Methodologies and procedures for data collection

Deliverable 5 (Revision -2)

Submitted by

GeotechMaldives

11th July 2021

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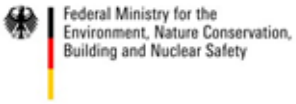
Initiative for Climate Action Transparency (ICAT) project supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the Children´s Investment Fund Foundation (CIFF), the Italian Ministry of Ecological Transition (IMET) and ClimateWorks.



The ICAT project is managed by the United Nations Office for Project Services (UNOPS)

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4 Acronyms

ADB	Asian Development Bank
BUR	Biennial Update Report
CCD	Climate Change Department
DOC	Degradable Organic Carbon
EIA	Environment Impact Assessment Report
EPA	Environmental Protection Agency
FOD	First Order Decay
GHG	Green House Gas
HPA	Health Protection Agency
IC	Island Council
ICAT	Initiative for Climate Action Transparency
IPCC	Intergovernmental Panel on Climate Change
IWMC	Island Waste Management Center
IWMF	Integrated Waste Management Facility
LGA	Local Government Authority
MEMP	Maldives Environment Management Project
MoE	Ministry of Environment
MoT	Ministry of Tourism
MoFA	Ministry of Fisheries and Agriculture
MTCC	Maldives Transport and Contracting Company
MVR	Maldivian Rufiyaa
NC	National Communication
NBS	National Bauru of Statistics
QA/QC	Quality Assurance/ Quality Control
RWMF	Regional Waste Management Facility
SAP	Strategic Action Plan
SoE	State of the Environment Report
SWM	Solid Waste Management
SWD	Solid Waste Disposal

TACCC	Transparency, Accuracy, Consistency, Comparability, Completeness
TAP	Tourism Adaptation Project
Tpd	Tonnes Per day
UNOPS	United Nations Office for Project Services
UNFCCC	United Nations Framework Convention of Climate Change
WB	Work Bank
WAMCO	Waste Management Cooperation
MRV	Measuring, Reporting and Verification
UNOPS	United Nations Office for Project Services

1 Introduction

This report involves development of procedures and methodologies for data collection and data management for the waste sector, and its integration into the existing MRV arrangements of the country. To ensure that the emission data reported by the country is collected using standard set by the Intergovernmental Panel on Climate Change (IPCC), the country will use the "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5, Waste" for data collection and estimation of emission.

This report is divided into three chapters. The Chapter 1 of the report presents review and analysis of the existing methodologies and procedures for data collection and sharing in waste sector and barriers to implement effective data management system and suggestion for improvements. Chapter 2 looks into the need for better data in waste sector and methodologies and procedures for data collection following IPCC guidelines. Chapter 3 presents institutional arrangements procedures supporting the use of IPCC methodologies for data collection and management for preparation of GHG inventory focusing on data flow structure while maintaining necessary Quality Control and Quality Assurance (QC/QA) measures throughout the process. The procedures and data collection are designed based on the assessment and diagnostic study and experience gained from the waste audit conducted in 9 inhabited islands in the Maldives. Template forms for data collection and checklist are provided to ensure that necessary QC/QA supports the use of IPCC methodologies.

4.1 Existing methodologies and procedures for data collection in Waste Sector

Very limited literature exists on data collection and data management in waste sector in the Maldives. Most focuses on waste management issue rather than data collection. In general, environment data in the Maldives is collected and reported in ad hoc basis (NBS 2018[1]). There is no systematic data collection process, procedures and standards especially in waste sector. Saafu Raajje (Saafu Raaje Initiative, 2015) waste management policy strategy 7 aims towards establishment of waste related statistical data system and collection, management and dissemination of information system at national and island level. The current government policy on waste is to promote waste as a valuable resource for income generation by integrating international waste management practices in a more circular economy approach, establishing extended producer responsibilities, and polluter pay principles while reducing pollution through

[1] National Bureau of Statistics NBS (2018) Review report on Water and Waste Accounts

a complete ban on the use and sale of single use plastic by 2023 (SAP, 2018). Actions identified under waste management through evidence-based policies strategy 1.5 includes: Conduct and develop a national database and establish methods for information collection, collation, access and dissemination to ensure its comprehensiveness and public availability, conduct comprehensive waste audits across all islands to identify volume of different waste streams and to formulate reduction targets,

Develop a national database and establish methods for information collection, collation, access and dissemination to ensure its comprehensiveness and public availability. MoE has been identified as the lead implementing agency for these activities. Other implementing agencies identified include Local Councils, EPA, HPA, Resorts, Industries, waste service providers NBS and NDC.

National Bureau of Statistics (NBS) has the mandate for statistical data collection, analysis and compilation at the national level. NBS has been reporting data on waste management practices and waste transported to Thilafushi Island in censuses and other statistical reports. MoE as the responsible ministry for waste policy formulation and implementation is mandated by Presidents Office for the waste related data collection, analysis and compilation. Stakeholders including Government Institutions and the service providers (Utility Companies) resort, Island and Atoll Councils, private service provider's involvement and support are needed to establish a robust and reliable mechanism to collect and collate waste data. Maldives Customs Services provide data on the exports and imports[2], and it can be used to collect information on export of recyclable items.

