California Air Resources Board

Co-benefit Assessment Methodology for Soil Health and Conservation

California Climate Investments
Greenhouse Gas Reduction Fund

July 9, 2018

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Section A. Introduction

The goal of California Climate Investments is to reduce greenhouse gas (GHG) emissions and further the objectives of the California Global Warming Solutions Act of 2006, Assembly Bill (AB) 32. The California Air Resources Board (CARB) is responsible for providing guidance on reporting and quantification methods for all State agencies that receive appropriations from the Greenhouse Gas Reduction Fund (GGRF). Guidance includes developing methodologies for estimating GHG emission reductions and other economic, environmental, and public health benefits of projects, referred to as "co-benefits."

The Center for Resource Efficient Communities at the University of California, Berkeley (UC Berkeley), in consultation with CARB staff, developed this Co-benefit Assessment Methodology to estimate soil health and conservation for relevant California Climate Investments programs.

Co-benefit Assessment Methodologies are intended for use by administering agencies, project applicants, and/or funding recipients to estimate the outcomes of California Climate Investments. Co-benefit estimates can be used to inform project selection and track results of funded projects. In addition to this methodology, general guidance on assessing California Climate Investment co-benefits is available in CARB's Funding Guidelines for Agencies Administering California Climate Investments (Funding Guidelines) available at www.arb.ca.gov/cci-fundingguidelines.

Soil Health and Conservation Co-benefit Description

Soil conservation refers to the prevention of soil loss and degradation from water and wind erosion, typically resulting from urbanization, deforestation, overgrazing, and intensive agricultural cultivation. Soil conservation also refers to the restoration of soil productivity and health.

Soil health refers to a complex agglomeration of physical, chemical, and biological factors that contribute to a given soil's capacity to:

- Sustain biological diversity, activity and productivity (including agricultural productivity);
- Regulate water and solute flow;
- Filter, buffer, and degrade organic and inorganic materials;
- Store and cycle nutrients and carbon; and
- Provide physical stability and support.[1]

These critical functions are generally assessed through the measurement of key indicators including available water capacity, bulk density, infiltration capacity, electrical

[1] Natural Resources Conservation Service. 2015. Soil Quality Indicators. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/health/assessment/?cid=stelprdb1237387.

conductivity, pH, soil organic matter, total organic carbon, erosion, alkalinity, acidity, and several others. Soil organic matter, "the fraction of the soil that consists of plant or animal tissue in various stages of breakdown,"[2] contributes to all the soil functions listed above and is an indicator that can often serve as a good proxy for overall soil heath.

California Climate Investments can cause both positive and negative soil health and soil conservation co-benefits. These co-benefits may accrue directly (as a central objective of the project) or indirectly (as a consequence of project activities).

A ***positive*** soil health and conservation co-benefit results when a California Climate Investments project improves soil health by conserving or restoring agricultural and natural soils by: a) implementing management practices to restore and/or maintain soil health; b) producing compost or other soil amendments that are applied to agricultural soils; or c) conserving land with productive and healthy soils that would otherwise be developed or disturbed.

A ***negative*** soil health and conservation co-benefit results when a California Climate Investments project degrades soil health or conservation through a) the construction of new infrastructure, facilities, or buildings on agricultural or natural soils, resulting in soil disturbance, a change in land use classification, and/or soil erosion; or b) forest site preparation activities that involve deep ripping.

Soil Health and Conservation Co-benefit Project Categories

This Co-benefit Assessment Methodology may apply to California Climate Investments[3] projects that involve:

- Changes in agricultural practices;
- Compost production
- Agricultural or natural land conservation; and
- Construction and/or development on agricultural or natural lands.

California Climate Investments that result in soil health and conservation fall into four project categories covered by this Co-benefit Assessment Methodology.

Project Category 1. Agricultural Soil Health Practices: Projects that apply practices that meet United States Department of Agriculture's Natural Resources Conservation Service Conservation Practice Standards (USDA-NRCS CPS) applicable to California Department of Food and Agriculture (CDFA) Healthy Soils Program and/or compost application in accordance with CDFA-supported Compost Application Rates.

Project Category 2. Production of Soil Amendments: Projects that improve soils indirectly by diverting organic matter from waste streams and using it for the

[2] Cornell Cooperative Extension. 2008. Soil Organic Matter. Agronomy Fact Sheets: Fact Sheet 41. http://franklin.cce.cornell.edu/resources/soil-organic-matter-fact-sheet.
[3] This list is based off of project types funded by the Greenhouse Gas Reduction Fund as of April 2018 and may be modified as California Climate Investments evolve or expand.

production of compost and other soil amendments that are applied to agricultural (croplands, rangelands, or pasturelands) and natural (forests, grasslands, watersheds, or wetlands) soils outside of the project area.

