CLIMATE ACTION RESERVE

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Organic Waste Composting

Project Protocol

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Abbreviations and Acronyms

BMP	Best Management Practice
CDM	Clean Development Mechanism
CH_4	Methane
CO_2	Carbon dioxide
CRT	Climate Reserve Tonne
EPA	Environmental Protection Agency
FOD	First Order Decay
GHG	Greenhouse gas
ISO	International Organization for Standardization
lb	Pound
MSW	Municipal solid waste
MT	Metric ton (or Tonne)
N_2O	Nitrous oxide
OPC	Optional Process Control
OWC	Organic Waste Composting
OWD	Organic Waste Digestion
Reserve	Climate Action Reserve
SSO	Source separated organics
SSRs	Sources, sinks, and reservoirs
UNFCCC	United Nations Framework Convention on Climate Change

1 Introduction

The Climate Action Reserve (Reserve) Organic Waste Composting Project Protocol provides guidance to account for, report, and verify greenhouse gas (GHG) emission reductions associated with the diversion of eligible organic wastes away from anaerobic landfill disposal systems and to composting operations where the material degrades in a controlled aerobic process.

The Climate Action Reserve is a national offsets program working to ensure integrity, transparency, and financial value in the U.S. carbon market. It does this by establishing regulatory-quality standards for the development, quantification and verification of GHG emissions reduction projects in North America; issuing carbon offset credits known as Climate Reserve Tonnes (CRT) generated from such projects; and tracking the transaction of credits over time in a transparent, publicly-accessible system. Adherence to the Reserve's high standards ensures that emission reductions associated with projects are real, permanent and additional, thereby instilling confidence in the environmental benefit, credibility and efficiency of the U.S. carbon market.

Project developers that initiate composting projects use this document to register GHG reductions with the Reserve. The protocol provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Reserve. Additionally, all project reports receive annual, independent verification by ISO-accredited and Reserve-approved verification bodies. Guidance for verification bodies to verify reductions is provided in the Reserve Verification Program Manual and Section 8 of this protocol.

This protocol is designed to ensure the complete, consistent, transparent, accurate, and conservative quantification and verification of GHG emission reductions associated with organic waste composting projects.[1]

[1] See the WRI/WBCSD GHG Protocol for Project Accounting (Part I, Chapter 4) for a description of GHG reduction project accounting principles.

2 The GHG Reduction Project

2.1 Background

Methane (CH_4), a potent greenhouse gas (GHG), can be formed as a by-product of microbial respiration reactions that occur when organic materials decompose in the absence of oxygen (i.e. under anaerobic conditions). Organic waste deposited in municipal solid waste (MSW) landfills will decompose primarily under anaerobic conditions, producing significant quantities of methane gas and biogenic carbon dioxide (CO_2), as well as other trace gases. The resulting CH_4 component of the landfill gas, if not oxidized by landfill cover material or captured and destroyed by a gas collection system, will eventually be released to the atmosphere.

The rate at which CH_4 production occurs in a landfill is governed by the decay rates of the specific types of waste that are deposited in the landfill. Although many landfills actively control LFG through gas collection and combustion systems, recent research indicates that typical landfill gas collection system efficiencies increase with time after initial waste burial as the collection system is installed and subsequently expanded. [2] Therefore, the fraction of CH_4 that is collected from the decay of a certain type of waste will be inversely proportional to the decay rate of the waste type. For rapidly decaying organic waste streams such as food waste, a greater fraction of the CH_4 produced from decay will go un-captured as compared to slowly degrading waste types.

When organic waste is composted, the material decomposes under primarily aerobic conditions. By diverting rapidly degrading food waste away from landfills to aerobic composting operations, significant emissions of CH_4 to the atmosphere can be avoided. Biogenic CO_2 is the primary decomposition byproduct from aerobic composting, although composting systems also emit nitrous oxide (N_2O) and CH_4 to the atmosphere. The degree to which N_2O and CH_4 are released to the atmosphere depends on the environmental conditions under which the decomposition occurs at the composting facility.

CH_4 and N_2O formation primarily occurs when compost piles contain anaerobic pockets where oxygen levels are depleted. In order to achieve sufficient aeration and minimize the potential for anaerobic pockets within a composting system, wetter and denser composting feedstocks are generally mixed with drier materials that have some structural stability. This allows for airflow and allows aerobic conditions to be maintained. Commercial and municipal composting facilities in the U.S use a wide array of technologies from the relatively simple to the mechanically complex. The major classes of facilities are discussed in Table A.1 of Appendix A, however there are various iterations within and between the major classes of facilities. Because aerobic composting is a biologically mediated process, the fundamental biological principles are the same regardless of scale or technology. While technologies differ, commercial and municipal composting facilities are generally designed and operated in a manner that promotes aeration and minimizes the presence of anaerobic pockets, as anaerobic decomposition requires more time, results with lower temperatures inside the pile, and produces malodors.

2.2 Project definition

For the purpose of this protocol, the GHG reduction project is defined as the diversion of one or more eligible waste streams to an aerobic composting facility where the waste is composted in a

[2] De la Cruz, F.B. and Barlaz, M. *Estimation of Waste Component Specific Landfill Decay Rates Using Laboratory-Scale Decomposition Data*. (2010).

system that complies with Best Management Practices (BMPs), which ensure the composting process is operated under optimal conditions.[3] For the purposes of this protocol, a waste stream is defined as a stream of waste originating from a specific facility (if commercial waste) or jurisdiction (if residential waste). An *eligible* waste stream is one that:

1. Consists of food waste and non-recyclable food soiled paper waste (referred to hereafter as MSW food waste and soiled paper waste, respectively), as defined in Section 3.4.1; and

2. Continually passes the Legal Requirement Test criteria as outlined in Section 3.4.2.[4]

To ensure optimal composting, the project composting facility must comply with the following BMPs:

1. Time, Temperature, and Turning Frequency BMP Requirements:

   - For Forced Aeration Systems (Aerated Static Pile (ASP) and/or enclosed, in-vessel, or in-building composting), the temperature of the compost is maintained at 55°C or higher for 3 full days, or

   - For Turned Windrow Systems (non-forced aeration), the temperature of the compost is maintained at 55°C or higher for 15 full days or longer, during which time the windrow is turned a minimum of five times.[5]

2. Food Waste Handling BMP Requirements:

   - All waste stream deliveries containing food waste must be:

     a. Mixed and incorporated into the composting process in a timely manner, no more than 24 hours after delivery of the waste to the facility, or

     b. Covered with a layer of high-carbon materials[6] or finished compost no more than 24 hours after delivery, and mixed and incorporated into the composting process no more than 72 hours after delivery, or

     c. Placed in a controlled environment[7] in a timely manner, no more than 24 hours after delivery.

Section 6.3 of this protocol provides the BMP monitoring requirements for a project facility per this protocol.

[3] BMPs in this protocol are largely taken from the EPA Time and Temperature standards for pathogen reduction, available at: http://www.epa.gov/OWM/mtb/biosolids/503pe/503pe_5.pdf
[4] Each food waste stream must have documented the county or jurisdiction of origination in order to ensure the stream is eligible per the Legal Requirement Test.
[5] Project developers can use an alternative windrow turning frequency if it can be demonstrated that the frequency of turning complies with or conforms to state agency issued regulations or Best Management Practice guidelines.
[6] Wood chips, shredded yard waste, or similar high carbon organic materials.
[7] A controlled environment refers to a building under negative air pressure, with exhaust gas vented through a biofilter.

A facility that composts waste using non-aerated static or passive pile composting does not meet the BMP requirements per this protocol, and therefore does not meet the definition of an eligible project.

2.3 The Project Developer

The “project developer” is an entity that has an active account on the Reserve, submits a project for listing and registration with the Reserve, and is ultimately responsible for all project reporting and verification. Project developers may be compost facility operators, GHG project developers, or other entities such as municipalities, institutions, or waste management companies.

In all cases, the project developer must attest to the Reserve that they have exclusive claim to the GHG reductions – including indirect emission reductions – resulting from the project. Indirect emission reductions are reductions in GHG emissions that occur at a location other than where the reduction activity is implemented, and/or at sources not owned or controlled by project participants. A composting project will result in indirect emission reductions if eligible waste feedstocks are diverted away from landfills that are not located at the project site or that are not owned or controlled by project participants. Each time a project is verified, the project developer must attest that no other entities are reporting or claiming (e.g. for voluntary reporting or regulatory compliance purposes) the GHG reductions caused by the project.[8] The Reserve will not issue CRTs for GHG reductions that are reported or claimed by entities other than the project developer (e.g. waste generators, landfills, or municipalities not designated as the project developer).

[8] This is done by signing the Reserve’s Attestation of Title form, available at: http://www.climateactionreserve.org/how/projects/register/project-submittal-forms/

3 Eligibility Rules

Projects must fully satisfy the following eligibility rules in order to register with the Reserve. The criteria only apply to projects that meet the definition of a GHG reduction project (Section 2.2).

Eligibility Rule I:	Location	⟶	*U.S. and its territories*
Eligibility Rule II:	Project Start Date	⟶	*Within six months prior to project submission**
Eligibility Rule III:	Additionality	⟶	*Meet performance standard*
		⟶	*Exceed regulatory requirements*
Eligibility Rule IV:	Regulatory Compliance	⟶	*Compliance with all applicable laws*

* See Section 3.2 for additional information on project start date

3.1 Location

Only projects located in the United States, or on U.S. tribal lands, are eligible to register reductions with the Reserve under this protocol. All eligible food waste streams composted by a project must originate within the United States. Under this protocol, reductions from international projects are not eligible to register with the Reserve.

3.2 Project Start Date

The project start date for a composting project is to be chosen by the project developer, but must be on or subsequent to the date that the project facility has implemented and documented a Monitoring Plan ensuring compliance with the BMPs defined in Section 2.2 of this protocol, and has begun composting eligible waste.

To be eligible, the project must be submitted to the Reserve no more than six months after the project start date, unless the project is submitted during the first 12 months following the date of adoption of this protocol by the Reserve board (the Effective Date).[9] For a period of 12 months from the Effective Date of this protocol (Version 1.0), projects with start dates no more than 24 months prior to the Effective Date of this protocol are eligible. Specifically, projects with start dates on or after June 30, 2008 are eligible to register with the Reserve if submitted by June 30, 2011. Projects with start dates prior to June 30, 2008 are not eligible under this protocol. Projects may always be submitted for listing by the Reserve prior to their start date.

3.3 Project Crediting Period

The crediting period for projects under this protocol is ten years. At the end of a project's first crediting period, project developers may apply for eligibility under a second crediting period. However, the Reserve will cease to issue CRTs for GHG reductions associated with eligible food and/or soiled paper waste streams if at any point in the future, the diversion of those waste streams becomes legally required, as defined by the terms of the Legal Requirement Test (see

[9] Projects are considered submitted when the project developer has fully completed and filed the appropriate Project Submittal Form, available on the Reserve's website.

Section 3.4.2). Thus, the Reserve will issue CRTs for GHG reductions quantified and verified according to this protocol for a maximum of two ten year crediting periods after the project start date, or until the project activity is required by law (based on the date that a legal mandate takes effect), whichever comes first. Section 3.4.1 describes requirements for qualifying for a second crediting period.

3.4 Additionality

The Reserve strives to register only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of a carbon offset market.

Projects must satisfy the following tests to be considered additional:

1. The Performance Standard Test
2. The Legal Requirement Test

3.4.1 The Performance Standard Test

Projects pass the Performance Standard Test by meeting a performance threshold, i.e., a standard of performance applicable to all composting projects, established by this protocol.

Compost facilities commonly process various feedstocks. The performance standard for this protocol defines compost feedstocks that the Reserve has determined are likely to be deposited in landfills under common practice or “business-as-usual” management practices.[10] Only projects that divert and compost eligible feedstocks are deemed to exceed common practice and are therefore eligible for registration under this protocol. Based upon the results of the performance standard research, MSW food waste and co-mingled non-recyclable food soiled paper waste are the sole composting feedstocks deemed eligible per this protocol.[11] For the purposes of this protocol, MSW food waste and food soiled paper are defined below:

- MSW Food Waste: defined as non-industrial solid food waste commonly disposed of in a MSW system, consisting of uneaten food, food scraps, spoiled food and food preparation wastes from homes, restaurants, kitchens, grocery stores, campuses, cafeterias, or similar institutions.

- Food Soiled Paper Waste: non-recyclable paper items that are co-mingled with food waste, consisting of paper napkins and tissues, paper plates, paper cups, fast food wrappers, used pizza boxes, wax-coated cardboard, and other similar paper or compostable packaging[12] items typically disposed of in an MSW system.

The Reserve’s performance standard research indicates that approximately 2.5% of the MSW food waste generated in the U.S. is composted annually as common practice, and that this is

[10] A summary of the study used to establish this list of feedstocks and define this protocol’s performance standard is provided in Appendix B.
[11] Non-recyclable (soiled) paper as a category was not separately addressed in the performance standard research or through national waste characterization studies, however residential and commercial non-recyclable paper waste is co-mingled with food waste in the MSW waste stream and would be expected to have a diversion rate similar to or less than the diversion rate of food waste due to the fact that the waste is non-recyclable. Source separated compostable waste streams are likely to include food waste co-mingled with some amount of soiled paper.
[12] Non-paper compostable packaging products such as polyactide polymer (PLA) may replace paper or plastic packaging on some food products, and are assumed to have similar properties to soiled paper.

limited mostly to MSW food waste from grocery stores and supermarket diversion programs.[13] Therefore, MSW food waste and soiled paper waste streams are not eligible if they are sourced from grocery stores and/or supermarkets that have historically diverted these waste streams from landfills. Additionally, all grocery store waste streams composted by the project facility prior to the project start date are not eligible.

Projects must demonstrate the eligibility of each new grocery store waste stream composted by the project by documenting that the food and soiled paper component of the grocery store waste was being disposed of in a landfill for a period of at least 36 months prior to the date that the grocery store waste was first delivered to the project composting facility, or documenting that the grocery store waste stream was previously deemed to be an eligible waste stream at another OWC project that is registered with the Reserve. Waste streams originating from new grocery store facilities are deemed eligible. Section 6.2 provides requirements for documenting the pre-project disposal of grocery store waste. All other MSW food and soiled paper waste sources described above are eligible.

Eligible waste streams at the time a project is registered shall remain eligible throughout a project's first crediting period, regardless of changes in any future versions of this protocol. However, projects must demonstrate the eligibility of all new grocery store waste streams composted by the project facility according to the requirements above.

If a project developer wishes to apply for a second crediting period, the project must meet the eligibility requirements of the most current version of this protocol, including any updates to the Performance Standard Test.

3.4.2 The Legal Requirement Test

All projects are subject to a Legal Requirement Test to ensure that the GHG reductions achieved by a project would not otherwise have occurred due to federal, state, or local regulations, or other legally binding mandates. For composting projects, the Legal Requirement Test is applied to each eligible waste stream composted by the project. A MSW food waste and/or soiled paper stream passes the Legal Requirement Test when:

1. There are no laws, statutes, regulations, court orders, environmental mitigation agreements, permitting conditions, or other legally binding mandates that require the diversion of the eligible waste stream from landfills, and/or that require the aerobic treatment of the waste stream (see Sections 3.4.2.1 below, for further guidance on regulations affecting organic solid waste); or

2. A legally binding local mandate requiring diversion and aerobic treatment of the waste stream is enacted in conjunction with the project, as specified in Section 3.4.2.2.

To satisfy the Legal Requirement Test, project developers must submit a signed Attestation of Voluntary Implementation form[14] prior to the commencement of verification activities each time the project is verified (see Section 8). In addition, the project's Monitoring Plan (Section 6) must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the Legal Requirement Test.

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[13] Based on composting data supplied by the stakeholder work group that advised development of this protocol, and evidence from compost experts.

[14] Form available at http://www.climateactionreserve.org/how/projects/register/project-submittal-forms/.

If a project composts an eligible MSW food waste stream that later becomes subject to a legal mandate requiring its diversion and/or aerobic treatment, the waste stream will remain eligible up until the date that the legal mandate takes effect. The project may continue to report GHG reductions to the Reserve associated with other eligible waste streams that are not subject to such mandates. The Reserve will continue to issue CRTs for the avoidance of methane associated with the composting of eligible waste streams that are not legally required to be diverted or aerobically treated.

3.4.2.1 Guidance on Solid Organic Waste Regulations

There are various state and local regulations, ordinances, and mandatory diversion targets that may obligate waste source producers or waste management entities to divert organic wastes away from landfills. An organic solid waste stream that is banned from landfilling, or for which a strong regulatory incentive exists to manage the waste stream in a system other than a landfill, fails the Legal Requirement Test.

