	3	3	19
North Western	11	1	1	13
Eastern	10	2	1	13
Western	9		3	12
Northern	6	2	1	9
North central	7		1	8
Sabaragamuwa	7	1	1	9
Uva	8			8
Central	7	3		10
Unknown	2			2
Sub total	80	12	11	103
Uva province				1
JICA				1
CEA Head office				1
CEA Uva				1
WMA				1
MoMDE				1
NSWMSC				1
Univesity				2
Others				10
Total				122

Presentation by Prof. Kawamoto

Seminar Participant

Presentation by MCK

2.15.3 PP Final Report Seminar

The PP final report seminar was held on 31 January 2019 at the auditorium of Central Environmental Authority. Usage of ”Manual for Improvement of Solid Waste Disposal Site” and ”Manual for 3Rs Promotion” and PP at three local authorities were given to the participants. The number of participants consisted of approximately 170 people from 140 organizations. The agenda and the summary of attendance is shown as below table.

Table 2-138: The agenda of the PP final report seminar

Time	Activity	
08.00- 9.00	Registration of participants	
09.00-09.10	Welcome	Director General of CEA
09.10- 09.15	Opening remarks	JICA Sri Lanka Office
09.15 - 09.45	Key note	Chairman of CEA
9.45 – 10.15	Pollution Management Aspects in SWM & Environmental Standards	Deputy Director General, Environmental Pollution Control -CEA
10.15- 10.45	CEA SWM initiatives for 2019 (Action Plan)	Deputy Director General, Waste Management, CEA
10.45-11.15	Proposed New National Waste Management Policy	Dr P. Batuwitage, Former Additional Secretary Ministry of Environment
11.15-11.30	*Tea Break*	
11.30-11.45	Findings and Recommendations of Pilot Projects	Dr Naofumi Sato – Chief Consultant ReEB Waste Project
11.45- 12.15	Utilization of 3R Manual & Landfill Operational Manual	Director National Solid Waste Management Support Centre
12.15 – 12.45	Progress of Pilot Projects	
	Rathnapura MC	MOH, Rathnapura MC
12.45-13.00	Kurunegala MC	MOH, Kurunegala MC
13.00 -13.30	Katharagama PS	Secretary/DO/Site Manager Katharagama PS
13.30-13.55	Discussion	
13.55-14.00	Closing Remarks	DDG, Waste Management, CEA
14.00-15.00	*Lunch*	


Opening remar


Welcome speech

Q1

Why did you select Kurunegala MC, Rathnapura MC and Katharagama PS as pilot project areas among 10 local authorities?

Answer

Critical observations and evaluations were done in LA level to identify the correct LAs to initiate the pilot projects. Also considered the counterpart decisions and problems related to land ownership and etc. All the decisions were discussed and finalized in the stakeholder meetings.

Q2

Ehaliyagoda PS is collecting 10 – 12 tons of waste per day. We don't have enough financial strength to purchase collection vehicles and gully bowsers. Land issue also in a critical stage for dumping the waste. What is the possibility of giving CEA support to Ehaliyagoda PS?

Answer

Ministry already imported 100 compactors and another 190 will be imported within this year. We will distribute those vehicles in coming months by considering on how much waste generation, how much waste collected, efforts done by LAs so far to manage the waste.

CEA is not responsible for finding a land for every small LA. CEA has selected lands for dumping in national level but not for regional level. CEA will only give technical support for waste dumping lands in regional level.

Q3

Balangoda MC is doing composting since 17 years ago. Our 2 acres landfilling site capacity is over now. Bailing machine is broken, bob cat machine is older than 10 years and what can be our alternatives for these issues?

Answer

LA should handle the situation in a creative manner. There are some institutes who are giving loans for LAs in a very low interest rate. Also LA can move in to some money earning alternatives through waste management and that earning can be dispatched for other sections too.

Q4

Ruwanwella PS was planned to have a landfilling site in year 2018. But still we couldn't achieve it. We were able to participate in a night soil treatment program which I funded by World Bank. Now we are facing financial issues even for tractor tailor repairing, bob cat tire purchasing and etc. We are having some earnings from sales of compost, sales of PET/ plastic bottles. But the cost for waste management is really high. So we are unable to give good

service for the residence in PS area. It would be really grateful if CEA can support in small things such as purchasing 3 tractor tailors and bob cat tires. Also, give us an opportunity to have JICA support to establish the landfilling site as soon as possible.
Answer
Ruwanwella landfilling site which is in Kegalle district is already approved by CEA. We will get all the resources and support from government to establish the landfilling site in near future.
Q5
Agalawatta PS is doing composting since 2009 under a PILISARU project. Compost production is 10 tons per month and sales price is Rs. 12 per 1kg. Income will be used to pay incentives for labors at composting yard. Also we received 2 crusher machines for recycling items under a PURA NAGUMA project. Crusher machines consume higher electricity power and PS cannot afford the cost. I believe we can improve the situation for recyclable items and use the crusher machines effectively with the support from CEA. Also collection through gully bowsers are transported to Galkissa treatment facility it takes a higher cost too. So it's better if we can have a night soil treatment facility within our PS area.
Answer
If you cannot pay the electricity bills for crusher machine, we can give crusher machines for another LA those who are able to manage it properly. Some LAs are not using machines, vehicles distributed by CEA 1 or 2 years ago. We should avoid this kind of situations. If we cannot use that particular machine or vehicle, we should give it to a LA those who can use it. Also every LA should share the available equipment/ machine and resources with other LAs.

2.16 D.1: Pilot Project Evaluation

2.16.1 Kurunegala MC

(1) PRB

The installation of PEB was started on 27July2018 and completed on 27 August 2018. The underground water samplings at two monitoring wells were conducted before construction in July 2017, during construction in August 2018 and after construction in October and November 2018. Although the high value of "Fe"; 63.46 (mg/l) at Bor.No1 and 32.83 mg/l at Bor.No.2 during the construction was detected, the low or less 0.01 value of those were detected after the construction. Since the majority of value of EC, COD ,BOD_5 TSS and Pb at Bor.No2 is less than Bor.No1 after the construction, PRB seems to function to improve some parameters by filtration.

Table 2-139: The comparison of EC, COD, BOD5, TSS, Pb and Fe before, during and after construction of PRB

Parameter	Sampling month	Monitoring well**	
		Bor. No1	Bor.No2
EC mS/cm	July2017	3.33	3.94
	Aug2018	3.88	3.29
	Oct2018	4.52	4.16
	Nov2018	4.99	4.53
COD (mg/l)	July2017	80	80
	Aug2018	98	49
	Oct2018	64	44
	Nov2018	86	40
BOD_5 (mg/l)	July2017	4	5
	Aug2018	16	26
	Oct2018	25	16
	Nov2018	13	7
TSS (mg/l)	July2017	432	268
	Aug2018	1352	67
	Oct2018	547	235
	Nov2018	2904	64
Pb mg/l	July2017	<0.01	<0.01
	Aug2018	0.04	<0.01
	Oct2018	<0.01	<0.01
	Nov2018	<0.01	<0.01
Fe (mg/l)	July2017	<0.01	<0.01
	Aug2018	63.46	32.83
	Oct2018	0.33	1.09
	Nov2018	<0.01	<0.01

(2) Leachate treatment facility

The leachate collected at the bottom of slop of current disposal site is pumped up to the existing night soil treatment facility. Since the clogging during the pumping up easily happens, regular cleaning of pumping system by Kurunegara MC is required.

As of January 2019, the night soil treatment facility sometimes does not function well due to over loading of night soil. But it is expected to function soon after the sewage project lunches and proper amount of night soil is loaded to night soil treatment facility.

Table 2-140: Comparison between influent and effulent at leachate treatment faciltiy

No	Item	Date	Influent	Effluent	Tolence
2	EC	July2017	33.5	-	-
	mS/cm	Aug2018	20.6	1.17	
		Oct2018	4.81	1.87	
		Nov2018	10.10	2.43	
4	COD	July2017	10000	-	(1)<250mg/l
	(mg/l)	Aug2018	6002	148	
		Oct2018	9178	98	
		Nov2018	1512	363	
5	BOD_5	July2017	348	-	(1)<30mg/l
	(mg/l)	Aug2018	194	20	
		Oct2018	241	10	
		Nov2018	136	76	
6	TSS	July2017	212	-	(1)<50mg/l
	(mg/l)	Aug2018	254	60	
		Oct2018	936	88	
		Nov2018	276	158	
12	Total	July2017	>16000	-	(1)-
	Coliforms	Aug2018	>16000	9200	
		Oct2018	>16000	>16000	
		Nov2018	>16000	>16000	
13	Fecal	July2017	16000	-	(1)40MPN/100ml
	Coliforms	Aug2018	16000	5400	
		Oct2018	16000	9200	
		Nov2018	16000	3500	

(3) Landfill mining

According to composition analysis and current waste amount at old disposal site, the approximately 7 years life time is expected to extend with landfill mining.

2.16.2 Ratnapura MC

(1) Intermediate evaluation

a. Outcome of the pilot project

In Ratnapura MC, the PP was conducted based on the Action Plan from 2018 to 2022, which was developed in cooperation with ReEB Waste Project and Ratnapura MC. Since the PP has been conducted towards targets of the first year (2018) of the Action Plan, outcome of the PP is evaluated in a way of comparison with 2018 target in the Action Plan. The table below shows the targets written in the Action Plan. Target values of the PP are highlighted in blue.

Table 2-141: Transition toward 2022 in the Action Plan of Ratnapura MC

	Situation in 2017	2018 PP-1	2019 PP-2	2020	2021	Target In 2022
No. of HH doing home compost (%)	6.0 (2014)	6.9%	8.0	9.0	10.0	10.0
Receiving amount of biodegradable waste at Kanadola (ton/day)	2.3	5.3	8.6	11.8	15.0	15.0
Compost production at Kanadola (ton/month)	2.3	5.3	8.6	11.8	15.0	15.0
Receiving amount of recyclable items (ton/day)	2.9	3.7	14.9	14.9	14.9	14.9
Sales amount/ Receiving amount (%)	4.8	10	10	20	30	40
Sales amount of recyclable wastes at Kanadola (ton/day)	0.14	0.37	1.49	3.00	4.47	5.78
Final disposal amount (ton/day)	38.5	35.3				20.1

The following table describes progress to the targets as of July 2018. Regarding (1). No. of HH doing home compost has been achieved by distributing 250 home compost barrels in the project.

All the status figures of (2). (4). and (7). are constantly available at Kanadola site from the monitoring of amounts of collection, treatment and disposal respectively shown in 2.14.2. Although target of (2). was achieved in May 2018 at once, the numerical number in July 2018 was lower because of lack of monitoring for night shift workers and data handling persons, since records of numbers of trips and fill factor during night shift in Kanadola by night shift workers, which was conducted once in May 2018, it was stopped after that. Currently, since Ratnapura MC is expanding biodegradable separation at the generation level by distributing separation bins to 5 GN divisions other than the PP areas (the PP was conducted in 4 GN divisions), it is expected to achieve this target at the final evaluation in November 2018, together with the instruction to night shift workers and data handling persons. With regard to (4). Incoming amount of recyclable items, the result was about half of that in 2017, but recovery percentage (selling amount / incoming amount) increased as shown in the achievement of (6) Average sales amount. Daily final disposal amount in (7) dramatically decreased with achievement of the target of 2022. Although baseline data was obtained from one week survey during May 2017 and from a survey during WACS in October to November 2017, implemented dengue programmes throughout 2017 associated with dengue epidemic in Ratnapura 2017 and disaster wastes from heavy flooding at the end of May 2017 may cause relatively higher baseline values.

Other than that, (3) and (6) were acquired from sales data book maintained at Kanadola site. In Ratnapura it normally takes 3-4 months to produce compost, however, it took much longer period because a skid loader had not been available from January to June 2018 for compost turning, which was assumed to be used in windrow system compost yard for increased amount of biodegradable waste from PP areas, and had to rely on an excavator that was only available several times during the half year. For this reason, there is a possibility that production amount of compost was not the same as amount of biodegradable waste that was received 3-4 month ago.

Table 2-142: Outcome of the PP in Ratnapura (as of July 2018)

In Ratnapura MC as a whole	Situation in 2017	Plan in 2018	Actual in July 2018
(1). No. of HH doing home compost (%)	6.0 (2014)	6.9	6.9
(2). Receiving amount of biodegradable waste at Kanadola (ton/day)	2.3	5.3	4.6
(3). Compost production at Kanadola (ton/month)	2.3	5.3	2.5
(4). Receiving amount of recyclable items (ton/day)	2.9	3.7	1.4
(6). Average Sales amount of recyclable wastes at Kanadola (ton/day)	0.14	0.37	0.46
(7). Final disposal amount (ton/day)	38.5	35.3	19.8

As shown in 2.10.2, waste separation percentage is another indicator of PP outcome, of which target is 90%. Since not all areas in Ratnapura MC have had the new waste separation categories applied, this indicator is evaluated only in 4 PP areas. Following table shows before and after PP of waste separation percentage by waste category. In 2017 when 2 waste separation categories were applied, biodegradable and non-biodegradable wastes separation percentage were 60.1% and 96.5% respectively. Both of biodegradable and non-biodegradable wastes were discharged in shopping bags before starting the PP, and although collected biodegradable wastes, of which actual percentage of biodegradables consists 60.1%, all of them used to be dumped at the dump site.