[2] https://www.customs.gov.mv/Statistics

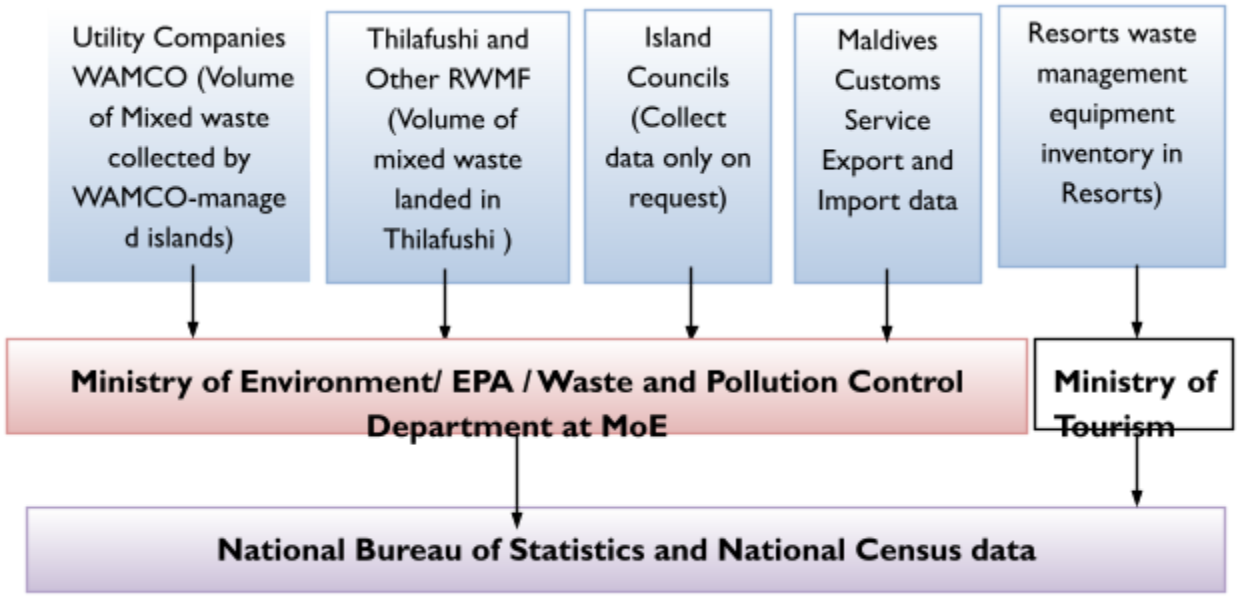

Figure 1. Existing data flows, interrelations and hierarchy between stakeholders in waste related data management

1.2. Data Collection and Sharing

Private and public service providers and utility companies collect and log waste sector data mainly weight and category for their own recording purpose. Data is shared with Government authorities only upon request. Data collation and analysis is not common and not conducted on regular basis at the island or atoll level. Data is collected and compiled at different frequencies for various data sets in response to requests by the Government authorities and institutions, or in relation to a project or study activity but not on an ongoing regular basis. It is necessary that the Government agencies and various stakeholders establish standard set of indicators or data requirements that is consistent. The best option would be to develop a mechanism and a process to engage Island Councils in data collection in islands where IWMC are operational or yet to become operational. The established data collection process needs to be structured systematically and must establish a regular reporting procedure.

4.2 Barriers to the implementation effective data management system

A study conducted by the Ministry of Home Affairs and Environment (2004) to identify existing barriers to Effective Solid Waste Management in Maldives highlighted the following issues

1- Insufficient funding of waste management infrastructure, equipment and practices except Male region
2- Lack of cost recovery mechanisms.
3- Inadequate institutional capacity & lack of clear leadership.
4- Inadequate level of public education and awareness raising
5- Weak legislative and regulatory framework
6- Limited involvement of the private sector in service delivery
7- Lack of data collection and management system and infrastructure

Some of the barriers identified above have been significantly improved now such as regulation, institutional capacity, leadership and financial resources. However, implementation of the formulated regulations is difficult due to lack of enforcement especially in the outer islands. Even though data collection and management has been recognized as a barrier in the above list most of the existing literature concentrate on developing waste management systems not data collection and management systems. It is difficult to make reliable decisions on an appropriate waste management system without appropriate evidence-based information.

One of the lessons learnt from the malfunctioning of some of the existing Island Waste Management Center (IWMC) might be attributed to the fact that the centers are developed without proper assessment and good supporting data. Such as good estimates of waste generation, land required, types of wastes, collection systems, and location of the IWMC etc.

Although the Waste Management Regulations (2013) calls for establishing a national waste database at national, regional and island level, a procedure for this has not been established yet. The data collection and management is currently not incorporate into the island waste management planning guideline. Although not specifically for waste management, there have been attempts to establish data portals. In 2019, with assistance from UNDP, a data portal was established in the name of (Laamu Koasharu) for Laamu atoll. It was designed in a way data can be entered by all councils of Laamu atoll. However, due to lack of technical and human resource capacity, these were not used by the island councils. Prior to that, another portal was established in the name of Maldivinfo in 2007. The only data available in the portal on waste is the waste generation data in 2014. It is important to identify reasons why data portals are not updated, so that databases can be designed in a way that can be regularly updated, used and analyzed.

Solid waste management data currently collected on regular basis in the Maldives is only limited to the volume of waste based on the carrying capacity of the vehicles that Waste Management Cooperation (WAMCO) uses to collect and transport waste in areas where WAMCO provides waste collection service. This can be highly inaccurate; therefore, WAMCO is planning to install weighing equipment in transfer stations and disposal sites. Waste transfer stations in Male and landing and disposal facilities in Thilafushi do not have simplest equipment for data collection such as weighbridges which can be regarded as basic equipment required at the waste disposal site or transfer stations. Similar equipment or appropriate size of weighing scales are not equipped in RWMFs and IWMCs.

It is generally not possible to obtain reliable information as to the waste quantities and densities in any situation without making field measurements. Experience elsewhere has shown that staffs involved in waste management services are rarely able to give reliable information about how much waste is generated in any particular area unless the authority has a weighbridge at the disposal site. Often the local officials involved use the nominal load capacity of a truck (in tons) and multiply it by the number of truck loads instead of using the truck's volumetric capacity. This can generate overestimated figures as high as 500%, Manus Coffey & Adrian Coad (2010). Apart from the data that has been based on waste audits, most of the waste statistics used in the Maldives is collected based on the above-mentioned method. The following issues can be highlighted from the existing system:

- Lack of weighing bridges at WAMCO transfer stations and disposal sites.
- Waste is not segregated from the source therefore it would be very difficult to estimate the weight and volume of different categories and types of waste.
- Lack of an adequate mechanism to provide training to engage the Island Councils to collect data from islands without centralized systems.
- The Ministry of Tourism do not collect or maintain any records on waste data fromthe resorts
- lack of use of a data collection sheet that would serve as a standardized form for all key data needs by/ and for the key organizations.

Table 1: Status and limitation of data available in waste sector identified by NBS: (Source (NBS 2018)

Waste generation data

#	Data/ Indicator	Status	Data Collection method/frequency	Agency	Limitations
1	Mixed residential and commercial waste	Available weight	Monthly records/ only for Male' and Hulhumalè and Villingili based on the number of trucks and vessels	WAMCO	Largely weight based on the truck load weighted using a weighbridge or scale and data is not segregated, available Only in Male region
2	Card board	Available	Monthly/Annual records	Bottling Company	Minimal data available only from bottling company

4.3 Suggestions for improvement

Lack of technical expertise and data to address complex interdependencies can result in additional waste issues to solve and are often identified as the main reasons for the slow progress of environmental data management systems. Maldives is trying to address this issue by compiling more comprehensive ways of collection and management of data in waste sector. Below are some proposals for improvement of data collection and management in the Maldives.