State Regulations

States may have mandatory landfill diversion targets that require a percentage of waste generated be diverted from landfills to alternative management systems. Although waste diversion targets may not specify a reduction or percentage of diversion that must be met from *food* waste, these targets nevertheless provide strong regulatory incentives to divert all wastes (including food wastes) from landfills. Thus, food waste originating from a jurisdiction that is not in compliance with a mandated landfill diversion target does not pass the Legal Requirement Test until the date at which the jurisdiction comes into compliance with the mandated landfill diversion target.

Mandatory state diversion targets are not to be confused with state diversion goals. Should a state adopt a statewide waste diversion goal that does not impose penalties on jurisdictions for failing to meet diversion targets, then this state goal would not result in a failure of the Legal Requirement Test.

Local and Municipal Regulations and Ordinances

Local jurisdictions may have bans on certain types of waste going to landfill, or may have mandatory ordinances that require the diversion of organic solid wastes from landfills. If a local jurisdiction has established a mandatory ban on food waste disposal at landfills, or otherwise has enacted food waste diversion mandates, food waste streams originating from regulated sources within the jurisdiction fail the Legal Requirement Test.

3.4.2.2 Local Food Waste Diversion Mandates Enacted in Conjunction with a Composting Project

A food waste stream subject to a local food waste diversion mandate passes the Legal Requirement Test if (and only if):

1. The project composting the local food waste stream has an operational start date prior to, but no more than 5 years before, the date that the food waste diversion mandate is enacted by the local jurisdiction; or

2. The project is *implemented* subsequent to, but no more than 6 months after, the date of passage into law of the local food waste mandate.

For the purposes of this protocol, the date of project implementation may be defined with respect to the date at which the project first broke ground, purchased food waste composting equipment, or began the permitting process to compost food waste at the facility.

All food waste streams must continue to pass the Legal Requirement Test on the state and federal level in order to be considered eligible per the Legal Requirement Test.

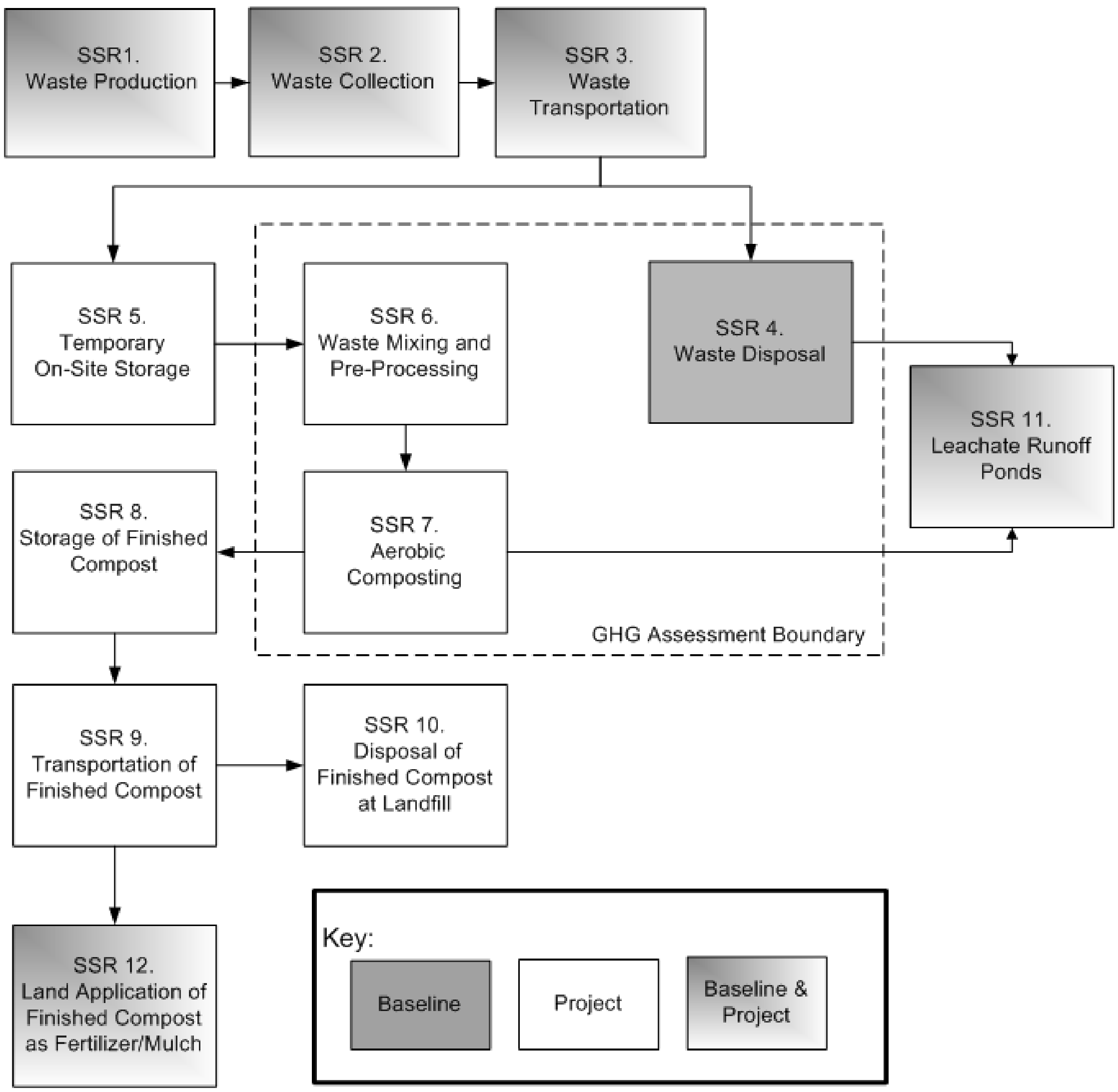
3.5 Regulatory Compliance

As a final eligibility requirement, project developers must attest that the project is in material compliance with all applicable laws relevant to the project activity (e.g. air, water quality, wastewater discharge, nutrient management, safety, etc.) prior to verification activities commencing each time a project is verified. Project developers are required to disclose in writing to the verifier any and all instances of material non-compliance of the project with any law. If a verifier finds that a project is in a state of recurrent non-compliance or non-compliance that is the result of negligence or intent, then CRTs will not be issued for GHG reductions that occurred during the period of non-compliance. Non-compliance solely due to administrative or reporting issues, or due to “acts of nature,” will not affect CRT crediting.

4 The GHG Assessment Boundary

The GHG Assessment Boundary delineates the GHG Sources, Sinks, and Reservoirs (SSRs) that must be assessed by project developers in order to determine the net change in emissions caused by a food waste composting project.[15] Figure 4.1 illustrates all relevant GHG SSRs associated with the management of eligible waste streams and delineates the GHG assessment boundary.

Table 4.1 provides justification for the inclusion or exclusion of certain SSRs and gases from the GHG Assessment Boundary.



Note: Emissions from all sources within the dashed box above are accounted for within this protocol.

Figure 4.1. General Illustration of the GHG Assessment Boundary

[15] The definition and assessment of sources, sinks, and reservoirs (SSRs) is consistent with ISO 14064-2 guidance.

Table 4.1. Description of All Sources, Sinks, and Reservoirs

SSR	Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
1. Waste Production	Fossil fuel emissions associated with the generation of waste	CO_2	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
		CH_4	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
		N_2O	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
2. Waste Collection	Fossil fuel emissions from mechanical systems used to collect, handle, and/or process waste prior to transportation.	CO_2	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
		CH_4	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
		N_2O	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
3. Waste Transportation	Fossil Fuel emissions from transport of waste to final disposal/treatment system (e.g. garbage trucks, hauling trucks, etc.)	CO_2	E	N/A	Excluded. Emissions from project activity will in most instances be of comparable magnitude to baseline transportation emissions [16] The difference between project and baseline waste transportation distance can be large without significantly affecting a project's total net GHG reductions.
		CH_4	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
		N_2O	E	N/A	Excluded. Project activity is unlikely to affect emissions relative to baseline activity.
4. Waste Disposal at Landfill	Emissions resulting from landfill equipment, and anaerobic decay of food and food soiled paper waste disposed of at a landfill	CO_2	Fossil: E Biogenic:E	N/A	Fossil Fuel emission from landfill equipment excluded. This is conservative. Biogenic emissions are excluded.
		CH_4	I	Baseline: Modeled w/ FOD model based on site-specific measurement of quantity of food waste diverted, waste specific characteristic factors, and local climate Project: N/A	This a primary sources of GHG emissions that may be avoided by an OWC project.
		N_2O	E	N/A	Excluded for conservativeness.[17]

[16] SAIC, Methane Avoidance from Composting Issue Paper (2009).
[17] The Reserve will continue to follow scientific research regarding N_2O emissions from landfills. It is conservative to exclude N_2O from the landfill baseline emissions quantification.

SSR	Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
5. Temporary On-Site Storage	GHG emissions may result if waste is stored for long periods of time under anaerobic conditions prior to active composting	CO_2	E	N/A	Biogenic emissions are excluded.
		CH_4	E	N/A	Excluded, as projects are required to utilize waste handling BMP requirements that minimize emissions from waste storage. Thus, CH_4 emissions are likely to be very small.
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small. N_2O is unlikely to be produced until later stages of the active composting cycle.
6. Waste Mixing and Pre-Processing	Emissions resulting from the use of fossil fuels or grid delivered electricity for pre-processing equipment used for processing/mixing eligible waste materials	CO_2	I	Baseline: N/A Project: Estimated using fossil fuel use or electricity use data and appropriate emission factors	Depending on the specifics of project waste pre-processing practices, increases in GHG emissions from this source could be significant.
		CH_4	E	N/A	Excluded, as this emission source is assumed to be very small.
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small.
7. Aerobic Composting	Emissions resulting from the composting process, including active composting and curing of eligible waste at project facilities	CO_2	Fossil: I Biogenic: E	Baseline: N/A Project: Estimated using fossil fuel use or electricity use data and appropriate emission factors	Project CO_2 emissions resulting from on-site fossil fuel use and/or grid delivered electricity may be significant. Biogenic CO_2 emissions from aerobic processing are excluded.
		CH_4	I	Baseline: N/A Project: Estimated using emission factors adjusted for project-specific composting practices	Project CH_4 emissions depend on the type of composting as well as the management of the composting process. Projects are required to account for emissions based on project-specific composting practices.
		N_2O	I	Baseline: N/A Project: Estimated using emission factors adjusted for project-specific composting practices	Project N_2O emissions depend on the type of composting as well as the management of the composting process. Projects are required to account for potential emissions based on project-specific composting practices.
8. Storage of Finished Compost	Emissions from the continued decay of stored finished compost	CO_2	E	N/A	Biogenic emissions are excluded.
		CH_4	E	N/A	Excluded because the CH_4 potential of the waste is largely depleted within the first four weeks of the aerobic composting treatment, thus this emission source is assumed to be very small.[18]
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small.

[18] SAIC, Methane Avoidance from Composting Issue Paper (2009).

SSR	Source Description	Gas	Included (I) or Excluded (E)	Quantification Method	Justification/Explanation
9. Transportation of Finished Compost	Fossil fuel emissions from the transport of the finished compost to the site of end-use	CO_2	E	N/A	Excluded, as transportation distance can be large without significantly affecting a project's total net GHG reductions. It is expected that the majority of compost users are located in close proximity to the compost supplier.[18]
		CH_4	E	N/A	Excluded, as this emission source is assumed to be very small.
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small.
10. Disposal of Finished Compost at Landfill	Emissions from the disposal of finished compost at a landfill or other anaerobic disposal system	CO_2	E	N/A	Biogenic emissions are excluded.
		CH_4	E	N/A	Excluded because this practice is not common, and the biodegradable components of the waste have largely decayed. Emissions are likely to be very small.
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small.
11. Leachate Run-Off Ponds	Emissions from anaerobic storage and treatment of food and soiled paper leachate run-off	CO_2	E	N/A	Biogenic emissions are excluded.
		CH_4	E	N/A	Excluded. This is a small source, and leachate from food and soiled paper waste is likely treated similarly at landfills and at composting facilities, therefore project activity is unlikely to affect emissions relative to baseline activity.
		N_2O	E	N/A	Excluded, as this emission source is assumed to be very small.
12. Land Application	Emissions and sequestration related to the land application of fertilizers and finished compost.	CO_2	E	N/A	Excluded, as project activity is unlikely to increase emissions relative to baseline fertilizer application. Furthermore, the application of finished compost as soil amendment or mulch on agricultural lands has been shown to result in significant GHG benefits due to avoided fossil based fertilizer use, increased carbon sequestration, increased water retention in soils, and other impacts. This protocol does not address the GHG benefits of compost end-use, which is considered a complementary and separate activity.
		CH_4	E	N/A	
		N_2O	E	N/A	

5 Quantifying GHG Emission Reductions

GHG emission reductions from a composting project are quantified by comparing actual project emissions to the calculated baseline emissions. Baseline emissions are an estimate of the GHG emissions from sources within the GHG Assessment Boundary (see Section 4) that would have occurred in the absence of the project. Project emissions are actual GHG emissions that occur at sources within the GHG Assessment Boundary as a result of the project. Project emissions must be subtracted from the baseline emissions to quantify the project's total net GHG emission reductions (Equation 5.1). GHG emission reductions must be quantified and verified on at least an annual basis. Project developers may choose to quantify and verify GHG emission reductions on a more frequent basis if they desire. The length of time over which GHG emission reductions are periodically quantified and verified is called the "reporting period."

Equation 5.1. Calculating GHG Emission Reductions

$$ER = BE - PE$$

Where,			Units
ER	=	The total emission reductions for the reporting period	$MTCO_2e$
BE	=	The total baseline emissions for the reporting period, from all SSRs in the GHG Assessment Boundary (as calculated in Section 5.1)	$MTCO_2e$
PE	=	The total project emissions for the reporting period, from all SSRs in the GHG Assessment Boundary (as calculated in Section 5.2)	$MTCO_2e$

5.1 Quantifying Baseline Emissions

Total baseline emissions for the reporting period are estimated by calculating and summing the emissions from all relevant baseline SSRs that are included in the GHG assessment boundary. As indicated in Table 4.1, total baseline emissions are equivalent to the emissions of methane that would have occurred had eligible food and food soiled paper waste streams been disposed of at a MSW landfill (SSR 4).

The baseline calculation assumes that the quantity of eligible food and soiled paper waste that is composted by the project would otherwise have been disposed of at a landfill or waste incineration plant in the absence of the project.[19] While the majority of non-recovered organic MSW in the U.S. is disposed of at landfills, a small percentage of waste is also incinerated at Waste to Energy (WTE) facilities.[20] Organic wastes that are landfilled will degrade primarily under anaerobic conditions and will release methane to the atmosphere, whereas waste that is combusted will produce insignificant emissions of methane to the atmosphere. The baseline calculation for eligible food waste streams assumes that the food waste is landfilled, however the baseline methane emissions are adjusted to reflect that some of the waste would have gone to WTE facilities. The percentage of food and soiled paper waste that is assumed to be incinerated in the baseline is equal to the waste incineration rate for the U.S. state where the project is located, as specified in Table A.4.A.4 of Appendix A.

[19] US EPA, Municipal Solid Waste in the United States, 2007 Facts and Figures. (2007)
[20] Biocycle Magazine, State of Garbage (2006)

Equations 5.2, 5.3, and 5.4 below must be used to calculate the baseline methane emissions from the eligible food and soiled paper waste streams that are composted by the project during the reporting period. These equations are based on a First Order Decay (FOD) model.[21] The FOD model estimates the methane emissions that would have been emitted to the atmosphere over a period of ten years had the food and soiled paper waste been disposed of in a landfill instead of being composted by the project. The ten-year emission estimate is summed and applied to the total baseline emissions for the current reporting period.

Equations 5.3 and 5.4 represent the FOD model calculations that must be used to estimate baseline emissions for both the food waste component and the soiled paper component of the eligible waste that is composted by the project. For the calculation, the total weight of the food and soiled paper waste from each eligible waste stream must be aggregated over the reporting period. The inputs to the FOD model include:

- The State Waste Incineration (WTE) rate – the percentage of the waste that would have gone to a waste incineration plant instead of a landfill on a state-by-state basis
- The Landfill Gas Collection Efficiency (LCE) – the percentage of landfill gas that is captured and controlled due to the presence of a landfill gas collection and control system (see Box 5.1 for further information on the LCE parameter)
- The waste-specific fraction of total Degradable Organic Carbon (DOC_S), and fraction of DOC_S that is degradable under anaerobic conditions (DOC_f)
- The decay rate of the waste, k, which is a function of both the type of waste and external climate of the region where the waste would have been landfilled

[21] The FOD model used in Equation 5.3 and 5.4 is referenced from the UNFCCC Clean Development Mechanism (CDM) approved methodology for calculating avoided methane emissions from waste diversion (Tool to determine methane emissions avoided from dumping waste at a SWDS (V4.0)). The model is adapted in order to quantify and sum the emissions over a ten year horizon of waste degradation rather than quantifying the annually distributed emissions. Due to model uncertainty, it is conservative to limit the calculation time frame to ten years, although waste would likely continue to break down in a landfill for a much longer period.