Awareness raising and monitoring activities after distribution of waste separation bin to PP areas made biodegradable waste separation percentage massively increase to 96.6-99.9% from 60.1%. Currently collected biodegradable waste from the PP areas is not dumped but used for composting. Also, as

confirmed in the outcome of non-biodegradable waste separation percentage in July 2017, namely 99.8-100%; meaning the amount of biodegradable waste contaminating (mixed in) the waste collected as non-biodegradables was extremely low. Therefore, waste separation percentage has been increased in Ratnapura MC.

However, as described in the outcome of targeted non-biodegradable waste separation percentage in July 2018, although there are 4 non-biodegradable waste categories i.e. plastic/polythene, paper, glass/metal/coconut shell, and others, percentage of targeted non-biodegradable waste out of collected waste as targeted non-biodegradable remains 64.0-74.3% (therefore 25.7-36.0% are non-targeted non-biodegradable wastes). For the purpose to increase this figure to 90%, awareness raising and monitoring was evaluated in November 2018.

Table 2-143: Waste separation percentage before and after the PP

Types of waste	2017 (2 separation categories)	July 2018 (5 separation categories)
Biodegradable waste (Biodegradable waste/Collected wastes as biodegradables)	60.1%	96.6-99.9%
Non-biodegradable waste (Non-biodegradable waste/Collected wastes as non-biodegradables)	96.5%	99.8-100%
Targeted non-biodegradable waste (Targeted non-biodegradable waste/Collected wastes as targeted non-biodegradables)	-	64.0-74.3%

b. Capacity assessment

Factors that effect the above mentioned waste separation percentage are:

- Understanding of waste separation by drivers and collectors as well as waste collection and transportation of separately discharged waste
- Implementation of public awareness raising initiatives

In Ratnapura MC, awareness raising program and distribution of equipment in accordance with start-up of new waste separation categories in the PP started in December 2017 and has been ongoing, and collection and transportation of new waste separation categories in all 4 PP areas started since February 2018. Therefore, from June to July 2018, that is a half year since starting the new waste separation

categories, a project member and an evaluator assigned by Ratnapura MC evaluated the drivers, waste collectors and supervisor for around a month, in addition to above mentioned survey of waste separation percentage. Evaluation items are summarised in the following table.

At the same timing, self-evaluation regarding above described 'Implementation of public awareness raising' were also implemented by PHI, supervisors and overseers.

Table 2-144: Evaluation items

Object person	Evaluation item	Detailed evaluation contents
Collectors and drivers	Knowledge	- Knowledge of collection route - Knowledge of type of waste to collect - Knowledge of collection days of the collected waste - Knowledge of collection days by type of wastes in a route
	Preparation	- Having necessary sanitary items - Having necessary equipment to collect separated wastes separately
	Behaviour	- Collecting separated waste separately - Not collecting non-targeted waste - Dealing with tools and equipment neatly - Taking care of collected wastes during transportation - Recovering materials (picking up valuable items)
	Communication	- Communicating with public regarding simple matter - Instructing public if necessary - Communicating with public regarding advance matter - Identifying issues - Reporting/ Sharing issues to/ with supervisors and upper mangers
	Cooperation	- Cooperation
Supervisor	Knowledge	- Knowledge of collection route - Knowledge of type of waste to collect - Knowledge of collection days of the collected waste - Knowledge of collection days by type of wastes in a route - Knowledge of equipment distribution (PP activities) - General knowledge of area specific issue
	Preparation	- Having a leaflet of a route area
	Relationship with public	- Communicating with public regarding simple matters - Instructing public if necessary - Communication with public regarding advanced matters
	Instruction to drivers and collectors	- Instructing drivers/ collectors if necessary
	Problem solving skill	- Identifying issues - Reporting/ Sharing issues to /with appropriate upper managers

Evaluation results are given in the following figures. Basically, collection of biodegradable wastes got higher scores than non-biodegradable wastes collection. About non-biodegradable collection, although supervisors have relatively good level of knowledge, this knowledge has not been transferred to drivers and collectors who are in charge of non-biodegradable waste collection.

These results were shared with (C) PHIs, supervisors, overseers, drivers, collectors etc. in Ratnapura MC in August 2018, therefore, it is expected to improve outcome of non-biodegradable waste separation percentages in the final evaluation planned in November 2018.

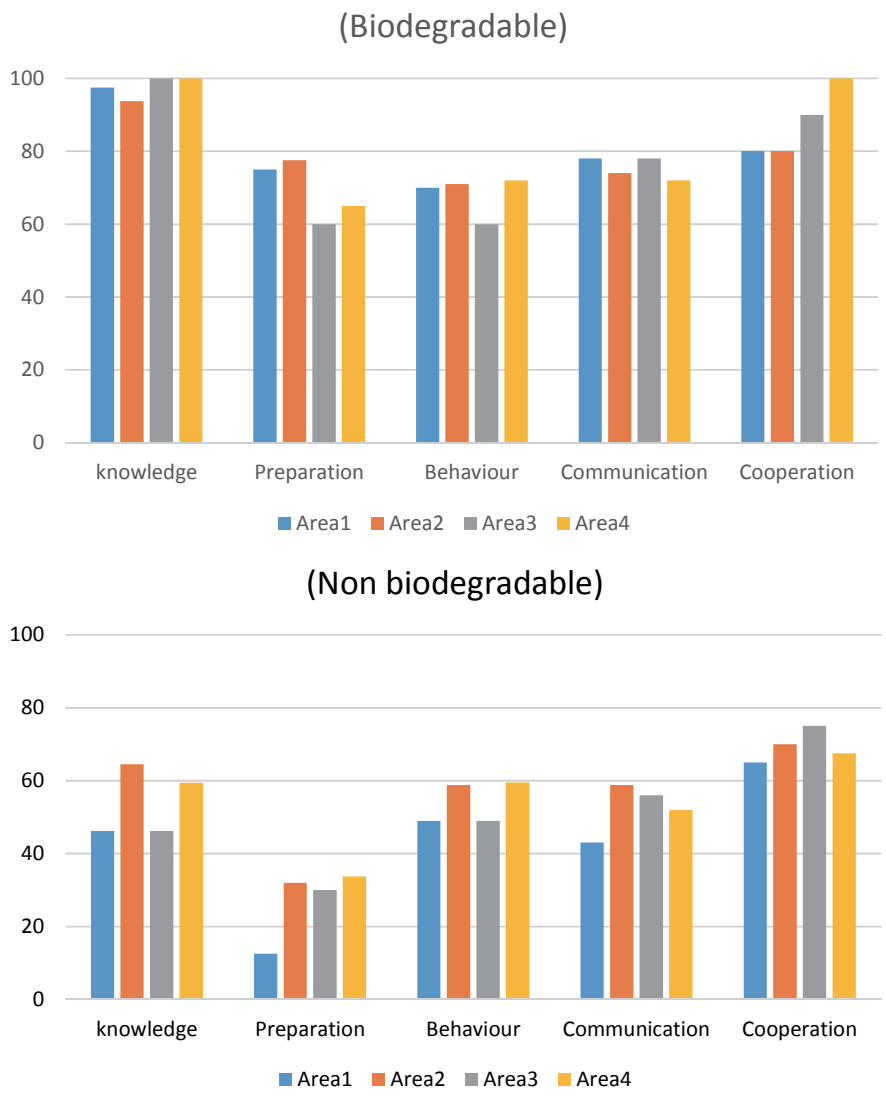


Figure 2-82: Evaluation results of drivers and collectors

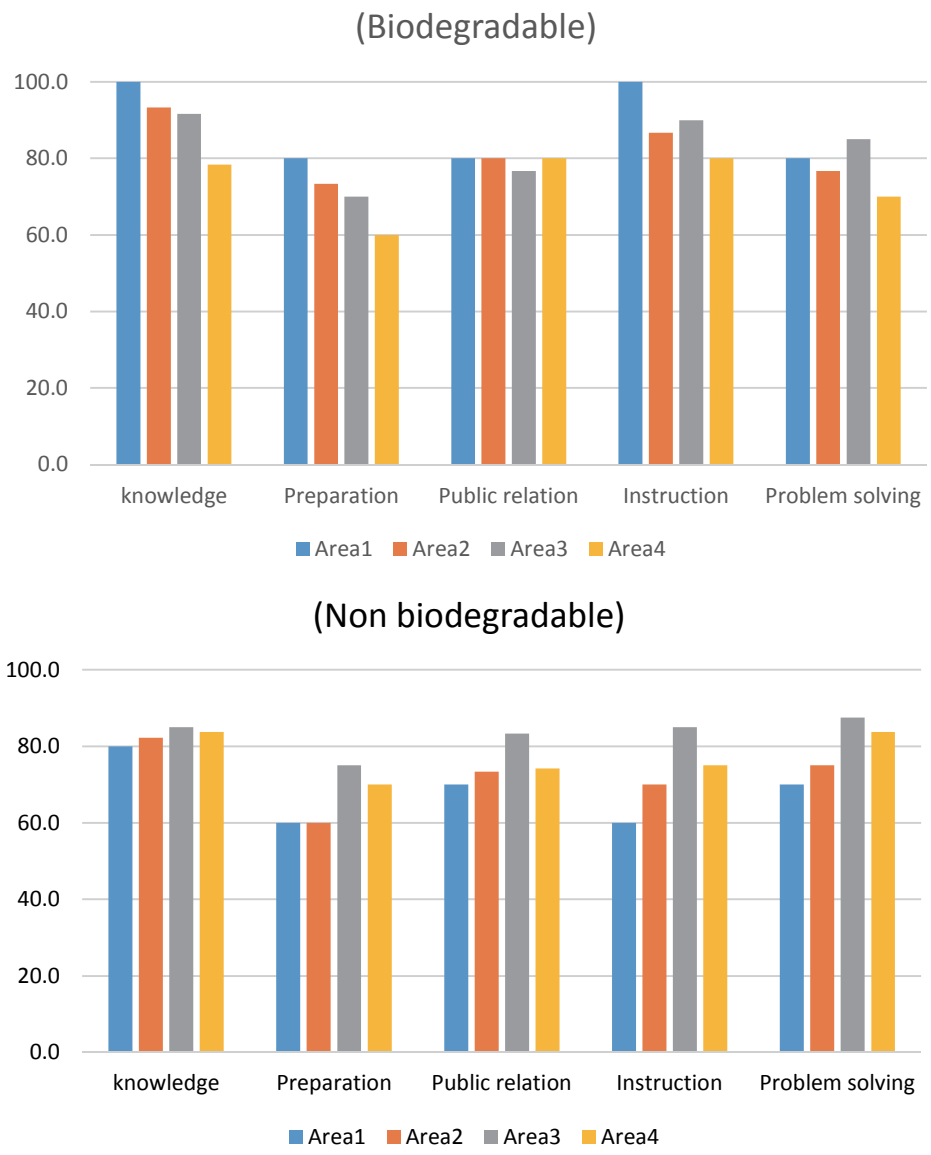


Figure 2-83: Evaluation results of supervisors

(2) Final evaluation

a. Questionnaire survey after the pilot project

Questionnaire survey after the pilot project was conducted in October 2018, previous of which was conducted in October 2017 before starting the project, so those results are compared. The survey method

was same as the one conducted in 2017. The following shows the respondents information and some representative results.

Table 2-145: Respondents information of questionnaire survey in RMC

	Household		Commercial	
	October 2017 (Before the PP)	October 2018 (After the PP)	October 2017 (Before the PP)	October 2018 (After the PP)
Total number of respondents	200	179	143	78
Area 1 Batugedara	56	85		
Area 2 Town	0	0		
Area 3 Kospalawinna	48	42	143	78
Area 4 Muwagama	96	52		
Age of respondents	50.5	51.4		
Gender of respondents				
Female	44%	38%		
Male	56%	62%		
Number of family member on average	4.2	4.3		

Before starting the pilot project, although RMC had been applying two waste separation categories, 18% of household respondents and 10% of commercial respondents had not been practicing waste separation. After the pilot project, however, 99% of household respondents and 98% of commercials respondents answered that they separate their wastes.