#	Recommendation	Responsible Agency
1	Sharing information with stakeholders Promotion of information disclosure is an effective methodology to initiate/enhance the public participation in waste sector.	MoECCT/WAMCO/Councils
2	Publishing relevant administrative documents e.g.: Allocated budget and annual reports online for better communicate the strategy on island council websites	Ministry of Finance/MoECCT/Island Council
3	Promote waste Education, Awareness and Citizen Participation and aware general public on the waste management practices such as sorting	MoECCT/WAMCO/Councils
4	Conduct waste audits, needs assessment, cost-benefit-analysis and explore cost recovery mechanisms prior to mobilizing/allocation of resources to local communities prior to establishment IWMCs and RWMFs.	MoECCT

5	Proper assessments of quantities and types of municipal waste (waste audits) needs to be carried out nationwide (Malé, atolls, industrial islands, resorts etc).	Councils
6	Appropriate assessments on management and disposal of biomedical waste and hazardous waste should be established throughout the country.	WAMCO/Councils
7	All the islands do not have designated dumpsites, it is difficult to quantify informal dumping (illegal dumping)	MLSA/Council
8	There is lack of international classification of waste statistics[3].	MoECCT
9	Lack of human resource capacity is found to be a major barrier for data collection and management in the Maldives.	MLSA/Council
10	Establishment of proper systems for communication, data collection and management and sharing is also crucial. This can be improved by establishing a database on environmental management or integrate data into a NBS database that is already established at a national level.	MoECCT/WAMCO/Councils/ NBS
11	Cooperate with others to identify ways on how sectorial waste data on waste can be incorporated to the current data collection mechanisms already established in respective ministries and agencies. For example, as per the Tourist Statistic Regulation (2011/R19), all the tourist facilities are required to submit data on the tourist occupancy to the Ministry of Tourism on a weekly or monthly basis. If information on waste generation can be incorporated it can be useful for planning waste management in island and at national level.	Ministry of Tourism/MoECCT

[3] UNECE Working Paper Series on Statistics, Issue 3, March 2017 Problems with Waste Statistics and action taken UNECE and Statistics Netherlands

5 Need for better data in Waste sector

In general, environmental monitoring has so far been inadequate in Maldives. Simple measures like monitoring waste going into a disposal site or emissions would provide information for authorities to recognize the state of waste in their areas and evidence for action.

Solid Waste Management (SWM) is a priority sector for the Maldives due to high economic and social dependence on a healthy environment (GOM, 2019, ME, 2015). This is crucial as the resident population of the Maldives is expected to increase by 37 percent between 2014 and 2054. Maldives has done a tremendous amount of work to strategically plan sustainable waste management in the country. In this process the country is divided into seven distinctive zones for waste management. Establishment of Regional Waste Management Facility (RWMF) in each zone and development of Island Waste Management Centers (IWMC) at island level is an ongoing process.

One of the major challenges for the policy makers, planners, researchers and professional engaged in waste management is the lack of up-to-date, complete and reliable data on waste and its management. Without proper data, it is difficult to be accountable and transparent, to design sound strategies or to make wise decisions. Better data is a priority in an effort to improve waste management. Data is needed on:

Quantities of waste, i.e. quantity of waste that is generated, how much is collected (by formal and informal sectors), how much is treated by each means available, how much is recovered and recycled, how much is disposed of and how much is accounted for. Ideally, quantities of waste would be measured by weight. Waste composition, which needs to be determined on a consistent basis (i.e. using a robust waste classification system and adequate sampling), and take into account seasonal variation and change over time (e.g. as consumption patterns or production methods change).

Waste-related governance, to provide an insight into user and service provider inclusivity, financial sustainability of services, as well as institutional strength and capacities.

Waste-related statistics facilitate evidence-based decision-making and ability to then design systems, select appropriate technologies, budget for investment needs, and assess policy performance. Statistics also deliver a useful guide on compliance adherence and the effectiveness of the approaches used throughout the waste management system.

5.1 Methodologies and procedures for data collection following IPCC guidelines

The aim of developing a system for data collection is to use it for GHG emission inventories required for the Biennial and NC reporting required by the UNFCCC. Therefore, the proposed procedures developed is aligned with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5, Waste. The approach followed in this methodology will have adequate quality assurance/quality control QA/QC plan to improve Transparency, Accuracy, Consistency, Comparability, Completeness (TACCC principles) and standards outlined in the IPCC guideline for designing waste Data collection and management procedures from generation to disposal.

5.1.1 Solid waste Generation

According to the IPCC guidelines 2006 waste types from (1) to (6) contain most of the Degradable Organic Carbon (DOC) in municipal solid waste. Waste categories that are used in the IPCC Spreadsheet Waste model are:

- Food waste;
- Garden;
- Paper/cardboard;
- Wood and straw;
- Textiles;
- Disposable nappies;
- Sewage sludge;
- Industrial waste.

5.1.2 Default data

The IPCC 2019 refined guideline has provided default data for region-specific waste generation rate per capita per year based on the weight of the wet waste. This is most commonly used method. This data can be used in the absence of country specific data. MSW generation rate values given in the default data in IPCC 2019 refined guidelines for Maldives is 0.91 tonnes /cap/yr[4]. According to the IPCC guidelines the generation rates should be multiplied by the total

[4] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5, Waste

population to estimate the total waste generated in the country. One of the major outcomes of the waste audit is the update in the waste generation rate values (tones/cap/yr).

5.1.3 Solid Waste Disposal (SWD)

The IPCC methodology for estimating CH4 emissions from SWDS is based on the First Order Decay (FOD) method. This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH4 and CO2 are formed. IPCC 2006 Guidelines has provided three tiers to estimate the CH4 emissions from SWDS:

Tier 1 estimations are based on the IPCC FOD method using mainly default activity data and default parameters.

Tier 2 use the IPCC FOD method and some default parameters, but require good quality country-specific activity data on current and historical waste disposal at SWDS. Historical waste disposal data for 10 years or more should be based on country-specific statistics, surveys or other similar sources.

Tier 3 is based on the use of good quality country-specific activity data and the use of either the FOD method with (1) nationally developed key parameters, or (2) measurement derived country-specific parameters.

IPCC has developed a spreadsheet to assist countries in implementing the FOD[5]. The Figure 2 adopted from IPCC 2006 guidelines shows the decision tree that can be used for choosing most appropriate method for solid waste disposal.