Equation 5.2. Calculating Baseline Methane Emissions for Food Waste Streams (SSR 5)

$$BE = \sum_{S} BE_{CH_4,S}$$

Where, Units

BE	=	The total sum of the baseline emissions during the reporting period	$MTCO_2e$
$BE_{CH4,S}$	=	The baseline methane emissions from composted waste stream 'S' during the reporting period	$MTCO_2e$

$$BE_{CH_4,S} = BE_{FW,S} + BE_{SP,S}$$

Where, Units

$BE_{FW,S}$	=	The baseline methane emissions from the food waste component of eligible waste stream 'S' that is composted during the reporting period	$MTCO_2e$
$BE_{SP,S}$	=	The baseline methane emissions from the soiled paper component of eligible waste stream 'S' that is composted during the reporting period	$MTCO_2e$

Equation 5.3. Baseline Methane Emissions from Eligible Food Waste, by Waste Stream

$$BE_{FW,S} = 0.9 \times W_{FW,S} \times (1 - WTE_S) \times L_{o,FW} \times \rho \times FE_{FW,S} \times 21$$

Where,			<u>Units</u>
0.9	=	Model correction factor to account for model and waste composition uncertainties related to waste composition and waste characteristics[22]	Fraction
$W_{FW,S}$		The aggregated weight of eligible food waste (on a wet basis) from eligible waste stream 'S' that is composted by the project during the reporting period. See Section 5.1.1 for guidance on determining the weight of eligible food waste	MT of Food Waste (wet weight)
WTE_S	=	The fraction of the waste from eligible waste stream 'S' that would have been incinerated at a Waste to Energy plant in lieu of being landfilled. This fraction is equal to the state-specific fraction of total generated waste that is incinerated. Referenced by waste origination State from Table A.4 in Appendix A	Fraction
$L_{o,FW,S}$	=	The methane potential of food waste, measured on a wet basis. Projects must use a value of **128** for all food waste streams.[23]	m^3CH_4/MT of Food Waste (wet weight)
ρ	=	The density of methane, equal to **0.000674**	$MTCH_4/m^3$
$FE_{FW,S}$	=	The fraction of the methane generated that is emitted to the atmosphere over a ten year time horizon, as calculated using the First Order Decay function. The fraction emitted to the atmosphere is a function of the decay rates of food waste, the landfill gas collection assumptions (See Box 5.1), and the amount of methane generated that is oxidized in the cover soil	Fraction
21	=	The global warming potential (GWP) of methane	$MTCO_2e$ / $MTCH_4$

[22] As per CDM Annex 10 – Tool to determine methane emissions avoided from dumping waste at a SWDS (V4.0) http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v4.pdf/history_view
[23] U.S. EPA Inventory of Greenhouse Gas Emissions and Sinks, 1990-2008. Annex 3, Ch. 3.14, pg. A-295.

Equation 5.3. (Continued)

$$FE_{FW,S} = \sum_{x=1}^{10} \left[e^{-k_{FW,S} \cdot (x-1)} \times (1 - e^{-k_{FW,S}}) \times \left(1 - (GC_S \times LCE_x)\right) \right] \times (1 - OX)$$

Where,			Units
e	=	A mathematical constant, approximately equal to 2.71828	None
$k_{FW,S}$	=	The decay rate for food waste stream 'S'. The decay rate is a function of the climatological characteristics of the region where the waste is landfilled. Referenced from Table A.2 by waste origination county climate category, which is referenced from Figure A.2	yr^{-1}
x	=	The placeholder for the iterative calculation. The FOD equation calculates emissions out over a period of ten years (x = 1 to 10) following the year in which the waste is initially diverted to the compost facility. The ten year calculation is summed and applied to the total baseline emissions for the current reporting period	None
GC_S	=	The gas collection factor for the waste stream 'S'. The gas collection factor is equal to the fraction of waste disposed at landfills utilizing gas collection for the state from which the waste stream 'S' originates. Referenced by state from Table A.3 in Appendix A	Fraction
$LCE_{,x}$	=	The fraction of methane that would be captured and destroyed by LFG collection systems in the year x, starting with the year that the waste is diverted to the project (x =1) and ending with year x = 10. All projects shall use a value of '0.0' for the first two years of calculated waste decay (x=1 to 2), a value of '0.5' for the third year (x=3), a value of 0.75 for years 4-7 (x=4 to 7), and a value of 0.95 for the remaining years of decay until the end of the calculation period (x =8 to 10). See Box 5.1 for a discussion on LCE assumptions[24]	Fraction
OX	=	Factor for the oxidation of methane by cover soil bacteria. A value of 0.1 shall be used[25]	Fraction

[24] The Reserve will periodically re-assess the LCE default parameters in order to ensure that landfill gas collection assumptions remain conservative and accurate.

[25] As per the Reserve Landfill Project Protocol V3.0, CDM Annex 10 – Tool to determine methane emissions avoided from dumping waste at a SWDS (V4.0), and U.S. EPA *Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sinks,* Chapter 6, Pg. 87, ftnt27.

Equation 5.4. Baseline Methane Emissions from Eligible Soiled Paper Waste, by Waste Stream

$$BE_{SP,S} = 0.9 \times W_{SP,S} \times (1 - WTE_S) \times L_{o,SP} \times \rho \times FE_{SP,S} \times 21$$

Where,			Units
$W_{SP,S}$	=	The aggregated weight of eligible soiled paper waste (on a wet basis) from eligible waste stream 'S' that is composted by the project during the reporting period. See Section 5.1.1 for guidance on determining the weight of eligible food waste	MT of Soiled Paper (wet weight)
$L_{o,SP,S}$	=	The methane potential of soiled paper waste, measured on a wet basis. Projects must use a value of **310** all soiled paper waste streams[26]	m^3CH_4/MT of Food Waste (wet weight)
$FE_{SP,S}$	=	The fraction of the methane generated that is emitted to the atmosphere over a ten year time horizon, as calculated using the First Order Decay function. The fraction emitted to the atmosphere is a function of the decay rates of soiled paper waste, the landfill gas collection assumptions (See Box 5.1), and the amount of methane generated that is oxidized in the cover soil	Fraction

$$FE_{SP,S} = \sum_{x=1}^{10}\left[e^{-k_{SP,S}\cdot(x-1)} \times (1 - e^{-k_{SP,S}}) \times \left(1 - (GC_S \times LCE_x)\right)\right] \times (1 - OX)$$

Where,			Units
$k_{SP,S}$	=	The decay rate for food waste stream 'S'. The decay rate is a function of the climatological characteristics of the region where the waste is landfilled. Referenced from Table A.2 by waste origination county climate category, which is referenced from Figure A.2	yr^{-1}

[26] U.S. EPA *Solid Waste Management and Greenhouse Gases: A Lifecycle Assessment of Emissions and Sinks,* Chapter 6, Exhibit 6-3. The Value represents the methane potential of 'office paper'.

Box 5.1. Organic Waste Composting Protocol Treatment of Landfill Gas Collection Systems

Landfill Gas Collection System Assumptions

The baseline emission calculation excludes methane that would have otherwise been captured and controlled by an active landfill gas collection system. The Reserve acknowledges that many landfills have active gas collection and control systems in operation, of which the majority are in place due to federal, state, or local regulations.[27] Due to the uncertainty and difficulty associated with tracking and verifying pre-project waste disposal activities on a project-by-project basis, this protocol utilizes a conservative and highly standardized approach to determining the landfill gas collection efficiency (LCE) parameter for eligible waste baseline emission calculations that incorporates the most up-to-date scientific understanding of landfill gas collection efficiencies and state-specific landfill gas collection practices.

Specifically, the baseline calculation reflects the following assumptions:

1. The fraction of each eligible waste stream composted by the project that would have been disposed at a landfill with a collection system in the absence of the project is equal to the fraction of total disposed waste that is accepted at landfills with known or potential landfill gas collection systems on a state-specific basis. The state-specific gas collection fraction (GC_S), is referenced from Table A.3 in Appendix A based on where each eligible waste stream composted by the project originated.[28] The fraction of each eligible waste stream composted by the project that would have been disposed at a landfill without gas collection ($1-GC_S$) is assumed to have a landfill gas collection efficiency of 0%.

2. The Landfill Gas Collection Efficiency (LCE) parameter assumes landfills with gas collection will have a phased gas collection efficiency consistent with common landfill gas management.[29] The LCE_x parameter in Equations 5.3 and 5.4 shall be equal to zero for a period of two full years following the diversion and composting of the waste, followed by 50% collection efficiency in the third year, 75% collection in years 4-7, and 95% collection for years 8-10.

5.1.1 Determining the Weight of Eligible Wastes

Eligible waste is likely to be delivered to the project composting facility mixed with varying quantities and types of ineligible organic and/or inorganic materials. The type and quantity of eligible and ineligible waste contained in each delivery will depend primarily on the waste generation source where the material originates, and the methods by which organics are separated, or not, from the upstream waste. Depending on the operational design of the compost facility, the project might accept non-source separated MSW streams (mixed MSW) and/or various types of Source Separated Organics (SSO) streams.

The project must track delivery of waste from each eligible waste stream and determine the percentages of MSW food waste and soiled paper in each eligible waste stream according to Equation 5.5 below.

[27] Per the Performance Standard Analysis conducted for the Reserve's Landfill Project Protocol, V 2.0. See Appendix C of the Reserve's Landfill Project Protocol.
[28] The GC_S fraction was determined using data from the 2008 U.S. EPA Landfill Methane Outreach Program (LMOP) database.
[29] M.Barlaz et al. Memorandum to Jennifer Brady, Office of Resource Conservation and Recovery, US EPA: *WARM Component-Specific Decay Rate Methods.* (2009).

Equation 5.5. Determining Weight of Eligible Food and Soiled Paper Waste

$$W_{FW,S} = W_{T,S} \times FC_S \times F_{FW,S}$$

Where,			Units
$W_{FW,S}$	=	The aggregated weight of eligible food waste (on a wet basis) from waste stream 'S' that is composted by the project during the reporting period	MT food waste
$W_{T,S}$	=	The aggregated total weight of waste (on a wet basis) from waste stream 'S' that is delivered to the facility during the reporting period	MT
FC_S	=	The fraction of the waste stream 'S' that is composted during the reporting period	Fraction
$F_{FW,S}$	=	The food waste fraction of waste stream 'S'. The fraction must be determined based on the corresponding methods described in Sections 5.1.1.1and 5.1.1.2 below, according to the type of waste delivered to the site	Fraction

$$W_{SP,S} = W_{T,S} \times FC_S \times F_{SP,S}$$

Where,			Units
$W_{SP,S}$	=	The aggregated weight of eligible soiled paper waste (on a wet basis) from waste stream 'S' that is composted by the project during the reporting period	MT soiled paper
$F_{SP,S}$	=	The soiled paper waste fraction of the waste stream 'S'. The fraction must be determined based on the corresponding methods described in Sections 5.1.1.1and 5.1.1.2 below, according to the type of waste delivered to the site	Fraction

5.1.1.1 Determining the Fraction of Eligible Waste in a Mixed MSW Waste Stream (Non-Source Separated)

If a composting project is receiving a mixed MSW stream, the weight of food waste shall be determined by assuming that food waste is 18% of the total measured weight of the mixed MSW.[30] Alternatively, a project developer may elect to use a food waste composition factor other than 18% based on a site-specific waste characterization study, or state, regional, or municipal published waste characterization studies. The waste characterization study must have been conducted no more than 5 years prior to the current project reporting year.

[30] Based on the EPA's *Municipal Solid Waste in the United States, 2007 Facts and Figures*. Figure 13, pg. 64. (2008)

5.1.1.2 Determining the Fraction of Eligible Waste in a Source Separated Organics (SSO) Waste Stream

SSO waste is generated by both the commercial and residential sectors. Residential food waste collection programs are likely to produce a waste stream that is a combination of yard waste, food waste, and soiled paper. In certain regions and/or seasons, residential SSO may have limited yard waste material and may be primarily food and soiled paper. Commercial sector waste generators are broken down further into separate categories (Table 5.1). The types of commercial generators listed in Table 5.1 will primarily produce waste streams that consist of food waste and soiled paper in varying proportions.

5.1.1.2.1 Residential SSO Waste Stream Characterization

In order to determine the percent of food and soiled paper waste in a residential SSO waste stream, projects must use local or site-specific waste characterization data to determine the average fraction of food waste and soiled paper waste by weight collected by the residential diversion program. If available, projects may use local municipal waste characterization data provided by the local jurisdiction or a representative entity to quantify the proportion by weight of both food waste and soiled paper in the residential SSO waste stream. If local data are not available, projects must conduct site-specific waste sampling for each residential waste stream composted at the facility.

The site-specific waste sampling shall be done according to the following requirements:

- All hand-sorting events shall use at least a 100 lb sample from a recent delivery of the residential SSO stream in question prior to mixing with other waste streams
- The SSO waste sample shall be sorted into the following categories: food waste, soiled paper, other ineligible material
- Each sampling event must quantify and record the proportional weight of food waste and of soiled paper as compared to the total weight of the sample
- Sampling events must occur at least quarterly to account for seasonal variation in the composition of the residential SSO stream
- Each residential SSO stream shall have a minimum of 8 sampling events (2 per quarter) for the first year that the stream is composted at the facility, followed by 4 sampling events every year thereafter for SSO stream (1 per quarter)
- The project must quantify the mean food waste proportional weight and soiled paper proportional weight ($F_{FW,S}$ and $F_{SP,s}$), respectively, for each quarter of the calendar year
- Photo documentation must be recorded and retained for verification purposes, clearly showing the waste stream from which the sample is taken, the waste sample itself, and the separated categories of waste following the hand sorting

5.1.1.2.2 Commercial SSO Waste Stream Characterization

Commercial SSO waste is primarily food and food soiled paper waste (excluding corrugated cardboard, which would be an ineligible waste type). By volume, commercial waste streams would likely contain a high proportion of soiled paper wastes to food waste, however on a weight basis it would be expected that the paper component of the waste stream would constitute a much smaller proportion due to the fact that food waste is very high in moisture, whereas paper material would be much less dense with a much lower moisture content. In order to quantify the proportional weight of food waste and soiled paper waste in a commercial stream, projects may apply the default factors in Table 5.1 or may use a waste sampling approach that meets the requirements for site-specific waste sampling as described above in Section 5.1.1.2.1.[31] Waste sampling events may occur on site or at the commercial waste generation facility.

Table 5.1. Waste Generator Categories and Default Food and Soiled Paper Fractions by Weight

Waste Generator Category	Fraction of Food Waste by Weight	Fraction of Soiled Paper by Weight
Restaurants/Cafeterias/Dining Halls/Other Food Service	0.80	0.10
Super Markets and Grocery Stores	0.80	0.10
Food Wholesale Distributors	0.70	0.20
Special Events and Public Venues	0.60	0.30
Other commercial (hotels, office buildings, wholesale distributors)	0.50	0.40

5.2 Quantifying Project Emissions

Project emissions are actual GHG emissions that occur within the GHG Assessment Boundary as a result of the project activity. Project emissions must be quantified every reporting period on an *ex-post* basis.

As shown in Equation 5.6, project emissions equal:

- Carbon dioxide emissions from mobile and stationary combustion of fossil fuels and/or the use of grid delivered electricity (SSRs 6,7), plus
- Methane emissions produced during the composting process (SSR 7), plus
- Nitrous oxide emissions produced during the composting process (SSR 7)

[31] Default values are developed by determining the ratio of Misc. Paper and Composite Paper to Food Waste generated within each waste generator category. Each category assumes 10% ineligible feedstock by weight as a conservativeness factor. The composition data is taken from California's Targeted Statewide Waste Characterization Study: Waste Disposal and Diversion Findings for Selected Industry (Cascadia Consulting Group), 2006. The data is specific to California, however the types and proportions of material generated within a category would be expected to be relatively independent of region.

Equation 5.6. Total Project Emissions from All Sources

$$PE = PE_{CO_2} + PE_{CH_4,C} + PE_{N_2O,C}$$

Where,			Units
PE	=	The total project emissions for the reporting period, from all SSRs within the GHG Assessment Boundary	$MTCO_2e$
PE_{CO2}	=	The total project carbon dioxide emissions for the reporting period from fossil fuel and grid electricity sources included in the GHG Assessment Boundary (SSRs 6, 7)	$MTCO_2e$
$PE_{CH4,C}$	=	The project methane emissions for the reporting period from the composting of eligible waste (SSR 7)	$MTCO_2e$
$PE_{N2O,C}$	=	The project nitrous oxide emissions for the reporting period from the composting of eligible waste (SSR 7)	$MTCO_2e$

5.2.1 Project Emissions from On-Site Fossil Fuel Combustion and Grid Delivered Electricity (SSRs 6, 7)

On-Site Stationary Combustion and Grid Electricity

Included in the GHG Assessment Boundary are carbon dioxide emissions resulting from fossil fuel combustion and/or the use of grid delivered electricity for on-site equipment that is used for:

- Sorting and pre-processing of eligible waste (SSR 6)
- Composting eligible waste materials (SSR 7)

If the project utilizes fossil fuel or grid electricity to power equipment necessary for performing the above processes, the resulting project carbon dioxide emissions shall be calculated per Equation 5.7 below.