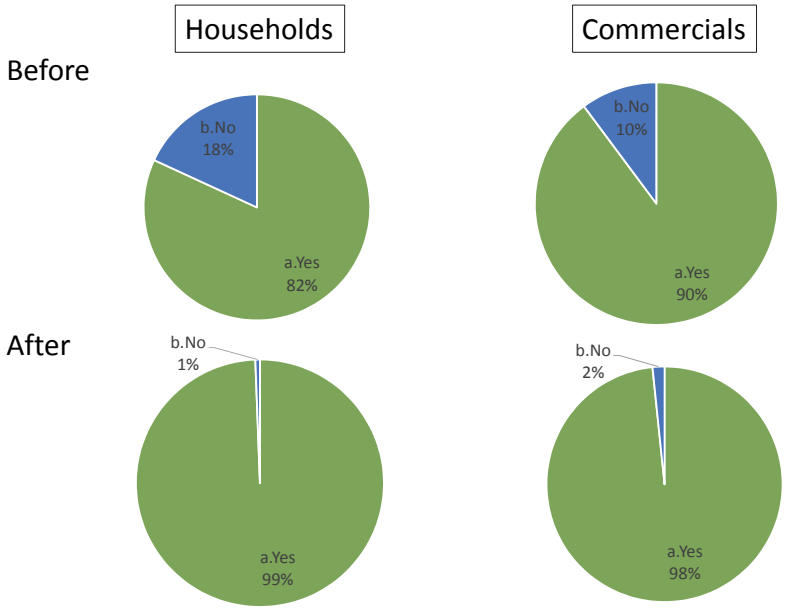


Figure 2-84: Are you separating wastes?

Regarding self-disposal method show in the figure below, 71 households and only 14 households answered that they burn wastes and practice home compost respectively before the pilot project, whereas the number of those burn wastes has decreased and make compost has increased to 27 households after the project.

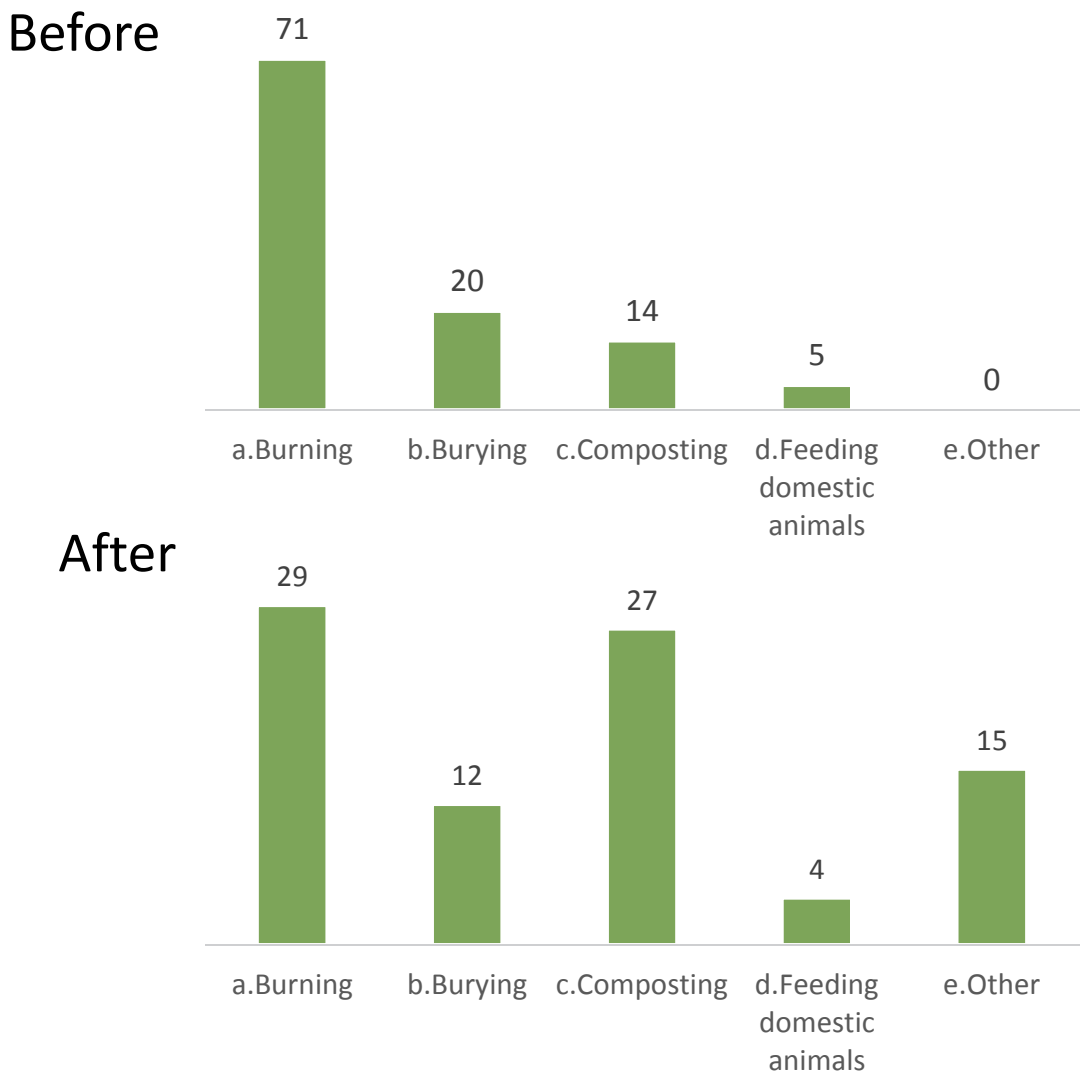


Figure 2-85: (For households) If self-disposing, how are you treating the wastes?

As shown in the following table, the percentage of shopping bag which used to be the main material in discharging, has significantly decreased from 49% to 3%, which is one of the most successful part in the pilot project.

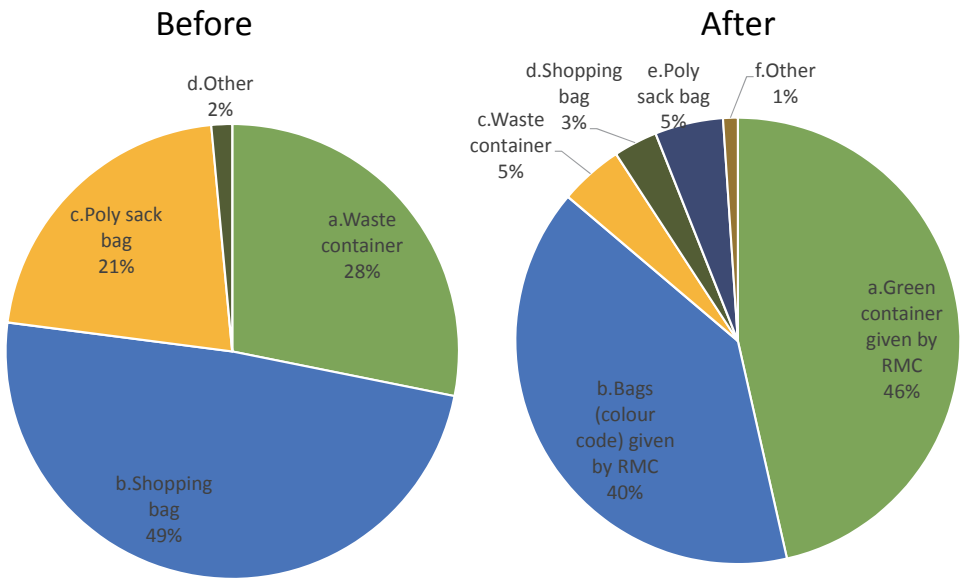


Figure 2-86: (For households) How do you discharge your wastes?

During the pilot project, information on collection days and time has been repeatedly provided for households and commercials in the pilot project areas. As shown in the following figure, those information are recognised by most of the residents and commercials.

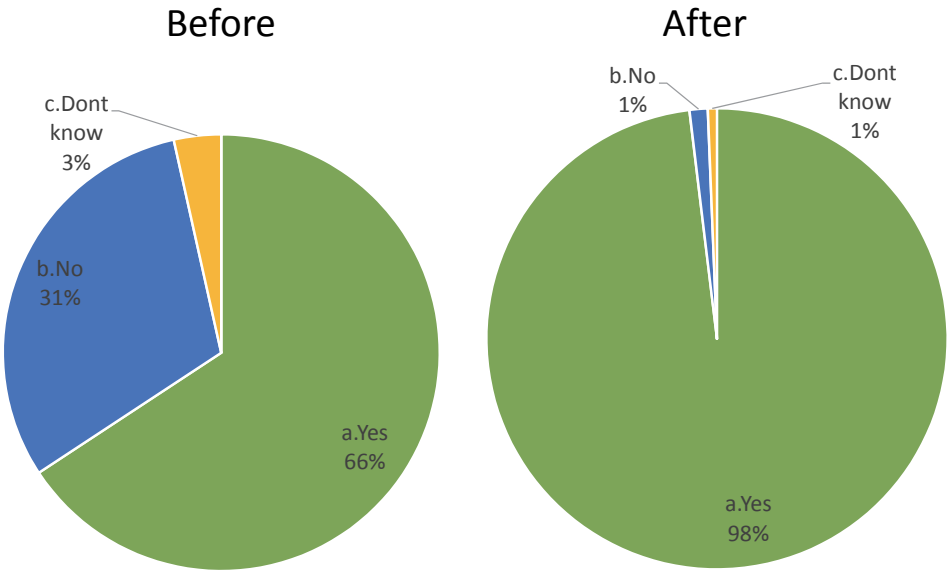


Figure 2-87: (For households) Does RMC provide information on collection day/time?

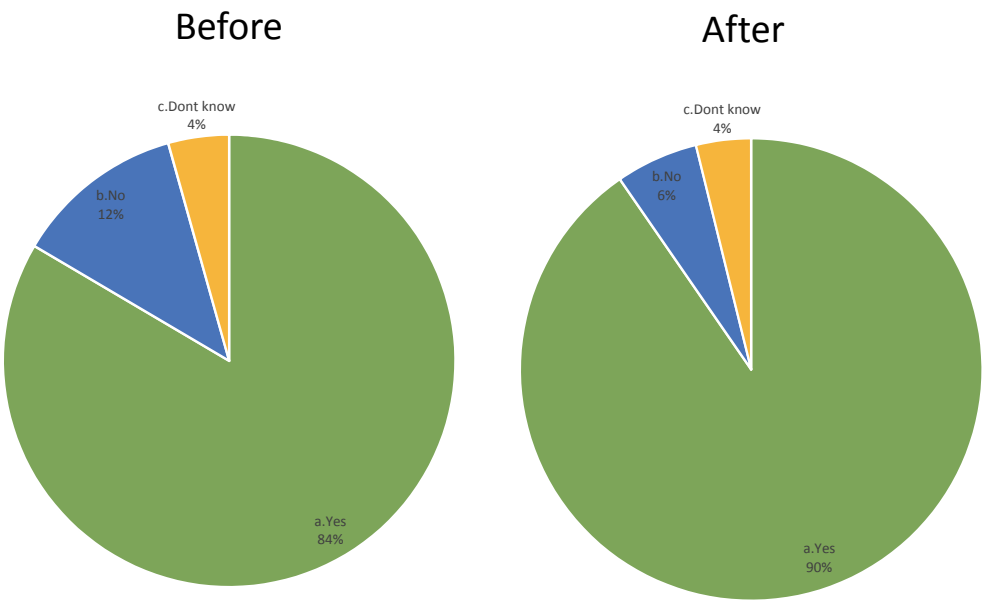


Figure 2-88: (For commercials) Does RMC provide information on collection day/time?

Satisfaction on SWM service provided by RMC seems to be improved throughout the pilot project.

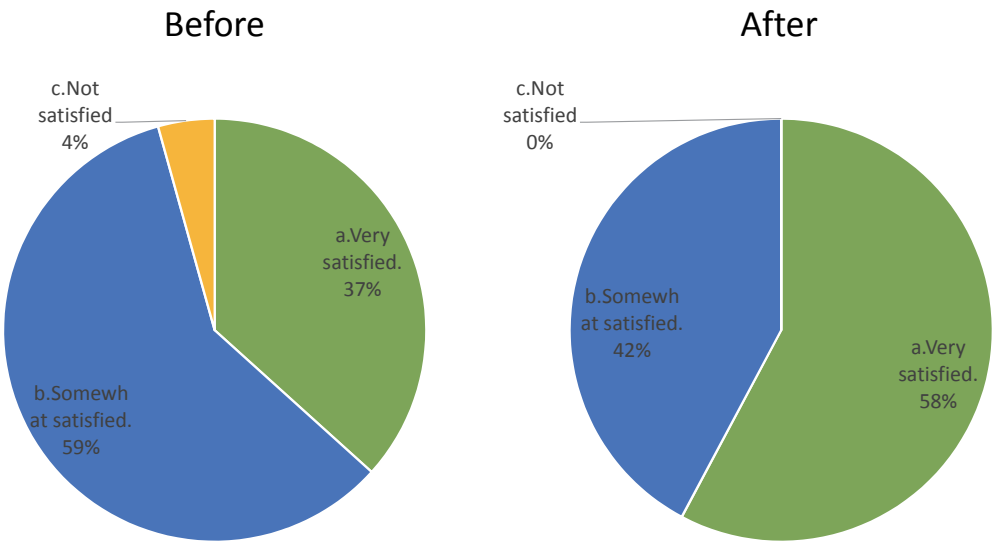


Figure 2-89: (For households) How do you satisfy with solid waste management service provided by RMC?

