February 2, 2019

TO: California Air Resources Board; California Environmental Protection Agency; California Department of Food and Agriculture; California Natural Resources Agency

FROM: Carbon Cycle Institute

VIA: https://arb.ca.gov/cc/natandworkinglands/natandworkinglands.htm.

RE: GOAL SETTING for the NWL SECTOR; Comment on the January 2019 DRAFT California 2030 Natural and Working Lands Climate Change Implementation Plan.

Dear CARB, Cal EPA, CDFA and CNRA;

Thank you for the opportunity to comment on the January 2019 Draft California 2030 Natural and Working Lands Climate Change Implementation Plan. As noted in the introduction to the Draft Plan, CARB Resolution 17-46 directs the CARB Executive Officer to: work with CNRA, CDFA, CalEPA, and other agencies to reevaluate the 15–20 MMT CO2e 2030 goal (proposed in the California 2030 Natural and Working Lands Climate Change Implementation Plan Concept Paper); determine if the goal should be adjusted in light of ongoing analyses to estimate the GHG mitigation potential of natural and working lands; and, to develop the Natural and Working Lands Climate Change Implementation Plan.

As further noted in the Draft Plan Introduction, in September 2018, Governor Brown signed Executive Order B-55-18, which establishes a goal for the State to achieve carbon neutrality by 2045 and maintain net-negative emissions after that. As made clear in the Draft Plan, ***the 15-20 MMT CO2e 2030 goal is at least an order of magnitude too low to achieve carbon neutrality within the NWL sector by 2045.***

Critically, as noted in the Draft Plan (page 9), "California's lands are losing carbon, with an estimated net loss of approximately 170 MMT of carbon from 2001–2014. This loss of carbon is equivalent to a cumulative 630 MMT CO2e of sequestered carbon removed from the land over the same 13-year period. The majority of these losses are due to wildfire." At this rate of loss, for the state's NWL to be carbon neutral by 2045 (26 years from now), they must avoid losses of, or sequester, within the NWL sector, a cumulative 1260 MMT CO2 by 2045. Even if the state chooses to ignore "the majority of these losses… due to wildfire" (assumed to constitute 74% of the total; see figure 8, ARB NWL Inventory 2018), the state's NWL must still reduce and sequester/avoid some 164 MMT CO2e by 2032 (13 years from now) and an estimated 328 MMT CO2e by 2045 to

achieve carbon neutrality in this sector alone.

Clearly, the proposed goal of 15-20 MMT by 2030 is insufficient to address this level of terrestrial carbon capture; if Governor Brown's C-neutrality goal is to be realized, the state must increase its commitment to NWL carbon sequestration at a level at least commensurate with actual rates of loss to the atmosphere. Therefore, **the 2030 NWL goal must be 164 MMT CO2e by 2032 and roughly 328 MMT CO2e by 2045.**

Assuming this rate of NWL CO2 loss, and that agricultural land is 20% of state NWL and thus must offset 20% of NWL emissions to achieve carbon neutrality, the state's managed pastures and croplands must capture roughly 66 MMT CO2e by 2045. This would require engaging an estimated 770,000 new acres annually across the 26 year period, sequestering roughly 1.5 tonnes CO2e per acre per year[1]. This rate of sequestration is consistent with observed rates achieved with compost application on grazed grasslands in CA, and about twice the rate achieved through a holistic Carbon Farm planning framework (engaging, as appropriate, the full suite of NRCS and Healthy Soils Program conservation practices outlined in COMET-Planner), including the implementation of multiple practices on the working landscape. Wholesale diversion of the state's untapped organic waste streams to crop and grassland-applied compost could substantially reduce the acreage required to achieve this goal. Utilizing 10MT tons of additional compost annually through required diversion of organics under AB1383, at 10 tons per acre, would engage 1M acres each year, representing an estimated 9MMT[2] CO2e/year (see appendix), or roughly 90MMT of CO2e transferred beneficially to the state's soils by 2030.