Equation 5.7. Project Carbon Dioxide Emissions from Fossil Fuel and Grid Electricity

$$PE_{CO_2} = \sum_m PE_{CO_2,FF} + PE_{CO_2,GE}$$

Where,			Units
$PE_{CO2,FF}$	=	The total carbon dioxide emissions from the destruction of fossil fuel during the reporting period	$MTCO_2$
$PE_{CO2,GE}$	=	The total indirect carbon dioxide emissions from the consumption of electricity from the grid during the reporting period	$MTCO_2$

$$PE_{CO_2,FF} = \frac{\sum_i \left(FF_{PR,i} * EF_{FF,i}\right)}{1000}$$

Where,			Units
$FF_{PR,I}$	=	Total fossil fuel consumed by on-site combustion during the reporting period, by fuel type i	Volume Fossil Fuel
$EF_{FF,i}$	=	Fuel specific emission factor, reference from Appendix B	$kgCO_2$ / Volume Fossil Fuel
1000	=	Kilograms per tonne	$kgCO_2/tCO_2$

$$PE_{CO_2,GE} = \left(EL_{PR} * EF_{EL}\right)$$

Where,			Units
EL_{PR}	=	Total electricity consumed by project operations during the reporting period	MWh
EF_{EL}	=	Carbon emission factor for electricity used, referenced in Appendix B	$MTCO_2/MWh$

5.2.2 Project Emissions from the Food Waste Composting Process (SSR 8)

Project emissions from the aerobic composting process consist of both CH_4 and N_2O. Both gases are formed during the composting process largely as a result of depleted oxygen levels in the piles/windrows. The degree to which emissions of CH_4 and N_2O occur at a compost facility depend primarily on two controllable factors: the extent to which the composting system achieves and maintains sufficient aeration and promotes aerobic decomposition throughout the entire pile/window, and the extent to which the GHGs that may have formed in the pile/windrow are oxidized prior to venting to the atmosphere. Typically, adequate aeration can be ensured by controlling the moisture content and porosity of the compost, ensuring proper turning frequency in windrow systems, and/or utilizing forced aeration either with positive or negative pressure blower systems. Additionally, there are certain controls that can be implemented that result with higher oxidation rates in active compost systems. For turned windrow and static pile systems, applying a layer of finished compost to the windrow/pile during the initial composting phase has been shown to greatly increases the rate at which GHGs are oxidized, while venting air through a bio-filter system (such as wood chips) also results with higher oxidation rates.[32]

Because different composting technologies utilize varying levels of operational controls, it is to be expected that emissions of both CH_4 and N_2O will vary depending on the technology used, as well as the various process controls utilized at the project facility. The project composting facility may use one or more of the classes of compost technologies described in Table A.1 in Appendix A, or may use hybrid systems that incorporate components from more than one composting class. The composting systems are grouped into two main categories for quantifying GHG emissions: turned (non-forced aeration) systems, and forced aeration systems. Should a composting facility utilize more than one category of composting technology on-site, the project must quantify the emissions from each category based on the amount of eligible waste composted by each system. All composting projects must quantify the emissions for each reporting period in accordance with Section 5.2.2.1 and Section 5.2.2.2, respectively.

5.2.2.1 CH_4 Emissions from the Composting Treatment System

CH_4 emission factors are selected based on the site-specific composting technologies and controls implemented and monitored at the project facility to reflect the fact that some composting systems have a lower risk of emitting CH_4 to the atmosphere.

Projects must use Equation 5.8 to calculate the project CH_4 emissions from the composting of all eligible food and soiled paper waste at the project facility. Projects must use the emission factor in Table 5.2 corresponding to the category of composting technology implemented and monitored at the facility.

[32] Summary of compost GHG control options based off of information obtained from: Brown et al. *Greenhouse Gas Balance for Composting Operations* (2008)

Equation 5.8. CH_4 Emissions from Composting

$$PE_{CH_4,C} = \sum_{T} \left[W_{C,T} \times EF_{CH_4,T} \right]$$

Where,			Units
$PE_{CH4,C}$	=	The total project emissions of CH_4 from the composting of eligible wastes at the project facility during the reporting period	$MTCO_2e$
$W_{C,T}$	=	The aggregated weight of eligible food and soiled paper waste from all eligible waste streams composted during the reporting period in composting system category 'T'	
$EF_{CH4,T}$	=	The methane emission factor for the composting treatment system category 'T', taken from Table 5.2[33]	$MTCO_2e$ / MT eligible waste

$$W_{C,T} = \left(W_{FW} + W_{SP} \right) \times F_{EW,T}$$

Where,			
W_{FW}	=	The aggregated weight of eligible food waste from all eligible waste streams composted during the reporting period at the facility (on a wet basis)	MT food waste
W_{SP}	=	The aggregated weight of eligible soiled paper waste from all eligible waste streams composted during the reporting period at the facility (on a wet basis)	MT soiled paper waste
$F_{EW,T}$	=	The fraction of the eligible waste that is treated in each composting system category 'T' during the reporting period	Fraction

[33] If available, the official source tested emission data shall be used to determine emission factors in place of the default emission factors. Otherwise, project developers have the option to use either the default emission factors provided, or the site specific emission factors as provided by a state or local agency accredited source test service provider.

Table 5.2. CH_4 and N_2O Emission Factors

Composting Category 'T'	Optional Process Controls (OPCs)	OPC Monitoring Requirements	CH_4 Emission Factor ($MTCO_2e$/MT of eligible waste)*	N_2O Emission Factor ($MTCO_2e$/MT of eligible waste)*
Turned Systems (Non-forced aeration turned windrows or piles)	None	N/A	0.09	0.09
	Windrows covered with 15 cm or more of finished compost for first 3 weeks of composting cycle	Section 6.4.1	0.06	
Forced Aeration Systems (ASP or other forced aeration system)	None	N/A	0.06	0.06
	ASP systems using synthetic covers	Section 6.4.1	0.03	
	Positive Aeration – piles covered with 15 cm or more of finished compost for first 2 weeks of composting cycle	Section 6.4.1	0.03	
	Negative Aeration - exhaust gas directed through a control system consisting of wood chips or other biofilter	Section 6.4.2	0.03	

*Bounds for emissions of CH_4 were developed based upon estimates taken from the following sources: 2006 IPCC Guidelines for National GHG Inventories, U.S. EPA Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks (2006), CDM AM0025 V.10, and Brown et al. *Greenhouse Gas Balance for Composting Operations* (2008). All Emission Factors are within the range of emission factors prescribed by the IPCC. The default value for windrow systems (0.09 MT CO_2e/MT waste) is equivalent to the IPCC default emission factor for composting.

5.2.2.2 N_2O Emissions from the Composting Treatment System

N_2O emission factors are selected based on the site-specific composting technologies used at the project facility to reflect the fact that some composting systems have a lower risk of emitting N_2O to the atmosphere.

Projects must use Equation 5.9 to calculate the project N_2O emissions from the composting of food waste at the project facility. Projects must use the emission factor in Table 5.2 above corresponding to the category or categories of composting technology used on-site.

Equation 5.9. N_2O Emissions from Composting

$$PE_{N_2O,C} = \sum_{T} \left[W_{C,T} \times EF_{N_2O,T} \right]$$

Where,			Units
$EF_{N2O,T}$	=	The nitrous oxide emission factor for the composting treatment system 'T', taken from Table 5.2 [34]	$MTCO_2e$ / MT eligible waste

[34] If available, the official source tested emission data shall be used to determine emission factors in place of the default emission factors. Otherwise, project developers have the option to use either the default emission factors provided, or the site specific emission factors as provided by a state or local agency accredited source test service provider.

6 Project Monitoring

The Reserve requires a Monitoring Plan to be established for all monitoring and reporting activities associated with the project. The Monitoring Plan will serve as the basis for verifiers to confirm that the monitoring and reporting requirements in this section and Section 7 have been and will continue to be met, and that consistent, rigorous monitoring and record-keeping is ongoing at the project site. The Monitoring Plan must cover all aspects of monitoring and reporting contained in this protocol and must specify how data for all relevant parameters in Table 6.1 (below) will be collected and recorded.

At a minimum the Monitoring Plan shall stipulate the frequency of data acquisition; a record keeping plan (see Section 7.2 for minimum record keeping requirements); the frequency of instrument calibration activities; and the role of individuals performing each specific monitoring activity. The Monitoring Plan should include QA/QC provisions to ensure that data acquisition is carried out consistently and with precision.

The Monitoring Plan must include detailed monitoring procedures that the project developer will follow to demonstrate that the project waste handling and composting methods continually comply with the BMPs outlined in Section 2.2.

Finally, the Monitoring Plan must include procedures that the project developer will follow to ascertain and demonstrate that the project at all times passes the Legal Requirement Test and the Regulatory Compliance Test (Section 3.4.2 and 3.5, respectively).

Project developers are responsible for monitoring the performance of the project and ensuring that the operation of all project-related equipment is consistent with the manufacturer's recommendations.

6.1 Monitoring In-Coming Eligible Waste Streams

In order to quantify the GHG reductions from a composting project, the project must accurately measure the quantity of in-coming waste delivered to the composting facility, by waste stream. All projects must monitor and record each shipment of waste delivered to the facility using on-site scales and/or commercial receipts. The compost facility must keep a daily log showing:

- Date and time of all deliveries of material to the facility
- The weight of each delivered in-coming waste stream
- The source of each delivered in-coming waste stream

In addition, the project must retain all weigh scale receipts generated either on or off-site indicating the weight and source of all delivered material to the facility. This information is necessary to aggregate the weight of eligible food and soiled paper waste delivered to the site from each eligible waste stream according to the guidance provided in Section 5.1.1 and to verify eligibility of MSW food waste from grocery store sources.

A QA/QC procedure for the inspection and calibration of weigh scales must be included in the Monitoring Plan. All weigh scales that are not used for commercial activities must be inspected and calibrated in accordance with manufacturer's specifications. The project may document in-coming waste weight using commercial receipts from on or off-site scales.

6.2 Monitoring and Documenting Pre-Project Waste Disposal for Grocery Store Waste Streams

Waste streams originating from grocery stores or supermarkets are eligible if, and only if, the project developer can document that:

- For a continuous period of at least 36 months prior to the date that waste sourced from the grocery store was first composted at the project composting facility, food and soiled paper waste generated by the grocery store was sent to a landfill, or
- Food and/or soiled paper waste originating from the grocery store was deemed as eligible waste at an OWC project registered with the Reserve, or
- The grocery store from which the waste originated is a new facility

In order to document the eligibility of the grocery store waste stream, projects must monitor the following information for each grocery store waste stream:

- The initial date the waste stream is delivered to the project composting facility, for all new grocery store waste streams
- The origin of the new grocery store waste stream (by facility)
- The previous waste disposal methods used by the grocery store waste generator, for each new grocery store waste stream
- The opening date of any new grocery store facilities supplying waste to the project

Additionally, documentation demonstrating that grocery store waste was sent to landfill(s) prior to diversion to the project composting facility or that the grocery store is a new facility should be collected and retained by the project for verification purposes. Acceptable documentation includes, but is not limited to:

- Landfill tipping receipts from the grocery store and/or contracted waste haulers
- Waste hauler contracts
- Internal memo’s and/or employee training documents detailing waste handling and/or organics separation procedures, goals, and timelines
- Media or marketing campaigns detailing dates related to the grocery store waste diversion program
- Internal documentation, store leasing documents, or media or marketing campaigns announcing the opening date of the grocery store facility

6.3 Required Compost Best Management Practice (BMP) Monitoring

Composting projects must include detailed monitoring procedures in the Monitoring Plan to monitor and document that the project waste handling and composting methods continually comply with the BMPs outlined in Section 2.2.

6.3.1 Time, Temperature, and Turning Frequency BMP Monitoring

To demonstrate compliance with the Time, Temperature, and Turning Frequency BMP requirements specified in Section 2.2, projects must monitor:

- Temperature: At a minimum, temperature shall be monitored and recorded daily starting at the beginning of the active composting cycle until the temperature drops below 55°C after reaching and maintaining a temperature of 55°C or more for the required length of time.[35] Temperature measurements shall be measured as follows:
    - For Turned Windrow Systems – At a minimum, each facility shall monitor and record a temperature measurement for every 150 feet of windrow. The temperature shall be measured at least 12 to 24 inches below the pile surface.
    - For ASP or other Forced Aeration Systems – At a minimum, each facility shall monitor and record a temperature measurement for every 200 cubic yards of active compost. The temperature shall be measured at least 12 to 18 inches below the surface, or below the point where the cover meets the active compost pile, if using a synthetic or insulating cover.
- Turning Frequency (Turned Windrow Systems only): At a minimum, each facility shall monitor and record all turning events for every 150 feet of windrow. The turning record must include, for each turning event, the calendar date and day of the composting cycle on which the turning event occurred. Turning event monitoring and recording shall commence at the start of the active composting cycle, and conclude when the temperature falls below 55°C upon completion of the time and temperature requirements.

The temperature and turning frequency records shall be used to establish the rate of compliance with the Time, Temperature, and Turning Frequency BMP requirements from Section 2.2. The project facility must demonstrate that at a minimum, 90% of the volume of eligible waste composted at the facility was composted in an active composting cycle that met the BMP requirements for Time, Temperature, and Turning Frequency.

6.3.2 Waste Handling BMP Monitoring

To demonstrate compliance with the Waste Handling BMP requirements specified in Section 2.2, projects must record, as part of the daily log:

- The date and time that each delivered waste stream is mixed and incorporated into the composting process
- The type of carbonaceous material applied to the waste delivered to the facility (if any)

[35] Daily temperature readings may have gaps due to site closure. Data gaps not exceeding 3 days are permitted if the measurements prior to and subsequent to the data gap indicate that the pile/windrow reached and maintained 55°C or higher for the required length of time.

- The date and time that carbonaceous cover material is applied to the waste delivered to the facility (if applicable)

6.4 Monitoring Requirements for Optional Process Controls

For each Optional Process Control (OPC) implemented at the facility, all parameters must be monitored as specified in the corresponding monitoring section. For periods where monitoring is insufficient or is lacking data, the project developer must assume the OPC was not implemented and use default emission factors specified in Table 5.2.

6.4.1 Monitoring Requirements for Application of Finished Compost to Pile/Windrow Surface and Synthetic Covers

Composting projects that select CH_4 emission factors based on the practice of applying a layer of finished compost to the piles/windrows for the initial phase of the active composting cycle must monitor and record the following data:

- Turned Windrow Systems: For the first 3 weeks of the active composting cycle, the project must monitor and record for every150 feet of windrow (a) the days on which finished compost is applied and (b) the depth of each application.

- Positive ASP Systems: For the first 2 weeks of the active compost cycle, the project must monitor and record for every 200 cubic yards of active compost (a) the days on which finished compost is applied and (b) the depth of each application.

Composting projects that select CH_4 emission factors based on the utilization of ASP systems with synthetic breathable covers must demonstrate that the pile is appropriately covered during the first two weeks of the active composting phase by monitoring and recording the following data:

- All ASP systems: For the first 2 weeks of the active compost cycle, the project must monitor and record for every 200 cubic yards of active compost (a) the days on which the pile is covered with the synthetic cover (b) the days on which the cover is removed from the pile, and (c) the type of cover applied

Additionally, projects utilizing synthetic covers must do so in a manner consistent with manufacturer specifications.

6.4.2 Monitoring Requirements for Documenting Use of Biofilter Exhaust Gas Control Systems

Composting projects that select CH_4 emission factors based on the practice of venting exhaust gas from a negative ASP composting system through a biofilter gas control system must document and record the following data:

- The type of material or material mixture used as the biofilter media
- The area and depth of the biofilter media
- The ventilation rate of the designed system

- The designed residence time of the exhaust gas in the biofilter media[36]

The above documentation is used to provide evidence during verification that the biofilter system is designed and operated to ensure oxidation of the methane component of the exhaust gas. If the residence time of exhaust gas in the media is not known or is less than 4 seconds, the project may not assume methane oxidation and therefore must use an alternate emission factor from Table 5.2.

6.5 Monitoring Parameters

Prescribed monitoring parameters necessary to calculate baseline and project emissions are provided in Table 6.1.