The percentage of those who know 3Rs and have heard about 3Rs was less than 20% before the pilot project, however, as a result of the pilot project, close to 70% residents now know about or have heard about 3Rs.

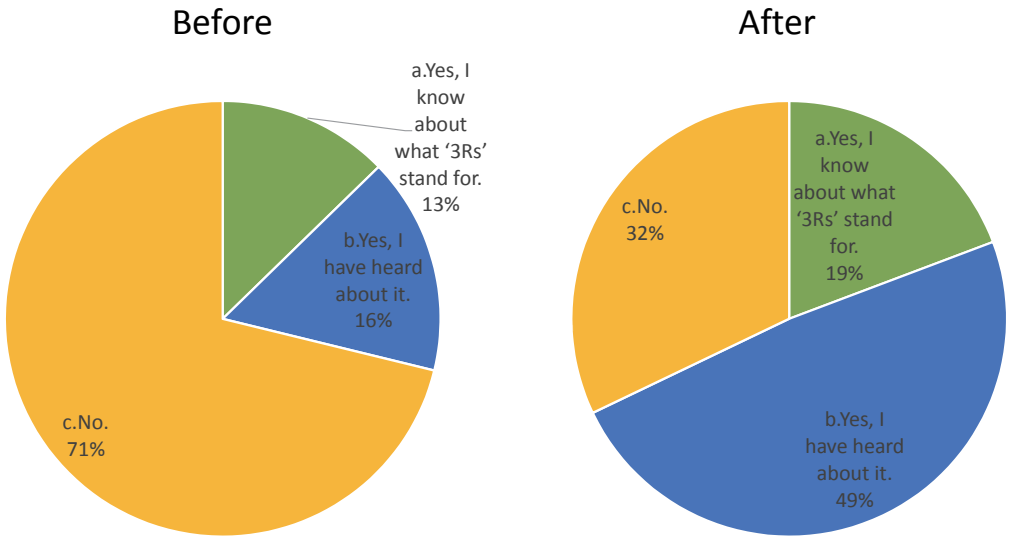


Figure 2-90: (For household) Do you know 3Rs?

b. Pilot project outcome

The final pilot project outcome is listed in the table below

Table 2-146: Outcome of 3Rs pilot project in RMC

Items	Before September 2017	After PP in July 2018	After PP in Nov 2018	Target in 2018 of Action Plan
Number of household doing home compost	6 % (2014)	6.9 %	6.9%	6.9%
Receiving amount of biodegradable waste at Kanadola (ton/day)	2.3	4.6	5.3	5.3
Production of compost at Kanadola (ton/month)	2.3	2.5	2.5	5.3
Receiving amount of recyclable items (ton/day)	2.86	1.4	2.3	3.7
Sales of recyclable wastes at Kanadola (ton/day)	0.14	0.46	0.37	0.37
Final disposal amount (ton/day)	35.76	19.8	28.5	35.3

Waste separation percentage of non-biodegradable wastes, which was below the target of 2018 in the intermediate evaluation conducted in July 2018, was confirmed again in the final evaluation. The result is summarised in the following table. Waste separation percentage of targeted non-biodegradable waste has improved in comparing the intermediate evaluation, but still could not achieve the target of the Action Plan. In the final evaluation, only one sample among 14 samples composed about 4% of biodegradable wastes in the collected waste as non-biodegradables and remaining all 13 samples did not include biodegradable waste in non-biodegradable waste collections.

Table 2-147: Percentage (%) of bio-degradable waste amount to collection amount as "bio-degradable waste

Timing of evaluation	Area 1	Area 2	Area 3	Area 4	Average
Before PP in September 2017	43.65	58.82	65.98	72.11	60.14
After PP in July of 2018	99.12	97.23	99.05	98.28	98.42
After PP in November 2018	Evaluation was not conducted				

Table 2-148: Percentage (%) of correctly separated recyclable material as 5 categories to separate collection waste amount

Timing of evaluation	Area 1	Area 2	Area 3	Area 4	Average
Before PP in Sep 2017	No category of recyclable material collection				
After PP in July of 2018	74.3	68.6	64.0	71.4	69.6
After PP end of 2018	73.0	85.5	76.3	86.0	80.2

2.16.3 Rehabilitation of a final disposal site in Kataragama PS

The 1st monitoring committee was held on 17 November 2018 and the result of monitoring was summarized below table.

Table 2-149: Result of 1st monitoring committee

No	Items	Acceptable	Medium	Terrible	Score
Rate		0	1	2	
A1.	Fire & Smoking	11	0	0	0
A2.	Offensive dour	11	0	0	0
A3.	Waste water control	10	1	0	1
A4.	Withering of trees caused by discharged waste	11	0	0	0
A5.	Waste scattering	10	1	0	1
A6.	Animals (Wild elephants, Dogs, monkeys etc.)	10	1	0	1
A7.	Vermin (Flies etc.)	11	0	0	0
A8.	View	7	4	0	4
A9.	Entry of scavenger (If no scavenger is the site : select "0")	11	0	0	0
Total of Category A					7

No	Items	Functioning	Medium	No functioning	Total Score
Rate		0	1	2	
Landfill site					
B1.	Drainage system				
	B1-1.Rip pap	9	1	1	3
	B1-2.Earth drain	5	3	1	5
B2.	Leachate collection & treatment system	4	2	2	6
B3.	Gas ventilation system	8	1	1	3
B4.	Fence	7	0	1	2
	B4-1.Hanging type electric fence	9		1	2
	B4-2.Normal fence	7	1	1	3
B5.	Access road				0
	B5-1. in Landfill site	8	1	1	3
	B5-2. Cause way	6	2	1	4
B6.	Security facilities				
	B6-1.Gate	9	0	1	2
	B6-2.Security house	8	1	0	1
B7.	Waste scattering prevention net fence	8	0	1	2
B8.	Turffing	1	6	2	10
Compost plant					
B9.	Night soil treatment facility	3			0
B10.	Weight bridge	5			0
Total of Category B					46

2.16.4 Promotion of 3Rs in Kataragama PS

(1) Monitoring for waResult of Step 1 (Bio-degradable waste separation)

The second Waste Composition Survey was conducted in order to see the impact of the pilot project's Step 1, in which the community was requested to separate bio-degradable waste from non-biodegradable waste.

a. Date of survey

From 21 June 2018 until 29 June 2018, and excluding the 27th June, a Poya holiday with no collection service.

b. Target Area of the Survey

b.1. Zone 3

b.2. Zone 1 and 4 (Although Zone 1 is not the target area of the PP, it has been covered by the same vehicle that operates in Zone 4 on each collection day, and the KPS has requested the community in Zone 1 to follow the same rules as in Zone 4. Therefore, the evaluation survey has been conducted without excluding this non-PP area.

c. Method of the Survey

All waste is brought to the Resource Center of KPS (the composting site) after collection from the community according to the collection schedule set under the PP as below.

- Days of bio-degradable waste collection: Monday, Wednesday, Friday, Sunday
- Days of non-bio-degradable waste collection: Tuesday, Thursday, Saturday

The following process thereafter was the same as in the baseline survey.

d. The result of Waste Composition Survey

d.1. Zone 3 (Refer to Appendix 24)

	Non Biodegradable 21/06/2018				Biodegradable 22/06/2018				Non Biodegradable 23/06/2018				Biodegradable 24/06/2018				Biodegradable 25/06/2018				Non Biodegradable 26/06/2018				Non Biodegradable 28/06/2018				Biodegradable 29/06/2018		
	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight		total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight
Kichen Waste	1.43		0.83	3.565936			361.4	97.35991	0		0	0			366.5				638.4	100	4.06		0.808	3.458	9.717366	0		0	0			659	99.63429
Grass and Wood	10.57		9.967	43.87649					9.769	0.598	8.165	22.92065									17.942	3.2	14.742	41.4264	15.169	0.83	14.339	41.83042				
Paper	2.107		1.527	6.766454					1.539	0.81	0.609	2.205719									1.308	0.612	0.694	1.950205	1.408	0.613	0.795	2.257309				N 1.365709
Textile	0.934		0.611	0.323	1.421968				0		0	0									0.949		0.61	0.339	0.952622	1.318		0.61	0.709	2.028368				
Soft Plastic	1.821		0.61	1.211	5.771517		9.8	2.640088	2.163		0.613	1.55	3.859466								2.47		0.62	1.85	5.186874	10.459		0.613	10.063	29.00999				
Hard Plastic	0.85		0.61	0.35	1.649832				0.888		0.634	0.362	0.901372								0.206		0	0.206	0.578878	1.061		0.668	0.453	1.303339				
Metal	0.619		0.61	0.009	0.902481				0		0	0									0		0	0	0	0		0	0	0				
Glass	0		0	0	0				0.223		0	0.223	0.555265								0		0	0	0	0		0	0	0				
Leather and Rubber	0		0	0	0				0		0	0	0								0		0	0	0	0		0	0	0				
Ceramic and Stone	0		0	0	0				0		0	0	0								1.523		0.613	0.91	2.557189	0		0	0	0				
King coconut combs	8.68		0.618	7.942	34.96368				27.335		0	27.335	68.09354								13.77		0.62	13.15	38.95273	8.378		0.607	7.769	22.35233				
Other	0.88		0.61	0.27	1.188642				1.208		0.608	0.6	1.492997								0.837		0.6	0.237	0.665992	1.023		0.61	0.413	1.18825				
Total Weight				22.715	100			371.2				40.161	100			366.5				638.4	100				35.586	100				34.757	100		659	100
Fill Factor					80				10			75				10				10					75				100			40	
Density (g/L)					175.62				307.26			335.03				519.667				595					363.83				319.8			252.612	
Total Volume (m^3)					7.0466				6.588			3.353				3.2832				3.2833					3.3048				3.3048			3.2858	

d.2. Zone 1 + 4 (Refer to Appendix 27)

	Non Biodegradable 21/06/2018				Biodegradable 22/06/2018				Non Biodegradable 23/06/2018				Biodegradable 24/06/2018				Biodegradable 25/06/2018				Non Biodegradable 26/06/2018				Non Biodegradable 28/06/2018				Biodegradable 29/06/2018		
	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight		total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight	Percentage	total weight	Container weight	Net weight
Kichen Waste	0	0	0	0			489.6	100	0	0	0	0			994.4	100			916	100	0	0	0	0	0	0	0	0			1910.6	100
Grass and Wood	3.665	0.66	3.005	27.03366					13.869	3.2	10.669	55.78562									5.728	0.613	5.11	39.62739	19.04	3.2	15.84	52.72092				
Paper	2.307	0.608	1.699	15.13318					1.537	0.81	0.91	4.75817									2.113	0.61	1.503	11.69488	4.904	0.612	4.911	13.28341				
Textile	0	0	0	0					0.665	0.588	0.077	0.402614									0.663	0.6	0.063	0.492366	2.848	0.6	1.748	5.81734				
Soft Plastic	2.424	0.611	1.813	16.14957					1.539	0.621	0.918	48									5.258	3.2	2.058	15.95367	5.052	3.2	1.852	6.164087				
Hard Plastic	1.51	0.607	0.903	8.04311					1.87	0.622	1.248	7.048366									2.153	0.613	1.54	11.94381	1.957	0.61	1.347	4.483278				
Metal	0	0	0	0					0.044	0	0.044	0.230965									0.142	0	0.142	1.101202	1.412	0.58	0.832	2.76918				
Glass	1.871	0.612	1.259	12.10473					1.09	0.622	0.468	2.447059									0.193	0	0.193	1.481194	1.362	0.58	0.782	2.603648				
Leather and Rubber	0	0	0	0					0	0	0	0									0	0	0	0	0.127	0	0.127	0.455983				
Ceramic and Stone	0	0	0	0					0	0	0	0									0	0	0	0	0	0	0	0				
King coconut combs	2.29	0.612	1.678	14.94611					3.019	0.61	2.409	12.58039									2.74	0.612	2.128	16.50292	1.18	0.58	0.58	1.930438				
Other	1.345	0.605	0.74	6.591253					2.89	0.605	2.285	11.94771									0.75	0.615	0.135	1.046917	3.533	0.609	2.926	9.738729				
Total Weight			11.227	100			489.6				19.125	100			994.4	100			916				12.895				30.045	100			1910.6	
Fill Factor				80				10				100				10				20					100				100			30	
Density				103.45				863.81				109.04				854.524				824.6					109.469				114.63			903.172	
Total Volume				4.86				4.86				4.86				6.897				6.897					6.897				6.897			6.897	

d.3. Composition of waste collected on the day of Bio-degradable waste collection