Actual current Agricultural GHG emissions are roughly 34MMT CO2e **per year,** including CO2, CH4 and N2O from all ag sources (https://www.arb.ca.gov/cc/inventory/data/data.htm). To achieve carbon-neutrality and thus offset **all** agricultural sector GHG emissions would require engaging all 20M acres at the rate of 1.7 tonnes CO2e per acre per year sequestered or avoided on an ongoing basis. This is a high rate of carbon capture, but could be achieved through a comprehensive statewide strategy of ag sector carbon sequestration and GHG emission avoidance, engaging whole-farm planning and practice implementation for optimum carbon enhancement, yielding a host of environmental and community-level environmental justice co-benefits.

Specific Comments on the January 2019 Draft Plan

Page 10

"Fire suppression leads to landscapes that are misaligned with their natural state and increases the risk of high severity wildfires that emit immense quantities of GHGs and

[1] This assumes 1.5 tonnes of additional CO2e sequestered on each engaged acre every year under an

[2] Assuming compost is 25% carbon, each tonne of compost represents about 0.9 tonnes of CO2e.

can damage ecosystems and the benefits they provide."
Comment: The highlighted phrase is ecologically nonsensical. We suggest changing the sentence to read: "Fire suppression leads to accumulation of fuels, increasingly unpredictable wildfire behavior, and increased risk of high severity wildfires that emit immense quantities of GHGs and damage ecosystems and the benefits they provide."

Page 12
"The declining health and net GHG emissions of the State's lands are expected to increase through a negative feedback loop as climate change further stresses these systems."
Comment: This is an incorrect use of the term "negative feedback." Negative feedbacks work to maintain systems at equilibrium. It is **positive feedbacks** that drive system change; stresses from climate change will drive further negative changes in our ecosystems over time, due to deviation-amplifying **positive feedbacks** (with negative systemic consequences).

"The 2030 goal focuses on demonstrated and quantifiable land-based activities that provide near and long-term climate benefits and are currently funded by State agencies."
Comment: Unfortunately, current state-funded activities are inadequate to meet state carbon neutrality goals. This is not a viable strategy on which to base 2030 NWL GHG reduction/sequestration goals. We will not solve this problem using existing levels of funding and institutional engagement.

Page 13
"The projected climate outcomes of this level of effort is cumulative emissions of 21.6–56.8 MMT CO2e by 2030 and cumulative emission reductions of -36.6 to -11.7 MMT CO2e by 2045."
Comment: Based upon current CO_2 losses from NWL (page 9, Draft Plan), this appears to suggest a reduction in CO_2e losses by at least a cumulative (164 – 56.8 =) **107 MMT by 2030** and a cumulative (368 - 68.5 =) **299 MMT by 2045**, ***excluding the roughly 74% of losses from wildfire*** . Please make the relevant assumptions underlying these projected outcomes explicit so that this analysis is transparent for the reader.

Page 14
"Modeling results are in line with our understanding that many forests are currently overstocked (hold too much carbon)."
Comment: **This is incorrect**. Forests may be "overstocked," but the problem is **not** the absolute quantity of carbon in these systems, which is almost certainly well below pre-European settlement levels. Rather, the problem arises from the way carbon is currently allocated among forest carbon pools. We need MORE total carbon in these systems **-in the soil and in larger live standing trees-** and LESS in the form of above ground fine and ladder fuels, dead trees, and dense stands of small diameter trees.

"Despite near-term carbon losses, thinning overstocked forests will result in lower forest

densities, larger and more fire-resistant trees, and reduced fuel loads to minimize long-term black carbon and GHG emissions and create more stable carbon sequestration."
Comment: These forest management activities need not result in near term net carbon losses; forest biomass can be allocated to the forest floor via mulching, mastication, etc., or used to displace fossil fuels through allocation to biomass fuel plants with energy and biochar recovery, and allocation to furniture or building uses. Low intensity prescribed fire certainly has a role to play, with potential for relatively minor near term carbon losses, as noted, as well as the benefits noted, including lower black carbon emissions and larger diameter trees, relative to the impacts of catastrophic wildfire.

Page15: Pathways and Acreage Goals. CONSERVATION/Land Protection.
Comment: In the face of the Draft Plan's reported NWL losses of roughly 48 MMT CO2e per year, land conservation, while essential for many reasons, should be tied to the management of those lands as carbon sinks, with positive carbon enhancement requirements. Slowing the rate of loss of NWL to urban development, while essential, is NOT by itself a strategy for increasing net carbon capture on NWL (table 4).