Project Category 3. Conservation Easements: Projects that protect cropland, rangeland, grassland, watershed, or forest soils from conversion and development through easements, conservation agreements, or other protective measures.

Project Category 4. Land Use Conversion: Projects that entail construction or development of the built environment on agricultural (croplands, rangelands, or pasturelands) or natural (forests, grasslands, watersheds, or wetland) lands, resulting in the loss or degradation of those soils (such as the construction of new transit facilities, rails, housing, or buildings).[4]

A single California Climate Investments project may provide benefits in multiple categories. In such cases, users should use the methods outlined for each relevant category to estimate the total soil health and conservation co-benefit.

Methodology Development

UC Berkeley developed this Co-benefit Assessment Methodology, consistent with the guiding principles of California Climate Investments. The methodology is developed to:

- Support calculating the applicable co-benefits for individual projects;
- Apply to the project types proposed for funding;
- Provide uniform methods that can be applied statewide and are accessible by all applicants and funding recipients;
- Use existing and proven tools or methods, where available;
- Include the expected period of time for when co-benefits will be achieved; and
- Identify the appropriate data needed to calculate co-benefits.

UC Berkeley assessed peer-reviewed literature and consulted with experts, as needed, to identify:

- The direction and magnitude of the co-benefit;
- Project types to which the co-benefit is relevant;
- The limitations of existing empirical literature;
- Existing assessment methods and tools; and

[4] Other land use conversion projects that convert urban parcels or other developed sites to natural or agricultural lands could have a positive effect on soil conservation. However, these projects are excluded from this methodology due to uncertainty surrounding the magnitude and directionality of the benefit as well as the ability to quantify these impacts. Though conversion of urban parcels to vegetated open spaces likely represents a revival of the soil body's biological productivity, it may also increase soil's vulnerability to erosion through the exposure of soils during the re-vegetation process, and through exposure to high pedestrian traffic, recreational use and rainfall.

- Knowledge gaps and other issues to consider in developing co-benefit assessment methods.

This work is summarized in a literature review on this co-benefit, which can be found at: www.arb.ca.gov/cci-cobenefits. UC Berkeley also considered ease of use, specifically the availability of project-level inputs from users for the applicable California Climate Investments programs.

CARB released the Draft Soil Health and Conservation Co-benefit Assessment Methodology for public comment in April 2018. This Final Soil Health and Conservation Co-benefit Assessment Methodology has been updated to address public comments, where appropriate. CARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified.

Administering agencies, project applicants, and/or funding recipients estimate GHG emission reductions using CARB GHG Quantification Methodologies and Calculator Tools. Some of the data used for estimating GHG emission reductions may also be used to estimate soil health and conservation co-benefits. CARB anticipates incorporating methods used to estimate the soil health and conservation co-benefit into CARB Calculator Tools.

Program Assistance

For assistance with this Co-benefit Assessment Methodology, send questions to: GGRFProgram@arb.ca.gov. For more information on CARB's efforts to support implementation of California Climate Investments, see: www.arb.ca.gov/auctionproceeds.

Section B. Co-benefit Assessment Methods

This section describes how users estimate soil health and conservation co-benefits by project category. Overall, the methods for assessing soil health and conservation are qualitative and quantitative, amounting to using a set of qualitative criteria to estimate the number of acres of soil impacted during the project quantification period[5] compared to a no-project scenario.

Additional information about the specific data inputs (e.g., default values and data sources) is provided in Section C and Appendix A. Examples of how to apply the methods and data inputs needed are provided in Appendices B and C.

Project Category 1. Agricultural Soil Health Practices

Project Category 1 includes projects that apply USDA-NRCS CPS applicable to CDFA Healthy Soils Program and/or apply compost in accordance with CDFA-supported Compost Application Rates. The following method should be used to estimate the soil health and conservation co-benefit for Project Category 1. Users should estimate the following:

- Type of Practice: The specific type of practice supported by the project that meet practice standards (see Appendix A for list of practices and applicable requirements)
- Project Area$_{\text{Practice}}$: The area (acres) where each qualifying soil health practice is implemented (e.g., acres to receive soil amendments)

This method rests on the assumption that implementation of an eligible soil health practice, consistent with applicable requirements, will result in generally improved soil health on the acreage in which the practice is applied.[6]

If a project expands a continuing practice from the previous year, or have selected Conversion to Herbaceous Cover or Woody Plantings practices that are characterized primarily by length, the user should estimate Practice Area as follows:

Continuing Practices

Practices that were implemented in the previous year on a farm are considered “continuing”, and are already improving soil health on the area where they were implemented. Soil health improvements associated with the continuing practice on the previously implemented area are not quantified in this method. However, applicants

[5] The project quantification period varies for the different programs and is defined in each of CARB’s GHG Quantification Methodologies and Calculator Tools.