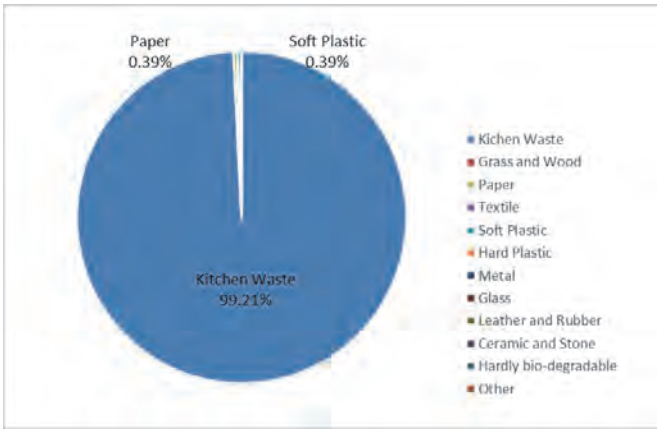


Figure 2-91: Zone 3 - Composition of “Bio-degradable waste”

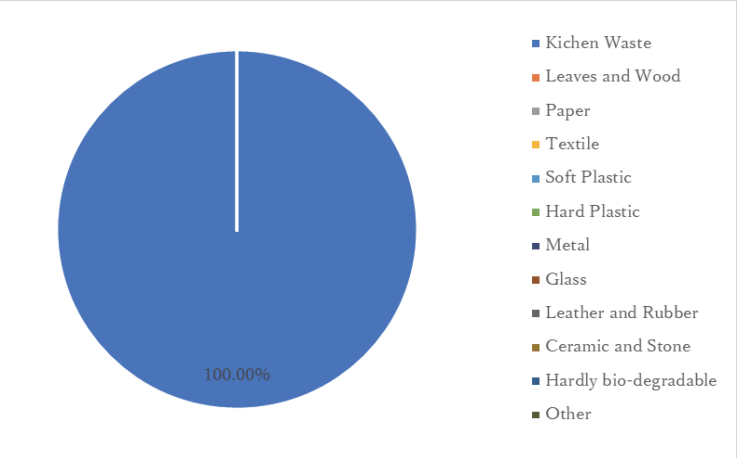


Figure 2-92: Zone 1&4 - Composition of “Bio-degradable waste”

d.4. Composition of Non bio-degradable waste collection

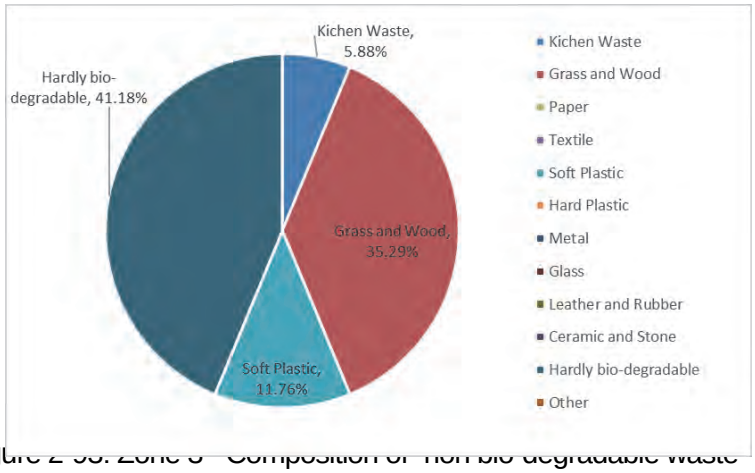


Figure 2-93: Zone 3 - Composition of “Non bio-degradable waste”

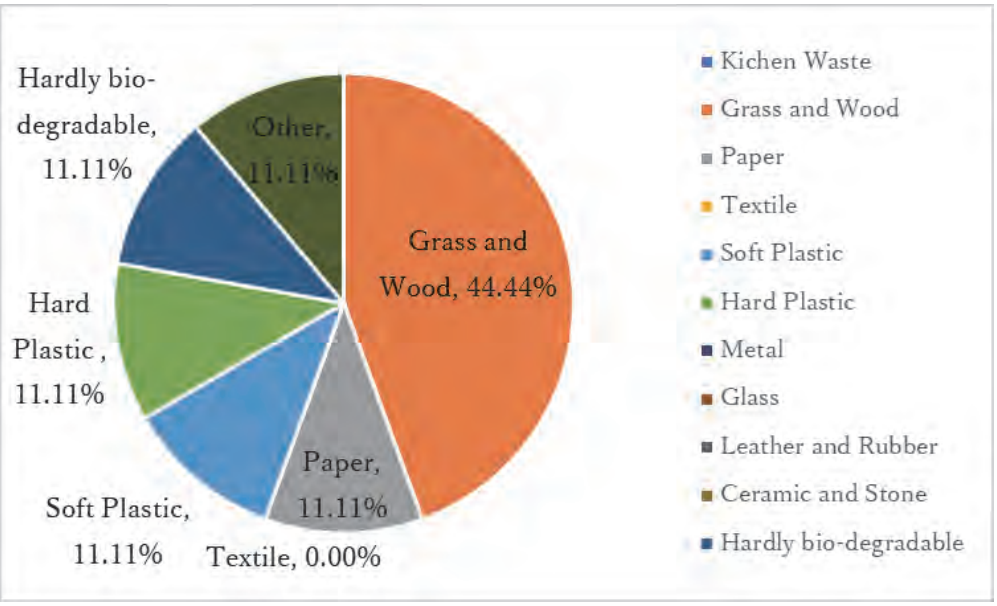


Figure 2-94: Zone 1&4 - Composition of "non bio-degradable waste"

d.5. The impact of Step 1

As shown in d.4. and d.5. above, Zone 4 (with Zone 1) successfully separated kitchen waste from the other waste, although "non-bio degradable waste" still contained a large portion (by weight) of garden waste as well as hardly bio-degradable waste.

The force behind this success was the commitment of the team of the collection vehicle driver, collection workers and the monitoring staff, although the area that is covered by this vehicle has been added to non-PP targeted (thus no provision of separation bins) area. They made sure that every discharged waste is separated, and otherwise they would not accept it. Another encouraging aspect to Zone 4 was that they had been provided the separation bins earlier, and they had a longer period of time to get themselves accustomed to the new practice than their cohorts in Zone 3.

Meanwhile, garden waste (grass and tree branches) are still discharged as "non bio-degradable" waste, even though the leaflet explains it is bio-degradable. This might be because bulky branches along with other hardly-degradable waste (such as banana branch, pineapple stem, king coconut shells, and other hard-shell of fruits) are currently excluded from bio-degradable waste and are sent to the landfill. Separating "garden waste" into "soft" garden waste

and “hard” garden waste could have been too confusing. This is expected to be solved after installing a chipping machine to the site.

(2) Result of Step 2 and the PP: Changes in Waste Composition.

The third waste composition survey was conducted in order to measure the impact of 3-category separation (Bio-degradable waste, Recyclables, and Other Waste) implemented during Step 2, targeting the waste transported in to the compost site.

a. Schedule of the Survey

From 11 November, 2018 to 18 November, 2018

b. Targeted area of the Survey

Zone 3 and Zone 4 combined with Zone 1 were targeted as the second WACS.

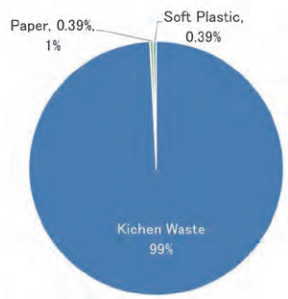
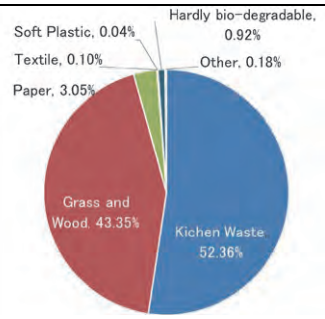
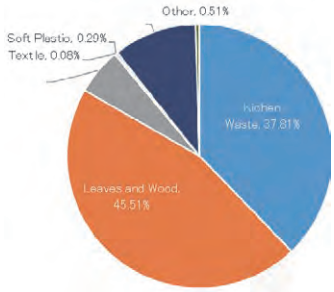
c. Method of the Survey

The waste collected according to the schedule developed in PP were surveyed as they were transported in to the compost site. The collection schedule is as following:

- Collection of Bio-degradable waste: Monday, Wednesday, Friday, Sunday
- Collection of Recyclables: Wednesday
- Collection of other waste: Tuesday, Thursday, Saturday

d. Result of the 3rd WACS and Comparison between pre-PP and post-PP

Progress of Separation of Bio-degradable Waste
Before the implementation of PP, waste was separated by workers on the loading compartment of a collection vehicle while collecting waste and by the time the waste was brought in to the compost site, so the waste brought in to the compost site was "separated". Under PP1, the days of collection for bio-degradable waste and non-biodegradable waste were designated respectively, and one load of a vehicle transported the waste in one category. On the other hand, hardly bio-degradable waste such as king coconut comb and banana stems were categorized as "other waste". Furthermore, the garden waste had not been recognized as bio-degradable waste as kitchen waste, and had not been separated by the people. When PP2 was initiated, a chipping machine was provided to the compost site, and the community was also informed "hardly bio-degradable waste" could now be discharged as "bio-degradable waste". At the same time, garden waste became recognized as bio-degradable waste which should be discharged together with kitchen waste.
Changes in “bio-degradable waste” in Zone 03

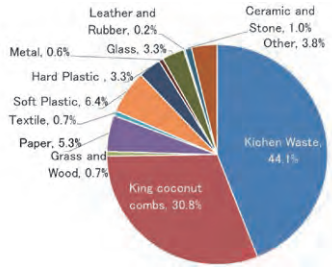
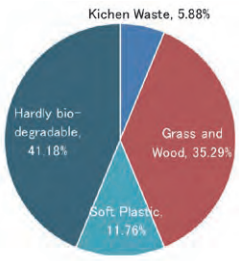
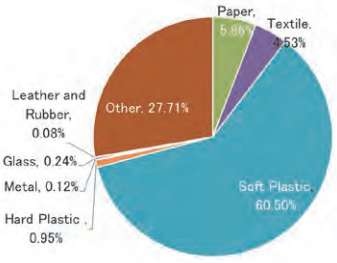
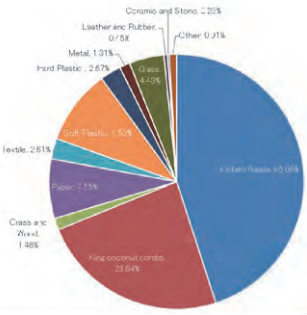
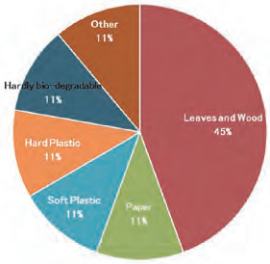
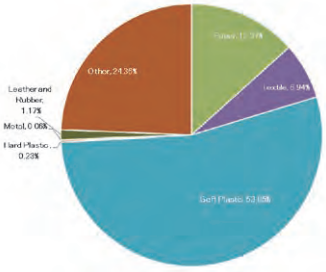
		
1st WACS (Before PP1)	2nd WACS (After PP 1)	3rd WACS (After PP 2)
Changes in “bio-degradable waste” in Zone 04		
		
1st WACS (Before PP1)	2nd WACS (After PP 1)	3rd WACS (After PP 2)

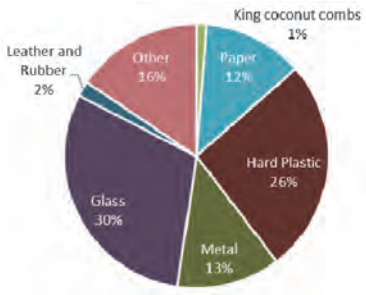
Progress of Separation of "Other Waste"

During PP1, separate collection of "recyclables" were not specifically instructed. Therefore, it had been expected that such recyclable waste would be found mixed with other waste until the second WACS. However, some private recyclable collection business had started operating frequently in KPS during the implementation period of PP1, the result of the second WACS did not find the recyclables discharged as much as expected. Soft plastic found in these survey mean that there is not market for them. In the third WACS, KPS themselves also implemented collection of "recyclables" (which already have destinations after being sold) on a designated day of a week, and "Other waste" no longer include such recyclables.