Enhanced carbon in forested ecosystems. Shifting timberlands to less intensive management regimes.
Comment: The use of the term "less intensive" is ill advised here. In fact, the state is, correctly, proposing significant intensification of the management of its forests to reduce fuel loads and enhance carbon stocks in soils and larger live standing trees. Timber harvest regimes may be less frequent under this scenario, but overall management will almost certainly be more, not less, intensive.

Page 16: RESTORATION Riparian restoration
"Reforesting areas near rivers and streams can restore plant and animal habitat while protecting waterways from the impact of adjacent land uses."
Comment: This describes riparian forest buffers, not riparian restoration. Riparian restoration entails much more than reforestation near rivers and streams. It includes stream bank stabilization, in-stream structural enhancement, native species reintroduction and many more practices to insure restoration of hydrologic function and ecosystem processes. Consequently, the net GHG impact of riparian restoration is significantly greater than tree planting alone.[3]

Page 17: Urban forestry and urban greening.
Comment: Roadside tree and shrub planting should be added to this sector. With over 400,000 miles of roadways in the state, these sites of enhanced runoff concentration offer enormous potential for water harvesting for increased carbon capture through well-designed roadside forestry projects. Such projects would generate long-term public job and revenue opportunities from forest planting and maintenance and long-rotation timber

[3] Lewis, D. et al 2015. Creek Carbon: Mitigating Greenhouse Gas Emissions Through Riparian Revegetation. UCCE Marin.

sales, while improving runoff water quality and enhancing groundwater recharge. Sequestration rates can be expected to equal or exceed that of riparian forest buffers.

Section 4: AGRICULTURE
"Compost application; Compost application on cropland, rangeland, and pasture may increase carbon sequestration while enhancing water-holding capacity, forage production, and the release of nutrients in soils."
Comment: Compost application does these things, but also increases crop productivity (ie, carbon capture), improves the nutrient retention and nutrient cycling properties of soils, increases the nutrient density of foods grown in treated soils, and avoids the release of GHG and short-lived climate pollutants, including nitrous oxide, methane and black carbon, by providing an alternative to synthetic fertilizers, anaerobic disposal and storage of organic waste streams and open burning as a disposal strategy for on-farm woody waste materials.

Page 18, Figure 7: Implementation Acreage Goals for California's Natural Climate Solutions.
Comment: These are extremely modest acreage goals, and insufficient to reach carbon neutrality by 2045. To take just the example of croplands, the proposed 66,600 (maximum) acres is 0.0033% of the state's 20M+ ag land acreage and less land than is currently engaged under NRCS carbon-sequestering conservation practices across the state each year (80,000 acres). This level of "ambition" by the state will require 150 years to engage even half of the state's ag lands in the proposed practices.

The maximum acreage proposed for compost application, 71,000 acres, if applied at the extremely low rates supported by the CDFA Healthy Soils Program (6-8 tons per acre), would utilize at most 568,000 tons of compost, or less than 2% of the state's estimated 30M tons of unrealized annual organic waste stream-to-compost potential, and require 150 years to apply compost to even 50% of the state's cropland, one time only. We propose a target of utilizing at least 10M tons of additional compost annually, based upon additional diversion of organics ***required*** under AB1383. At 10 tons per acre, this would engage 1M acres each year, representing an estimated 9MMT[4] CO2e/year (see appendix), or roughly 90MMT of CO2e transferred to the state's soils by 2030.

The Nature Conservancy and others have proposed a 2030 NWL goal of 130MMT, focusing on woodlands and forest lands, and largely excluding agricultural lands from their analysis. As noted previously (see appendix), combining the full suite of working land acreage and management scenarios offers the state a means of achieving carbon neutrality in the NWL sector as well as offsetting some percentage of non-NWL sector emissions. If the state is serious about engaging NWL as a climate change solution, it needs to think much more broadly and holistically about how to engage NWL and the multiple resource connections associated with its management for GHG reductions and

[4] Assuming compost is 25% carbon, each tonne of compost represents about 0.9 tonnes of CO2e.

sequestration, including water quality and water quantity.

