TECHNICAL APPENDIX

Implementing Innovative Approaches: Greater Bay Area Food Recovery and Compost Expansion Initiative

Measure 1: Food Recovery Expansion Program

GHG Reduction Estimate Method:

GHG impacts from recovered food was quantified using the California Air Resources Board's (CARB) *Food Waste Prevention and Rescue Program Quantification.*

Table 1. General Approach to Quantification by Project Type

Edible Food Rescue and Food Waste Prevention
GHG emission reductions = Avoided Food Production due to Food Waste Rescue or Prevention – Increased vehicle miles traveled (if applicable) – New Refrigeration Electricity Use and Refrigerant Leakage (if applicable)

Except from Quantification Methodology for the CalRecycle Food Waste Prevention and Rescue Program

The methodology used is consistent with the EPA's Field to Bin report, which states "While it can be challenging to assess whether food donation actually affects overall food production, donation can be credited with source reduction benefits, since donation is a redistribution of food that would otherwise not be consumed"[1] The emissions reduction benefit of food recovery thus includes the upstream impact of additional food production prevented.

Model/Tools Used

GHG impacts from the food recovered was quantified using the California Air Resources Board's (CARB) *Food Waste Prevention and Rescue Program Quantification.* This tool was selected given the California context and the tool's specific application to food rescue programs. It is the tool used by the California Climate Investments program to inform the State's grantmaking.

Measure Implementation Assumptions

The following inputs were used to populate the CARB tool:

Pounds of food recovered: 16.5 million lbs of food recovered total during the 5-year grant period. Based on recent studies of the average cost of food recovery per pounds of food recovered[2], a conversion factor of 1 lb / $1.50 is applied to the direct implementation budget for 33 1a, which seeks to recover edible food generally, and a conversion of 1 lb / $3.00 is applied to the implementation budget for

[1] EPA. From Field to Bin https://www.epa.gov/system/files/documents/2023-10/part2_wf-pathways_report_formatted_no-appendices_508-compliant.pdf

[2] ReFED Insight Engine estimates $0.42 per lb, which would result in higher total lbs and GHG reduction. $1.50 reflects studies conducted by Bay Area counties, including a study by Santa Clara County, filed with CalRecycle, that showed a range from $0.35 - 5.78 per lb. A study commissioned by neighboring San Mateo County shows a range of $0.81-2.52. As an average, $1.50 per lb is used for general food recovery and $3.00 is used for prepared food. Unpublished internal studies are available upon request.

Strategy 1b which focuses on prepared food, with the increased cost indicating that this type of food is more difficult and resource-intensive to recover.

Strategy	Food Recovery Organization (FRO) Budget	Dollars per lb of Food Recovered	Pounds of Food Recovered
1a. Invest in improvements to individual and shared facilities and operational capacity.	$21,500,000	$1.50 / lb	14,333,334
1b. Expand the coordination and use of technology platforms to promote discounted selling and to improve the efficiency of FROs logistical operations	$6,500,000	$3.00 / lb	2,166,666
Total	$28,000,000		16,500,000

Refrigeration: We estimate that CPRG funds could support the purchase and/or upgrade of 80 commercial refrigerators. The impact of these were modeled in the CARB tool with the following variables for a sample model: solid door refrigerators with 46 cf capacity and R-290 refrigerant. This represents a refrigerator model that has been used for prior CARB funded programs[3]. The actual models will depend on the needs of specific FROs, to be determined during the RFI/Q process, which will specify requirements for the purchase of Energy Star rated units and should replace older appliances. To ensure a similar GHG emissions level, procured specifications will reference similar efficiency and low GWP refrigerants.

Food recovery vehicles: 8 refrigerated vehicles (hybrid vans) driving an estimated 13,123 miles per year. The distance traveled is pre-programmed into the CARB tool. In practice, this proposal aims to reduce the total miles traveled by selecting centralized facility locations specifically to mitigate excessive food recovery miles currently driven in the base case scenario. As with refrigerators, the actual number and types of vehicles will depend on the needs of the FROs.

Measurement and reporting from grant subrecipients will monitor and track the input variables above to ensure the measure implementation delivers the predicted GHG reductions.

GHG Reduction Estimate Assumptions

The assumptions for converting implementation inputs into GHG emissions values are contained in CARB's *Food Waste Prevention and Rescue Program Quantification* calculator tool (Excel) on the tabs labeled GHG ERF's (Emissions Reduction Factors Worksheet). The key emissions factors from the tool that are applicable to this proposal's calculations are listed below with the source cited by the CARB tool:

- Food Waste prevention: 1.78 MTCO2e/short ton feedstock (Source: The Climate Change and Economic Impacts of Food Waste in the United States)
- Commercial refrigerator with solid doors: 36.5 kWh/year per ft3 of volume (Source: 10 CFR 431.66 Energy conservation standards)

[3] Vista(R) Bottom Mount Reach in Refrigerator RB49HC: https://cdnimg.webstaurantstore.com/documents/specsheets/rb49hc-1s.pdf