Table 6.1. Organic Waste Composting Project Monitoring Parameters

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference(r) Operating Records (o)	Measurement Frequency	Comment
General Project Parameters						
	Regulations	Project developer attestation of compliance with regulatory requirements relating to the composting project	Environmental regulations	n/a	Each verification cycle	Information used to: 1) To demonstrate ability to meet the Legal Requirement Test – where regulation would require the diversion of MSW food waste from landfills. 2) To demonstrate compliance with associated environmental rules, e.g. criteria pollutant wastewater discharge, etc.
Baseline Calculation Parameters for Food Waste Streams						
5.3	Origin of the Food Waste	The facility (if commercial) or jurisdiction where the food waste originates	Facility or jurisdiction (municipality or county)	n/a	For each shipment of in-bound waste	This information is necessary to track eligible food waste streams and ineligible food waste streams that are composted by the project, as well as to determine appropriate decay rates (k values) to use in the calculation.
5.5	$W_{T,S}$	The aggregated weight total wet weight of waste delivered to the site from source 'S' during the reporting period	MT of Waste	m	For each shipment of in-bound waste for each waste stream 'S'	Total weight must be measured for each delivery of waste in order to determine the weight of eligible food and soiled paper waste from each waste stream that is composted by the facility during the reporting period.

[36] Residence time is determined by dividing the volume of the biofilter bed by the airflow rate through the bed.

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference(r) Operating Records (o)	Measurement Frequency	Comment
5.3, 5.5	$W_{FW,S,}$	The wet weight of each eligible food waste stream composted during the reporting period	MT of Waste	m, c	For each shipment of in-bound waste for each waste stream 'S'	Total weight must be measured for each delivery of waste, and the proportional weight of food waste determined for each source and aggregated over the reporting period.
5.4, 5.5	$W_{SP,S}$	The wet weight of each eligible soiled paper waste stream composted during the reporting period	MT of Waste	m, c	For each shipment of in-bound waste for each waste stream 'S'	Total weight must be measured for each delivery of waste, and the proportional weight of soiled paper waste determined for each source and aggregated over the reporting period.
5.5	$F_{FW,S}$	The food waste fraction by wet weight of waste stream 'S'	Fraction by Weight	m, c	Quarterly or each reporting period	The fraction of food waste must be determined for each waste stream 'S'. The fraction is determined according to Sections 5.1.1.1or 5.1.1.2. For Residential SSO waste, measured quarterly or referenced from local data each reporting period. For Commercial SSO waste, referenced for each reporting period.
5.5	$F_{SP,S}$	The soiled paper waste fraction by wet weight of waste stream 'S'	Fraction by Weight	m, c	Quarterly or each reporting period	The fraction of soiled paper waste must be determined for each waste stream 'S'. The fraction is determined according to Sections 5.1.1.1or 5.1.1.2. For Residential SSO waste, measured quarterly or referenced from local data each reporting period. For Commercial SSO waste, referenced for each reporting period.

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference(r) Operating Records (o)	Measurement Frequency	Comment
5.3, 5.4	WTE_S	The fraction of the waste from waste stream 'S' that would have been incinerated in the absence of the project	Fraction by Weight	r	Each reporting period	Referenced for each waste stream from Appendix A by state of origin of the waste stream.
5.3, 5.4	GC_S	The state-specific gas collection fraction. Equal to the fraction of total waste that is disposed at open landfills with known or potential LFG collection systems	Fraction	r	Each reporting period	Referenced from Appendix A, Table A.3.
5.3	$k_{FW,S}$	Decay rate of food waste, by waste stream 'S'	yr^{-1}	r	Each reporting period	Referenced from Appendix A, Figure A.2. The appropriate k value shall be chosen based on the k value applicable to the county-specific climate where the waste originated.
5.4	$k_{SP,S}$	Decay rate of soiled paper waste, by waste stream 'S'	yr^{-1}	r	Each reporting period	Referenced from Appendix A, Figure A.2. The appropriate k value shall be chosen based on the k value applicable to the county-specific climate where the waste originated.
	Project Calculation Parameters					
5.7	$FF_{PR,i}$	Total fossil fuel consumed by on-site combustion, by fuel type i	Volume	o	Each reporting period	Referenced from fuel use records or estimated based on miles traveled (for mobile combustion sources not owned or operated by the project developer).
5.7	$EF_{FF,i}$	Fuel specific emission factor	$kgCO_2$ / volume	r	Each reporting period	Referenced from Appendix A.
5.7	EL_{PR}	Total electricity consumed by the project composting equipment	MWh	o	Each reporting period	From electricity use records.
5.7	EF_{EL}	Carbon emission factor for electricity used	$lbCO_2$ / MWh	r	Each reporting period	Referenced from Appendix A.

Eq. #	Parameter	Description	Data Unit	Calculated (c) Measured (m) Reference(r) Operating Records (o)	Measurement Frequency	Comment
5.8, 5.9	$W_{C,T}$	The aggregated wet weight of al eligible food and soiled paper waste composted during the reporting period in composting system 'T'	MT of Waste	m	Each reporting period	Aggregated from the weight of food and soiled paper waste from all eligible waste streams delivered to the site.
5.8	W_{FW}	The aggregated wet weight of eligible food waste from all eligible waste streams 'S' delivered to the facility	MT of Waste	m	Each reporting period	Aggregation of eligible waste streams only.
5.8	W_{SP}	The aggregated wet weight of eligible soiled paper waste from all eligible waste streams 'S' delivered to the facility	MT of Waste	m	Each reporting period	Aggregation of eligible waste streams only.
5.8	$F_{EW,T}$	The fraction of eligible waste composted in system 'T' during the reporting period	Fraction by weight	o	Each reporting period	Based on the net volume of waste composted in each system 'T' at the facility.
5.8	$EF_{CH4,T}$	The methane emission factor for composting system 'T'	$MTCO_2e$ / MT Waste	r	Each reporting period	Referenced from Table 5.2 for each composting system.
5.9	$EF_{N2O,T}$	The nitrous oxide emission factor for composting system 'T'	$MTCO_2e$ / MT Waste	r	Each reporting period	Referenced from Table 5.2 for each composting system.

7 Reporting Parameters

This section provides requirements and guidance on reporting rules and procedures. A priority of the Reserve is to facilitate consistent and transparent information disclosure among project developers. Project developers must submit verified emission reduction reports to the Reserve annually at a minimum.

7.1 Project Submittal Documentation

Project developers must provide the following documentation to the Reserve in order to register a composting project.

- Project Submittal form
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form
- Verification Report
- Verification Opinion

Project developers must provide the following documentation each reporting period in order for the Reserve to issue CRTs for quantified GHG reductions.

- Verification Report
- Verification Opinion
- Signed Attestation of Title form
- Signed Attestation of Regulatory Compliance form
- Signed Attestation of Voluntary Implementation form

At a minimum, the above project documentation will be available to the public via the Reserve's online registry. Further disclosure and other documentation may be made available on a voluntary basis through the Reserve. Project submittal forms can be found at http://www.climateactionreserve.org/how/projects/register/project-submittal-forms/.

7.2 Record Keeping

For purposes of independent verification and historical documentation, project developers are required to keep all information outlined in this protocol for a period of 10 years after the information is generated or 7 years after the last verification. This information will not be publicly available, but may be requested by the verifier or the Reserve.

System information the project developer should retain includes:

- All data inputs for the calculation of the project emission reductions, including all required sampled data
- Copies of all permits, Notices of Violations (NOVs), and any relevant administrative or legal consent orders dating back at least 3 years prior to the project start date
- Executed Attestation of Title forms, Attestation of Regulatory Compliance forms and Attestation of Voluntary Implementation forms
- On-site weigh station calibration results
- Waste delivery receipts and records
- Daily logs detailing weight and source of all in-coming waste streams

- Grocery store waste stream pre-project waste handling documentation and monitoring records
- Results of all residential waste stream hand sorting events
- Compost BMP and OPC monitoring data
- On-site fossil fuel use records
- On-site grid electricity use records
- Results of CO_2e annual reduction calculations
- Initial and annual verification records and results
- All maintenance records relevant to the composting equipment and monitoring equipment

7.3 Reporting Period & Verification Cycle

Project developers must report GHG reductions resulting from project activities during each reporting period. Although projects must be verified annually at a minimum, the Reserve will accept verified emission reduction reports on a sub-annual basis, should the project developer choose to have a sub-annual reporting period and verification schedule (e.g. monthly, quarterly, or semi-annually). A reporting period cannot exceed 12 months, and no more than 12 months of emission reductions can be verified at once, except during a project's first verification, which may include historical emission reductions from prior years.

8 Verification Guidance

This section provides verification bodies with guidance on verifying GHG emission reductions associated with the diversion of organic waste away from landfills to aerobic composting systems. This verification guidance supplements the Reserve's Verification Program Manual and describes verification activities specifically related to OWC projects.

Verification bodies trained to verify organic waste composting projects must be familiar with the following documents:

- Climate Action Reserve Program Manual
- Climate Action Reserve Verification Program Manual
- Climate Action Reserve Organic Waste Composting Project Protocol

The Reserve's Program Manual, Verification Program Manual, and project protocols are designed to be compatible with each other and are available on the Reserve's website at http://www.climateactionreserve.org.

Only ISO-accredited verification bodies trained by the Reserve for this project type are eligible to verify OWC project reports. Verification bodies approved under other project protocol types are not permitted to verify OWC projects. Information about verification body accreditation and Reserve project verification training can be found on the Reserve website at: http://www.climateactionreserve.org.

8.1 Standard of Verification

The Reserve's standard of verification for OWC projects is the OWC Project Protocol (this document), the Reserve Program Manual, and the Verification Program Manual. To verify an OWC project report, verification bodies apply the guidance in the Verification Program Manual and this section of the protocol to the standards described in Sections 2 through 7 of this protocol. Sections 2 through 7 provide eligibility rules, methods to calculate emission reductions, performance monitoring instructions and requirements, and procedures for reporting project information to the Reserve.

8.2 Monitoring Plan

The Monitoring Plan serves as the basis for verification bodies to confirm that the monitoring and reporting requirements in Section 6 and Section 7 have been met, that consistent, rigorous monitoring and record-keeping is ongoing at the project site, and that the project has implemented and is monitoring the BMPs prescribed in Section 2.2 of this protocol. Verification bodies shall confirm that the Monitoring Plan covers all aspects of monitoring and reporting contained in this protocol and specifies how data for all relevant parameters in Table 6.1 are collected and recorded.

8.3 Verifying Project Eligibility

Verification bodies must affirm an OWC project's eligibility according to the rules described in this protocol. The table below outlines the eligibility criteria for OWC projects. This table does not present all criteria for determining eligibility comprehensively; verification bodies must also look to Section 3 and the verification items list in Table 8.2.

Table 8.1. Summary of Eligibility Criteria for an Organic Waste Composting Project

Eligibility Rule	Eligibility Criteria	Frequency of Rule Application
Start Date	For 12 months following the Effective Date of this protocol, a pre-existing project with a start date on or after June 30, 2008 may be submitted for listing; after this 12 month period, projects must be submitted for listing within 6 months of the project start date	Once during first verification
Location	United States and its territories, and U.S. tribal areas	Once during first verification
Performance Standard	The following eligible waste streams are aerobically composted at the project's composting facility: ▪ Municipal Solid Waste (MSW) Food Waste: Food waste commonly disposed into a MSW system, consisting of uneaten food, food scraps, spoiled food and food preparation wastes ▪ Food Soiled Paper Waste: non-recyclable paper items that are co-mingled with food waste, consisting of paper napkins and tissues, paper plates, paper cups, fast food wrappers, used pizza boxes, and other similar paper items typically disposed of in an MSW system ▪ MSW food and soiled paper waste from grocery stores that historically sent food waste to landfills prior to sending food waste for composting at the project facility ▪ MSW food and soiled paper waste from new grocery store facilities	Every verification
Legal Requirement Test	Signed Attestation of Voluntary Implementation form and monitoring procedures for ascertaining and demonstrating that the project passes the Legal Requirement Test	Every verification
Regulatory Compliance Test	Signed Attestation of Regulatory Compliance form and disclosure of non-compliance to verifier; project must be in material compliance with all applicable laws	Every verification

8.4 Core Verification Activities

The Organic Waste Composting Project Protocol provides explicit requirements and guidance for quantifying the GHG reductions associated with the diversion of organic waste away from landfills to aerobic composting. The Verification Program Manual describes the core verification activities that shall be performed by verification bodies for all project verifications. They are summarized below in the context of an OWC project, but verification bodies must also follow the general guidance in the Verification Program Manual.

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review. The three core verification activities are:

1. Identifying emissions sources, sinks, and reservoirs (SSRs)
2. Reviewing GHG management systems and estimation methodologies

3. Verifying emission reduction estimates

Identifying emission sources, sinks, and reservoirs

The verification body reviews for completeness the sources, sinks, and reservoirs identified for a project, such as, *inter alia*, food and soiled paper waste disposal at landfills, and on-site aerobic composting of food and soiled paper waste.

Reviewing GHG management systems and estimation methodologies

The verification body reviews and assesses the appropriateness of the methodologies and management systems that the OWC project operator uses to gather data and calculate baseline and project emissions.

Verifying emission reduction estimates

The verification body further investigates areas that have the greatest potential for material misstatements and then confirms whether or not material misstatements have occurred. This involves site visits to the project to ensure the systems on the ground correspond to and are consistent with data provided to the verification body. In addition, the verification body recalculates a representative sample of the performance or emissions data for comparison with data reported by the project developer in order to double-check the calculations of GHG emission reductions.

8.5 OWC Verification Items

The following tables provide lists of items that a verification body needs to address while verifying an OWC project. The tables include references to the section in the protocol where requirements are further specified. The table also identifies items for which a verification body is expected to apply professional judgment during the verification process. Verification bodies are expected to use their professional judgment to confirm that protocol requirements have been met in instances where the protocol does not provide (sufficiently) prescriptive guidance. For more information on the Reserve's verification process and professional judgment, please see the Verification Program Manual.

Note: These tables shall not be viewed as a comprehensive list or plan for verification activities, but rather guidance on areas specific to OWC projects that must be addressed during verification.

8.5.1 Project Eligibility and CRT Issuance

Table 8.2 lists the criteria for reasonable assurance with respect to eligibility and CRT issuance for OWC projects. These requirements determine if a project is eligible to register with the Reserve and/or have CRTs issued for the reporting period. If any one requirement is not met, either the project may be determined ineligible or the GHG reductions from the reporting period (or sub-set of the reporting period) may be ineligible for issuance of CRTs, as specified in Sections 2,3 and 6.

Table 8.2. Eligibility Verification Items

Protocol Section	Eligibility Qualification Item	Apply Professional Judgment?
2.2	Verify that the project meets the definition of an OWC project	No
2.2	Verify that the project composting facility has implemented the required BMPs for composting	No
2.3	Verify ownership of the reductions by reviewing Attestation of Title	No
3.2	Verify project start date	No
3.2	Verify that the project has documented and implemented a Monitoring Plan that contains a mechanism to ensure compliance with the BMPs defined in Section 2.2 of this protocol	No
3.2	Verify accuracy of project start date based on operational records	Yes
3.3	Verify that project is within its 10 year crediting period	No
3.4.1	Verify that the project meets the performance standard test	No
3.4.1	Verify that that the project has documentation showing that all eligible waste streams originating from grocery stores or super markets were previously landfilled prior to the date that the waste is first delivered to the composting facility	Yes
3.4.2	Confirm execution of the Attestation of Voluntary Implementation form to demonstrate eligibility under the Legal Requirement Test	No
3.4.2	Verify that the project Monitoring Plan contains a mechanism for ascertaining and demonstrating that the project passes the Legal Requirement Test at all times	No
3.5	Verify that the project activities comply with applicable laws by reviewing any instances of non-compliance provided by the project developer and performing a risk-based assessment to confirm the statements made by the project developer in the Attestation of Regulatory Compliance form	Yes
6	Verify that monitoring meets the requirements of the protocol. If it does not, verify that variance has been approved for monitoring variations	No

8.5.2 Quantification

Table 8.3 lists the items that verification bodies shall include in their risk assessment and re-calculation of the project's GHG emission reductions. These quantification items inform any determination as to whether there are material and/or immaterial misstatements in the project's GHG emission reduction calculations. If there are material misstatements, the calculations must be revised before CRTs are issued.