[6] While more specific quantitative indicators of soil health would be ideal (e.g., soil organic matter, available water capacity, infiltration capacity, electrical conductivity, pH, total organic carbon, erosion, alkalinity, and acidity), measurement of these indicators in most cases requires soil sampling, which would create a substantial burden for projects. Therefore, this method relies on a simpler qualitative estimate of the total project area on which each qualifying practice will be implemented, and requires that practice-specific standards for alignment are met.

that are expanding the continuing practice to additional acres or fields can include the additional area in the quantification. The acreage that will be quantified for each continuing practice is estimated as:

$$Quantified\ Area_{Practice} = Project\ Area_{Practice} - Continuing\ Area_{Practice} \quad \text{(Eq. 1)}$$

Where:

- Quantified $Area_{Practice}$ = The area in the project that will be quantified using the co-benefit method for the practice (acres)
- Project $Area_{Practice}$ = The total area where the practice is implemented in the project (acres)
- Continuing $Area_{Practice}$ = The area in the project where any implementation of the practice occurred in the previous year; a new practice has a value of zero (acres)

If a practice was implemented on acreage last year, and the same practice is implemented again on that same acreage, it is considered a continuing practice.

Conservation Practices Characterized by Length

For Conversion to Herbaceous Cover and Woody Plantings practices that are typically characterized by their length, refer to Appendix A and the Conservation Practice Standards and Specifications in the USDA-NRCS Field Office Technical Guide for conservation practice width requirements and guidance. The acreage of length-based practices is estimated as:

$$Project\ Area_{Practice} = \frac{1}{43{,}650} \times Length_{Practice} \times Width_{Practice} \quad \text{(Eq. 2)}$$

Where:

- Project $Area_{Practice}$ = The area of a practice (acres)
- $\frac{1}{43{,}650}$ = Conversion factor (acres/ft^2)
- $Length_{Practice}$ = The center-line length of a practice, determined by applicant or Conservation Management Plan (ft)
- $Width_{Practice}$ = The width of a practice, determined by applicant, Conservation Practice Standard, Conservation Practice Specification, or Conservation Management Plan.

Project Category 2. Production of Compost

Project Category 2 includes projects that improve soils indirectly by diverting organic matter from waste streams and using it for the production of compost that is applied to agricultural or natural soils outside of the project area. The following method should be used to estimate the soil health and conservation co-benefit for Project Category 2.

$$Application\ Area = \frac{Compost \times Ag\ Use}{AR \times Years} \quad \text{(Eq. 3)}$$

Where:

- Application Area = The agricultural land *outside* of the project area improved through application of compost by downstream users (acres)
- Compost = The quantity of compost produced during the quantification period per Equation 4 (dry tons)
- Ag Use = The portion of the compost to be applied by agricultural end-users (%)
- AR = The compost application rate (dry tons per acre per year).
- Years = Length of project quantification period (years)

The method for determining the quantity of compost produced during the quantification period is as follows:

$$Compost = Waste\ Diverted\ \times CF \times Dry \quad \text{(Eq. 4)}$$

Where:

- Waste Diverted = The amount of organic waste (e.g., landfill organic material or manure volatile solids) diverted for the production of compost during the project life, per Equations 5 or 6 (tons)
- CF = Conversion factor to convert from tons of initial feedstock to tons of compost produced

  0.58 for landfill organic material (e.g., green waste, food materials);[7] 0.39 for manure volatile solids (VS)[8]
- Dry = Factor to convert wet tons of compost to dry tons of compost

  0.7289 if compost C:N ≤ 11; if compost C:N > 11 use 0.6586[9]

The methods for determining the Waste Diverted variable will depend on the materials diverted for compost production, as described below.

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[7] CARB (2017) https://www.arb.ca.gov/cc/waste/cerffinal.pdf

[8] A conversion factor of 0.39 for manure volatile solids (corresponding to an average mass loss of 60.78%) was calculated as an average of those cited in peer-reviewed sources: 42.5% (Eghball, et al. 1997), 65.6% (Larney et al. 2006), 56% (sawdust-amended windrows) (Michel et al. 2004), 79% (straw-amended windrows) (Michel et al. 2004).