[5] IPCC Spreadsheet for Estimating Methane Emissions from Solid Waste Disposal Sites (IPCC Waste Model)

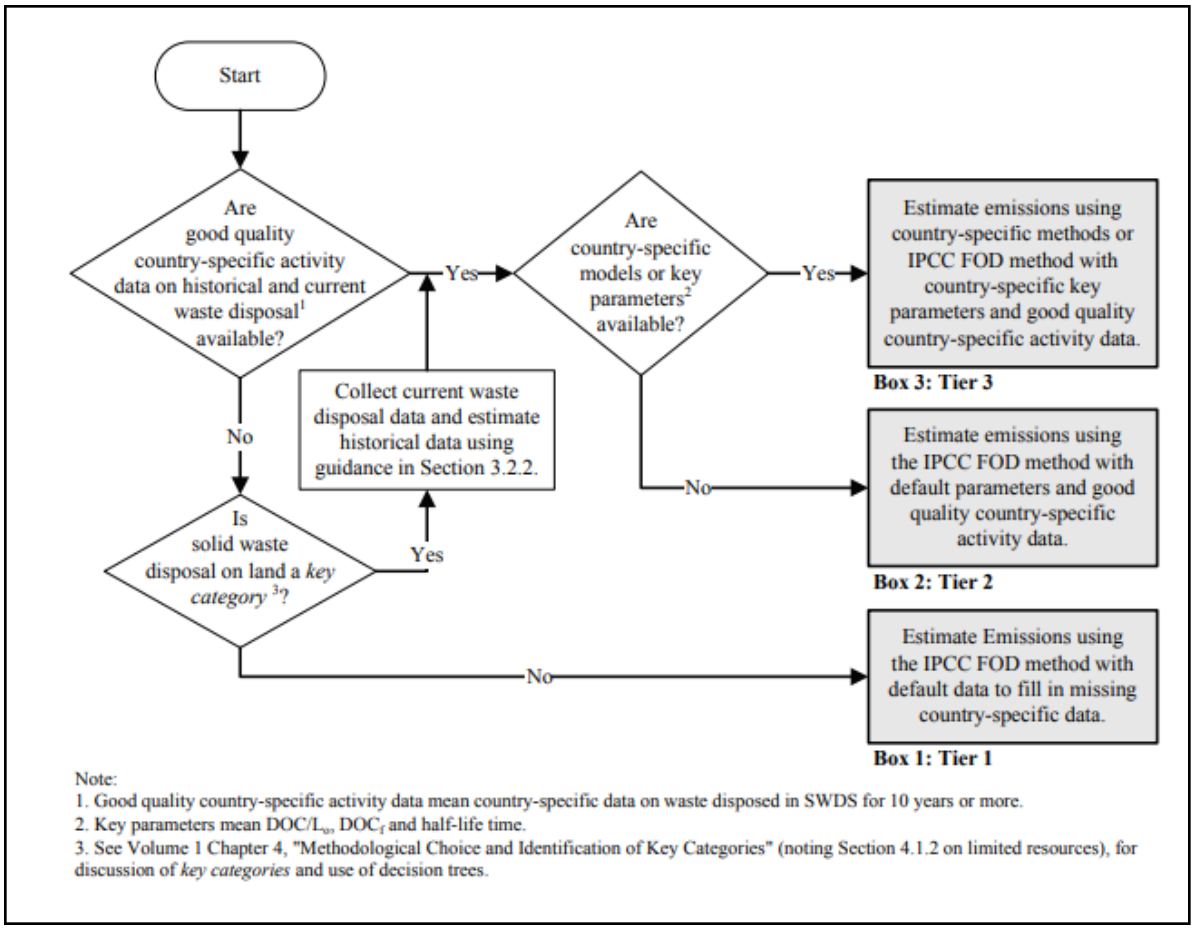

Figure 2: Decision Tree for CH4 emissions from Solid Waste Disposal Sites (Source: IPCC 2006 Guidelines)

The recommended procedures and methodologies and institutional arrangements for data collection and data management for the waste sector ensures that the data needed for compilation of waste emission inventory is in line with the IPCC guidelines and methodologies.

6 PROCEDURES SUPPORTING THE USE OF IPCC METHODOLOGIES FOR DATA COLLECTION AND MANAGEMENT

The main objective of this assignment is to establish a proper and reliable legal framework and data collection and data management procedure and mechanism that are robust to estimate waste emission inventory as per the IPCC standards in the Maldives. The procedures and methodologies developed for data collection will integrate into the existing MRV arrangements in the country.

"2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5, Waste" IPCC Guidelines requires, adequate quality assurance/quality control QA/QC plan to improve transparency, accuracy, consistency, comparability, completeness (TACCC principles), which is defined by IPCC 2006 Guidelines as follows:

Transparency - means that the inventory compiler should provide sufficient and clear documentation and report a level of disaggregation that sufficiently allows individuals or groups other than the compiler team to understand how the inventory was compiled and assure it meets good practice requirements for national greenhouse gas emissions inventories. The transparency of emission reporting is fundamental to the effective use, review and continuous improvement of the inventory.

Accuracy - means that emissions are neither overestimated nor underestimated, as far as can be judged. This implies all endeavors to remove bias from the inventory estimates.

Completeness -means that estimates are reported for all pollutants, all relevant source categories and all years and within the entire territorial boundaries of the country. Where elements are missing their absence should be clearly documented together with a justification for exclusion.

Consistency -means that estimates for any different inventory years, gases and categories are made in such a way that differences in the results between years and source categories reflect real differences in emissions. Annual emissions, as far as possible, should be calculated using the same method, and data sources for all years, and resultant trends should reflect real fluctuations in emissions and not the changes resulting from methodological differences. Consistency also means that, as far as practicable and appropriate, the same data are reported under different international reporting obligations.

Comparability - means that the national inventory is reported in such a way that allows it to be
compared with national inventories of other countries. This can be achieved by following IPCC Guidelines and i.e. appropriate choice of key categories, using the reporting guidance, tables, classification and definition of categories of emissions as presented in IPCC 2006 Guidance, Volume 1, Chapter 8 on Reporting Guidance and Tables.

The following section describes the proposed institutional arrangement for the implementation and
execution of the QA/QC plan recommended to follow to obtain reliable accurate high quality data in waste sector required for the national GHG inventory of the Maldives.

6.1 Waste Sector Data Collection and Management for GHG Inventory

Data flow

Based on the assessment, diagnostic study and the waste audit the following three levels of data flow structure is proposed to obtain activity data on waste (mainly waste amount) that can used for the compilation of the GHG inventory. Particular attention must be paid to avoid overlapping data collected from the different 3 levels.

Level 1. Island level pertinent to waste collection and disposal to IWMC (closed sites) and designated dump sites (open sites) is collected by island councils/contractors in forms provided by the lead agency for waste management matters (MoECCT). Such data are usually sourced from the service providers in the island, contractors engaged in collection and disposal vehicle operators and site supervisors. At the same level, the dumpsites (disposal sites will report the amount of waste landed at the site in forms distributed by the NBS) / EPA or CCD (template Form 1,**Table 4**). The assumption made here is that each dump site will have either a weighbridge or portable appropriate weighing facility which is the minimum requirement to collect data.

