Methodology for the Quantification, Monitoring, Reporting and Verification of Greenhouse Gas Emissions Reductions and Removals from the Restoration of California Deltaic and Coastal Wetlands

Errata & Clarification

October 2017

This is a supplemental document to the ACR Methodology *Restoration of California Deltaic and Coastal Wetlands, V1.0*. Topics in this document will be incorporated into an updated version of ACR Methodology *Restoration of California Deltaic and Coastal Wetlands, V1.1*.

1.1 Errata: October 2017

The following errors were identified in version 1.0 posted in April 2017. Errata listed here are reflected in version 1.1 of the methodology.

Section Reference	Change
Acknowledgements	Luca Silva (University of CA, Davis) *to* Lucas Silva (University of Oregon)
Acknowledgements	California Coastal Commission *to* California Coastal Conservancy
Acronyms	*Added:* MT (Metric Ton)
1.1 Background Table 1	Land Use: Agricultural *to* Land Use: Managed non-tidal wetland
1.1 Background	For definition of land uses, see sections 1.1.2 *to* For definition of land uses, see sections 1.1.1 and 1.1.2
1.2.2 Modules and Tools Table 3	Used by All Projects, Managed Wetland Construction, Model- W/RC (M) and MM-W/RC (C)

	to Used by All Projects, Managed Wetland Construction, Model- W/RC (C) and MM-W/RC (M)
1.2.2 Modules and Tools Table 3	Used by All Projects, Tidal Wetland Restoration, Model- W/RC (M) and MM-W/RC (C) *to* Used by All Projects, Tidal Wetland Restoration, Model- W/RC (C) and MM-W/RC (M)
1.2.2 Modules and Tools Table 3	Used by All Projects, Rice Cultivation, Model- W/RC (M) and MM-W/RC (C) *to* Used by All Projects, Rice Cultivation, Model- W/RC (C) and MM-W/RC (M)
1.2.5 Applicability Criteria Table 5	Project activity includes any of the following: alteration of sediment supply, water quality, plant communities and nutrients, infrastructural modification, earth moving, diversion of channel water into wetlands, management of surface water levels and wetlands outflow, plantings seeding or natural plant regeneration, or levee breaching (permitted). *to* Project activity includes any of the following: alteration of hydrologic conditions, sediment supply, water quality, plant communities and nutrients; hydrologic management; infrastructural modification, earth moving; diversion of channel water into wetlands; management of surface water levels and wetlands outflow; plantings, seeding, or natural plant regeneration; or levee breaching (permitted)
1.2.5 Applicability Criteria Tables 6, 9, 10 footnotes	See Figure 2 and the Methods Module for a description of currently available models and measurements. The model and method list will be regularly updated. *to* See the Methods Module for a description of currently available models and measurements. The model and method list will be regularly updated.
1.2.5 Applicability Criteria Table 8, Title	Agriculture *to* Seasonal Wetland

Throughout	ACR Forest Carbon Project Standard *to* ACR Standard
1.3.4 STEP 4 Developing a Monitoring Plan	Ex-post *to* Ex-ante
1.5 Parameter Tables UNC	Percentage *to* Fraction dimensionless
2.1.2.1 Identification of the Baseline Scenario	*Deleted:* And Performance Standard Evaluation
2.1.2.1 Identification of the Baseline Scenario	*Deleted:* EVALUATION AGAINST ESTABLISHED PERFORMANCE STANDARD. Net GHG emission reductions achieved by a rice cultivation or wetland Project must exceed those likely to occur in a conservative business-as-usual scenario and are subject to a practice-based performance standard. Practice based performance standard requirements are detailed in the Methodology Framework Module (MF-W/RC).
2.3.2.2 Establishment and Documentation of the GHG Boundary	Allochthonous carbon accumulation in the Baseline may be conservatively set to zero, as its exclusion from the balance between GHG losses and gains would underestimate total GHG emissions. *to* Allochthonous carbon accumulation in the Baseline may be conservatively set to zero, as its exclusion from the balance between GHG losses and gains would underestimate net GHG reductions (i.e., ERTs).
2.3.2.2 Establishment and Documentation of the GHG Boundary	Pools or sources may be excluded if the exclusion tends to underestimate net Project GHG emission reductions relative to the Baseline. *to* Pools or sources may be excluded if the exclusion tends to underestimate net Project GHG emission reductions (i.e. ERTs)
2.3.2.4 Quantify Baseline Carbon Stocks and GHG Emissions	*Deleted:* The Baseline net carbon stock changes for the reporting period are equal to the yearly carbon stock change plus the yearly net Baseline