[9] Based on moisture contents reported in California Department of Food and Agriculture. (2016). https://www.cdfa.ca.gov/oefi/efasap/docs/CompostApplicationRate_WhitePaper.pdf

Landfill Organic Material

For projects where applicants divert organic waste (green waste, food materials, or alternative daily cover) from landfills for compost production, Waste Diverted will be a straightforward estimation since project applicants are already required to estimate the annual tonnage of organic material that will be newly diverted from a landfill for composting when estimating GHG emission reductions using the applicable CARB GHG Quantification Methodology and Calculator Tool.

$$Waste\ Diverted = Waste\ Diverted_{Annual} \times Years \quad \text{(Eq. 5)}$$

Where:

- Waste $\text{Diverted}_{\text{Annual}}$ = The annual tonnage of organic waste newly diverted from landfills
- Years = Length of project quantification period (years)

Manure Volatile Solids (VS)

For projects where applicants divert manure VS for compost production, Waste Diverted will be estimated using the equation below. The inputs for this step are the same as those required from applicants to estimate GHG emission reductions using the applicable CARB GHG Quantification Methodology and Calculator Tool.

$$Waste\ Diverted = \left[\sum(Livestock_{cat} \times VS_{cat} \times Project\ Compost_{cat}) - \sum(Livestock_{cat} \times VS_{cat} \times Baseline\ Compost_{cat})\right] \times Years \quad \text{(Eq. 6)}$$

Where:

- $\text{Livestock}_{\text{cat}}$ = The quantity of each livestock by category (see Table 1 below)
- VS_{cat} = The average manure VS produced by livestock of the relevant category (metric tons per year) (see Table 1 below)
- Project $\text{Compost}_{\text{cat}}$ = The percent of manure volatile solids diverted for composting in the project scenario, by category (%)
- Baseline $\text{Compost}_{\text{cat}}$ = The percent of manure volatile solids diverted for composting in the baseline scenario, by category (%)
- Years = Length of project quantification period (years)

Table 1. Average Volatile Solids Produced by Livestock *Category*[10]	
Category of Livestock	**Average VS (metric tons/animal/year)**
Dairy cows (lactating)	2.8320
Dry cows (non-milking dairy cows)	1.3881
Heifers (on feed)	1.2538
Bulls	1.9268
Calves	0.3332
Cows (grazing)	1.7911
Heifers (grazing)	1.8900
Nursery swine	0.0405
Grow/finish swine	0.1369
Breeding swine	0.1960
Sheep	0.2081
Goats	0.2219
Horses	1.0023
Poultry: Layer Hens	0.0067
Poultry: Other Chickens	0.0072
Poultry: Pullets	0.0067
Poultry: Broilers	0.0056
Poultry: Turkeys	0.0210

[10] Average VS (kg/animal/day) are provided in California Climate Investments Quantification Methodology Emission Factor Database available at: www.arb.ca.gov/cci-quantification. Conversion to (metric tons per animal per year) was calculated using the following equation (1 metric ton = 1,000 kg):
$VS_{annual} = VS_{daily} \times 365 \div 1{,}000$

Project Category 3. Conservation Easements

Project Category 3 includes projects that protect cropland, rangeland, grassland, watershed, or forest soils from conversion and development through easements, conservation agreements, or other protective measures.

Users should report the area (acres) of agricultural or natural soil protected by the project easement or conservation agreements.

This approach rests on the assumption that protection of agricultural or natural land will result in better long-term soil health than had that land been converted and/or developed.

Project Category 4. Land Use Conversion

Project Category 4 includes projects that entail construction or development of the built environment on agricultural or natural lands, resulting in the loss or degradation of those soils (such as the construction of new transit facilities, rails, housing, or buildings).

Users should report the net area (acres) of agricultural or natural soil converted by the land use change project. Only report net conversion (i.e., if mitigation measures resulted in 1:1 conservation on other lands of equal value the net conversion is 0 acres).

This approach rests on the assumption that any agricultural or natural land acreage that is converted for development will result in worse soil health than had that land been maintained for agricultural or natural use.

Section C. Data Requirements and Tools

This section describes the data requirements and tools required for the Soil Health and Conservation Co-benefit Assessment Methodology. The data that a user will need to provide to apply the methods above will vary by project category.

Project Category 1. Agricultural Soil Health Practices

Data requirements for Project Category 1 may include the following:

- **Area of agricultural or natural soil where eligible soil health practice is implemented, by qualifying practice type:** Soil health practices are eligible for co-benefit quantification based on the practice requirements outlined in USDA-NRCS CPS applicable to the CDFA-Healthy Soils Program found in Appendix A. Users will identify the soil health practice to be implemented by its class and practice implementation as listed in Appendix A, and identify any associated requirements for alignment:
    - For the classes of Cropland Management, Cropland to Herbaceous Cover, establishment of Woody Plantings, or Grazing Lands, identify the corresponding practice and refer to supporting documentation on the USDA-NRCS website for practice-specific requirements (e.g., practice duration, compost application rates, and density of plantings) for alignment.[11]
    - For the class of Compost Application, standards refer to CDFA-supported Compost Application Rates adopted from Gravuer (2016).[12]

  If the practice is not among these eligible classes, it is not eligible for quantification for the soil health and conservation co-benefit.