Level 2 RWMF, Waste collection and dumpsters sites at Regional Waste Management Facilities (RWMF) are compiled by the NBS /EPA based on the data received from Regional Facility and transferred to the CCD representative at MoE. These data sheets will have data on waste that has been transported from other islands /Atolls. The data will be provided by the management of RWMF to EPA/NBS.

Level 3, Cities and Greater Male region (mainly managed by WAMCO) the data will be collected and compiled by WAMCO and transferred to the NBS / EPA, MoE CCD, which is responsible for the compilation and documentation of data at the national level (level 3). The compiled data of each city Council will be documented by CCD MoE in (template Form 3, Table 6).The compiled national data from these levels by NBS and EPA will be transferred to the MoE CCD for calculations of emissions. The flow of data collected across the 3 levels is illustrated in **Figure 3**

6.1.2 Data collection/reporting frequency

According to IPCC guidelines the most common estimation method for municipal waste is simply to weigh a sample of the waste collection vehicles before and after collection, and to gross up to cover the whole population. The emphasis given here is to collect weight data on regular basis. The waste data collection form and mechanics are made extremely simple to ensure that personnel engaging in waste collection and supervision of disposal sites/dumpster can simply read and write and operate weighing machines. The waste audit conducted for this study has shown in each level identified above can collect data using either simple android phone application or a Google form, where the person engaged in waste sector can communicate weights of waste values to island/Atoll council or to the EPA /NBS etc on daily/monthly basis then aggregated monthly/yearly data can be obtained regularly or by requesting. Recommended data collection/reporting frequencies are given below:

At level 1, **IWMC** data collected monthly in forms 1 and 2 respectively.

At level 2, **RWMF** data is compiled on a monthly basis and transferred to EPA NBS.

At level 3, **Level 3, Cities and Greater Male region** (mainly managed by WAMCO) data from forms 1 and 2 is compiled into form 3 on a yearly basis (by compiling the monthly forms). The data collection for the GHG inventory emission estimates takes place at the national level on a yearly basis by CCD using the data compiled by NBS/EPA for the waste sector Table 3.

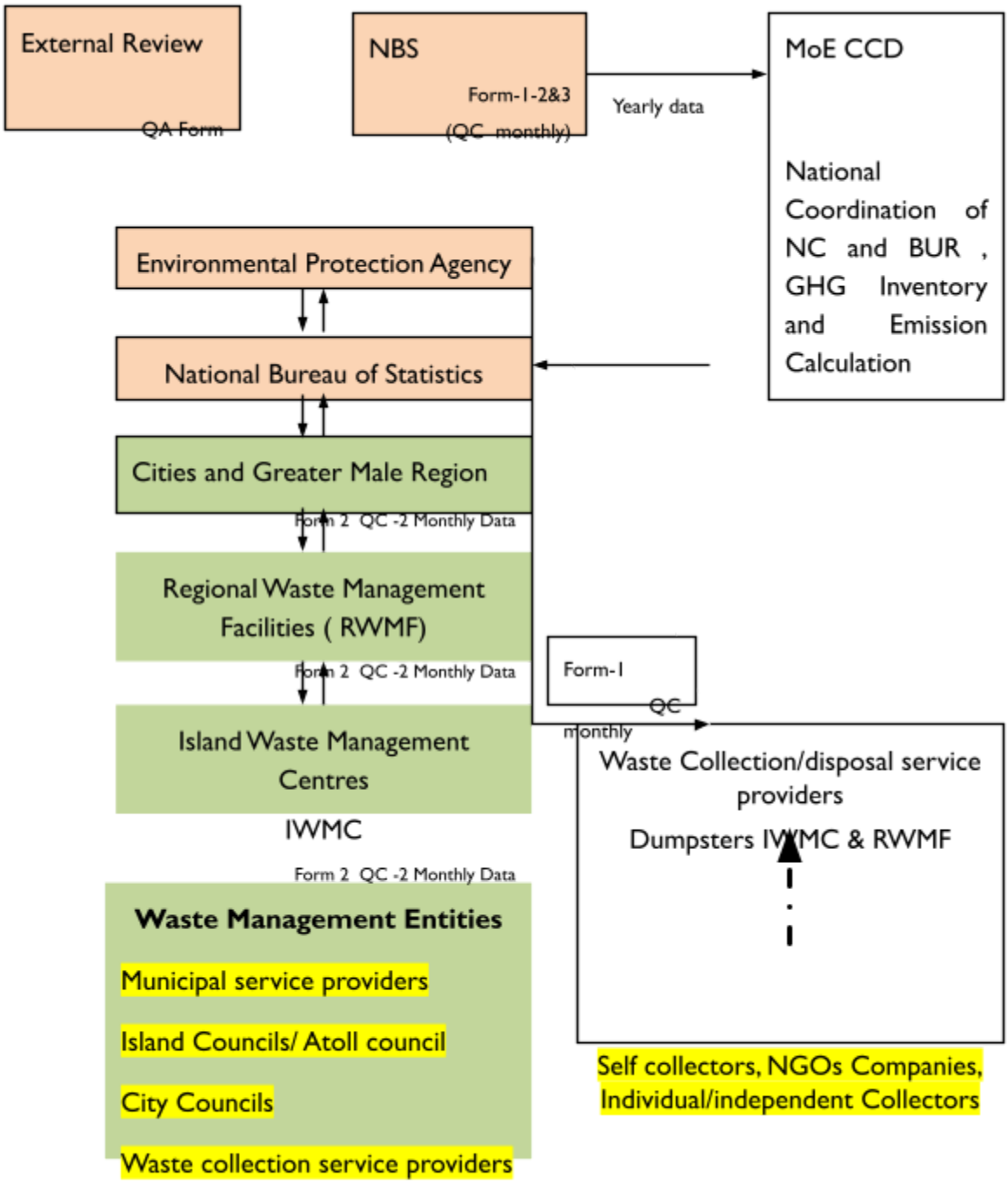

Figure 3.Proposed Data flow structure for GHG Inventory Waste sector

Table 2. List of data sources and agencies/institution responsible for data flow

Data Type	Data source Form	Agency/ Institution	Person responsible	Contact details
Activity data				
Amount of waste collected	1 &2	Contractor/service provider		
SWDS	1	Island councils/contractors		
Vessels and vehicle	2	IWMC &RWMF managers supervisors		
Cities and Greater Male Regions	3	WAMCO, Contractors		
Monthly collected waste details	1-2	NBS/ EPA		
Emission factors and estimates				
Emission factors		MoE CCD		
Emissions estimates		MoE CCD		

Specifics details of data collected in template forms 1-3 are presented in Tables 3.