	GHG emissions (including the combustion of fossil fuels, if determined to be significant), summed over the number of years in the Baseline reporting period. Project Proponents may elect to set to zero carbon stock changes and GHG emission in the Baseline Scenario.
3.1.2.4.1 Pertinent Concepts and Assumptions	The actual net GHG removals resultant from the carbon-stock accumulation (resultant from carbon sequestration via photosynthesis) minus GHG emissions (resultant from decomposition of organic matter) shall be estimated using the equations in this section. *to* The actual net GHG removals shall be estimated using the equations in this section.
3.2.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	As per guidance in the Measurement Module (MM-W/RC), aqueous carbon fluxes shall be accounted for when eddy covariance methods are used for estimating carbon stock changes. *to* As per guidance in the Measurement Module (MM-W/RC), aqueous carbon fluxes shall be accounted for.
3.2.2.4.1 Pertinent Concepts and Assumptions	In the Project Scenario, allochthonous carbon must always be accounted for. In the Baseline Scenario, net accumulation of allochthonous carbon must be accounted for and subtracted from the Baseline, or can be conservatively set to zero. To In the Baseline Scenario, net accumulation of allochthonous carbon can be accounted for and subtracted from the Baseline total carbon stock change, or can be conservatively set to zero.
3.3.2.4.1 Pertinent Concepts and Assumptions Equation 10, term ΔC_{actual_rc}	is the cumulative total of carbon stock changes and GHG emissions (MT CO_2e) under the Project Scenario for the Project area during the reporting period. To is the cumulative total of carbon stock changes and GHG emissions (MT CO_2e) under the Rice cultivation Project Scenario for the Project area during the reporting period.
4.1.3 Parameters and Estimation Methods	It is assumed that 100% of the harvested biomass is eventually consumed and oxidized to as CO2 and CH4, back into the atmosphere.

	to It is assumed that 100% of the harvested biomass is eventually consumed and released as CO2 and CH4, back into the atmosphere. Net GHG exchanges should be converted to MT CO2e based on global warming potentials (GWP) in the latest version of ACR Standard.
4.1.3.1.1 Introduction	(Knox et al. 2014) *to* (Knox et al. 2015)
4.1.3.1.3 Quality Assurance and Quality Control Table 25	Standard EC practice as described in the literature cited above shall be employed to measure the covariance between turbulence and C fluxes at 10 Hz intervals (every 0.1 s). To Standard EC practice shall be employed to measure the covariance between turbulence and C fluxes at 10 Hz intervals (every 0.1 s).
4.1.3.4.4 Equations	*Deleted:* In the Project Scenario, allochthonous carbon must always be accounted for.
4.1.3.5.4 Equations	When the cumulative net Baseline GHG emissions (ΔGHGBS L in t COMT CO2e) for the Project area due to the oxidation of organic soils can be estimated by changes in the soil carbon pools using the depth of subsidence, the following equation can be used: *to* When the cumulative net Baseline carbon stock changes and GHG emissions ΔGHG_{BSL} in MT CO_2e for the Project area can be estimated by changes in the soil carbon pools using the depth of subsidence, the following equation can be used:
4.1.3.5.4 Equations Equation 18	$\boldsymbol{\Delta GHG_{BSL}}$ *to* $\boldsymbol{\Delta C_{BSL}}$
4.1.3.6.1 Introduction	*Deleted:* Bulk density shall be determined as per methodology described in Blake and Hartge (1986).
4.4.8 Parameter Tables $\mathbf{E_{P,SS}}$	Monitoring frequency may range from 5 to 10 years and can be fixed to coincide with the crediting period *to*

	Monitoring frequency may range from 5 to 10 years and can be fixed to coincide with the reporting period

1.2 Clarifications: October 2017

The following were identified for clarification in the version 1.0 of the methodology posted in April 2017. Clarifications listed here are reflected in version 1.1.