Project Category 2. Production of Compost

Data requirements for Project Category 2 may include the following:

- **Quantity of organic waste newly diverted for the production of compost for use by agricultural end-users, by waste type:** The quantity of organic waste newly diverted for the production of compost is estimated by the applicant, or estimated with variables supplied by the applicant, in order to quantify GHG emission reductions using a CARB GHG Quantification Methodology and Calculator Tool.

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[11] Available at https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849#U

[12] Projects may apply a higher rate of compost application than the range listed in Appendix A if it is agronomically feasible; however, for co-benefit calculation purposes, users should only report the compost application that results from CDFA funding (consistent with CDFA's Compost Application Standard), not any additional application financed by farmers themselves. In cases where actual compost application rates exceed those supported financially through California Climate Investments, only the application up to the CDFA Compost Application Rate is used to estimate this co-benefit.

- **The portion of the compost to be applied by agricultural end-users:** If end-use is unknown, users can assume 56% of total compost production is applied by agricultural end-users.[13]
- **Compost application rate by end-users:** The compost application rate by end-users is available as a default rate for annual crops. If the user knows and provides documentation on the class of land on which the compost will be applied (i.e., annual crops; perennials, orchards and vineyards; or trees and vineyards) as well as the specific C:N ratio of the compost (i.e., C:N > 11 or C:N ≤ 11), the user can look up the associated recommended application rate range in the CDFA-supported Compost Application Rates in Appendix A (e.g., "Application rate must be between 2.2-3.6 dry tons per acre per year"). The user will take the average of the two endpoints. If the applicant does not know the downstream use or the specific C:N ratio of the compost, the default application rate is 4.65 dry tons per acre per year for application to annual crops.[14]

Project Category 3. Conservation Easements

Data requirements for Project Category 3 may include the following:

- **Area of agricultural or natural soil protected by easement or conservation agreement:** The area of agricultural or natural soil protected by easement or conservation agreement is determined by project-specific characteristics.

Project Category 4. Land Use Conversion

Data requirements for Project Category 4 may include the following:

- **Net area of agricultural or natural soil converted by the land use change project:** The net area of agricultural or natural soil converted by the land use change project is determined by project-specific characteristics.

When inputs required to estimate the soil health and conservation are inputs to, or outputs from, a CARB GHG Quantification Methodology or Calculator Tool (e.g., acres conserved), the values used in estimation of GHGs and this co-benefit must be identical.

[13] CalRecycle (2010) http://www.calrecycle.ca.gov/publications/Documents/Organics%5C2010007.pdf.
[14] Determined as the average value of the range of application rates for Compost with C:N > 11 as outlined in Appendix A.

Appendix A. USDA-NRCS Conservation Practice Standards applicable to CDFA Healthy Soils Program

CDFA-supported Compost Application Rates

Eligible practice implementations are listed below by class. Individual Conservation Practice Standard (CPS) information sheets include more detailed information about practice requirements, and are available on the NRCS website.[15] Additional practices may be identified in the future as California Climate Investments programs evolve.

Table 2. Healthy Soils Practice Implementations and Practice Requirements to Ensure Alignment with Soil Health and Conservation Co-benefit Estimation Methods[16]

Soil Management Group		
Cropland Management Class Practices[1]	**Practice Implementations in USDA-NRCS COMET-Planner CDFA HSP Tool**	**Requirements for Alignment**
Cover Crop (CPS 340)	Add Legume Seasonal Cover Crop to	
	Add Legume Seasonal Cover Crop to Non-	
	Add Non-Legume Seasonal Cover Crop to	
	Add Non-Legume Seasonal Cover Crop to Non-Irrigated Cropland	
Mulching (CPS 484)	Add High Carbon Mulch to Croplands	
Residue and Tillage Management – No-Till (CPS 329)	Intensive Till to No Till or Strip Till on Irrigated	
	Intensive Till to No Till or Strip Till on Non-Irrigated Cropland	
Residue and Tillage Management – Reduced Till (CPS 345)	Intensive Till to Reduced Till on Irrigated	
	Intensive Till to Reduced Till on Non-Irrigated	

[15] A full list of USDA-NRCS Conservation Practice Standards is available at https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849

[16] Note that these practice requirements are the same as those used to ensure alignment with GHG Estimation Methods.