Table 8.3. Quantification Verification Items

Protocol Section	Quantification Item	Apply Professional Judgment?
4	Verify that all SSRs in the GHG Assessment Boundary are accounted for	No
5.1	Verify that the baseline emissions from different eligible waste stream are properly aggregated	No
5.1.1	Verify that the correct k value is used for each food and soiled paper waste stream's baseline calculation	No
5.1	Verify that the FOD equation is used correctly for the food waste and soiled paper components of each eligible waste stream	No
5.1	Verify that baseline equation parameters, including referenced parameters, are applied correctly in the FOD equation	No

Protocol Section	Quantification Item	Apply Professional Judgment?
5.1.1	Verify that the proportional weight of food and soiled paper waste is determined for each eligible waste stream according to the requirements in Section 5.1.1.1 and/or 5.1.1.2	No
5.1.1.2.1	Verify that all Residential SSO waste streams have used either local jurisdiction waste characterization data or quarterly hand sorting to determine the proportion of food and soiled paper in the waste stream	No
5.1.1.2.2	Verify that all Commercial SSO waste streams have used either generator supplied waste characterization data or the sector-specific default values to determine the proportion of food and soiled paper in the waste stream	No
5.2	Verify that the project emissions calculations were calculated according to the protocol with the appropriate data	No
5.2.1	Verify that the project developer correctly monitored, quantified and aggregated electricity use	Yes
5.2.1	Verify that the project developer correctly monitored, quantified and aggregated fossil fuel use	Yes
5.2.1	Verify that the project developer applied the correct emission factors for fossil fuel combustion and grid-delivered electricity	No
5.2.2	Verify that the project developer has correctly categorized the on-site composting treatment systems as either ‘Turned Systems’ or ‘Forced – Aeration Systems’	Yes
5.2.2.1	Verify that the project developer has correctly applied methane emission factors	No
5.2.2.1	If default methane emission factors are not used, verify that project specific emission factors are based on official source tested emissions data or are from an accredited source test service provider	No
5.2.2.1	Verify that the project developer has correctly documented and monitored all Optional Process Controls	Yes
5.2.2.2	Verify that the project developer correctly applied nitrous oxide emission factors	No
5.2.2.2	If default methane emission factors are not used, verify that project specific emission factors are based on official source tested emissions data or are from an accredited source test service provider	No

8.5.3 Risk Assessment

Verification bodies will review the following items in Table 8.4 to guide and prioritize their assessment of data used in determining eligibility and quantifying GHG emission reductions.

Table 8.4. Risk Assessment Verification Items

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
6	Verify that the project Monitoring Plan is sufficiently rigorous to support the requirements of the protocol and proper operation of the project	Yes
6	Verify that the Composting system was operated and maintained according in a manner that would ensure that the BMPs in Section 2.2 are met	Yes
6	Verify that appropriate monitoring equipment is in place to meet the requirements of the protocol	No
6	Verify that the individual or team responsible for managing and reporting project activities are qualified to perform this function	Yes
6	Verify that appropriate training was provided to personnel assigned to	Yes

Protocol Section	Item that Informs Risk Assessment	Apply Professional Judgment?
	greenhouse gas reporting duties	
6	Verify that all contractors are qualified for managing and reporting greenhouse gas emissions if relied upon by the project developer. Verify that there is internal oversight to assure the quality of the contractor's work	Yes
7.2	Verify that all required records have been retained by the project developer	No

8.6 Completing Verification

The Verification Program Manual provides detailed information and instructions for verification bodies to finalize the verification process. It describes completing a Verification Report, preparing a Verification Opinion, submitting the necessary documents to the Reserve, and notifying the Reserve of the project's verified status.

9 Glossary of Terms

Accredited verifier	A verification firm approved by the California Registry to provide verification services for project developers.
Additionality	Organic waste management practices that are above and beyond business-as-usual operation, exceed the baseline characterization, and are not mandated by regulation.
Anaerobic	Pertaining to or caused by the absence of oxygen.
Anthropogenic emissions	GHG emissions resultant from human activity that are considered to be an unnatural component of the Carbon Cycle (i.e. fossil fuel destruction, de-forestation, etc.).
Biogenic CO_2 emissions	CO_2 emissions resulting from the destruction and/or aerobic decomposition of organic matter. Biogenic emissions are considered to be a natural part of the Carbon Cycle, as opposed to anthropogenic emissions.
Carbon dioxide (CO_2)	The most common of the six primary greenhouse gases, consisting of a single carbon atom and two oxygen atoms.
CO_2 equivalent (CO_2e)	The quantity of a given GHG multiplied by its total global warming potential. This is the standard unit for comparing the degree of warming which can be caused by different GHGs.
Direct emissions	Greenhouse gas emissions from sources that are owned or controlled by the reporting entity.
Effective Date	The date of adoption of this protocol by the Reserve board: June 30, 2010.
Emission factor (EF)	A unique value for determining an amount of a greenhouse gas emitted for a given quantity of activity data (e.g. metric tons of carbon dioxide emitted per barrel of fossil fuel burned).
First Order Decay (FOD) model	A calculation developed to model the decay of waste under anaerobic conditions, based off of first-order kinetic equations.
Fossil fuel	A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
Greenhouse gas (GHG)	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), or perfluorocarbons (PFCs).
Grocery Store or Supermarket	A grocery store is a store established primarily for the retailing of food. Large grocery stores that stock products other than food, such as clothing or household items, are referred to as supermarkets.
GHG reservoir	A physical unit or component of the biosphere, geosphere, or hydrosphere with the capability to store or accumulate a GHG that

	has been removed from the atmosphere by a GHG sink or a GHG captured from a GHG source.
GHG sink	A physical unit or process that removes GHG from the atmosphere.
GHG source	A physical unit or process that releases GHG into the atmosphere.
Global Warming Potential (GWP)	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one unit of a given GHG compared to one unit of CO_2.
Indirect emissions	Reductions in GHG emissions that occur at a location other than where the reduction activity is implemented, and/or at sources not owned or controlled by project participants.
Landfill	A defined area of land or excavation that receives or has previously received waste that may include household waste, commercial solid waste, non-hazardous sludge and industrial solid waste.
Landfill gas (LFG)	Gas resulting from the decomposition of wastes placed in a landfill. Typically, landfill gas contains methane, carbon dioxide and other trace organic and inert gases.
Metric ton (MT) or "tonne"	A common international measurement for the quantity of GHG emissions, equivalent to about 2204.6 pounds or 1.1 short tons.
Methane (CH_4)	A potent GHG with a GWP of 21, consisting of a single carbon atom and four hydrogen atoms.
MMBtu	One million British thermal units.
Mobile combustion	Emissions from the transportation of materials, products, waste, and employees resulting from the combustion of fuels in company owned or controlled mobile combustion sources (e.g. cars, trucks, tractors, dozers, etc.).
Mixed MSW	Non-source separated waste consisting of organic and inorganic components, reflecting waste typically disposed of at a landfill.
MSW food waste	Non-industrial food waste commonly disposed into a MSW system, consisting of uneaten food, spoiled food and food preparation wastes from homes, restaurants, kitchens, grocery stores, campuses, cafeterias, and similar institutions.
National Emission Standards for Hazardous Air Pollutants (NESHAP)	Federal emission control standards codified in 40 CFR 63. Subpart AAAA of Part 63 prescribes emission limitations for MSW landfills.
New Source Performance Standards (NSPS)	Federal emission control standards codified in 40 CFR 60. Subpart WWW of Part 60 prescribes emission limitations for MSW landfills.
Project baseline	A business as usual GHG emission assessment against which GHG emission reductions from a specific GHG reduction activity are measured.

Project developer	An entity that undertakes a GHG project.
Resource Conservation and Recovery Act (RCRA)	Federal legislation under which solid and hazardous waste disposal facilities are regulated.
Soiled Paper Waste	Non-recyclable paper items that are co-mingled with food waste, consisting of paper napkins and tissues, paper plates, paper cups, fast food wrappers, used pizza boxes, and other similar paper items typically disposed of in an MSW system.
Stationary combustion source	A stationary source of emissions from the production of electricity, heat, or steam, resulting from combustion of fuels in boilers, furnaces, turbines, kilns, and other facility equipment.
Verification	The process used to ensure that a given participant's greenhouse gas emissions or emission reductions have met the minimum quality standard and complied with the Reserve's procedures and protocols for calculating and reporting GHG emissions and emission reductions.
Verification body	A Reserve approved firm that is able to render a verification opinion and provide verification services for operators subject to reporting under this protocol.
Waste stream	For the purpose of this protocol, an eligible waste stream is defined as an eligible waste type per the eligibility requirements in Section 3.4.1 that originates from a specific source. ▪ Examples: Source Separated Organics from a residential collection program at a specific county or municipal jurisdiction ▪ MSW Food waste and soiled paper waste from a specific grocery store, supermarket distribution center, restaurant, college etc.

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Appendix A Data Lookup Tables

Table A.1. Composting System Descriptions

Composting System	Description	% of Market	Likely to Meet BMP Requirements
Passive Piles	Passive piles rely predominantly on natural convection, a function of the porosity (or free air space) of the material or mix being composted. Passive piles are often turned very infrequently and may not be suitable for all feedstocks. Passive piles are likely to contain anaerobic pockets. Temperatures in these piles may not heat up to regulatory requirements for pathogen destruction, one of the hallmarks of commercial and municipal composting. For these reasons, passive piles do not meet the BMP requirements per this protocol.	<5%	No
Turned windrows	The predominant method of composting in the US. Windrow composting involves making elongated trapezoidal piles, which are turned with either a tractor, front-end loader, or specialized turning equipment. There can be significant variation in windrow size (which typically depends on the equipment used to turn the pile), windrow length, and management intensity. Some facilities can make quality compost in 8 to 9 weeks or longer from start to finish. Windrow operations can easily reach temperatures required for pathogen destruction. In these systems, any anaerobic regions are concentrated at the bottom of the windrow. Heat from decomposition dries these piles and in many cases, additional water is added to maintain sufficient moisture for microbial decomposition	90%	Yes
Aerated Static Piles (un-contained and contained)	These systems use a blower to introduce air into the composting mass, either with positive or negative pressure. ASPs can be uncontained or contained using membrane cover, or contained in an enclosed (in-vessel) or in-building system. The advantage of negatively aerating a static pile is that the exhaust can be directed to a point source and put through a control system such as a biofilter.	<5%	Yes

Table A.2. Decay Rates (k) by Waste Type and Climate

Climatic Category	Food Waste Decay Rates $k_{FW,S}$ (yr^{-1})	Soiled Paper Decay Rate $k_{SP,S}$ (yr^{-1})*
Temperate, Dry	0.06	0.04
Temperate, Wet	0.185	0.06
Tropical, Dry	0.085	0.045
Tropical, Wet	0.4	0.07

Source: UNFCCC Clean Development Mechanism: Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site.

* Soiled Paper decay rate assumed to be equal to the decay rate of office paper, per communication with M. Barlaz.

Table A.3. Gas Collection (GC_S) Fractions, by State

	Total annual waste acceptance at open landfills (tons)					
Landfill State	Landfills with no LFG Collection System	Landfills where LFG Collection status is unknown	Landfills with LFG Collection Systems	All landfills	Fraction of total waste that is accepted at open landfills with known or potential LFG collection systems	GC_S
AK	479,674	72,900		552,574	13%	**0.13**
AL	2,273,383		2,966,106	5,239,489	57%	**0.57**
AR	471,646		1,830,354	2,302,000	80%	**0.80**
AZ	1,215,394		2,074,811	3,290,205	63%	**0.63**
CA	2,791,219		68,565,366	71,356,585	96%	**0.96**
CO	1,696,630		5,354,439	7,051,069	76%	**0.76**
CT			158,164	158,164	100%	**1.00**
DE			847,546	847,546	100%	**1.00**
FL	3,008,324	130,000	14,821,616	17,959,940	83%	**0.83**
GA	858,978	2,731,798	10,989,840	14,580,616	94%	**0.94**
HI	760,099		170,335	930,434	18%	**0.18**
IA	681,200		1,164,736	1,845,936	63%	**0.63**
ID	585,741		1,041,000	1,626,741	64%	**0.64**
IL	1,603,004		9,759,084	11,362,088	86%	**0.86**
IN	4,717,764	65,000	13,100,745	17,883,509	74%	**0.74**
KS	1,700,853		3,706,642	5,407,495	69%	**0.69**

KY	1,361,084		4,785,800	6,146,884	78%	**0.78**
LA	439,677		4,187,976	4,627,653	90%	**0.90**
MA	154,957		2,990,030	3,144,987	95%	**0.95**
MD	441,873	251,956	3,810,246	4,504,075	90%	**0.90**
ME	54,355		825,679	880,034	94%	**0.94**
MI	446,988		15,643,712	16,090,700	97%	**0.97**
MN	225,080		1,971,998	2,197,078	90%	**0.90**
MO	784,856		2,932,184	3,717,040	79%	**0.79**
MS	1,922,800		1,401,578	3,324,378	42%	**0.42**
MT	379,717		474,030	853,747	56%	**0.56**
NC	2,512,093	192,041	5,073,637	7,777,771	68%	**0.68**
ND	197,579		420,000	617,579	68%	**0.68**
NE	556,694		465,662	1,022,356	46%	**0.46**
NH	171,467		4,392,248	4,563,715	96%	**0.96**
NJ			10,311,656	10,311,656	100%	**1.00**
NM			1,082,131	1,082,131	100%	**1.00**
NV	341,668		4,115,628	4,457,296	92%	**0.92**
NY	1,028,818	38,868	20,126,707	21,194,393	95%	**0.95**
OH	2,071,380	199,940	19,465,181	21,736,501	90%	**0.90**
OK	624,180		1,547,474	2,171,654	71%	**0.71**
OR	142,749		5,077,078	5,219,827	97%	**0.97**
PA	507,926		49,981,126	50,489,052	99%	**0.99**
PR	2,319,087		1,122,478	3,441,565	33%	**0.33**
RI	9,760		6,031,388	6,041,148	100%	**1.00**
SC	1,239,513	95,000	9,699,883	11,034,396	89%	**0.89**
SD	272,703		225,000	497,703	45%	**0.45**
TN	1,523,037		6,666,613	8,189,650	81%	**0.81**
TX	265,600	143,160	27,257,775	27,666,535	99%	**0.99**
UT	564,766		1,744,125	2,308,891	76%	**0.76**
VA	1,273,754	669,596	22,149,577	24,092,927	95%	**0.95**
VI	230,000			230,000	0%	**0.00**

VT	11,788		1,410,000	1,421,788	99%	**0.99**
WA	411,961		7,501,837	7,913,798	95%	**0.95**
WI	892,814		8,412,898	9,305,712	90%	**0.90**
WV	1,304,758		462,024	1,766,782	26%	**0.26**
WY	275,453			275,453	0%	**0.00**
Grand Total	47,804,844	4,590,259	390,316,143	442,711,246	89%	N/A

Source: U.S. EPA Landfill Methane Outreach Program (LMOP) Database (2008).

Table A.4. Fraction of Waste Sent to Waste to Energy (WTE) Facilities, by State

State	WTE_S (Fraction)
ALABAMA	0.03
ALASKA	0.03
ARIZONA	0.00
ARKANSAS	0.01
CALIFORNIA	0.02
COLORADO	0.00
CONNECTICUT	0.65
DELAWARE	0.00
FLORIDA	0.25
GEORGIA	0.01
HAWAII	0.28
IDAHO	0.00
ILLINOIS	0.00
INDIANA	0.05
IOWA	0.01
KANSAS	0.00
KENTUCKY	0.00
LOUISIANA	0.04
MAINE	0.19
MARYLAND	0.20
MASSACHUSETTS	0.37
MICHIGAN	0.07
MINNESOTA	0.21
MISSISSIPPI	0.00
MISSOURI	0.01
MONTANA	0.01
NEBRASKA	0.00
NEVADA	0.00
NEW HAMPSHIRE	0.16
NEW JERSEY	0.15
NEW MEXICO	0.00
NEW YORK	0.20
NORTH CAROLINA	0.01
NORTH DAKOTA	0.00
OHIO	0.00
OKLAHOMA	0.08
OREGON	0.04
PENNSYLVANIA	0.19
RHODE ISLAND	0.00
SOUTH CAROLINA	0.05
SOUTH DAKOTA	0.00
TENNESSEE	0.00
TEXAS	0.00
UTAH	0.04
VERMONT	0.09
VIRGINIA	0.13
WASHINGTON	0.04
WEST VIRGINIA	0.00
WISCONSIN	0.03
WYOMING	0.00

Source: Biocycle State of Garbage Report (2006).
Table 3. (http://www.jgpress.com/images/art/0604/table3.gif)