Section Reference	Change
Preface	*Added:* ACR may require revisions to this Methodology to ensure that monitoring, reporting, and verification systems adequately reflect changes to project activities. This Methodology may also be periodically updated to reflect regulatory changes, emission factor revisions, or expanded applicability criteria. Before beginning a project, the project proponent should ensure that they are using the latest version of the Methodology.
1.1 Background	Baseline or business-as-usual scenarios include agriculture, seasonal wetlands, and open water areas, where Baseline carbon stock changes and GHG emissions result primarily from the oxidation of organic matter (1). *to* Baseline or business-as-usual scenarios include agriculture, seasonal wetlands, and open water areas, where Baseline carbon stock changes and GHG emissions result primarily from the oxidation of organic matter (Table 1).
1.1.1.3 (BL-OW) Open Water in the San Francisco Bay	*Added:* (www.southbayrestoration.org)
1.1.2.2 (PS-TW) Tidal Wetlands in San Francisco Bay Estuary, San Francisco Bay, and the California Coast	*Added:* (Moseman-Valtierra 2011, 2012; Badiou et al. 2011; Wang et al. 2017; Yu et al. 2007; Liikanen et al 2009)
1.2.3 Verification	*Added:* (MM-W/RC and MODEL-W/RC)
1.3.2.3 Carbon Pools and Sources	*Added:* When annual soil carbon stock changes are quantified, they already include changes in the bio-mass and litter pools. Above- and below-

	ground biomass, litter, and change in soil car-bon stock do not need to be included repeatedly.
1.3.2.3 Table 12	*Added:* May be excluded if subject to double-counting.
2.1.2.3 Baseline stratification Table 15	*Deleted:* For Baseline conditions, soil organic matter content is the most important determinant of GHG emissions. Other factors such as pH, carbon-to-nitrogen ratio, and texture may affect Baseline GHG emissions.
2.1.2.3 Baseline stratification Table 15	*Added:* Etc.
2.1.2.4 Quantify Baseline Carbon Stocks and GHG Emissions Equation 4	$\Delta GHG_{BSL\_Ag} + \Delta EFF_{BSL\_Ag}$ *to* $fGHG_{BSL\_Ag} + fEFF_{BSL\_Ag}$
2.1.2.4 Quantify Baseline Carbon Stocks and GHG Emissions Equation 4	*Added:* Comment: The terms will be added in case GHG exchanges are going in the same direction (from biosphere to atmosphere or vice versa) and subtracted when in opposite directions.
2.2.2.3 Baseline Stratification Table 18	Wetland vegetation *to* Wetland age, years since wetland creation
2.2.2.4 Quantify Baseline Carbon Stocks and GHG Emissions Equation 5	$\Delta GHG_{BSL\_SW} + \Delta EFF_{BSL\_SW}$ *to* $fGHG_{BSL\_SW} + fEFF_{BSL\_SW}$
2.2.2.4 Quantify Baseline Carbon Stocks and GHG Emissions Equation 5	*Added:* Comment: The terms will be added in case GHG exchanges are going in the same direction (from biosphere to atmosphere or vice versa) and subtracted when in opposite directions.
2.2.3 Parameter Tables Parameter $\boldsymbol{\Delta Cs_{BSL\_SW}}$	Cumulative net carbon stock changes for the Project area during the reporting period for the Baseline Scenario *to* Cumulative net carbon stock changes for the Project area during the reporting period for the seasonal wetlands Baseline Scenario