Page 20, Figure 9
Comment: This table appears to significantly underestimate the cumulative benefits of NWL practices. Land engaged in durable carbon sequestering practices, whether durable because the practice is sustained through management over time or because the practice itself results in ongoing carbon capture (woody perennial growth, for example), will continue to sequester carbon for the life of the project. Hence, while the cumulative benefit of engaging 500,000 acres versus 1 million acres by 2030 is roughly 5.3 MMT vs 10.7 MMT, as noted by Figure 9 (assuming 1.4 mt per acre per year), because each engaged acre continues to capture additional carbon every year the practice is maintained, while retaining previously captured carbon, by 2045 these values increase to 24 and 44 MMT respectively, not 12 and 24 MMT as shown in figure 9.

This is critically important, as it radically reduces the cost per tonne of CO2e sequestered as the length of the project increases from 2030 to 2045, and carbon continues to accumulate on each treated acre, from about $311/tonne in year one, to $44/tonne in year 12, to $21/tonne in year 27. These results emphasize the importance of: 1) beginning NOW to implement carbon-beneficial NWL practices; 2) a long-term commitment to project planning, implementation and maintenance for terrestrial sequestration projects to yield their full potential in GHG reduction benefits at lowest cost per tonne and 3) engaging the maximum acreage possible as quickly as possible to insure long-term capacity to maximize GHG reductions, drawdown and sequestration through enhanced management of NWL.

The proposed 500,000 and 1 million acre targets represent less than 2.5% and 5%, respectively, of the state's 20M acres of arable land, while the projected **cumulative** 2030 benefits represent only 15% of the state's **annual** agricultural emissions of 34 MMT CO2e, and 5% of the 107 MMT CO2e needed to offset existing NWL emissions (excluding wildfire emissions; see page 13 note above). It is impossible to reconcile these figures with the need to engage the state's NWL as a significant component of the 2045 carbon neutrality goal.

Page 23
"The expected climate benefits from CNRA programs will be determined using CALAND."
Comment: CALAND should be open to public review and comment before being adopted as a quantification tool.

Page 24: "Work with Multiple Partners;" Please change "understated" to "overstated."
"Leverage and support technical assistance providers: California's ninety-eight Resource Conservation Districts."
We emphasize the following with respect to implementation of the NWL Plan and emerging goal:
Unlike many states, California does not provide core support for its Resource Conservation Districts (RCDs), who work directly with landowners to plan, implement,

and monitor conservation projects such as those highlighted in the NWL Plan. Significant core funding for the state's RCDs is critical if these "boots on the ground" are to provide meaningful support for statewide NWL programs. **Indeed, given their critical position between local producers and national NRCS-USDA programs, their trained technical staff and statewide geographic scope, *providing core funding to the state's RCDs is arguably the single most effective and efficient way the state can engage its working lands, including its private lands, at the scale needed to reach carbon neutrality in the NWL sector by 2045*.** To this end, we strongly recommend core funding for RCDs to allow expansion of NWL climate programs, including planning and implementation, where they exist and/or staffing and initiation of such programs in those RCDs across the state where they do not**.** There are currently scores of RCDs with existing and emerging district-wide programs working with landowners, farmers, and ranchers to plan and implement the actions contained in the NWL Plan. We are currently working with these RCDs to develop a robust recommendation for necessary annual investment.

Page 25
"Build and strengthen national and international partnerships:"
Comment: This is a laudable goal, requiring partnerships with local and regional governments, agencies ,nonprofits, and businesses already interested and engaged in NWL work.

Page 26
"Coordinate Cross-Agency Implementation:" *Idem*.
Comment: A functional interagency task force, including CDFA, CARB, CalFIRE, CalRecycle, SWRCB, and DOC, is critically needed to realize the significant synergies inherent in a holistic approach to engaging NWL as a climate solution.

Page 31
"Continue to Invest in Research." Include socio-economic research (e.g., costs and benefits of practices, social barriers for implementation, obstacles to market development, behavioral change).
Comment: There should be a clear set of research areas and questions that would be prioritized; to date, research has lacked a clear connection to the NWL plan and its implementation.

Page 32
"Consider other mechanisms for driving additional actions in this sector"…
Comment: Needs more detail on how this would be accomplished.

Page 37, Table 1
Comment: Labels on columns A (1/2 million) and B (1 million) are confusing.

Page 41

Comment: Please add **Soils** to carbon pools impacted (soil carbon increases with decay of slash).