Table 3. Data flow details on template form 1-3

Form #	Template Form 1	Template Form 2	Template form 3
Required Data	Quantity of waste collected IWMC and designated dump sites	Quantity of waste collected at RWMF	Quantity of waste at Cities and Greater Male Region
Data Source	Site: Solid waste disposal site	Vehicle and Vessels	Disposal sites Thilafushi/ Fuvahmullah & Hithadhoo City

			R.Vandhoo
Frequency	Monthly	Monthly	Monthly
Collection Tool	Form -1	Form -2	Form -3 and compilation from form 1-2
Data Collection	Site supervisor QC site supervisor QA Island council	RWMF supervisor QC/Vehicle/ vessel operator EPA vehicle/vessel permit license	WAMCO, Contractors Compilation by NBS EPA
Data Review	QA-Island council QA- NBS EPA	QA- RWMF supervisor QA- NBS EPA	QA - WAMCO QA-NBS and EPA

Table 4. Template Form 1. Characteristics and information on Dumpsite/ Kunigondu

General information		**Comments**
Island Name/Atoll		
Island Population		
Location of Dump site (N,S, W)		
Size of the dumps site (m2)		
Boundary Wall	Yes No	
Reporting Month		
Waste Data		
Total amount of waste collected, Contractors NGOs governmental self-collection(tons)		
Total amount of waste received from individual HH and business etc (tons)		
Amount of Waste Burned		
Total amount of waste sent-out/ exported to WMRF etc (tons)		

Status of the dump site		
Accumulated waste (√)	Half of the site < ½ > ½	
Height of the accumulated waste (√)	<1m >1m	
Dominating types of accumulated waste (√)		
Biodegradables and food waste	< ½ >½	
Nappies	< ½ >½	
Paper/Cardboard	< ½ >½	
Metals	< ½ >½	
Plastics leather	< ½ >½	
Wood saw dust	< ½ >½	
C&D	< ½ >½	
Others	< ½ >½	

Table 5. **Template form 2** on waste data from Vessels and vehicle Collection Service providers (IWMC and RWMF)

General information			Comments
Island Name/Atoll			
Island Population			
Location of Dump site (N,S, W)			
Size of the dumps site (m2)			
Boundary Wall	Yes	No	
Reporting Month			
Waste Data			
Truck/Dhoni Capacity (m^3)			
No of trucks/ Dhoni Landed			
Number of trips			
Waste Density (ton/m^3)[6]			
Amount of waste (ton) = Truck/Dhoni Capacity (m3) X Number of trucks/Dhoni X Number of trips X Density of Waste (ton/m^3)			
Destination of the Collected waste			
Is the waste collected from outer island directed to RWMF	Yes	No	
If (yes) then the following information on waste originating island has to be filled			
Population			
Waste generation rate			

[6] Both compressed and uncompressed density of the waste has to be determined

(kg per capita per day)[7]		
Total amount of generated waste (ton/month)		

[7] Pre determined figure on the per capita generation rate for the island (kg/p/d)

Table 6. **Template form 3** waste data Collection from Cities and Greater Male Regions

General information								
City/ Region/ Zone			Region Population		Location of RWMF		Size of the dumps site (m2)	
Generated and disposed solid waste								
		Disposed waste				Generated Waste		
City	Region/Zone	(1) Amount of waste collected through WAMCO (ton)	(2) Amount of waste collected through collectors (ton)	2) Amount of waste collected through others (ton)	(1)+(2)+(3) Total amount of waste disposed (ton)	Resident populations	Waste generation (kg/ p/day)	Estimated total amount of generated waste (ton)
Waste Recycling, Exporting Composting details								
Recycling facility name (eg:Parley)		Amount of waste (ton	Name of Exporting Companies		Amount of Waste Exported (ton)	Name of composting facility		Amount of compost generated (ton)

Table 7. General and quick QA/QC activities checklist NBS/EPA at national level (√)

Quick check list	Please Tick (√)
Verify that document ID is completed	
Verify completeness of reported information- all relevant data is inputted	
Verify accuracy of reported data by monitoring discrepancies based on historical and comparisons between quantity of collected waste, and estimated generated quantity	
Verify documentation procedure- adequate storage of forms in folders and electronic files	

1.3. Quality Control Procedures

Routine Quality Control activities focus on the processing, handling, and documenting of procedures common to all categories based on Tier 1 and Tier 2 IPCC 2006 GL, in addition to TACCC data quality objectives and applicable procedures throughout the preparation of the GHG inventory for all categories of the waste sector. Table 8 and Table 9 presents an assessment of quality control checks against a checklist, for Tier 1 and Tier 2, consisting of the following categories in the waste sector:

Tier 1

- Data Gathering, Input, and Handling Checks
- Data Documentation Checks
- Emission Calculation Checks

Tier 2

- Emission Factors and Parameters Quality Checks
- Activity Data Quality Check
- Activity Data Quality Check: Site-specific Data
- Calculations Quality Check
- Uncertainty Related Quality Check

Table 8. Checklist of general Tier 1 QC activities and corrective measures

General Tier 1 Quality Control Activities			QC Activities Specific Corrective Measures		
Quality Control Activity	Procedures	Responsible person/agency/ office	Results of checks and corrective measures	Suggested checks to be performed in the future	Residual problems after corrective measure
Data Gathering, Input, and Handling Check					
Check assumptions and criteria for the selection of activity data, emission factors, and other estimation parameters are documented	• Cross-check descriptions of activity data, emission factors and other estimation parameters with information on categories and ensure that these are properly recorded and archived	MoE CCD Inventory Coordinator			
Check for transcription errors in data input and reference	• Confirm that data references are properly cited in the internal documentation. • Cross-check a sample of input data from each category (either measurements or parameters used	MoE CCD • Waste sector inventory QA/QC coordinator			

	in calculations) for transcription errors				
Identify spreadsheet modifications that could provide additional checks on Quality	• Utilize electronic data to minimize transcription errors. • Avoid hardwiring factors into formulas. • Use cell protection to avoid accidental change. • Build in automated checks, such as computational checks for calculations, or range checks for input data. • Utilize smart technologies, such as applications, modern weighing machines and data analysis for improved decision making. This would enhance identification of seasonal changes in waste production such as Ramadan time in the country.	MoE CCD • Double Check with disposal site Supervisor if there is any suspicion • Waste sector Inventory QA/QC Coordinator			
Check parameter, emission units and	• Check that units are properly labeled in the sheets.	MoE CCD • Double Check with dumpster			