2.3.2.4 Quantify Baseline Carbon Stocks and GHG Emissions Equation 6	$\Delta GHG_{BSL\_OW} + \Delta EFF_{BSL\_OW}$ *to* $fGHG_{BSL\_OW} + fEFF_{BSL\_OW}$
2.3.2.4 Quantify Baseline Carbon Stocks and GHG Emissions Equation 6	*Added:* Comment: The terms will be added in case GHG exchanges are going in the same direction (from biosphere to atmosphere or vice versa) and subtracted when in opposite directions.
3.1.1.2 Applicability	*Deleted:* The Baseline Scenario is defined for agricultural lands or seasonal wetlands;
3.1.2.2 Project Stratification Table 20	Wetland vegetation *to* Wetland age, years since wetland creation
3.1.2.3 Monitoring Project Implementation	*Deleted:* The geographic position of the Project boundary is recorded for all areas of land
3.1.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	GHG emissions shall be estimated using the methodology described in the Methods Module. *to* Carbon stock changes and GHG emissions shall be estimated using the methodology described in the Methods Module.
3.1.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	Emissions can be estimated using appropriate peer-reviewed proxy measurement data for similar situations, in which case the environmental setting for the estimates shall be detailed. *to* Carbon stock changes and GHG emissions can be estimated using appropriate peer-reviewed proxy measurement data for similar situations, in which case the environmental setting for the estimates shall be detailed.
3.1.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	Biogeochemical models that meet requirements listed in the Model Module (MODEL-W/RC) can be used for estimating GHG emissions. *to* Biogeochemical models that meet requirements listed in the Model Module (MODEL-W/RC) can be used for estimating carbon stock changes and GHG emissions.

3.1.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	A 5-year reporting frequency is considered adequate for the determination of changes in soil carbon stocks in managed wetlands. *to* A 5-year interval is considered adequate for the determination of changes in soil carbon stocks in managed wetlands.
3.1.2.4.1 Pertinent Concepts and Assumptions Equation 7	$\Delta GHG_{MW} + \Delta EFF_{MW}$ *to* $fGHG_{MW} + fEFF_{MW}$
3.1.2.4.1 Pertinent Concepts and Assumptions Equation 7	*Added:* Comment: The terms will be added in case GHG exchanges are going in the same direction (from biosphere to atmosphere or vice versa) and subtracted when in opposite directions.
3.1.3 Parameter Tables Parameter $\Delta Cs_{\_MW}$	Cumulative total of carbon stock changes for the Project area during the reporting period under the Project Scenario. *to* Cumulative total of carbon stock changes for the Project area during the reporting period under the managed wetland Project Scenario.
3.2.1.3 Parameters Parameter ΔC_{actual_TW}	Cumulative total of carbon stock changes and GHG emissions for the Project area during the reporting period under the Project Scenario. *to* Cumulative total of carbon stock changes and GHG emissions for the Project area during the reporting period under the tidal wetland Project Scenario.
3.2.2.2 Project Stratification	For estimation of ex-ante carbon stock changes and GHG emissions, strata should be defined based on parameters that affect GHG sequestration or emissions and/or that are key variables for the methods used to measure changes in carbon stocks. *to* For estimation of ex-ante carbon stock changes and GHG emissions, strata should be defined based on parameters that affect carbon sequestration or GHG emissions and/or that are key variables for the methods used to measure changes in carbon stocks.
3.2.2.3 Monitoring Project Implementation	*Deleted:* The geographic position of the Project boundary is recorded for all areas of land.

3.2.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	GHG emissions shall be estimated using the methodology described in the Methods Module (MM-W/RC), which provides the appropriate methods for measuring and estimating emissions for Project and Baseline activities (use Baseline Modules BL-Ag, BL-OW, or BL-SW). *to* Carbon stock changes and GHG emissions shall be estimated using the methodology described in the Methods Module (MM-W/RC), which provides the appropriate methods for measuring and estimating emissions for Project and Baseline activities (use Baseline Modules BL-Ag, BL-OW, or BL-SW).
3.2.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	A 5-year reporting frequency is considered adequate for the determination of changes in soil carbon stocks. *to* A 5-year interval is considered adequate for the determination of changes in soil carbon stocks.
3.2.2.4.1 Pertinent Concepts and Assumptions	The Project carbon stock change shall be estimated using the equations in this section. *to* The Project carbon stock change and GHG emissions shall be estimated using the equations in this section.
3.2.2.4.1 Pertinent Concepts and Assumptions Equation 9	$\Delta GHG_{TW} + \Delta EFF_{TW}$ *to* $fGHG_{TW} + fEFF_{TW}$
3.2.2.4.1 Pertinent Concepts and Assumptions Equation 9	*Added:* Comment: The terms will be added in case GHG exchanges are going in the same direction (from biosphere to atmosphere or vice versa) and subtracted when in opposite directions.
3.3.1.2 Applicability	*Deleted:* The Baseline is as defined for agricultural lands (BL-Ag) or seasonal wetlands (BL-SW).
3.3.2.3 Monitoring Project Implementation	*Deleted:* The geographic position of the Project boundary is recorded for all areas of land.