CONCLUSION

To meet its GHG reduction and carbon sequestration goals, California must build upon the work of USDA-NRCS, Resource Conservation Districts, UC Cooperative Extension, Carbon Cycle Institute, Fibershed and others' carbon sequestration activities on working lands, including information transfer, technical support, and sufficient resource allocation to land managers through these well-established frameworks. Robust, albeit conservative, methods to track results of these efforts have been developed; as the Draft Plan outlines, COMET-Planner, an on-line tool developed by Colorado State University in collaboration with USDA-NRCS and CDFA, allows quantification of GHG benefits of an extensive suite of NRCS conservation practices that have been successfully implemented in California and across the US for over 70 years (Swan et al 2017). The Project Tracker tool, developed by and for the state's Resource Conservation Districts, offers a means of tracking projects and their GHG impacts, as supported by state, federal and private agencies and individuals, under the auspices of these special districts of the state.

2030 is less than 11 years away. To date, the state has taken limited action to engage its NWL as carbon sinks, even as it amasses data on the rate of carbon loss from these systems and as the challenge of addressing climate change grows steadily greater. Natural and working land scenarios must begin to be implemented at scale ***now*** if results are expected by 2030. There is no way even the modest 2030 NWL goal of 15-20 MMT can be met if we continue to delay implementation of ***practices that have been known since at least the Dust Bowl years*** to be effective means of increasing carbon storage in soils and vegetation on working lands.

To engage NWL as an effective strategy to achieve carbon neutrality by 2045, we must begin to implement known carbon-beneficial land management practices immediately, and quickly scale the work on the ground. Significant NWL GHG sequestration efforts are already underway across the state under the auspices of the Resource Conservation Districts, USDA Natural Resources Conservation Service, technical service providers and independent land managers. Lacking to date is a comprehensive state-led framework, and commensurate financial support, to scale the work to the level necessary for the enormous potential of this sector to be realized.

Thank you for the opportunity to comment on the 2019 Draft 2030 Natural and Working Lands Climate Change Implementation Plan. Governor Brown's Executive Order B-55-18 establishes a goal of carbon neutrality for California by 2045, with net-negative emissions after that. As made clear in the Draft Plan, ***the 15-20 MMT CO2e 2030 goal is at least an order of magnitude too low to achieve carbon neutrality within the NWL sector by 2045.*** We echo Director Nichol's call for an ambitious NWL carbon sequestration and GHG reduction goal for California as the only viable path forward for NWL neutrality to be be realized.

Sincerely,

Pelayo Alvarez, Ph.D.
Director of Outreach and Partnerships, including Carbon Farming Network

Jeff Creque, Ph.D.
Director of Rangeland and Agroecosystem Management

Torri Estrada
Executive Director and Director of Policy

Carbon Cycle Institute

Appendix: *7/9/18 letter to California Air Resources Board; California Environmental Protection Agency; California Department of Food and Agriculture; California Natural Resources Agency*
from the Carbon Cycle Institute and multiple Resource Conservation Districts RE: GOAL SETTING for the NWL SECTOR: Comment on California 2030 Natural and Working Lands Climate Change Implementation Plan Concept Paper.

Summary of Key Recommendations from the Appendix:

Carbon Farming
Having emerged as a formal planning process in 2014, Carbon Farm Planning is rapidly being adopted across the Resource Conservation District (RCD) and Land Trust (LT) landscape. To-date, 36 Carbon Plans have been completed, covering 34,855 acres in 10 counties across California. When fully implemented, these 36 projects will sequester an average of 0.79 Mg CO2e per acre per year, totaling up to 330,425.4 Mg CO2e by 2030. By year 20, these few projects alone are expected to have sequestered 592,705 Mg CO2e and increased soil water holding capacity by 1,977 acre-feet above baseline conditions.

There are 31 new farm and ranch Carbon Plans in progress and demand for at least 49 additional Plans in the next 2 years, pending funding. Assuming similar carbon capture opportunities, these 80 new carbon farms and ranches alone represent the potential to capture an additional 629,472 Mg CO2e on 66,400 new acres by 2030. Together, these 116 farms and ranches encompass 101,255 acres, with the potential to sequester up to 959,897 Mg CO2e by 2030 on an area equivalent to roughly 0.05% of the state's arable land (table 1). Taking this work to scale by engaging even 50% of the state's arable land presents the potential to sequester at least 96MMT over time, with the potential to sequester at least 192MMT if all arable lands were engaged.