At the end of PP 1 (at the time of the second WACS), kitchen waste had no longer been found in the "other waste", and at the end of PP2 (at the time of third WACS) garden waste was no longer found either. Moreover, hardly bio-degradable waste, which is supposed to be "bio-degradable waste" but had been instructed to categorize in "other waste", has also become separated as "organic waste" by the time of the third WACS. These results show the high degree of acceptance of separate collection by the community as a result of the PP.

Changes in “Other Waste” in Zone 3

		
1st WACS (Before PP1)	2nd WACS (After PP 1)	3rd WACS (After PP 2)
Changes in “Other Waste” in Zone 04		
		
1st WACS (Before PP1)	2nd WACS (After PP 1)	3rd WACS (After PP 2)

Waste composition of “Recyclables” collected at the time of the third WACS
Zone 03（Data for Zone 04 was unable to collect.） In KPS, destinations of “Soft Plastic” (Polythene bags, shopping bags, plastic lunch sheets, etc) have not been found（supposedly due to the cost of transportation being a remote location of KPS）, and have not been put on the process for recycling. In future, it will be necessary to consider securing method and space for storing in bulk, and to establish a route for selling them. At the same time, reduction of soft plastic use should also be promoted.


(3) Result of Step 2 and the PP: Changes in People’s practices of waste discharge

The second public opinion survey was conducted in order to understand any changes in people's practice of waste discharge and their attitude toward waste management as a result of the PP.

a. Survey Schedule

19 November, 2018 to 22 November 2018

b. Target areas and number of samples

The PP target areas, Zone 03 and Zone 4, were targeted. The sample numbers in each area is as below.

Zone 03

Hotel	3
Guesthouse	35
Restaurant	4
Others*	13
Total	55

* Others (Zone 3)

Retail Shop	7
Fabric business	1
"Food city" super market	1
House	1
Not specified	3

Zone 04

Hotel	1
Guesthouse	32
Restaurant	2
Holiday Bungalow**	3
House	19
Retail Shop	1
Other (Not specified)	1
Total	59

c. Method of survey

A pair of interviewers visited each sample, selected randomly, and interviewed them used a structured questionnaire.

d. Result of the Survey

Major findings are as below.

1) Treatment of food waste

Separate discharge of food waste to KPS's waste collection services seems to be promoted successfully, especially in Zone 4. Zone 3 might have reflected the delay in distribution of separation bins.

a. discharged together with other waste to the regular collection service
b. discharged separately to the regular collection service

c. disposing together with other waste in own premises
d. disposing separately in our own premises
e. other

POS 2017

Zone 03

	a	b	c	d	e
Hotels	0	1	0	1	0
Guesthouse	0	8	11	11	0
Restaurants	0	0	0	1	0
Others	0	1	0	0	0
Total	0	10	11	13	0
	0	29%	32%	38%	0%

Zone 04

	a	b	c	d	e
Hotels	0	1	1	2	0
Guesthouse	2	7	1	2	0
Restaurants	0	1	0	0	0
Others	0	2	1	2	0
Total	2	11	3	6	0
	9%	50%	14%	27%	0%

POS 2018

Zone 03

	a	b	c	d	e
Hotels	0	3	0	0	0
Guesthouse	1	10	2	14	0
Restaurants	0	2	0	0	0
Others	0	11	1	1	0
Total	1	26	3	15	0
(%)	2%	57%	7%	33%	0%

Zone 04

	a	b	c	d	e
Hotels	0	1	0	0	0
Guesthouse	1	30	0	1	1
Restaurants	0	2	0	0	0
Holiday Bungalow	1	1	0	1	0
House	0	15	2	3	0
Retail Shop	0	0	0	0	0
Others	0	1	0	0	0
Total	2	50	2	5	1
(%)	3%	85%	3%	8%	2%

2) Method of self-dispose

Self-discharge, especially “burning” in Zone 03 is still widely in practice, while in Zone 4 it is no longer their option. Further promotion of composting, or stopping self-disposing, need to be done.

____ a. burning
____ b. feeding to domestic animals
____ c. burying in soil (but not using for gardening or farming)
____ d. burying in soil to use later for gardening or farming
____ e. composting using any composting container
____ f. other

POS2017

Zone 03

	a	b	c	d	e	f
Hotels	1	0	1	0	0	0
Guesthouse	16	3	4	2	0	0
Restaurants	0	0	0	0	0	1
Others	0	0	0	0	0	0
Total	17	3	5	2	0	1
	71%	13%	21%	8%	0%	4%

Zone 04

	a	b	c	d	e	f
Hotels	3	0	1	0	0	0
Guesthouse	2	0	0	0	0	0
Restaurants	0	0	0	0	0	0
Others	3	0	0	0	0	0
Total	8	0	1	0	0	0
	89%	0%	11%	0%	0%	0%

POS 2018

Zone 03

	a	b	c	d	e	f
Hotels	0	0	0	0	0	0
Guesthouse	14	1	8	0	2	0
Restaurants	0	0	0	0	0	0
Others	1	0	0	0	2	0
Total	15	1	8	0	4	0
(%)	67%	7%	33%	0%	5%	0%

Zone 04

	A	b	c	d	e	f
Hotels	0	0	0	0	0	0
Guesthouse	0	1	0	0	0	0
Restaurants	0	0	0	0	0	0
Holiday Bungalow	0	1	0	1	0	0
House	0	0	1	3	0	0
Retail Shop	0	0	0	0	0	0
Others	0	0	0	0	0	0
Total	0	2	1	4	0	0
	0%	40%	20%	80%	0%	0%

3) Treatment of Kitchen Waste

Those who use plastic bags (garbage bags ans shopping bags) to discharge kitchen wastes have decreased, contributing less amount of non-biodegradable waste to be discharge for bio-degradable waste collection.

____ a. types of container do you use? (Select one):

(1) Green waste bin purchased from Pradeshiya Sabha (marked as "dirana")
(2) Other kind of waste bin,
(3) garbage bag,
(4) shopping bag

POS 2017 ("(1) Green waste bin" was not available at the time of first POS)

Zone 03

	2	3	4
Hotels	1	0	0
Guesthouse	12	2	7
Restaurants	1	0	0
Others	1	0	0
Total	15	2	7
%	79%	11%	37%

Zone 04

	2	3	4
Hotels	2	1	0
Guesthouse	10	0	0
Restaurants	1	0	0
Others	1	0	0
Total	14	1	0
%	70%	5%	0%

POS 2018

Zone 03

	1	2	3	4
Hotels	1	1	0	0
Guesthouse	6	20	1	0
Restaurants	1	1	1	1
Others	0	2	7	4
Total	8	24	9	5
%	15%	44%	16%	9%

Zone 04

	1	2	3	4	n/a
Hotels	0	1	0	0	0
Guesthouse	7	14	3	8	0
Restaurants	0	2	0	0	0
Holiday Bungalow	1	2	0	0	0
House	4	7	1	7	0
Retail Shop	0	0	0	1	0
Others	1	0	0	0	0
Total	13	26	4	16	0
%	36%	72%	11%	44%	0%

4) Degree of acceptance of bio-degradable separation bins distributed by KPS (asked in POS 2018 only)

Most of them think what have been provided are appropriate in price, size, and quality, but they would need more in quantity.

Out of those who are using KPS's bin

a. price	Zone 03	Zone 04
a.1 too high	0	1
a.2 appropriate	8	11
a.3 too low	0	0
b. about the size	Zone 03	Zone 04
b.1 too big	0	0
b.2 appropriate	8	10
b.3 too small	0	2
c. about the number	Zone 03	Zone 04
c.1 need more	3	4
c.2 appropriate	4	4
N/A	1	0
d. about the quality	Zone 03	Zone 04
d.1 too good	2	4
d.2 appropriate	5	5
d.3 poor	1	2

5) Treatment of garden waste

In both zones, those who dispose their garden waste in their own premises have decreased, while those who discharge separately to the collection service have increased. Especially in Zone 4, those who used to discharge garden waste together with other wastes seem to have changed to discharge them separately.

Q. “Currently how is the garden waste treated?

____ a. discharged together with other waste to the regular collection service
____ b. discharged separately to the regular collection service
____ c. discharged separately to a garden waste collection service
____ d. disposing in own promises
____ e. other

POS 2017

Zone 03

	a	b	c	d	e	n/a
Hotels	1	0	0	1	0	0
Guesthouse	0	4	1	24	0	1
Restaurants	0	0	0	1	0	0
Others	0	0	0	0	0	1
Total	1	4	1	26	0	2
	3%	12%	3%	76%	0%	6%

Zone 04

	a	b	c	d	e	n/a
Hotels	3	0	0	0	0	0
Guesthouse	6	2	0	0	0	0
Restaurants	0	0	0	0	0	0
Others	3	0	0	0	0	0
Total	12	2	0	0	0	0
	63%	11%	0%	0%	0%	0%

POS 2018 (Out of those who have gardens)

Zone 03

	a	b	c	d	e	n/a
Hotels	0	1	0	0	0	0
Guesthouse	1	4	5	11	0	3
Restaurants	0	0	0	1	0	0
Others	0	2	0	0	0	0
Total	1	7	5	12	0	3
% (out of 28)	4%	25%	18%	43%	0%	11%

Zone 04

	a	b	c	d	e	n/a
Hotels	0	1	0	0	0	0
Guesthouse	0	8	9	3	0	0
Restaurants	0	0	1	0	0	0
Holiday Bungalow	0	2	1	0	0	0
House	1	7	2	2	0	1
Retail Shop	0	0	0	0	0	0
Others	0	0	0	1	0	1
Total	1	18	13	6	0	2
%(out of 37)	3%	49%	35%	16%	0%	5%

For those who are disposing garden waste in their own premises, burning is still the primary method, which should be discouraged.

"Q. If self-disposing, how are you treating the garden waste? "
____ a. burning
____ b. burying in soil (not using as compost)
____ c. burying in soil to use later for gardening or farming
____ d. composting using any composting container
____ e. other (Please specify:_____)

POS 2017

Zone 03 Out of 24 who have garden

	a	b	c	d	e	n/a
Hotels	1	0	0	0	0	0
Guesthouse	21	0	0	0	0	1
Restaurants	1	0	0	0	0	0
Others	0	0	0	0	0	0
Total	23	0	0	0	0	1
(%)	96%	0%	0%	0%	0%	4%

Zone 04 Out of 19 who have garden

	a	b	c	d	e	n/a
Hotels	3	0	0	0	0	0
Guesthouse	6	2	0	0	0	0
Restaurants	0	0	0	0	0	0
Others	3	0	0	0	0	0
Total	12	2	0	0	0	0
(%) (out of 19)	63%	11%	0%	0%	0%	0%

POS 2018

Zone 03(out of 12 those who dispose in "own's premises")

	a	b	c	d	e
Hotels	0	0	0	0	0
Guesthouse	8	2	1	0	0
Restaurants	1	1	0	0	0
Others	0	0	0	0	0
Total	9	3	1	0	0
(%)	75%	25%	8%	0%	0%

Zone 04 (Out of 6 who dispose in "own's premises)

	a	b	c	d	e
Hotels	0	0	0	0	0
Guesthouse	2	1	0	1	0
Restaurants	0	0	0	0	0
Holiday Bungalow	0	0	0	0	0
House	1	2	1	0	0
Retail Shop	0	0	0	0	0
Others	0	0	1	0	0
Total	3	3	2	1	0
%	50%	50%	33%	17%	0%

6) Recyclable (Valuable) Waste

More people seem to be more consciously discharging recyclable waste separately for recycling, although it should be further promoted. The result of POS 2018 shows that people are now aware of the KPS's services of recyclables collection and utilizing it more than private recyclers.