3.3.2.4 Quantify Project Carbon Stock Changes and GHG Emissions	GHG emissions shall be measured using the methodology described in this section and the Measurement Module (MM-W/RC), which provides the appropriate methods for measuring carbon stocks and GHG emissions for Project activities. To Carbon stock changes and GHG emissions shall be measured using the methodology described in this section and the Measurement Module (MM-W/RC), which provides the appropriate methods for measuring carbon stocks and GHG emissions for Project activities
3.3.2.4.1 Pertinent Concepts and Assumptions	*Deleted:* The mass of carbon in the harvested grain shall be counted in the carbon stock change estimates;
3.3.2.4.1 Pertinent Concepts and Assumptions	*Added:* It is assumed that 100% of the harvested biomass is eventually consumed, resulting in releases of CO2 and CH4 back into the atmosphere. The mass of the carbon in the harvested grain shall be counted in the carbon stock change.
3.3.2.4.1 Pertinent Concepts and Assumptions	Emissions of GHG shall be measured in the field under Project conditions or may be quantified by an acceptable proxy, reference sample plots, or field monitoring of similar sites, using approved local or national parameters, peer-reviewed biogeochemical models, or peer-reviewed literature; *to* Exchanges of GHG shall be measured in the field under Project conditions or may be quantified by an acceptable proxy, reference sample plots, or field monitoring of similar sites, using approved local or national parameters, peer-reviewed biogeochemical models, or peer-reviewed literature;
3.3.2.4.1 Pertinent Concepts and Assumptions Equation 10	$\Delta GHG_{RC} + \Delta EFF_{RC}$ *to* $fGHG_{RC} + fEFF_{RC}$
3.3.2.4.1 Pertinent Concepts and Assumptions Equation 10	*Added:* Comment: The terms will be added in case GHG exchanges are going in the same direction (from biosphere to atmosphere or vice versa) and subtracted when in opposite directions.
3.3.3 Parameter Tables Parameter $\mathbf{\Delta Cs_{RC}}$	Cumulative total of carbon stock changes for the Project area during the reporting period under the Project Scenario.

	to Cumulative total of carbon stock changes for the Project area during the reporting period under the rice cultivation Project Scenario.
4 Parameters Figure 4	(Ag), (SW), (OW), (RC), (MW), (TW) *to* (BL-Ag), (BL-SW), (BL-OW), (PS-RC), (PS-MW), (PS-TW)
4.1.3 Parameters and Estimation Methods	The mass differences approach (Approach 1) can be based on inventories of carbon stocks in the ecosystems and their difference in time. *to* The mass balance approach (Approach 1) can be based on inventories of carbon stocks in the ecosystems and their difference in time.
4.1.3.1.1 Introduction	During the non-crop period, oxidation of organic matter resulted in a net GHG emission. *to* Oxidation of organic matter resulted in a net GHG emission.
4.1.3.4.4 Equations	For this reason, after it is quantified (as described in Equation 12), if a project area receives an input of allochthonous carbon, it should be deducted from the carbon balance of the Project area. *to* For this reason, after it is quantified (as described in **Error! Reference source not found.**), if a project area receives an input of allochthonous carbon, it should be deducted from the total carbon stock change of the Project area.
4.1.3.4.4 Equations	Allochthonous carbon accumulation in the Baseline may be conservatively set to zero, as its exclusion from the balance between GHG losses and gains would underestimate total GHG emissions. *to* Allochthonous carbon accumulation in the Baseline may be conservatively set to zero, as its exclusion from the balance between GHG losses and gains would underestimate total GHG emission reductions.
4.1.3.4.4 Equations	In the Baseline Scenario, net accumulation of allochthonous carbon must be accounted for and subtracted from the Baseline GHG balance or can be conservatively set to zero.