Table 2. (cont'd) Healthy Soils Practice Implementations and Practice Requirements to Ensure Alignment with Soil Health and Conservation Co-benefit Estimation Methods

Compost Application Class Practices[1,2]	Practice Implementations as per CDFA Compost Application Rates	Requirements for Alignment
Compost Application to Annual Crops	Compost (C:N ≤ 11) Application to Annual Crops	Application rate must[3] be between 2.2-3.6 dry tons/acre[4]
	Compost (C:N > 11) Application to Annual Crops	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]
Compost Application to Perennials, Orchards and Vineyards	Compost (C:N ≤ 11) Application to Perennials, Orchards and Vineyards	Application rate must[3] be between 1.5-2.9 dry tons/acre[4]
	Compost (C:N > 11) Application to Perennials, Trees and Vineyards	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]
Compost Application to Grassland	Compost (C:N > 11) Application to Grazed, Irrigated Pasture	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]
	Compost (C:N > 11) Application to Grazed Grassland[6]	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]

Table 2. (cont'd) Healthy Soils Practice Implementations and Practice Requirements to Ensure Alignment with Soil Health and Conservation Co-benefit Estimation Methods

Cropland to Herbaceous Cover Group		
Cropland to Herbaceous Cover Class Practices[1]	**Practice Implementations in COMET-Planner CDFA HSP**	**Requirements for Alignment[8]**
Contour Buffer Strips (CPS 332)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Field Border (CPS 386)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Riparian Herbaceous Cover (CPS 390)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover Near Aquatic Habitats	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover Near Aquatic Habitats	
Filter Strip (CPS 393)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Vegetative Barriers (CPS 601)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	Width of the Vegetative Barrier must be at least 3 feet.
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	
Herbaceous Wind Barrier (CPS 603)	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass Cover	Width of the Herbaceous Wind Barrier must be at least 2 feet.
	Convert Strips of Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	

Table 2. (cont'd) Healthy Soils Practice Implementations and Practice Requirements to Ensure Alignment with Soil Health and Conservation Co-benefit Estimation Methods

Establishment of Woody Cover Group		
Woody Plantings Class Practices[1]	**Practice Implementations in COMET-Planner CDFA HSP**	**Requirements for Alignment[8]**
Hedgerow Planting (CPS 422)	Replace a Strip of Cropland with 1 Row of Woody Plants	There must be at least 200 tree and shrub plantings per acre.[9] Width of each Hedgerow must be at least 8 feet.
	Replace a Strip of Grassland with 1 Row of Woody Plants	
Riparian Forest Buffer (CPS 391)	Replace a Strip of Cropland Near Watercourses or Water Bodies with Woody Plants	There must be at least 35 tree and shrub plantings per acre.[9]
	Replace a Strip of Grassland Near Watercourses or Water Bodies with Woody Plants	
Windbreak/Shelterbelt Establishment (CPS 380)	Replace a Strip of Cropland with 1 Row of Woody Plants	There must be at least 200 tree plantings per acre.[9] Width of each Windbreak must be at least 8 feet.
	Replace a Strip of Grassland with 1 Row of Woody Plants	
Grazing Lands Class Practices[1]	**Practice Implementations in COMET-Planner CDFA HSP**	**Requirements for Alignment**
Silvopasture (CPS 381)	Tree/Shrub Planting on Grazed Grassland	There must be at least 20 tree and shrub plantings per acre.[9]

[1] All NRCS Practices must be implemented per applicable Conservation Practice Standard (CPS) and Specification. (National Resource Conservation Service, 2017b)

[2] All CDFA Practices must be implemented per CDFA paper "Compost Application Rates for California Croplands and Rangelands for a CDFA Healthy Soils Incentives Program." (California Department of Food and Agriculture, 2016)

[3] Soils with organic matter content greater than 20% by weight when mixed to depth of 20 cm are not quantified for Compost practices in the Healthy Soils Program. Organic carbon content is defined by a simplification of the IPCC definition of Organic Soils.

[4] Applicants may apply a higher rate of compost than the minimum if it is agronomically feasible, as these are conservative minimum rates to receive funding by the Healthy Soils Program. A range is provided to estimate averages for projects in Project Category 3: Production of Soil Amendments.

[5] If compost (C:N ≤ 11) is received in wet tons, multiply wet tons by 0.7289 to estimate weight of compost in dry tons. (California Department of Food and Agriculture, 2016)

[6] If compost (C:N > 11) is received in wet tons, multiply wet tons by 0.6586 to estimate weight of compost in dry tons. (California Department of Food and Agriculture, 2016)

[7] Some rangeland sites are ineligible for compost application. See https://www.cdfa.ca.gov/oefi/efasap/docs/CompostApplicationRate_WhitePaper.pdf.