Table A.5. CO_2 Emission Factors for Fossil Fuel Use

Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Coal and Coke	**MMBtu / Short ton**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / Short ton**
Anthracite Coal	25.09	28.26	1.00	103.62	2,599.83
Bituminous Coal	24.93	25.49	1.00	93.46	2,330.04
Sub-bituminous Coal	17.25	26.48	1.00	97.09	1,674.86
Lignite	14.21	26.30	1.00	96.43	1,370.32
Unspecified (Residential/ Commercial)	22.05	26.00	1.00	95.33	2,102.29
Unspecified (Industrial Coking)	26.27	25.56	1.00	93.72	2,462.12
Unspecified (Other Industrial)	22.05	25.63	1.00	93.98	2,072.19
Unspecified (Electric Utility)	19.95	25.76	1.00	94.45	1,884.53
Coke	24.80	31.00	1.00	113.67	2,818.93
Natural Gas (By Heat Content)	**Btu / Standard cubic foot**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / Standard cub. ft.**
975 to 1,000 Btu / Std cubic foot	975 – 1,000	14.73	1.00	54.01	Varies
1,000 to 1,025 Btu / Std cubic foot	1,000 – 1,025	14.43	1.00	52.91	Varies
1,025 to 1,050 Btu / Std cubic foot	1,025 – 1,050	14.47	1.00	53.06	Varies
1,050 to 1,075 Btu / Std cubic foot	1,050 – 1,075	14.58	1.00	53.46	Varies
1,075 to 1,100 Btu / Std cubic foot	1,075 – 1,100	14.65	1.00	53.72	Varies
Greater than 1,100 Btu / Std cubic foot	> 1,100	14.92	1.00	54.71	Varies
Weighted U.S. Average	1,029	14.47	1.00	53.06	0.0546
Petroleum Products	**MMBtu / Barrel**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / gallon**
Asphalt & Road Oil	6.636	20.62	1.00	75.61	11.95
Aviation Gasoline	5.048	18.87	1.00	69.19	8.32
Distillate Fuel Oil (#1, 2 & 4)	5.825	19.95	1.00	73.15	10.15
Jet Fuel	5.670	19.33	1.00	70.88	9.57
Kerosene	5.670	19.72	1.00	72.31	9.76
LPG (average for fuel use)	3.849	17.23	1.00	63.16	5.79
Propane	3.824	17.20	1.00	63.07	5.74
Ethane	2.916	16.25	1.00	59.58	4.14
Isobutene	4.162	17.75	1.00	65.08	6.45
n-Butane	4.328	17.72	1.00	64.97	6.70
Lubricants	6.065	20.24	1.00	74.21	10.72
Motor Gasoline	5.218	19.33	1.00	70.88	8.81
Residual Fuel Oil (#5 & 6)	6.287	21.49	1.00	78.80	11.80
Crude Oil	5.800	20.33	1.00	74.54	10.29
Naphtha (<401 deg. F)	5.248	18.14	1.00	66.51	8.31
Natural Gasoline	4.620	18.24	1.00	66.88	7.36
Other Oil (>401 deg. F)	5.825	19.95	1.00	73.15	10.15
Pentanes Plus	4.620	18.24	1.00	66.88	7.36
Petrochemical Feedstocks	5.428	19.37	1.00	71.02	9.18
Petroleum Coke	6.024	27.85	1.00	102.12	14.65
Still Gas	6.000	17.51	1.00	64.20	9.17
Special Naphtha	5.248	19.86	1.00	72.82	9.10
Unfinished Oils	5.825	20.33	1.00	74.54	10.34
Waxes	5.537	19.81	1.00	72.64	9.58

Source: EPA Climate Leaders, Stationary Combustion Guidance (2007), Table B-2 except:
Default CO_2 emission factors (per unit energy) are calculated as: Carbon Content × Fraction Oxidized × 44/12.
Default CO_2 emission factors (per unit mass or volume) are calculated as: Heat Content x Carbon Content × Fraction Oxidized × 44/12× Conversion Factor (if applicable). Heat content factors are based on higher heating values (HHV).

Table A.6. CO_2 Electricity Emission Factors

eGRID subregion acronym	eGRID subregion name	Annual output emission rates	
		(lb CO_2/MWh)	(metric ton CO_2/MWh)*
AKGD	ASCC Alaska Grid	1,232.36	0.559
AKMS	ASCC Miscellaneous	498.86	0.226
AZNM	WECC Southwest	1,311.05	0.595
CAMX	WECC California	724.12	0.328
ERCT	ERCOT All	1,324.35	0.601
FRCC	FRCC All	1,318.57	0.598
HIMS	HICC Miscellaneous	1,514.92	0.687
HIOA	HICC Oahu	1,811.98	0.822
MROE	MRO East	1,834.72	0.832
MROW	MRO West	1,821.84	0.826
NEWE	NPCC New England	927.68	0.421
NWPP	WECC Northwest	902.24	0.409
NYCW	NPCC NYC/Westchester	815.45	0.370
NYLI	NPCC Long Island	1,536.80	0.697
NYUP	NPCC Upstate NY	720.80	0.327
RFCE	RFC East	1,139.07	0.517
RFCM	RFC Michigan	1,563.28	0.709
RFCW	RFC West	1,537.82	0.698
RMPA	WECC Rockies	1,883.08	0.854
SPNO	SPP North	1,960.94	0.889
SPSO	SPP South	1,658.14	0.752
SRMV	SERC Mississippi Valley	1,019.74	0.463
SRMW	SERC Midwest	1,830.51	0.830
SRSO	SERC South	1,489.54	0.676
SRTV	SERC Tennessee Valley	1,510.44	0.685
SRVC	SERC Virginia/Carolina	1,134.88	0.515

Source: U.S. EPA eGRID2007, Version 1.1 Year 2005 GHG Annual Output Emission Rates (December 2008).
* Converted from lbs CO_2/ MWh to metric tons CO_2/MWH using conversion factor 1 metric ton = 2,204.62 lbs.

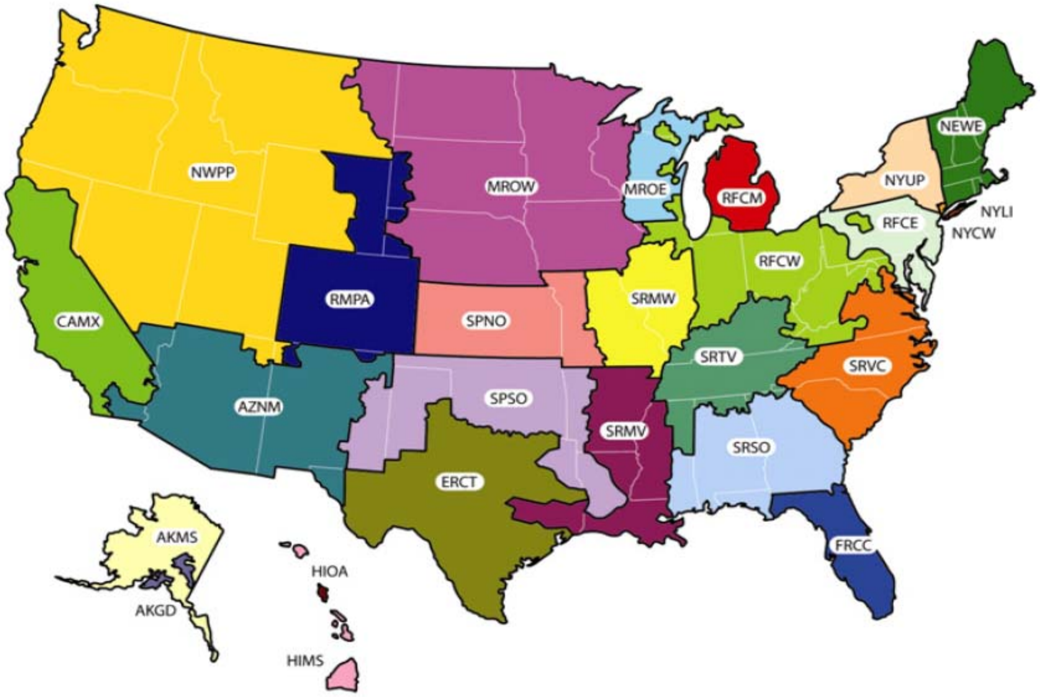
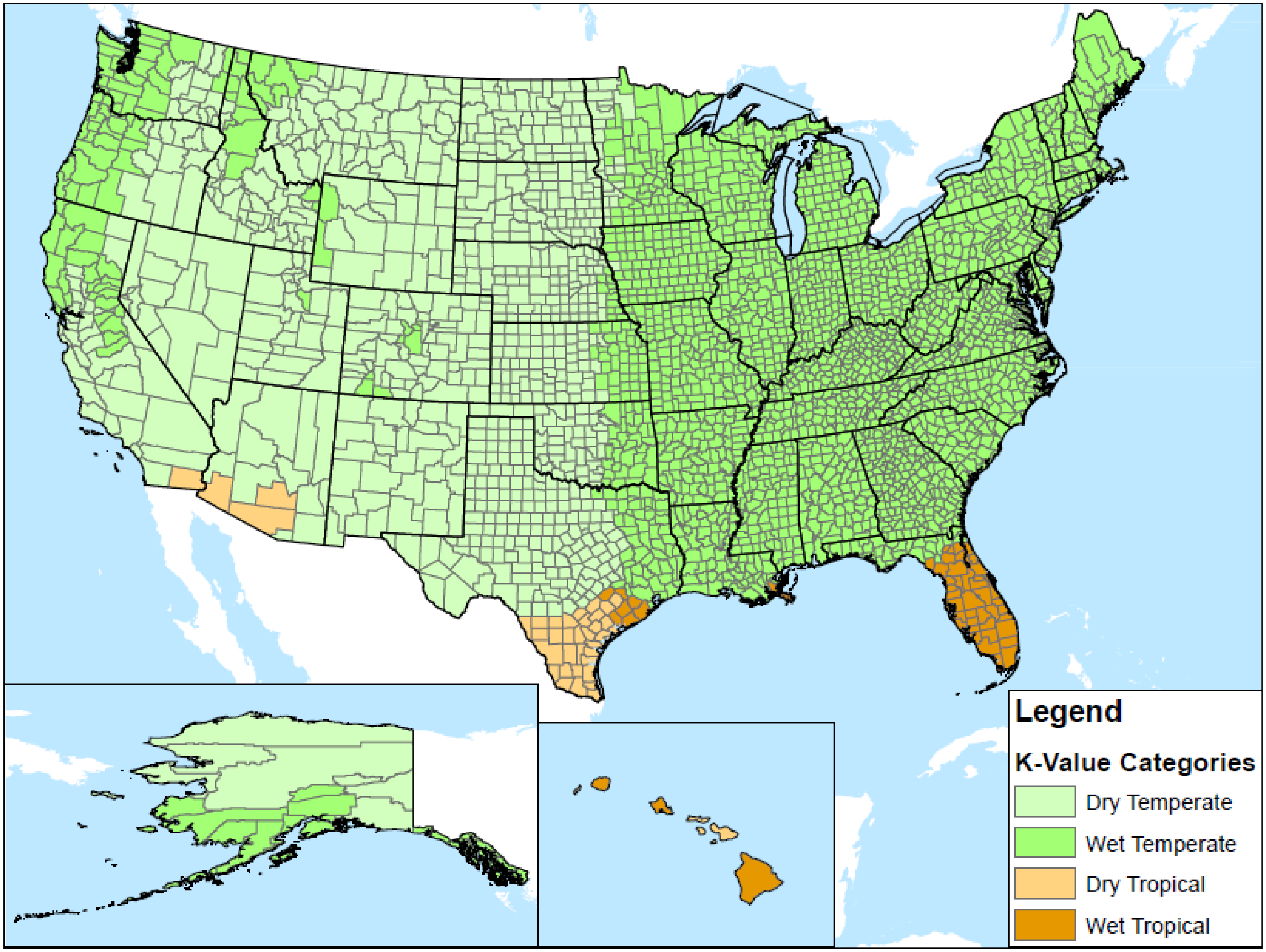


Figure A.1. Map of eGRID2007 Subregions



Source: USGS, Hydrologic landscape regions of the United States (2003).

Figure A.2. K-Value Categories in the U.S., by County

Appendix B Summary of Performance Standard and Regulatory Research

The Performance Standard for the Composting Project Protocol was modified from the Organic Waste Digestion Project Protocol Performance Standard analysis and the Methane Avoidance from Composting issue paper completed by Science Applications International Corporation[37] (SAIC) in May 2009 and September 2009, respectively. The analysis culminated in two papers that provided performance standard options and recommendations to support the Reserve's protocol development process, which the Reserve has incorporated into the protocol's eligibility rules (see Section 3).

The purpose of a Performance Standard is to establish a threshold that is significantly better than common practice with regard to greenhouse gas (GHG) emissions for a specified service. If the threshold is voluntarily met or exceeded by a project developer, then the criterion for "additionality" is satisfied. The Reserve's project protocol focuses on the following emission reduction activity: the composting of organic food waste that was previously treated in MSW Landfills.

The analysis to establish the Performance Standard for the OWD protocol evaluated organic waste management practices in the specified categories of waste streams. The SAIC research for this study did not provide a detailed quantitative analysis of organic waste practices or volumes in the U.S. but rather provided a qualitative review of current practices and regulations for the identified waste categories. Ultimately, the analysis recommended for each waste category whether a performance standard to improve GHG emissions could be established. The Methane Avoidance from Composting issue paper completed subsequent to the OWD performance standard analysis largely confirmed the findings in regards to how the OWD protocol utilized the information in the OWD performance standard to define eligible vs. ineligible materials. The following sections summarize the methodology and key findings of the Performance Standard research.

B.1 Selected Waste Generating Industries

As organic waste sources span across a range of different point sources and disposal locations, an industry-based approach was utilized to inform the performance standard. A list of 82 industries was identified using the North American Industry Classification System (NAICS), the standard used by federal statistical agencies in classifying business establishments.[38] The list of 82 industries was then shortlisted based on their organic waste generation and greenhouse gas emissions potential. Thirty-one industries were shortlisted for detailed analysis. These were organized under the two categories of organic waste relevant to composting projects:

- Food and food-processing solid waste sources
- Agricultural solid waste sources

Table B.1. shows the major organic waste generating industries considered in the paper.

[37] http://www.climateactionreserve.org/wp-content/uploads/2009/11/Reserve_Composting_Issue_Paper_Final.pdf
[38] http://www.census.gov/eos/www/naics/

Table B.1. Selected Organic Waste Source Industries Studied

Category	Industry	Organic Waste Source Categories		Primary Manufacturing	Secondary Manufacturing
		Food & Food Processing Solid Waste	Agricultural Solid Waste		
Grain Manufacturing	1. Rice Milling 2. Malt Manufacturing 3. Wet Corn Milling		X	X	
Oilseed Processing	4. Soybean Processing 5. Other Oilseed Processing		X	X	
Sugar Manufacturing	6. Sugarcane Mills 7. Cane Sugar Refining 8. Beet Sugar Manufacturing	X	X	X	X
Fruit and Vegetable Manufacturing	9. Frozen Fruit, Juice, and Vegetable Manufacturing 10. Fruit and Vegetable Canning	X		X	X
Pre-Cooked Foods	11. Frozen Specialty Food Manufacturing 12. Specialty Canning 13. Commercial Bakeries	X			X
Dairies	14. Fluid Milk Manufacturing 15. Creamery Butter Manufacturing 16. Cheese Manufacturing	X			X
Animal/ Seafood Processing	17. Animal (except Poultry) Slaughtering 18. Meat Processed from Carcasses 19. Rendering and Meat Byproduct Processing 20. Poultry Processing 21. Seafood Canning	X		X	X

Table B.1. Selected Organic Waste Source Industries Studied (Continued)

Category	Industry	Organic Waste Source Categories		Primary Manufacturing	Secondary Manufacturing
		Food & Food Processing Solid Waste	Agricultural Solid Waste		
Beverage Manufacturing	22. Soft Drink Manufacturing 23. Breweries 24. Wineries	X			X
Paper Milling	25. Paper (except Newsprint) Mills 26. Paperboard Mills 27. Cellulosic Organic Fiber Manufacturing	X*			X
Fertilizer Manufacturing	28. Nitrogenous Fertilizer Manufacturing 29. Phosphatic Fertilizer Manufacturing 30. Fertilizer (Mixing Only) Manufacturing + Compost Manufacturing	X*	X		X
Medicinal Manufacturing	31. Medicinal and Botanical Manufacturing	X*			X

* Non-food industries that generate organic wastes (note, for the purposes of this study, these industries were grouped with the food processing for research, analysis and discussion)

Primary manufacturing is characterized by industries that process an agricultural or forestry product. These manufacturing plants or operations will generally be largest, and will produce the greatest quantities of waste per plant. Because of their large waste volumes and the producers' motivation to sell products to their highest use (and value), manufacturers will typically sell waste products to buyers who use them as feedstock for secondary products. Secondary manufacturing, on the other hand, is producing a more finished product from the primary manufacturing products.

In addition to these "pre-consumer" industries, SAIC also uncovered relevant information on "post-consumer" organic wastes from the Municipal Solid Waste (MSW) streams in the U.S. such as food scraps and yard trimmings. Data was also obtained and analyzed for Fats, Oils, and Grease (FOG) wastes from pre and post-consumer sources.

B.2 Organic Waste Generation and Management and Composting Performance Standard Options

SAIC looked at two categories of organic waste relevant to composting projects: 1) solid food waste and 2) agricultural solid waste. They determined the types of waste and industries associated with each category, as well as waste quantities for each type of the waste and any seasonal and geographical variations. SAIC then looked at waste management practices in the U.S. for each of the two categories and provided an overview of how waste emissions arise, the methane potential of the waste, how it is managed in a "business as usual" setting and alternative management technologies.

The gathered evidence showed that for the two categories there is a strong economic incentive to extract and recover solids from waste streams and convert these into by-products or to burn wastes for energy.[39] Thus, the common practices of activity for these waste streams are already those with very low GHG emission potentials.