4 per Mille
The 4 per 1000 scenario (table 2, appendix), engaging only the state's roughly 20 million

acres of arable land, leads to terrestrial sequestration of 59MMT CO2e by 2030 and 146MMT by 2050.

The estimated combined 2030 sequestration potential under these scenarios is at least 155 MMT CO2e, enough to effectively offset NWL emissions anticipated for the period as outlined in the Draft Report (about 160 MMT, excluding wildfire emissions). This does not include the 130 MMT by 2030 from forests and woodlands being advocated by TNC and others. Yet these combined scenarios do not represent the maximum terrestrial CO2e sequestration potential, should California choose to seriously engage its natural and working lands –including its agricultural lands, forests, riparian areas, urban forests, rangelands, roadsides and coastal wetlands- as a key element in the state's climate change response, with all the attendant jobs, water quality and food security benefits such a commitment would provide.

APPENDIX

DATE: 7/9/18
TO: California Air Resources Board; California Environmental Protection Agency; California Department of Food and Agriculture; California Natural Resources Agency
FROM: Carbon Cycle Institute
VIA: https://arb.ca.gov/cc/natandworkinglands/natandworkinglands.htm.

RE: GOAL SETTING for the NWL SECTOR: Comment on California 2030 Natural and Working Lands Climate Change Implementation Plan Concept Paper

Dear CARB, Cal EPA, CDFA and CNRA;
Thank you for the opportunity to comment on the Natural and Working Lands Implementation Plan Concept Paper (Concept). What follows is our conservative estimate of the near-term potential GHG benefits available through the intentional management of the state's working lands for CO2 sequestration, under a variety of

scenarios. We look first at existing demand from a group of landowner early adopters working with their local Resource Conservation Districts and Land Trusts to increase carbon capture on their working landscapes through a planning and implementation process often called Carbon Farming. We then look at the potential for Carbon Farming to provide a a quantifiable pathway for California to engage the Four per 1000 Initiative1 goal across all the state's roughly 20 million acres by 2050. We then offer several examples of the near-term potential of specific practices mentioned in the Concept.

I. CARBON FARM PLANNING: Existing Plans and Demand through 2020

On-farm climate-beneficial agricultural practices, as identified through a comprehensive Carbon Farm Planning2 process, if implemented at scale, can play a key role in significantly reducing atmospheric GHG, while simultaneously improving the productivity, resilience and ecological integrity of working landscapes. Having emerged as a formal planning process in 2014, Carbon Farm Planning is rapidly being adopted across the Resource Conservation District (RCD) and Land Trust (LT) landscape. CCI and its and Land Trust partners recently assessed the total number of farms and ranches with carbon plans (and resulting carbon sequestration and water benefits) ready for implementation across the state.

To-date, 36 Carbon Plans have been completed, covering 34,855 acres in 10 counties across California. When fully implemented, these 36 projects will sequester an average of 0.79 Mg CO2e per acre per year, totaling up to 330,425.4 Mg CO2e by 2030. By year 20, these projects alone are expected to have sequestered 592,705 Mg CO2e and increased their soil water holding capacity by 1,977 acre-feet above baseline conditions.

There are 31 new farm and ranch Carbon Plans in progress and demand for at least 49 additional Plans in the next 2 years, pending funding. Assuming similar carbon capture opportunities,3 these 80 new carbon farms and ranches alone represent the potential to capture an additional 629,472 Mg CO2e on 66,400 new acres by 2030. Overall, these 116 farms and ranches encompass 101,255 acres, with the potential to sequester up to 959,897 Mg CO2e by 2030 on an area equivalent to roughly 0.05% of the state's arable land (table 1).

1 The initiative, "4 per 1000", launched by France on 1 December 2015 at the COP 21, consists of federating all voluntary stakeholders of the public and private sectors (national governments, local and regional governments, companies, trade organizations, NGOs, research facilities, etc.) under the framework of the Lima-Paris Action Plan (LPAP). https://www.4p1000.org/

2 www.marincarbonproject.org; www.carboncycle.org;

3 An average farm/ranch size of 830 acres is assumed.

Table 1. Status of Near Term Carbon Plans, (Complete, In Progress and Proposed) with 2030 CO2e Sequestration Potential and Estimated 20-year Soil Water Holding Capacity Increase.