[8] Some Cropland to Herbaceous Cover and Woody Plantings Practice Standard and Specification minimum width requirements are included to assist with Step 2.

[9] This is the minimum number of plantings per acre required for quantification. The conservation plan for a selected practice may require a number greater than this minimum.

Appendix B. Example Methods and Data Inputs for Project Category 1

The following is a hypothetical project[17] to demonstrate how the Soil Health and Conservation Co-benefit Assessment Methodology would be used to estimate the benefits of a Healthy Soils Program project in Project Category 1. This example does not include the supporting documentation that may be required of actual project applicants.

Overview of the Proposed Project

The applicant is proposing the following project components:

- Windbreaks;
- Intensive till to reduced till; and
- Compost application to cropland.

The proposed project has the following relevant project features:

- The proposed project is located in the County of Fresno;
- 200 acres of irrigated annual cropland with a fallow winter season;
- Plan to convert 3 acres to 1-row windbreaks along windward sides of project area, with 8-foot spacing on each side of the windbreak;
- Plan to apply compost with a carbon to nitrogen ratio of ten (C:N = 10) to remaining 197 acres at a rate of 3 dry tons per acre; project site soil organic matter concentration = 1.5%;
- Plan to change the tilling practice from intensive till to reduced till on the remaining 197 acres; and
- The project quantification period is 3 years, per the CARB GHG Quantification Methodology and Calculator Tool.

Methods to Apply

Step 1: Identify the Project Components and Appropriate Implementations for the Proposed Project

Refer to Table 2 (Appendix A) to match the practices with corresponding USDA-NRCS CPS applicable to the CDFA Healthy Soils Program, CDFA-supported Compost Application Rates, and any additional steps required to quantify the GHG benefit. Refer to the USDA-NRCS website to look up additional CPS requirements.[18]

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[17] The hypothetical project has not undergone verification of any program requirements; all assumptions about location type and features are for demonstration purposes only.
[18] Available at https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849#U

The 3 acres of windbreaks qualify under "Windbreak/Shelterbelt Establishment (CPS 380)" USDA-NRCS Practice, and the "Replace a Strip of Cropland with 1 Row of Woody Plants" implementation. The total width of the windbreak (16 feet) meets the minimum width requirement of the practice (8 feet). The program applicant would then need to review CPS 380 in detail to ensure all other requirements are met.[19]

The 197 acres that went from intensive tillage to reduced tillage are part of the "Residue and Tillage Management – Reduced Till (CPS 345)" USDA-NRCS Practice, and the "Intensive Till to Reduced Till on Irrigated Cropland" implementation. The program applicant would then need to review CPS 345 in detail to ensure all other requirements are met.[20]

The 197 acres of compost (C:N = 10) application to the annual cropland are part of the "Cropland Compost Application (CDFA)" Practice, and the CDFA-supported Compost Application Rate classified as "Compost (C:N ≤ 11) Application to Annual Crops" implementation as listed in Appendix A. The Cropland Compost Application practice is eligible for quantification because project site soil organic matter content is less than 20%, and because the application rate (3 dry tons per acre) is above the recommended minimum threshold of 2.2 dry tons per acre per year.[21]

Step 2: Determine the acreage upon which the selected practices will be quantified. No conservation practices are continuing on this project site. All acreage associated with each practice implementation will be quantified for GHG reductions.

Step 3: Summarize data in a table
Input the acreage for each qualifying practice into a Table to be submitted with the California Climate Investments project application. For compost application, also include the C:N ratio and vegetative cover.

In this example, it is estimated that the project would result in soil health and conservation co-benefits from a combination of practices on a total of 200 acres during the 3-year project quantification period.

Qualifying NRCS Conservation Practice	**Acreage**
$Type\ of\ Practice$	$Area_{practice}$
Windbreak/Shelterbelt Establishment (CPS 380)	3
Residue and Tillage Management – Reduced Till (CPS 345)	197
Cropland Compost Application (CDFA) - Compost (C:N ≤ 11) Application to Annual Crops	197
Total Acreage (do not double count acres with multiple practices)	200

[19] CPS 380 is available at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1046943.pdf
[20] CPS 345 is available at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1251402.pdf
[21] Note that if it were agronomically feasible for the project applicant to apply compost at a higher rate, this is also acceptable.