	To In the Baseline Scenario, net accumulation of allochthonous carbon must be accounted for and subtracted from the baseline total carbon stock change, or can be conservatively set to zero.
4.1.3.5.3 Quality Assurance and Quality Control	Therefore, the conservatively estimated subsidence at any point along the survey route followed in 1978 and 2006 is equal to the elevation determined in 1978 minus the closure error, minus the 2006 elevation plus the closure error. *to* Therefore, the conservatively estimated subsidence at any point along the survey route followed in 1978 and 2006 is equal to the elevation determined in 1978 minus the closure error, minus the sum of 2006 elevation and the closure error.
4.1.3.6.1 Introduction	The mass of carbon per unit volume is calculated by determining the product of the carbon concentration and bulk density (g/cm3). *to* The mass of carbon per unit volume is calculated as the product of the carbon concentration and bulk density.
4.2.3 Model Calibration and Validation	To use a biogeochemical model, it needs to be calibrated and validated for a specific Scenario, Project type, and area. Model calibration and validation do not need to be conducted within Project boundaries but must be conducted in and documented for a similarly managed system with similar soil qualities and climate conditions. Model calibration and validation should preferably use at least 2 years of eco-system flux data of CO2 and CH4. Other model input variables will also need to be recorded during this time. Based on experience, 2 years is the minimum for sufficient data for both parameterization and validation (recommended 70% data used for parameterization and 30% for validation). Also, the model may be calibrated with monitoring data collected after Project commencement. If discontinuous data are collected and used for calibration, model uncertainty will likely be greater and need to be quantified as per guidance in the Uncertainty Module (X-UNC). *to* In order to use a biogeochemical model, it needs to be parameterized and validated for a specific Scenario, Project type, and area. Project emissions of CO_2 and CH_4 and N_2O may be estimated using biogeochemical models. which must be run separately for each site, stratum, or cohort. The biogeochemical model must be parametrized for each stratum of each scenario (BL-

	AG, BL-SW, BL-OP, PS-MW, PS-TW, PS-RC) and for the specific characteristics of vegetation, soil, climate, hydrology of the stratum. Biogeochemical models must be validated for each GHG gas, verification period and stratum. If a range of condition exists among strata, the model can be validated only in the most diverse and extreme strata (for example highest and lowest soil organic matter, vegetation cover etc.) Validation within project boundary is not required if it is shown that the biogeochemical model can reproduce GHG fluxes for the range of conditions existing in the region, and that the condition range includes specific conditions existing at each stratum/site (different soil types, climate, water depth and salinity, vegetation cover, vegetation types). Model parameterization and validation should preferably use at least 2 years of ecosystem flux data of CO_2 and CH_4. Other model input variables will also need to be recorded during this time. Based on experience, 2 years is the minimum in order for sufficient data for both parameterization and validation (recommended 70% data used for parameterization and 30% for validation). Also, the model may be calibrated with monitoring data collected after Project commencement. If discontinuous data are collected and used for calibration, model uncertainty will likely be greater and need to be quantified as per guidance in the Uncertainty Module (X-UNC).
4.2.3.1 Quantification of Project Carbon Stock Changes	*Deleted:* Whole section
4.4.5 Estimating Project Uncertainty Equation 26, Term $\mathbf{E}_{P,SS,i}$	*Added:* i (1,2…n represent different carbon pools and/or GHG sources)
4.4.6.3 Systematic Measurement Error	These errors do not need to be deducted from emission reductions using eddy covariance techniques if they are appropriately avoided or corrected for as per guidelines in the section 4.1, Measurement Methods (MM-W/RC) Emissions and Carbon Stock Modules. *to* These errors do not need to be deducted from emission reductions using eddy covariance techniques if they are appropriately avoided or corrected for as per guidelines in the section 4.1, Measurement Methods (MM-W/RC).
Appendix A Figure 5	Updated
Appendix B	Updated

Figure 6	