Plan Status	# of Carbon Plans	2030 Mg CO2e	20 year WHC Increase (Acre Feet)	Acres
Existing	36	330,425	1,977	34,855
Proposed or in Progress	80	629,472	4,393	66,400
2020 Potential	116	959,897	6,370	101,255

With the first 3 Carbon Plans developed in Marin County in 2014, we now see 116 Plans completed, in progress, or pending with 32 RCDs across the state, with very limited funding from state, federal and philanthropic sources. Assuming similar rates of financial and technical support, planning and implementation going forward, this rate of increasing carbon capture capacity on the state's agricultural lands can be expected to continue indefinitely. Under a more ambitious Carbon Farming adoption scenario, many times this level of CO2e sequestration enhancement is possible. The following state-wide Carbon Farming scenario -outlined for the state's 20 million-plus arable acres only- is consistent with the French Ministry of Agriculture's Four per Mille (4 per 1000, or 0.4%) Global Initiative.

II. 4 PER 1000

Table 2 shows actual USDA NRCS acreage and carbon sequestration data for conservation practices implemented in California with NRCS cost-share funding from 2006 through 2017, compared with the GHG implications of Carbon Farming scaled in accordance with the French Ministry of Agriculture's global 4 per 1000 initiative. Engaging an additional 3% of the state's 20 million-plus acres of cropland and pastureland in carbon farming practices annually, (rather than the .004% currently engaged annually by NRCS, table 2), 600,000 new acres would be engaged as enhanced carbon sinks each year. By increasing the organic carbon content in a steadily increasing percentage of the state's arable soils by 0.4% per year, California could sequester 59 MMT CO2e on 8.4 million acres by 2030, and 146 MMT CO2e on 20.4 million acres by 2050.

4. 5.3 dry tons per acre is the maximum application rate assumed within the Compost-Planner tool; it does not represent much higher commonly accepted agronomic rates of compost application, particularly common on croplands

Table 2. Application of a 4 per 1000 model, increasing soil organic carbon by 0.4% each year, on an additional 3% (600,000 new acres) of California's roughly 20 million acres of cropland and pastureland each year through 2050.

	CO2e Mg/yr (avg)	New Acres/Yr	% of 20 M acres /yr	NRCS Cost/yr	Estimated total cost/yr	Cumulative CO2e 2030	Cumulative Acreage 2030	Cumulative CO2e 2050	Cumulative Acreage 2050
NRCS-Baseline-2006-2017	20,291	79,849	0.004	$1,996,225	$5,988,675	7,700,000	1,916,376	21,001,227	3,593,203
4 per 1000 (cropland/ pasture only)	152,471	600,000	3.0	$15,000,000	$45,000,000	58,968,000	8,400,000	146,328,000	20,400,000

Pastureland Compost Application

Assuming all 12 million acres of the state's managed grasslands and pastures (as distinct from rangelands) could be treated with compost one time at 5.3 dry tons/acre, an estimated 54.4 MMT CO2e could be sequestered by 2030 (Compost-Planner).

Cropland Compost Application

Applying a minimal amount of compost (5.3 dry tons per acre annually-well below accepted agronomic maximums) on the state's 11 million irrigated acres would alone result in sequestration of 49 million metric tons of CO2e per year (Compost-Planner). In addition, at 1-2% N, this amount of compost would obviate the need for 500,000 to 1 million tons of synthetic N fertilizer each year, avoiding 7.8 to 15.6 MMT of CO2e annually, while also eliminating the attendant water and air quality impacts of that use.5 . By treating only 5% of the state's irrigated cropland annually at this rate, over 25 MMT of CO2e could be sequestered, and 4 MMT CO2e avoided, by 2030.