Appendix C. Example Methods and Data Inputs for Project Category 2

The following is a hypothetical project[22] to demonstrate how the Soil Health and Conservation Co-benefit Assessment Methodology would be used to estimate the benefits of an Alternative Manure Management Practices (AMMP) project in Project Category 2. This example does not include the supporting documentation that may be required of actual project applicants.

Overview of the Proposed Project

The applicant is proposing the following project components:

- Install an advanced centrifuge solid separation system at a dairy with an uncovered anaerobic lagoon to replace the simple stationary screen solid separator currently in use; and
- Divert separated manure solids from entering an anaerobic lagoon to be composted in vessel.

The proposed project has the following relevant project features:

- 1,500 lactating dairy cows in freestalls (40% VS diverted in project scenario);
- 800 dry cows (15% VS diverted in project scenario;
- 400 heifers (on feed) (15% diverted in project scenario;
- No composting in baseline scenario (separated solids are applied directly to land);
- Compost is produced on-site from manure volatile solids, with a C:N ratio of ≤11;
- All compost to be sold to a vineyard; and
- The project quantification period is five years, per the CARB GHG Quantification Methodology and Calculator Tool.

Methods to Apply

Based on the project specifications above, this user would apply Equations 3, 4 and 6 from Section B:

$$Application\ Area = \frac{Compost \times Ag\ Use}{AR \times Years} \quad \text{(Eq. 3)}$$

$$Compost = Waste\ Diverted\ \times CF \times Dry \quad \text{(Eq. 4)}$$

$$Waste\ Diverted = \left[\sum(Livestock_{cat}\ \times\ VS_{cat} \times Project\ Compost_{cat}) - \sum(Livestock_{cat}\ \times VS_{cat} \times Baseline\ Compost_{cat})\right] \times Years \quad \text{(Eq. 6)}$$

[22] The hypothetical project has not undergone verification of any program requirements; all assumptions about location type and features are for demonstration purposes only.

Step 1: Estimate quantity of waste to be diverted
Estimate the quantity of waste to be diverted (tons) using Equation 6 and Table 1 from Section B:

$$Waste\ Diverted = [((1500 \times 2.8320 \times 40\%) + (800 \times 1.3881 \times 15\%) + (400 \times 1.2538 \times 15\%)) - ((1500 \times 2.8320 \times 0\%) + (800 \times 1.3881 \times 0\%) + (400 \times 1.2538 \times 0\%)] \times 5$$

$$= [(1{,}699.2 + 166.6 + 75.2) - (0)] \times 5$$

$$= 1{,}941 \times 5$$

$$= 9{,}705 \text{ tons}$$

The total quantity of waste diverted for compost production during the project quantification period is 9,705 tons.

Step 2: Estimate the quantity of compost produced
Estimate the quantity of compost (dry tons) using Equation 4. User 0.39 tons compost per ton feedstock for volatile solids and 0.7289 dry tons per wet ton for compost with a C: N ≤ 11.

$$Compost = 9{,}705 \times 0.39 \times 0.7289$$

$$= 2{,}759 \text{ dry tons}$$

The total quantity of compost produced during the project quantification period is 2,759 dry tons

Step 3: Estimate the application area
Estimate the agricultural acres improved through compost application. Use an "Ag Use" value of 100% because the applicant has a contract to sell all of the compost produced to a vineyard for agricultural application. The application rate is 2.2 dry tons per acre per year, the average of the range of 1.5-2.9 for compost with a C:N ≤11 that will be applied on a vineyard.

Compost Application Class Practices[1,2]	**Practice Implementations as per CDFA-supported Compost Application Rates**	**Requirements for Alignment**
Compost Application to Annual Crops (CDFA)	Compost (C:N ≤ 11) Application to Annual Crops	Application rate must[3] be between 2.2-3.6 dry tons/acre[4]
	Compost (C:N > 11) Application to Annual Crops	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]
Compost Application to Perennials, Orchards and Vineyards (CDFA)	Compost (C:N ≤ 11) Application to Perennials, Orchards and Vineyards	Application rate must[3] be between 1.5-2.9 dry tons/acre[4]
	Compost (C:N > 11) Application to Perennials, Trees and Vineyards	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]
Compost Application to Grassland (CDFA)	Compost (C:N > 11) Application to Grazed, Irrigated Pasture	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]
	Compost (C:N > 11) Application to Grazed Grassland[6]	Application rate must[3] be between 4.0-5.3 dry tons/acre[5]

$$Application\ Area = \frac{2{,}759 \times 1}{2.2 \times 5} = \frac{2{,}759}{11} = 251\ acres$$

In this example, it is estimated that the project would result in soil health and conservation co-benefits on 251 acres during the 5-year project quantification period.

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