- Electricity emissions factor: 0.000285 MTCO2e/kWh (Source: CARB California electricity emissions factor for GGRF programs)
- R-290 refrigerant GWP: 4 MTCO2e/metric ton (Source: CARB Refrigerant Management Program)
- Commercial refrigeration system refrigerant leak rate: 15% (Source: CARB High GWP Gas Emissions Inventory)
- Hybrid van: 830 g/mile (Source: EMFAC 2014)
- Average miles per year: 13,123 (US Department of Transportation Table VM-1 Annual Vehicle Distance Traveled)

Short-term GHG Reductions (2025-2030)

Below are the outputs from the tool, which show that the food recovered over five years through Measure 1: Food Recovery Expansion Program results in 14,053 net MTCO2e (14,685 gross MTCO2e) avoided, based on an emissions factor of 1.78 MTCO2e per short ton of food recovered and/or prevented from being wasted. The CARB calculator acknowledges the additional energy loads and related GHG emissions from increasing use of refrigeration and food transportation vehicles. Estimations for these emissions were also calculated by the CARB tool.

Implementation Assumptions	**Emissions Factor (CARB)**	**Metric Tons CO2e**
16.5 million lbs of food recovered over 5 years	1.78 MTCO2e/short ton	14,685
80 commercial refrigerators x 5 years	36.5 kWh/year per ft^3 of vol 0.000285 MTCO2e/kWh R-290 refrigerant GWP = 4 MTCO2e/metric ton	-355
8 refrigerated vans x 5 years	13,123 avg miles per year 830 g/mile for hybrid van	-277
Net Total Reduction		**14,053**

Note: Although the GHG emissions impact is accounted for across five years per the CARB tool methodology, not all equipment will be in operation in the first two years, so the cumulative GHG emissions over five years would be lower than estimated in the table.

Year	**Edible Food Rescued (lbs)**	**Net Tons of Material Diverted (Short Tons)**	**Gross EFR GHG Benefit (MTCO2e)**	**Less GHG from Refrigerators**	**Less GHG from Vehicles**	**Net GHG Benefit (MTCO2e)**
Year 1	1,433,333	717	1,276	-55	-71	1,149
Year 2	1,433,333	717	1,276	-55	-71	1,149
Year 3	4,544,445	2,272	4,045	-55	-71	3,918
Year 4	4,544,445	2,272	4,045	-55	-71	3,918
Year 5	4,544,445	2,272	4,045	-55	-71	3,918
Total	**16,500,001**	**8,250**	**14,685**	**-277**	**-355**	**14,053**

With the Measure 1 CPRG funding request amount of $34.8 million, the cost per MTCO2e is $2,474. The primary variable affecting this cost effectiveness is the cost per lb of food recovery activities.

Long Term GHG Reductions (2025-2050)

The primary source of GHG reduction during the grant period will result from funding FRO operations. After the grant, the new physical capacity created by the facility investments will continue to contribute to GHG reductions as food recovery activities continue (as guaranteed by the implementation of SB 1383). These emissions reductions should persist annually following the grant period as long as the facilities remain operational, for an estimated lifetime of 5 years. Previous experience with funding food recovery infrastructure and operations have shown that, with programmatic support to identify new sources of operational funding, these investments result in ongoing operations for at least the duration of the original funding period. Therefore, the long-term reduction potential is estimated at year 5 operations continued on for five more years through 2035.

Emissions Reduction Period	**MTCO2e**	**Source**
Short-term (2025-2030) cumulative MTCO2e	14,053	See calculations above
Year 5 annual MTCO2e	3,918	See table above
5-year post-grant (2030-2035) cumulative MTCO2e	19,590	Year 5 annual x 5 years
Total long-term (2025-2050) cumulative MTCO2e	**33,643**	**Short-term + 5-year post-grant**

Reference Case Scenario

The calculations above represent a projection where the recovered food from CPRG funded sites is additive to what would otherwise occur under existing conditions and implementation of regulations and other mandatory requirements. California's Senate Bill 1383 requires diversion of organics from landfill and a portion of edible food to be recovered, so we expect the benefits of reduced GHG emissions to continue after the conclusion of this grant. The measure targets a hard-to-recover segment of the available surplus edible food volume. Compliance with the regulation will be sought through easier-to-reach segments which will be targeted at scale by enforcement agencies but will remain limited in scope without the scale of funding that CPRG offers.

Measure 2: Compost Expansion Program

GHG Reduction Estimate Method

We utilized the publicly available COMET-Planner for the CDFA Healthy Soils Program. GHG reduction estimates represent the average impact of a conservation practice compared to baseline conditions, over a range of soils, climate and cropland management within multi-county regions defined by Major Land Resource Areas (MLRAs). MLRAs, defined by the USDA, are geographical units characterized by similarities in physiography, climate, soils, biological resources, and land use. Within each county-rectified MLRA, the COMET-Planner developers used a unique random point sampling method, selecting approximately 100 points per broad land use category. Sample sizes varied based on MLRA size and agricultural land use density.