"Q. What kinds of valuable waste do you discharge? Please select all applicable, and provide us the following information."

a. There is no recyclable discharged.
b. I don't know what recyclables we have in our waste.
c. We have recyclables but do not separate them.

d. Glass
e. PET,
f. Other Plastic
g. newspaper,
h. cardboard,
i. paper in general,
j. iron
k. aluminium
l. other metal
m. others(1),
n. others(2)

<u>POS 2017</u>

Zone 03

	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Hotels	0	0	0	2	2	0	1	1	0	0	0	0	1	0
Guesthouse	2	0	8	16	5	3	2	2	2	1	0	0	1	0
Restaurants	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	8	19	7	3	3	3	2	1	0	0	2	0
% (out of 55)	4%	0%	16%	38%	14%	6%	6%	6%	4%	2%	0%	0%	4%	0%

Zone 04

	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Hotels	1	2	0	2	1	1	1	0	0	0	0	0	0	0
Guesthouse	3	3	0	7	2	0	2	1	0	0	0	0	1	0
Restaurants	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Others	2	3	0	2	1	0	1	0	0	0	0	0	1	0
Total	6	8	0	12	5	1	4	1	0	0	0	0	2	0
% (out of 21)	29%	38%	0%	57%	24%	5%	19%	5%	0%	0%	0%	0%	10%	0%

POS 2018

Zone 03

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	n/a
Hotels	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Guesthouse	0	0	0	20	14	13	11	12	10	13	7	5	8	0	0	15
Restaurants	0	0	0	3	2	2	2	2	2	2	2	0	0	0	0	1
Others	0	0	0	11	0	1	0	1	1	0	0	0	1	0	0	2
Total	0	0	0	37	16	16	13	15	13	15	9	5	9	0	0	18
% (Out of all 55)				67	29	29	24	27	24	27	16	9	16	0	0	33

Zone 04

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	n/a
Hotels	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Guesthouse	7	0	3	27	19	18	17	17	17	16	8	5	4	0	0	2
Restaurants	0	0	0	1	2	2	2	1	1	1	1	1	0	0	0	1
Holiday Bungalow	1	1	0	2	2	1	2	2	2	2	2	0	0	0	0	0
House	2	0	0	14	12	12	11	10	11	10	2	0	6	0	0	2
Retail Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Others	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0
Total	10	1	3	46	35	34	33	31	32	30	14	6	10	0	0	6
% (Out of all 59)	17	2	5	78	59	58	56	53	54	51	24	10	17	0	0	10

"Q. To whom are you discharging such recyclables?"

Discharging recyclables (a): to Pradeshiya Sabha; (b) to private recycler

*POS 2017 could not collect valid data for this question.

POS 2018

Zone 03

	d.		e.		f.		g.		h.		i.		j.		k.		l.		m	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Hotels	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guesthouse	12	11	8	10	11	10	7	8	8	12	7	7	8	5	6	5	5	4	4	8
Restaurants	3	0	2	0	2	0	2	0	2	2	2	0	2	0	2	0	0	0	0	0
Others	11	0	1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1
Total	29	11	11	10	13	10	10	8	11	15	9	7	10	5	8	5	5	4	4	9
% (Out of 37 who answered)	76	29	29	26	34	26	26	21	29	39	24	18	26	13	21	13	13	11	11	24

Zone 04

	d.		e.		f.		g.		h.		i.		j.		k.		l.		m	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Hotels	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Guesthouse	24	4	16	3	16	2	16	1	16	2	16	2	11	6	8	0	3	2	4	2
Restaurants	1	0	2	0	1	0	2	0	2	0	1	0	1	0	1	0	1	0	0	0
Holiday Bungalow	3	0	3	0	2	0	3	0	3	0	3	0	3	0	3	0	1	0	1	1
House	14	1	12	0	12	0	11	0	12	0	12	0	6	4	2	0	0	0	1	6
Retail Shop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0
Total	43	6	34	3	32	2	33	1	34	2	33	2	22	10	15	0	5	2	6	9
% (Out of 53 who answered)	81	11	64	6	60	4	62	2	64	4	62	4	42	19	28	0	9	4	11	17

7) About the Pradeshiya Sabha's collection services

In general, people seems to be satisfied with the current services. On the other hand, those who did not answer to this question could be the key sector for full implementation of the system in the entire KPS area. This portion of business may be the one which have not registered themselves for KPS's waste management, and it suggested that integration of this segment into the service is necessary.

"Q. Have you been provided with leaflet and necessary explanation about waste discharging rules?"

____ a. Yes. (separation categories/ collection schedule/ discharging methods)
____ b. No.

POS 2018

Zone 03

	a	b	n/a
Hotels	3	0	0
Guesthouse	10	11	14
Restaurants	3	0	1
Others	10	0	3
Total	26	11	18
%	47%	20%	33%

Zone 04

	a	b	n/a
Hotels	1	0	0
Guesthouse	31	0	1
Restaurants	1	1	0
Holiday Bungalow	3	0	0
House	12	1	6
Retail Shop	0	0	1
Others	1	0	0
Total	49	2	8
	83%	3%	14%

"Q. What do you think of the current collection rules?"

____ a. Very good
____ b. Good
____ c. OK
____ d. Not so good
____ e. Bad

POS 2018

Zone 03

	a	b	c	d	e	n/a
Hotels	1	2	0	0	0	0
Guesthouse	3	6	4	1	0	21
Restaurants	2	0	1	0	0	1
Others	6	5	0	0	0	2
Total	12	13	5	1	0	24
%	22%	24%	9%	2%	0%	44%

Zone 04

	a	b	c	d	e	n/a
Hotels	0	1	0	0	0	0
Guesthouse	12	16	1	2	1	0
Restaurants	1	0	0	0	1	0
Holiday Bungalow	1	1	1	0	0	0
House	4	10	2	0	0	3
Retail Shop	0	0	0	1	0	0
Others	0	1	0	0	0	0
Total	18	29	4	3	2	3
	31%	49%	7%	5%	3%	5%

"Q. What aspects of the collection services should be improved? (check all applicable)"

____ a. Separation categories are confusing
____ b. Collection frequency is not sufficient (for which waste?: Bio-degradable/ Recyclables/ Others)
____ c. Collection does not come on schedule
____ d. Leaflet is not easy to understand
____ e. Instruction from Pradeshiya Sabha's collection staff is not clear enough
____ f. Containers for separation of recyclables should be provided.
____ g. Signboards are not established in appropriate locations.
____ h. Explanation on signboards is not clear.
____ i. Attitude of Collection workers
____ j. Other:
____ k.

Zone 03 (could not obtain data)

Zone 04

	a	b	c	d	e	f	g	h	i
Hotels	0	0	0	0	0	0	0	0	0
Guesthouse	1	0	3	0	0	0	1	0	2
Restaurants	0	1	0	0	0	1	0	0	0
Holiday Bungalow	0	0	1	0	0	0	0	0	1
House	0	0	3	0	0	0	1	1	2
Retail Shop	0	0	0	0	0	0	0	0	1
Others	0	0	0	0	0	0	0	0	0
Total	1	1	7	0	0	1	2	1	6

Comment (Zone 04)
Collecting workers throw collecting bins (3)
Should improve disciplines
Do not put in to the bin. Because, the mouth of the bin is small and cannot unload easily.
Collection is not done by any vehicle in this area
Collection workers do not visit and collect waste
another method to inform while vehicles going through cross roads

(4) Outcome of 3Rs pilot project in KPS

Items		Before PP in Sep 2017	After PP in July 2018	After PP in Nov 2018	Target in 2018 of Action Plan
Bio degradable	ton/day	1.7	1.6	3.5	1.9
Recyclable	ton/day	0.4	0.2	0.3	0.6
Others waste	ton/day	8.3	3.7	0.4	8.0
Total received waste	ton/day	10.4	5.5	4.2	10.5
Final disposal	ton/day	8.3	3.7	0.4	8.0

(5) Conclusions and Implications for Future Implementation

The PP in Katharagama Pradeshiya Sabha took two steps to successfully implement separate collection of recyclable waste including bio-degradable waste. The results described above indicates the following:

a) Starting with simple 2-category separation of bio-degradable and non-biodegradable wastes was easy to be accepted, with proving ample information about why it is necessary and how beneficial it would be, through layers of activities including distribution of leaflet to door to door, site visit to the compost facilities by dischargers, and community meetings explaining the separation rules and intentions of the new rules.

b) Starting with separation of bio-degradable waste made it easier to further separate other recyclables at the recycling facility as well as at the discharging points.

c) For bio-degradable waste separation, distribution of separation bins which are in appropriate size and quality for both dischargers and collection workers, was an encouraging element. The timing of distribution seems to be crucial. If implementing in several zones, all zones should be provided with bins simultaneously (which requires administrative capacity of a local government).

d) Collection crew's strong commitment to keeping the rules during operation is necessary, being the first counterface with dischargers.

e) Allocation of field staffs, while maintaining close communication with the official in charge of SWM of the local government, to monitor the collection service and discharging practice was essential especially in the early stage of implementation when people need to understand and get used to the details of the rules.

D.2: Preparation of a Manual for Improvement of Existing Waste Disposal Site

The Draft Manual for the Improvement of the Existing Waste Disposal Site is being prepared among the NSWMSC, CEA and JICA team. The draft content is shown as below.

Chapter 1 Risk Finding & Environmental Monitoring	
1.1. Introduction	3.8. Leachate treatment facility
1.2. Methodology for Risk Finding	3.8.1 Basic component of leachate treatment system
1.2.1. Selection of attributes	3.8.2 Design Considerations
1.2.2. Allocation of scores and sensitivity	3.8.3 Calculation for Leachate generation volume
1.2.3. Risk evaluation	
1.2.4. Risk management: Action plan for mitigation of risk	3.8.4 Examples of low cost treatment trains
	3.8.5 A case studies of low cost treatment train
1.2.5. Identification of policy options for risk management	3.8.6 Advanced leachate treatment methods (options) in SATREPS guide
1.2.6. Implementation of policy options	3.9. Landfill administrative facilities
1.3. Environmental Monitoring	3.9.1 Site office and workers rest room
1.3.1 Purpose of environmental monitoring	3.9.2 Security
1.3.2 Typical parameters for environmental monitoring	3.9.3 Weigh bridge
	3.9.4 Access road
1.3.3 Formation of leachate and landfill gases from waste landfills	3.9.5 Landfill site protection against wild animal issues
	3.10. Buffer zone
Chapter 2 Landfill Site Selection	3.11. Rain water/ storm water management
2.1. Introduction	3.11.1 Rain water collection & drainage of landfill slope
2.1.1 Overview	
2.1.2 Potential site screening	3.11.2 Storm water management system

2.2. Ranking candidate sites 2.3. Factors to be Considered for Landfill Site Selection 2.4. Criteria for landfill site selection 2.5. Assessment for Landfill Site Selection 2.6. Methodology for Landfill Site Selection 2.7. Administrative planning and public consensus building 2.8. Conceptual site design and operational plan 2.9. Preliminary cost estimation 2.9.1. Process of public consultation Chapter 3Planning & Designing of Landfill facility 3.1. Introduction 3.2. General requirements 3.3. Preliminary survey and studies 3.3.1 Planning 3.3.2 Surveys 3.4. Geomechanics and slope stability 3.4.1 Geomechanics 3.4.2 Turfing slope 3.5. Liner System 3.5.1 Liner System 3.5.2 A case study of design for Landfill liner 3.6. Permeable Reactive Barrier (PRB) 3.7. Leachate Collection Pipe networks	Chapter 4Construction 4.1. Procedure of construction phase 4.2. Case studies of construction/rehabilitation of landfill site 4.2.1 Working procedures of the landfill construction/rehabilitation 4.2.2 Earth works 4.2.3 Installation of Liner system 4.2.4 Installation of the leachate treatment 4.2.5 Installation of the PRB 4.2.6 Leachate pipe networks 4.3. (Reference) Cost information Chapter 5Operation & Management 5.1. Legal Requirements for Operation and management 5.2. Operation plan 5.2.1 Securing sufficient number of staffs 5.2.2 Access Control 5.2.3 Landfilling 5.2.4 Spreading / Compaction 5.2.5 Working face 5.2.6 Soil Covering 5.2.7 Leachate control management 5.2.8 Gas management 5.3. Monitoring of operation and environmental impacts and their records 5.3.1 Weighing 5.3.2 Operation records 5.3.3 Environmental monitoring and its records 5.3.4 Landfill mining test 5.4. Closure Plan

2.17 D.3: Preparation of a 3Rs Promotion Manual

'3Rs Promotion Manual (tentative name)' has started to be developed to encourage promotion of 3Rs in Sri Lanka, with the experiences of PPs in Ratnapura MC and Katharagama PS in phase II of ReEB waste project, results of surveys conducted by a long term expert, and visits to Shibushi City Japan by CEA officers and other relevant officers of the PP sites. Target readers of this manual are assumed to be relevant officers in charge of SWM in LAs and PCs. The table below shows the content and details of the manual. These were shared in the Intermediate Report Seminar held on 30 August 2018 to the participants (refer to 2.15.2) by Dr. Sato, the leader of ReEB Waste Project. Completion and distribution of the manual are planned to be in January 2019 after the discussion with CEA and other relevant organisations, and it will be shared to the participants at the final seminar.