However, there are a few industrial solid food wastes that cannot be reused as byproducts and inevitably end up in landfill. Some examples of landfilled solid food waste identified in the research include milk solids, condemned animal carcasses, meat scraps, and pomace wastes from winery. Further studies should be conducted to determine if these niche pre-consumer waste streams can be better characterized and included into a food waste offset methodology.

Non-Industrial Food Waste

Studies by the U.S. EPA identified that 31.7 million tons of non-industrial food waste was generated in 2007, or 12.5% of total national MSW waste generated. In addition, studies by Biocycle Magazine estimate that just 0.8 million tons or 2.6% of this quantity was diverted from landfill to compost in 2007. Since only 2.6% of this waste is currently being diverted, this would typically qualify as achieving significantly improved GHG performance and meeting a stringent performance threshold. Although not specifically addressed in the Biocycle Magazine estimate or EPA waste diversion estimates, the composting work group has supplied evidence that the majority of the non-industrial food waste that is currently composted in the U.S. is likely a result of waste diversion programs implemented at super markets and grocery stores, particularly supermarkets that are part of large regional chains.

FOG Wastes

FOG wastes (Fats, Oils, and Grease) were also studied for their generation and disposal practices. It was discovered that yellow grease is a valuable product which is almost always recycled into byproducts such as biofuels and rendered animal fats are also converted into valuable products such as soap and cosmetics. Brown grease (or grease trap grease) is mostly sent to Publicly Owned Treatment Works (POTWs) with some individual practices being identified which involve solids being separated and sent to landfill. However, this is estimated to be a very small amount and in leading states, reuse of brown grease as biofuel feedstock is becoming common, as well as hauling to rendering plants for extraction of valuable components for reuse. Common practice therefore recognizes FOG waste as a recyclable resource and only small quantities are being sent to landfill, so it is concluded that these waste types would not qualify as achieving significantly improved GHG performance through application in composting projects.

Yard Waste

Another organic waste category studied was yard waste. An estimated 32.6 million tons of yard trimmings were generated in 2007, or 12.8% of total national MSW generated. Unlike the low

[39] The burning of agricultural solids generates biogenic carbon in the form of CO_2 and is therefore considered carbon neutral. However, open burning of these wastes is an incomplete combustion process and can generate soot, carbon monoxide, and other pollutants of concern. There could be some GHG benefits from reducing open burning by reducing carbon black formation and some N_2O formed during incomplete combustion, since these would be considered anthropogenic. Further study would be needed to establish if GHG emissions from carbon black and N_2O resulting from open burning are significant.

diversion rate of post-consumer food waste, the EPA estimated 20.9 million tons of yard trimmings, or 64.1% of the total quantity, was diverted from landfill for composting or mulching in 2007. This is therefore the common practice and for the same reasons as were given for pre-consumer solid waste, a performance standard showing significantly improved performance above common practice cannot be established for yard waste.

B.3 Regulatory Conditions and Regulatory Additionality Recommendations

In order to properly credit emission reductions from organic waste composting projects, it is important to establish regulatory additionality that determines whether a project fulfills a regulatory obligation or if a project provides additional emission reductions beyond what is required by law. All GHG reduction projects are subject to a Legal Requirement Test to ensure that the emission reductions achieved by a project would not otherwise have occurred due to federal, state or local regulations.

In the study, SAIC found that there are no federal or state regulations currently in place that obligate waste source producers to divert waste to an aerobic composting facility. For landfills, Federal and State laws have long required methane collection systems. In California, starting in 2010, AB32 will also require any remaining uncontrolled MSW landfills to install emission control systems to manage methane emissions from the decomposition of organic matter.

Through AB939, California also calls for all municipalities to currently divert 50% of their waste stream from landfills. Thus, any municipality that has already achieved its landfill diversion goal would meet the Legal Requirement Test for additional landfill diversions of food wastes. Conversely, a municipality that has not yet met its landfill diversion target may not fulfill the Legal Requirement Test for additional landfill diversions (at least until the target is achieved). Other States such as North Carolina and Missouri have similar landfill diversion goals that are not mandated on the jurisdiction level, and therefore do not impact regulatory additionality.

With a myriad of regulations that wholly or partly apply to activities involved with organic waste disposal (e.g. air quality, water quality, compost management) and with a wide variety of industries that generate organic wastes, compost project owners need to ensure their diversion of organics to an aerobic composting facility continues to meet relevant regulatory requirements for disposal. This will most likely need to be done on a case by case basis depending on the location, quantity of waste, and the operation that is generating the waste in order to properly account for any additional emission reductions that occur beyond what is required by law.

Relevant Regulations

SAIC conducted an evaluation of existing and pending state and national regulations related to composting activities to determine if they are or may be required by regulation. The following Table B.2 shows a summary of state recycling goals, landfill bans on yard trimmings, and the number of permitted composting facilities. Note that a goal implies a voluntary commitment, whereas a mandate requires a regulation in place.

Table B.2. Summary of Waste Regulations by State

State	State Recycling Goal/Mandate[40,41]	Yard Waste Ban[42] (Yes/No)	Estimated Number of Permitted Composting Facilities[43]
Alabama	25% goal in 1989 (the passing of HB 395 in '08 may up this rate)	No	Unknown
Alaska	25%	No	4
Arizona	No statewide recycling goal	No	10
Arkansas	50% goal by 2010	Yes	32
California	50% landfill diversion mandate	No	150
Colorado	Governor's challenge of 50% by 2000	No	29
Connecticut	40% goal by 2000	Yes	94
Delaware	70% goal by 2010	Yes (recent)	2 [4]
District of Columbia	45%		
Florida	75% goal by 2020	Yes	8
Georgia	25% goal by 1996	Yes	38
Hawaii	50% goal by 2000	No	5
Idaho	Non binding resolution for 25% goal	No	5
Illinois	25% by 1996 (The Illinois Solid Waste Planning and Recycling Act (415 ILCS 15)	Yes	40
Indiana	50% by 2001	Yes	122[44]
Iowa	50% by 2000	Yes	93
Kansas	No statewide goal	No	123
Kentucky	25% by 1997	*YW banned from some landfills	34
Louisiana	30%	No	?
Maine	50% by 1998	No	80
Maryland	40% goal (1999)	Yes	5 [4]
Massachusetts	46% by 2000	Yes	223
Michigan	1998 policy encourages SWM percentages, 30%	Yes	155
Minnesota	50% (TC metro) 35% state (1989)	Yes	80
Mississippi	25% by 1996 (SN2984, 1991)	No	11
Missouri	40% by 1998 (SB530, 1990)	Yes	93
Montana	25% by 1996 (1991)	No	22
Nebraska	50% by 2002 (1992)	Yes/(Changed)	9
Nevada	25% goal by 1995 (AB 320,	No	4

[40] "Appendix 1, State Recycling Goals and Mandates" in "Processing and Marketing Recyclables in New York City May 2004" (Original source www.AFand PA.org), New York City Bureau of Waste Prevention, Reuse, & Recycling.
[41] Personal Communication, Justin Gast, Resource Recycling, 2009.
[42] BioCycle Magazine, State of Garbage in America 2008.
[43] Compiled from various site web sources and published reports including BioCycle (2008). The definition of what constitutes a "facility" varies state to state. Most states do not permit agricultural composting facilities.
[44] Indiana, Department of Environmental Management, Registered Yard Waste Composting Facilities, www.in.gov/idem/5077.htm#composting

State	State Recycling Goal/Mandate[40,41]	Yard Waste Ban[42] (Yes/No)	Estimated Number of Permitted Composting Facilities[43]
	1991)		
New Hampshire	40% by 2000 goal	Yes	12
New Jersey	60% by 1996 (1992) 65% by 2000	Yes	172
New Mexico	50% by 2000 goal (SB 2, 1990)	No	29
New York	50% by 1997 (1987 SWMP)	No	35
North Carolina	40% by 2001 (1991)	Yes	120
North Dakota	40% by 2000 (1991)	No	8
Ohio	50% by 2000	*Some disposal restrictions on YW	444[45]
Oklahoma	Oklahoma State Recycling & Procurement Act	No	3
Oregon	50% by 2009 (1991)	No	44
Pennsylvania	35% goal by 2005	Yes	465
Rhode Island	70% (no deadline, 1989) SB 2797 (2008) sets municipal goals	No	13
South Carolina	35% by 1995(Bill 3927, 1999)	Yes	96
South Dakota	50% goal by 2001 (HB 1001	Yes	128
Tennessee	25% by 2003 (HB 1252, 1991)	No	2
Texas	40% goal by 1994 (SB 1340, 1991)	No	108
Utah	None	No	19[46]
Vermont	50% by 2005 Mandate?	No	12 BC
Virginia	25% by 1995 (1989)	No	30[47]
Washington	50% goal by 1995 (Mandatory)	No	41[48]
West Virginia	50% by 2010 (1991)	Yes	2[4]
Wisconsin	40%	Yes	197[49]
Wyoming	None	No	3

As shown in Table B.2, 23 out of 50 of the U.S. states (or 46%) ban some form of yard trimmings from landfills. Other states have high recycling goals that perhaps serve a similar purpose (California, Washington) and some states appear to have been more effective at implementing municipal and commercial composting programs. However, there is little data on the effectiveness of a given state's ban. It is fair to say that most of the state bans were put into

[45] Ohio EPA, Licensed Class I, Class II, Class III and Class IV Composting Facilities, www.epa.ohio.gov/dsiwm/pages/comp_docs.aspx
[46] Utah Department of Environmental Quality, 2008 Utah Compost Facility Inventory (Calendar 2007 Data), www.hazardouswaste.utah.gov/SWBranch/SWSection/PermittedSolidWasteLandfills.htm
[47] Mid Atlantic Composting Directory, Virginia Cooperative Extension, Publication 452-230, www.pubs.ext.vt.edu/452/452-230/452-230.html
[48] Washington Department of Ecology, 2007 Compost Facilities, http://www.ecy.wa.gov/programs/swfa/compost/
[49] Wisconsin Department of Natural Resources, Licensed Yard Waste Composting Facilities, www.dnr.state.wi.us/org/aw/wm/recycle/issues/compost.htm

effect as a means of preserving landfill capacity. One study[50] makes the argument that states with bans have greater yard waste diversion, but each state tracks facilities and volumes differently enough to introduce some uncertainty at developing good, comparable per capita yard trimmings diversion numbers (also yard trimmings generation variances are not well understood-some states may generate more yard trimmings than others). In recent years there have been several attempts to overturn state landfill bans on yard trimmings. For example, these have occurred in Iowa, Illinois, Nebraska, Missouri and Georgia. All of these to date with the exception of Nebraska (LB 776, 2006) have been unsuccessful.

Food waste bans have only been implemented in a limited number of jurisdictions, but several other governments are contemplating adding mandatory food waste bans to existing landfill bans. While the methods and responsible agencies for implementation vary, most bans involve outreach and coordination with residences and businesses (as applicable), haulers, and the ability to perform waste audits to ensure compliance and identify areas for program reinforcement.

Table B.3 contains a summary of key regulations related to diversion of organic waste from landfills to composting facilities.

Table B.3. Landfill Organic Waste Diversion Regulations

Regulation	Waste Applicability	Overview Summary / Goals	Implementation/ Enforcement
Mandatory Recycling and Composting - San Francisco Passed 6/9/2009 (San Francisco Supervisors, 2009)	Applies to all compostable waste generated within the City and County of San Francisco	100% segregation of trash, recyclables and compostable waste within the city. Specific requirements for multi-family and commercial properties, food/event managers, and haulers/processing facilities are established.	Specified containers must be provided at specific locations/events. Upon pickup, containers with contaminated material must be tagged with written notice following. Numerous tags/notices on the same container(s) result in administrative penalties for repeated violations not to exceed $100. Loads are available for inspection by the City.
Nova Scotia, effective 6/1/97 (Nova Scotia, 1996)	Compostable organic material - food waste, yard waste, soiled and non-recyclable paper	Nova Scotia is committed to achieving a national target of 50% waste diversion by the year 2000. Materials banned from landfill include beverage containers, corrugated cardboard, newsprint, scrap tires, used oil, lead-acid batteries, waste paint, automotive antifreeze, glass food containers, steel/tin cans, selected plastics and compostable organic materials.	Local municipalities given control over how to implement and enforce this regulation. Plans for each city must be provided to the Minister to ensure that the bans are implemented as described.
City of Seattle, WA table scrap recycling –	All single-family homes will be required	Supporting the City of Seattle's Zero Waste Strategy and to help meet its goal of diverting 72% of	Single family home residents are required to obtain new containers for

[50] DSM Environmental Services, 2004

Regulation	Waste Applicability	Overview Summary / Goals	Implementation/ Enforcement
effective April 2009 (City of Seattle, 2007 and Chan, 2007)	to subscribe to food-waste recycling, a program that is now optional through the yard-waste collection program	its garbage from the landfill by 2025, all single-family homes in Seattle must sign up for table-scrap recycling. Recycling food waste will be voluntary for apartments, as well as for businesses. A future ban of all organics from single family garbage will be considered once the collection system has been fully established.	food waste and pay for service. The city will not check whether they are actually dumping food in the new separate bin. Recycling food waste is voluntary for apartments, as well as for businesses. If a ban is implemented, it will likely follow a similar structure to existing bans: violators are fined or their garbage doesn't get picked up.
Massachusetts - Pending (Commonwealth of Massachusetts, 2006 - 310 CMR 19.017, and Massachusetts Executive Office of Environmental Affairs. 2006)	Current landfill ban regulations apply to leaves, grass clippings, weeds, hedge clippings, and brush up to 1 inch in diameter from disposal	The 2006 Solid Waste Master Plan states they will consider amending the waste regulations to add food waste to the list of materials banned from disposal once an adequate in-state food waste diversion infrastructure is in place. Targeted sectors include: residential, supermarkets, hospitals and other health care facilities, hotels and convention centers, colleges and universities, and state institutions such as prisons.	Under development; Under existing waste bans, no person is allowed to dispose or contract for disposal of restricted materials. Where appropriate, Technical assistance and partnerships to stimulate market development are in place. Solid waste facilities, waste haulers and generators have a shared responsibility to comply with waste bans. MassDEP plans to conduct waste ban inspections at solid waste facilities. When haulers and generators of failed loads are identified, MassDEP will pursue enforcement against those entities.
Pennsylvania – (Preliminary review) (Hursh, 2007 and Pennsylvania Commodity Disposal Ban Review, 2008)	Source separated food waste only	Currently lack collection and management infrastructure to handle increased volume of food waste.	Under development.
Alameda County Ban on landfilling plant debris	All plant debris banned from landfill disposal within Alameda County (applies to two large landfills)	All plant debris.	Jurisdictions required to prepare compliance plans.

B.4 Barriers to Composting Project Implementation

There are several barriers that currently prevent the diversion of food wastes to aerobic composting facilities absent GHG reduction project incentives.

Population Density

In less populated areas there is less pressure to conserve landfill space and to separately collect recyclables and/or compostables.

Cost

Composting involves more processing steps such as receiving and processing the material, and thus more operating costs, than disposing of it in a landfill.

One barrier is that to attract the waste stream, composters often charge less than the standard disposal rate (with hauling being equal). This need to under-price in order to get materials when in fact taking these materials results in higher operating and permit costs for a facility is a major disincentive for compost operations to accept food waste.

Site Permitting

Composting facilities (like many solid waste handling sites) can be difficult to site. Odors, land use compatibility, and traffic impacts are the most difficult of the potential issues to overcome.

Food waste composting is most commonly done as an add-on to existing yard waste composting. However, many institutions (universities, correctional facilities, resorts) will start up a food waste composting only project, typically using some small-scale composting technology. However, the bulk of food waste composting is currently done at larger scale operations with food waste being one of the feedstocks that is composted. The primary feedstock at these facilities is likely to be yard waste although some sites will also accept municipal biosolids or other materials.

The first major barrier for food waste composting is getting permitted to take food waste at a yard waste site. Some states make it easier than others, e.g., by starting out with a quantity limitation, or by only allowing pre-consumer vegetative food waste (i.e. not meats, dairy). Very quickly, composters who want to take all types and quantity of food waste will require a solid waste facility permit. Pennsylvania has created a General Permit that makes this less onerous, but that process is still challenging. In Illinois, food waste was recently redefined so that it is no longer considered as solid waste. This was done to make it easier to establish composting facilities that accept food waste. In general, regulations and permitting are the largest hurdles to establishing a food waste composting site.

Accepting food waste will also increase operating costs for running the facility. As food waste requires near immediate processing, staff and equipment has to be on site to accept and process materials when they are delivered. Appropriate process control and materials handling are critical to avoiding nuisance, odor, and vector problems.

Separate Collection

In some cases, separate collection (especially for food scraps) may be difficult to justify. In a few communities, particularly on the West Coast, food scraps are being added to the existing yard trimmings containers. This has proven to be a cost-effective tool in minimizing collection costs. This does not work out as well in states where yard trimmings generation is seasonal (the East Coast and Mid West), but food scraps generation is constant.