conversion factors are correctly used	• Check that units are correctly carried through • Check that conversion factors are correct	Supervisor if there is any suspicion • Waste sector Inventory QA/QC Coordinator			
Check the integrity of Database files.	• Confirm that the correct data processing steps are followed in the database. • Double check/confirm that data relationships are correctly represented in the database. • Check data fields con consistency labeling and design specifications. • Ensure documentation of database and model structure and operation are archived	MoE CCD • Waste sector inventory QA/QC coordinator			
Check for consistency in data between categories	• Identify parameters (e.g., activity data, constants) common to multiple categories and confirm consistency	MoE CCD Waste sector Inventory expert QA/QC coordinator			

	of values used for parameters in the emissions calculations.				
Check that the movement of inventory data among processing steps is correct.	• Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. • Check that emissions data are correctly transcribed between different intermediate products (e.g., calculation of DOCs.)	MoE CCD Waste sector Inventory expert QA/QC coordinator			
Data Documentation					
Review of internal Documentation and archiving	• Check detailed internal documentation to support the estimates and enable duplication of calculations. • Ensure primary data has a reference and data source. • Check that inventory data, supporting data and inventory records are archived and stored to facilitate detailed review.	NBS MoE CCD Waste sector Inventory expert QA/QC coordinator			

	• Ensure archive is closed and securely place after completion of the inventory • Check integrity of data archiving arrangements outside organizations involved in inventory preparation				
Emission Calculation Check					
Check emissions Calculations accuracy	• Reproduce a representative sample of emissions/removals calculations. • If models are used, apply a simple approximation method that gives similar results to the original and more complex calculation to ensure that there is no data input error or calculation error	MoE CCD Waste sector Inventory expert QA/QC coordinator			
Check time series consistency	• Check for temporal consistency in time series input data for each category. • Provide explanations for values varying by more than 10% across a year.	NBS MoE CCD Waste sector Inventory expert QA/QC coordinator			

	• Check for consistency in the algorithm/method used for calculations throughout the time series. • Check methodological and data changes resulting in recalculations. • Check that the effects of mitigation activities have been appropriately reflected in time series calculations				
Check completeness	• Confirm that estimates are reported for all categories and for all years from the appropriate base year over the period of the current inventory. • For subcategories, confirm that the entire category is being covered. • Check that units are properly labeled in the sheets. • Check that units are correctly carried through • Check that conversion factors are correct Check that data gaps are documented, including qualitative evaluation of the importance of the	MoE CCD Waste sector Inventory expert QA/QC coordinator			

	estimate in relation to total net emissions (e.g. subcategories classified as 'not estimated').				
Check trend	• For each category, compare current inventory estimates to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain significant changes check for possible input or calculation errors. • Check emission factors across time series. Are changes in emissions or removals being captured? • Check for any unusual or unexplained trends noticed for activity data or other parameters across the time series (e.g., waste disposal amounts, composition, population data, DOC)	MoE CCD Waste sector Inventory expert QA/QC coordinator			

Source: This list has been adapted from IPCC Good Practice Guidance and the 2006 IPCC Guidelines for National GHG Inventories.

Table 9. Checklist of general Tier 2 QC activities and corrective measures

General Tier 2 Quality Control Activities			QC Activities Specific Corrective Measures		
Quality Control Activity	Procedures	Responsible person/agency/ office	Results of checks and corrective measures	Suggested checks to be performed in the future	Residual problems after corrective measure
Emission Factors and Parameters Quality Checks					
Assess representativeness of IPCC default factors and parameters given national circumstances	• Evaluate whether national circumstances (e.g., disposal practice management level, climatic conditions) are similar to those used to develop the IPCC default values for factors and parameters for the following categories: a- SWDS: DOC (Waste Composition), CH4(Country Climatic Condition), MCF (managed/ semi managed landfill) b- Biological treatment by composting or anaerobic digestion: emission factors for CH4 and N2O	MoE CCD Waste sector Inventory expert QA/QC coordinator			

	c- Incineration and open burning: emission factors for CO2 (associated with waste composition) and CH4 and N2O (associated with incineration technology) ● Consider options for obtaining country specific factors from entities such as statistics department, external agencies, universities etc. ● Report and document results of this assessment				
Compare country specific factors to alternative factors (e.g., IPCC default, cross country, literature)	● Verify implementation of QC activities pertinent to data used to develop the country-specific factor. ● Assess whether secondary studies used to develop country specific factors were verified against at minimum Tier 1 QC activities (or evaluate referencing and QA/QC activities associated with secondary data. Verify that QC/QA activities cover QC activities at the Tier 1 level.)	MoE CCD Waste sector Inventory expert QA/QC coordinator			

	• Compare country specific factors to IPCC defaults; document any significant discrepancies. • Compare country specific factors to site or plant-level factors. • Compare to factors from other countries having comparable island nation conditions waste sector (using IPCC Emission Factor Database). • Document results of this assessment				
Search for options for more representative measurements	Consider waste composition measurements determined by various waste management agencies/entities (e.g., IWMC waste management entity and collaboration with EPA and other research organisations)	MoE CCD Waste sector Inventory expert QA/QC coordinator			
Activity Data Quality Check					
Review national level activity data	• Check applicability of data. • Determine the level of QC performed by the data collection /compiling agency,	MoE CCD Waste sector Inventory expert QA/QC coordinator			

	• Consider alternative data sources such as IPCC defaults and international data sets.
	• Adjust the relevant uncertainty accordingly.
	• Compare activity data from multiple reference sources such as peer reviewed academic journals/reports.
	  o SWDS: waste disposal amounts, composition, population data
	  o Bio treatment: DOC, waste disposal amounts, composition
	  o Incineration-open burning: DOC, waste disposal amounts, composition
	• If activity data such as quantity of waste is based on measurements on site, verify site equipment records for calibration etc.
	• The national agency in charge of statistics (NBS/EPA) should construct, if resources permit,				

	national mass balance on the waste generated, collected and disposed annually) ● Waste quantities should be compared with those reported in country profile reports such as World Bank/ADB to identify inconsistencies. ● Check methodology for data extrapolation to complete time series when data is not available annually. ● Provide observations on the completeness of the data set.				
Activity Data Quality Check: Site-specific Data					
Verify accuracy of data submitted in the forms	● Ensure total amount of waste recorded in monthly form 1 equals sum of quantities of waste reported in the Template form 1 ● Ensure monthly amounts of waste collected from all sources, in form 3 correctly correspond to the totals reported in template Form 1	IWMC and RWMF supervisor WAMCO/ EPA/NBS			