Prescribed Grazing

Prescribed grazing can be an effective strategy to increase carbon capture on rangelands and pastures at rates of 0.005 to 3.0 Mg CO2e/acre/year (COMET-Planner; Conant et al, 2011; Teague et al 2016). However, with very few exceptions, DPR does not use grazing as a tool to achieve conservation objectives on state lands, and neither CDFA nor DPR have the expertise needed to successfully implement or evaluate prescribed grazing as a practice to achieve terrestrial carbon sequestration benefits. We encourage state agencies to partner with institutions, organizations and rangeland management professionals (NRCS, UCCE, RCDs, CRMs, etc.) that can provide the relevant expertise to engage and optimize this potentially important sequestration strategy.

5 Every metric ton of nitrogen spread in the form of fertilizer is responsible for emissions of 10.5 t CO2e in the field (67%) and 5.1 t CO2e during its production (33%) (Foucherot and Bellassen, 2011).

Riparian Restoration

The Concept assumption that riparian restoration carbon capture rates are analogous to those of upland forests fails to recognize the significantly greater productivity of riparian ecosystems. Models show rates of CO2e capture by riparian vegetation and soils of 1.0 (COMET-Planner) to over 16 Mg/acre/year (Lewis et al 2015). Use of oak woodlands as a reference for carbon accrual in riparian systems should be reevaluated, as willow, alder, cottonwood and other phreatophytes accumulate carbon at much greater rates than oaks (Aishan et 2018). Although no attempt was made to quantify the carbon sink potential of the state's riparian areas for this analysis, an estimated 95 percent of riparian habitat in the Central Valley alone has been lost since European settlement (Katibah 1984), suggesting the enormous carbon sink potential of this land type across California. Overall, this analysis yields a potential to sequester at least 91 MMT CO2e by 2030, without maximizing acreage under any of the above Concept practices, and without engaging prescribed grazing, riparian restoration, urban forestry, roadside forest buffers, forest lands or coastal wetlands. This is nearly twice the amount of CO2e that could be sequestered by 2030 under the 4 per 1000 (arable land only) strategy outlined in Table 2.

CONCLUSION

The 4 per 1000 scenario outlined in table 2 –leading to terrestrial sequestration of 59MMT CO2e by 2030- is an ambitious goal, albeit for the state's arable lands alone. Achieving sequestration of 91 MMT of CO2e on other working lands of the state by 2030 is more ambitious. The estimated combined 2030 sequestration potential under the above scenarios is just under 148 MMT CO2e. Yet even these combined scenarios do not represent the maximum terrestrial CO2e sequestration potential, should California choose to engage seriously with all of its natural and working lands –including its agricultural lands, forests, riparian areas, urban forests, rangelands, roadsides and coastal wetlands; as a key element in the state's climate change response.

California can build upon the work of USDA-NRCS, Resource Conservation Districts, UC Cooperative Extension, Carbon Cycle Institute, Fibershed and others' carbon sequestration activities on working lands, including the information transfer, technical support and funding opportunities available to land managers through these well-established frameworks. Robust, albeit conservative, methods to track results of these efforts have been developed; as the Concept paper explicitly outlines, COMET-Planner, an on-line tool developed by Colorado State University, allows quantification of GHG benefits of an extensive suite of NRCS conservation practices that have been successfully implemented in California and across the US for over 70 years (Swan et al 2017). The Project Tracker tool, developed by and for the state's Resource Conservation Districts, offers a means of tracking projects and their GHG impacts, as supported by state, federal and private agencies and individuals, under the auspices of these special districts of the state.

2030 is less than 12 years away. Natural and working land scenarios must begin to be implemented at scale now if results are expected by 2030. There is no way even the modest 2030 NWL goal of 15-20 MMT can be met if we continue to delay implementation of practices that have been known since at least the Dust Bowl years to be effective means of increasing carbon storage in soils and vegetation on working lands. We already know that "the scale of implementation needs to be more aggressive," as amply evident in global climate trends. 2030 natural and working lands goals –whether conservative or ambitious- will not, and cannot, be met if implementation of projects at scale is delayed.

To achieve "deeper GHG goals" for 2050 through sequestration on natural and working lands, we must begin to implement known carbon-beneficial land management practices immediately.

Significant Carbon Farm Planning-based GHG sequestration efforts are already underway across the state under the auspices of the Resource Conservation Districts, USDA Natural Resources Conservation Service, technical service providers and independent land managers. Lacking to date is a comprehensive state-led framework, and commensurate financial support, to scale the work to the level necessary for the potential of this sector to be realized.

Sincerely,

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