Table 2-150: Summary of contents of the 3Rs promotion manual

Content	Details
Chapter 1 Introduction	
1. What is 3Rs?	- Explanation of 3Rs – Reduce, Reuse, Recycle
2. Target wastes	- Types of waste this manual covers
3. Requirement	- Necessity of PDCA cycle in SWM
	- Expected readers of the manual and their roles in SWM
	- Introduction of policy and legal requirement related to 3Rs
Chapter 2 Survey and Planning	
4. Waste flow	- Terminology used in Waste Flow
	- Ways to make Waste Flow – Current, Future with 3Rs activities, Future without 3Rs activities
5. Action Plan	- Understanding of current status of SWM
	- Ways of survey (POS, recycling survey etc)
	- Assessment of current SWM and identification of issues
	- Introduction of linked activities for current issues
	- Introduction of detailed activities
6. Waste Amount and Composition Survey	- Plan and preparation of WACS
	- Flow of WACS
	- Example of result of WACS
Chapter 3 Implementation and Monitoring	
7. Waste Generation and Discharge	- Approaches that LAs have to implement in related to waste generation and discharge
	- Introduction of equipment for 3Rs promotion (separation bin, compost barrels, etc)
	- Examples of tools (leaflet, notice board, etc)
	- Ways and tips of home compost practice
	- Awareness raising activities conducted by LAs
	- Monitoring of public discharge practice by LAs
8. Waste Collection and Transportation	- Approaches that LAs have to implement in related to waste collection and transportation
	- Examples of waste collection plans
	- Examples of waste collection method (installed equipment for workers handling, collection with set of collection points, bell collection, etc.)
	- Monitoring of collection and transportation by the use of GPS and monitoring sheet
9. Intermediate Treatment	- Approaches that LAs have to implement in related to intermediate treatment of waste
	- Operation and management of intermediate treatment in general i.e. resource and financial perspective
	- Ways of data acquisition of waste amount with/without weigh bridge
	- Introduction of compost and its process flow
	- Comparison of couple of different composting technique
	- Introduction of biogas and MRF
Chapter 4 Capacity Development and Communication	
10. Capacity development	- Introduction of results of workers satisfaction survey
	- Importance of SWM training, contents of training and contact numbers of training organisations
11. Communication with other relevant parties	- Introduction of results of recycling industry survey
	- Relationship with other stakeholders i.e. NGOs, media

2.18 D.4: General Advices for Development of New Landfill Project

2.18.1 Kurunegala

JICA Project Team gives Kurunegala MC general technical advice for development of Sundarapola landfill project. The contents of landfill facilities are shown as below;

- Waste discharge cell
- Embankment
- Leachate collection facility (liner sheet, collection pipe)
- Storm water drain and so on

In response to the decision of Kurunegala MC, further advice was given, mainly to make the slope gentler and to cover it in turf as closure techniques of the existing landfill site.

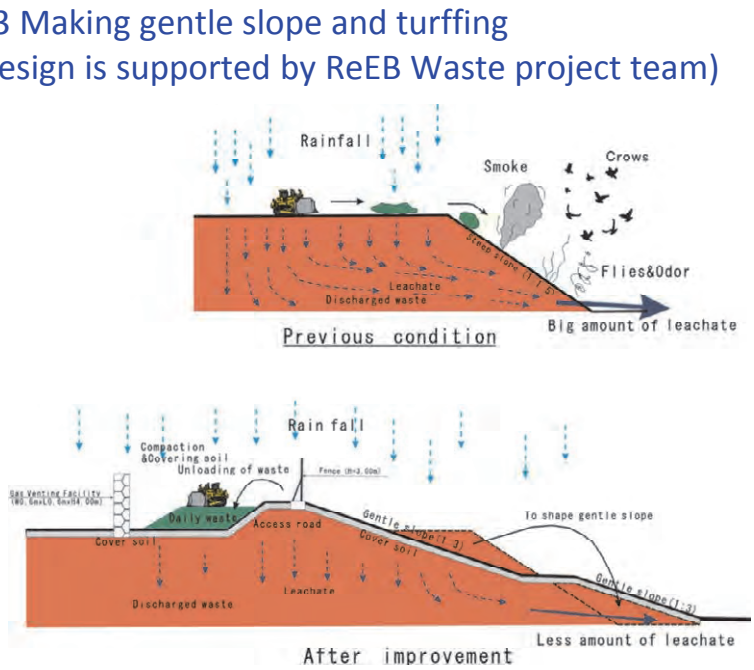
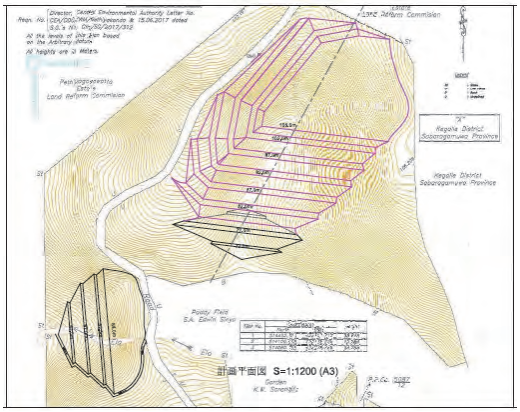


Figure 2-95: Making gentle slope and turfing for closure of the landfill site (from discussion material)

2.18.2 Gampaha

JICA Project Team gives CEA general technical advice of the plan of sanitary landfill site at Aththanagalla in Gampaha district which is at the design stage. Technical advice consists of concept design of plan and cross section of disposal site as below.



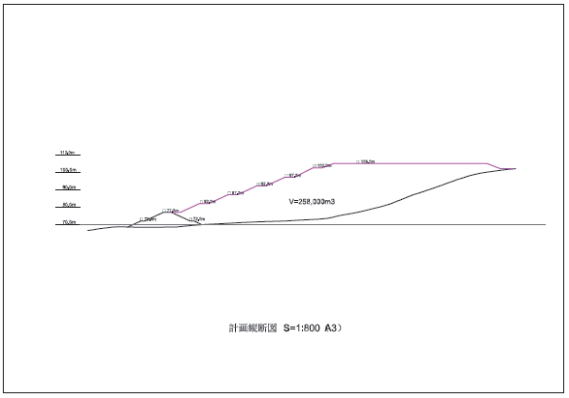


Figure 2-96: The plan and cross section of sanitary landfill site at Athuthanagalla in Gampaha district

2.18.3 Ratnapura

Since the current Sundarapora disposal site causes serious environmental issues because of poor management and operation, Ratnapura MC plans to establish a new sanitarily landfill site. JICA Project Team gives CEA general technical advice on the proposal of the sanitary landfill site. The contents of the proposal are shown as below.

Chapter 1 Introduction
Chapter 2 Project objectives
2.1 Vision, Mission, goal and objective
2.2 Justification of the project
2.3 Beneficiaries
2.4 Project sustainability
Chapter 3 Outline and current condition of Ratnapula MC
3.1 Outline of Ratnapura MC
3.2 Current condition of solid waste management of Ratnapura MC
3.2.1 Legal provisions to deal with solid waste
3.2.1.1 National environmental Act
3.1.1.2 Municipal council's ordinance
3.1.1.3 Fisheries and aquatic resources Act
3.2.1 Organization of solid waste management
3.2.1 Discharging, collection and disposal of waste
Chapter 4 Current condition of existing Kanadora disposal site

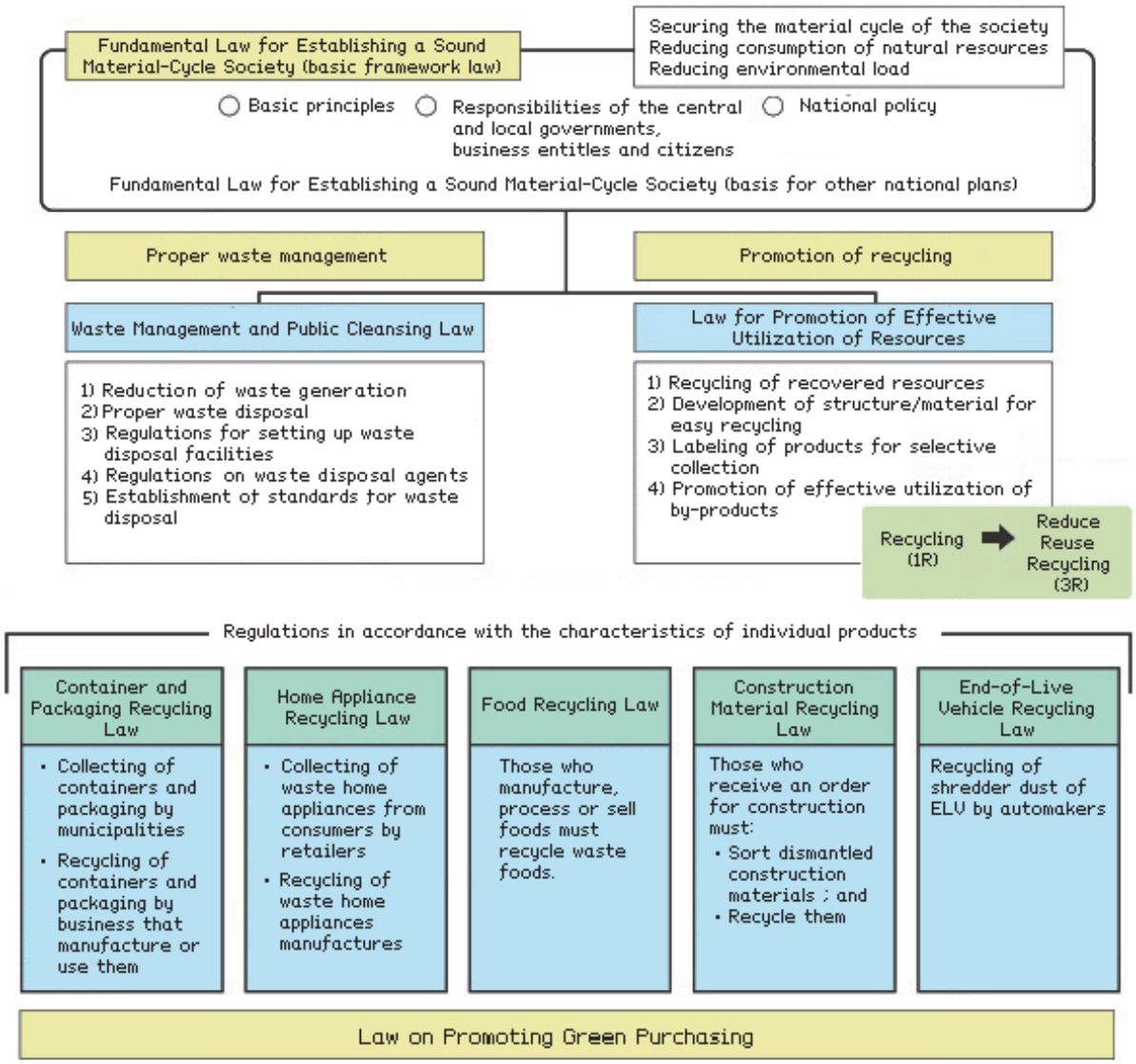
4.1 Outline
4.2 Environment issue
4.3 Social issue
4.4 Operation and maintenance issue
Chapter 5 Description of the project
5.1 Nature of the project
5.1.1 Integrated Solid Waste Management
5.1.2 Execution body and relevant authority
5.1.2.1 Responsible Agencies
5.1.2.2 Administrative Feasibility
5.1.2.3 Legal and Political Feasibility
5.1.2.4 Environmental Clearance
5.1.2.5. Social Acceptability

5.2Necessary sanitary landfill site facility
5.5.4Heavy equipment
5.5.5Occupational health and safety provided
5.5.6 Operation and maintenance cost
5.3 Details of phased development activities and time schedule
5.4Construction of sanitary landfill site
5.4.1 Construction details of major components of the landfill facility
5.4.2 Construction cost
5.4.3 Implementation schedule of construction
5.5Operational and Maintenance
5.5.1Details of operation and maintenance components of landfill facility
5.5.2Details of usage of cover material
5.5.3Requirement of labour and employment of local people

Chapter 6 Assessment of Anticipated Environmental Impacts
6.1Scoping for the Impacts during construction and Operation
6.2Evaluation of Environmental Impacts for Each Item
6.3Constructional Impacts
6.4Operational Impacts
Chapter 7 Proposed Mitigation Measures for the Environmental Impacts
7.1Required Mitigation Measures for the Environmental Impacts
7.1.1During the construction
7.1.2Landfill facility
7.1.3Landfill operation
Chapter 8 Monitoring Plan
8.1The monitoring committee
8.2Proposed member of the monitoring committee
8.3Monitoring frequency
8.4Monitoring check list
Chapter 9 Conclusion and Recommendations

2.19 D.5: Recommendation for Improvement of the legal system regarding SWM

JICA Project Team discussed with the CEA and NSWMSC counterpart regarding the enhancement of the current legal system related to solid waste management based on the results of the pilot project, the experience of study tour in Japan and the Japanese SWM laws and regulations shared at serval seminars. CEA understood to the importance the formulation of proper SWM legal system in Sri Lanka similar to Japanese one.



(Reference) Ministry of Economy, Trade and Industry

Figure 2-97: Japanese law and regulation related to solid waste management