Verify accuracy of calculations	• Ensure daily calculations are correct(Form 2 (IWMF &RWMF)) • Ensure that monthly values reported in form 2 correspond to the summation of the daily values (reported in daily registers at vehicle vessel records. Random QA checks on daily register should be carried out) • Ensure that for every island, the total waste collected from different categories is done correctly (Form 3) • Form 3 (NBS/EPA): Ensure that the ratio between the waste generated and waste collected is logical for every island (eg: kg/p/d is reasonable)	NBS/ EPA NBS/EPA NBS/EPA			
Compare total amount of waste derived from different sources	• Ensure total waste quantities reported in Form 3 tally form 1 • pertaining to disposed in IWMC/RWMF and form 2 collected	NBS/EPA			

(IWMC/ RWMF dumpsters and vehicle/ vessel collection)	by vehicles vessels, respectively) do not differ by more than 10%				
Perform random checks on data collection sites registers, i.e., Dump site and Vehicle/vessel Collection service	• Perform random monthly checks by "Waste management entities" to validate amounts of waste calculated and reported in Form 2 by checking: • Original registers of the Vessels/ vehicle daily logs "stamped proofs" from the disposal site for randomly picked vehicles/vessels	WAMCO /EPA			
Assess site-specific activity data	• Verify waste collection data with waste disposal data • Compare aggregated site-specific data (e.g. amounts of waste collected and disposed) to national statistics/data reported. • Provide observations on the completeness of the data set. • Check for inconsistencies across similar sites	NBS /EPA Waste sector Inventory expert QA/QC coordinator			

	• Compare top-down and bottom-up estimates for similar orders of magnitude				
Calculations Quality Check					
Emission comparisons	• Compare historical data for the source. Check for changes in year-over year estimates (> 10%). • Checks against independent estimates or estimates based on alternative methods	Moe CCD Waste sector Inventory expert QA/QC coordinator			
Check Data sheets	• Clearly reference to the data source of any numbers typed into the spreadsheet. • Provide subsequent calculations, in the form of formulas, so that auditing tools can be used to track back from result to the source data, and calculations can be evaluated by analyzing the formulae. • Document the spreadsheet itself specifying its name, version, authors, updates, intended use and checking	NBS/ EPA Waste sector Inventory expert QA/QC coordinator			

	procedures so that it can be used as a data source of the derived results and referenced further on in the inventory process				
Completeness	• Have all relevant GHG emissions (i.e. CH4 and N2O) been considered? Where elements are missing their absence should be clearly documented together with a justification for exclusion	MoE CCD Waste sector Inventory expert QA/QC coordinator			
Uncertainty Related Quality Check					
Quality control uncertainty estimates	• Apply Quality Control approaches for uncertainty estimates • Review uncertainty calculations and make sure they are well documented. • Document uncertainty assumptions • For uncertainty estimates involving expert judgment, the qualifications of any experts consulted should be documented	MoE CCD Waste sector Inventory expert QA/QC coordinator			

1.4. Quality assurance Procedures for Waste Sector Inventory Estimations

1.4.1. External review

Conducting external review through national experts and stakeholders in the different fields related to emissions from the waste sector is important to assure the quality of the data. The objective of QA process is to obtain an unbiased review and opinion of the inventory from experts from different technical backgrounds. This review will identify potential issues and suggest corrections where possible. The review should contain a review of calculations and assumptions by experts in relevant technical fields and is typically accomplished by reviewing the documentation associated with the GHG inventory. CCD of MoE should maintain a list of external experts from various backgrounds who have potential to be nominated to review the waste sub sectors. After selection of external reviewers review agreement and schedule has to be agreed with the CCD. Comments received from the external reviewers are collected and compiled and delivered to the inventory coordinator in order to update the inventory, as appropriate based on comments.

1.5. Verification of Inventory Estimations

Verification process is an integral part to improve the GHG inventory and it is a part of the overall

Quality assurance/ Quality Control process. Comparison between the GHG inventory and independent such as NGOs or Maldives National University estimates wherever possible will increase the confidence level and increase the reliability of the GHG inventory estimates by confirming the results. Significant differences may indicate weaknesses in either or both of the datasets. An ideal condition for verification is the use of fully independent data as a basis for comparison. It is good practice to reflect the results of the verification in the QA/QC report and incorporate recommendations for inventory improvement into the QA/QC plan. The Table 10 provides a sample data comparison table. The Inventory should be reviewed/updated as appropriate based on the comments received from the verification process.

Table 10. .Sample Verification and data comparison table

Data Type	Initial source of information (Agency name)	Verification source of information	Summary of Findings	Recommendations

		(Agency name)		
Generated waste Amounts				
Waste Composition				
Waste Disposal Details (e.g., amounts, site/technology details)				
Emission Factor				
GHG Emissions				

2. Bibliography and References

EMEP/EEA Emission Inventory Guidebook 2009. Inventory management, improvement and QA/QC. Goodwin J. and Pulles T. EMEP/EEA.

IPCC 2006. Guidelines for National Greenhouse Gas Inventories, Volume 1 General Guidance and Reporting. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). IGES, Japan.

IPCC 2008, 2006 IPCC Guidelines for National Greenhouse Gas Inventories – A primer, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Miwa K., Srivastava N. and Tanabe K. (eds). Published: IGES, Japan

IPCC (2019) Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 5, Waste

Manus Coffey & Adrian Coad (2010) Collection of Municipal Solid Waste in Developing Countries,UN-HABITAT), 2010

National Bureau of Statistics NBS (2018) Review report on Water and Waste Accounts

NBS (2019) Waste transported to Thilafushi 2016-2018, in Statistical Year Book 2019, National Bureau of Statistics

NBS (2020) Statistical Pocketbook of Maldives 2020

Ryfisch, D. J. J., Canu, Federico. Antonio., Reutemann, T., Lütken, S., & Hinostroza, M. L. (2018). *NAMA Information and Guidebook: Enabling implementation of NDCs through NAMAs*. UNEP DTU Partnership

SPREP, (2018)Practical guide to Solid Waste Management in Pacific Island Countries and Territories. Apia, Samoa

UNECE Working Paper Series on Statistics, Issue 3, March 2017, Problems with Waste Statistics and action taken, NECE and Statistics Netherlands

U.S. Environmental Protection Agency. Developing a National Greenhouse Gas InventorySystem. Template Workbook. Template 3: Description of QA/QC Procedures. US EPA.