Models/Tools Used

COMET-Planner employs methods outlined in the USDA Methods for Entity-Scale Inventory guidance. Estimation methods used for most GHG sources in COMET-Planner rely on Tier 3 IPCC quantification methods, such as process-based modeling in DayCent and regionally specific empirical calculations. SOC and soil N_2O are modeled to a soil depth to 30 cm, which aligns it with the current 2022 EPA U.S. National Greenhouse Gas Inventory methods. Direct and indirect soil N_2O emissions estimates follow a process-based methodology used in the U.S. National Greenhouse Gas Inventory that includes N_2O emissions from leached and volatilized N.

Measure Implementation Assumptions

For the 2025-2030 period of compost application to public land, we chose the specified area of application is based on known access to county-operated rangelands. Since this represents a small fraction of the total available area, we will have the flexibility to prioritize application to land that deemed to be disturbed by the UCCE/RCD team assessment criteria, which provide readily accessible sites for demonstration, in order to inform planning for more fragile eco-system areas For estimating the amount of privately available rangeland for compost application we relied upon a 2020 report on the carbon sequestration potential of Santa Clara County agricultural lands prepared by the Carbon Cycle Institute. Acreage in Alameda County was estimated using the 2022 Alameda County Crop Report and additional information in the Alameda County Waste Management Authority Altamont Property Carbon Farm Plan.

GHG Reduction Estimate Assumptions

The *Cropland Management* function in the CDFA COMET-Planner assumes compost users will continue to apply synthetic N at the full agronomic rate. (In fact, farmers typically do adjust N fertilization downward after applying compost). Future iterations of the model may take this fact into account and thereby permit higher rates of compost applications to farmlands. For the *Grazed Lands* function, the model assumes an average “grazing density” of “one cattle per acre” and an average excretion rate of 93.8 kg N/head/year, which is a tenfold higher than typical density in Alameda and Santa Clara Counties. In both cases, the assumption of higher N inputs, from synthetic fertilizer and cow urine, respectively, leads to recommendations for lower compost application rates and higher estimates of N_2O release.

Experimental research conducted in Alameda County demonstrated that a one-time application of compost increased soil carbon concentrations 4 MTCO2e/acre-year, suggesting that the carbon sequestration benefit could exceed that predicted by COMET planner l (Alameda County Resource Conservation District [RCD], “StopWaste” Carbon Farm Plan).

Short-term GHG Reductions (2025-2030)

During the initial 5-year period of our project, we anticipate a total estimated GHG emissions reduction of 36,533 MTCO2e. Of this total, 31,100 MTCO2e will result from applying 41,400 tons of compost to 2,300 acres of public open space and rangelands in Alameda and Santa Clara Counties over a three-year period, and 5,434 MTCO2e will be reduced through the application of 7,200 tons of compost applied to 300 acres of agricultural fields in San Benito County over a four-year period.

Long-term GHG Reductions (2025-2050)

In the twenty years following the grant-funding period, we anticipate a total reduction of 160,767 MTCO2e with 116,272 MTCO2e in GHG emissions from application of 154,782 tons of compost to private

rangelands in Alameda County and Santa Clara Counties, and 44,495 MTCO2e from application of 58,960 tons of compost to 9,827 acres of farmland in San Benito County.

Thus, all projected compost applications over the period from **2025 to 2050** including grant project funded and leveraged applications are estimated to achieve a total of **197,301 MTCO2e** in GHG reductions.

Reference Case Scenario

Compost applications on private farmland and rangeland and resulting carbon sequestration impacts have been well documented by Zero Foodprint, which has managed over 250 compost application projects on thousands of acres across 5 states. As a broker focused on GHG impacts of compost applications, Zero Foodprint has consistently utilized the CDFA COMET planner model to represent the emission reduction impacts referenced in this grant for California farm projects, and the standard COMET Planner model for all other states. Their experience in ongoing climate protection on natural and working lands as well as frequent communication and collaboration with soil science organizations including the California Association of Compost Producers, US Composting Council, Point Blue Conservation Science, Colorado State University, The Soil Inventory Project (TSIP), and others demonstrate an ongoing commitment to this work beyond this proposal, and will assure demonstrated results for the extended farmland applications in San Benito County, as well as more innovative applications on public lands in Santa Clara and Alameda Counties.

Measure-Specific Activity Data

Determinations of MTCO2e emissions reduced will be based on the documented acreage to which compost has been applied at 6 tons/acre, as calculated by the CDFA COMET-Planner model using its conservative assumptions as described above. The CDFA COMET-Planner for compost application is based on the DNDC model. Detailed references and methodoligies for this modeling are available from the California Air Resources Board "Quantification of Greenhouse Gas Emissions for Compost Application in California Croplands."[4]

[4]Quantification of Greenhouse Gas Emissions for Compost Application in California Croplands Research Division Transportation and Toxics Division California Air Resources Board: August 4, 2017 https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/dndc_calculations.pdf