EXHIBIT A

SCOPE OF WORK

☒ Contract ☐ Grant

Does this project include Research (as defined in the UTC)? ☒ Yes ☐ No

PI Name: Jorge L. Mazza Rodrigues

Project Title: Quantifying and Identifying the Potential Causes of Nitrous Oxide Emissions in California Soils under Fumigation (Phase 2)

Project Summary/Abstract

Briefly describe the long-term objectives for achieving the stated goals of the project.

Agroecosystems both contribute to and are affected by global climate change. As the world's fifth largest supplier of agricultural commodities and the top agricultural producer in the U.S. (USDA ERS, 2022), this situation is of particular concern to California. In 2016, the State of California adopted legislation to help growers reduce emissions of greenhouse gases, explicitly including nitrous oxide (N_2O) that has approximately 300 times the global warming potential of carbon dioxide (CO2). It has been estimated that ~50% N_2O emissions in California are from agricultural soils (CEC, 2005; Smart et al., 2011; CARB, 2022). N_2O emissions can vary widely due to environmental and agronomic factors (such as fertilization, irrigation, etc.). There is, however, a dearth of evaluation of the fumigation impacts on N_2O emissions under different management regimes in the cropping systems commonly found in California's Mediterranean climate, although it has been demonstrated that some fumigants can significantly increase the N_2O emissions elsewhere (Spokas and Wang, 2003; Fang et al., 2018).

The long-term goal of this collaborative project is to evaluate the effects of fumigation on N_2O emissions and propose potential mitigation strategies in selected cropping systems in California. In this entire project, the Contractor will divide **the project goal** into two phases (Phase 1-literature/data review and monitoring preparation; Phase 2-filed monitoring and analysis). **In current work, the Contractor will focus on the Phase 2 of the project as the Phase 1 goals were covered and approved as a separate agreement (see Attachment 1).** The specific aims of Phase 2 are to monitor N_2O emissions in the field during fumigation events, calculate N_2O emission and propose potential mitigation strategies. **The long-term objectives of Phase 2** are to: **(1) conduct** field N_2O flux measurements in the selected crop systems that were identified in Phase 1 with and without fumigation application under different management practices (e.g., fertilization and irrigation); **(2) determine** the N_2O emission factors associated with fertilization and fumigation rates; **(3) propose** potential mitigation strategies based on the field and lab studies by identifying the environmental and microbial controls on the N_2O emissions; **(4) upscale** observed fumigant impacts to statewide emissions; **(5) write** a report and publish scientific papers using all the data collected from the field and lab.

If Third-Party Confidential Information is to be provided by the State:

☐ Performance of the Scope of Work is anticipated to involve use of third-party Confidential Information and is subject to the terms of this Agreement; ***OR***

☐ A separate CNDA between the University and third-party is required by the third-party and is incorporated in this Agreement as Exhibit A7.

Scope of Work

Describe the goals and specific objectives of the proposed project and summarize the expected outcomes. If applicable, describe the overall strategy, methodology, and analyses to be used. Include how the data will be collected, analyzed, and interpreted as well as any resource sharing plans as appropriate. Discuss potential problems, alternative strategies, and benchmarks for success anticipated to achieve the goals and objectives.

Statement of significance

Nitrous oxide is one of the most potent greenhouse gases in the atmosphere, playing a key role in climate outcomes and atmospheric chemistry (Oertel et al., 2016). This potent greenhouse gas not only accounts for a global warming potential of 298 times that of CO_2 over a period of 100 years, but also it is the major cause for the depletion of the ozone layer in the stratosphere, through the formation of nitric oxide (NO) and nitrogen dioxide (NO_2) (Ravishankara et al., 2009).

In agricultural systems, N_2O emissions are substantially increased following the intensive use of N fertilizers and agrochemicals to achieve high production (Syakila and Kroeze, 2011). Nitrous oxide (N_2O) emissions have been reported to increase around 8-fold following chloropicrin (CP) fumigation in agricultural soils in Minnesota, U.S. (Spokas and Wang, 2003), with 82% contributed from microbial activities (fungal dominant activities) and 18% from abiotic processes (Spokas et al., 2005 and 2006). In contrast, a recent study by Fang et al. (2018) shows much larger (23-25 times) emissions in CP fumigated agricultural soils in China than observed by Spokas and Wang (2003), being primarily controlled by bacterial denitrification. Fang's group further demonstrates that biochar would be an option to mitigate N_2O emissions (> 50% reduction) in fumigated soil, but this option is dependent on the timing and biochar types (Fang et al., 2022). These few studies highlight how complex the processes associated with N_2O emissions in agricultural soils are and likely to vary due to soil physicochemical properties and agronomic management practices, such as timing of fertilization, soil N mineralization, residual soil N avaialbility and fumigation.

As the world's fifth largest supplier of agricultural commodities and the top agricultural producer in the U.S. (USDA ERS, 2022), this situation is of particular concern to California, where ~50% N_2O emissions are emitted from agricultural soils (CARB, 2022; Smart et al., 2011). Many growers rely on the use of fumigants, such as a combination of 1,3-dichloropropene and chloropicrin, to control weeds, soilborne diseases and nematodes. In general, these fumigants are either applied by bed injection or through a drip system, at rates up to approximately 82 kg of the active ingredient per acre at the pre-plant stage for crops like strawberries, tomatoes, lettuce, and almonds. **However, the long-term impacts of soil fumigation on N_2O emissions in the State of California are still unknown and have yet to be investigated:** First, we do not know whether fumigation, a chemical operation known to decrease soil biodiversity, will result in increased emissions of N_2O in California agricultural soils or not. Second, we do not know to what extent fumigation-induced denitrification occurs and how much will this affect N_2O emissions in California under different agricultural practices, given that the N_2O is regulated by carbon and nitrogen substrate availability, temperature, pH and soil moisture content (Zhu et al., 2013).

To fill the aforementioned knowledge gaps, the Contractor proposes a stepwise approach, consisting of two phases (**Phase 1 and Phase 2**), to identify the impacts and potential causes of soil fumigation on N_2O emissions and to develop potential mitigation strategies for California agricultural soils as follows:

Phase 1: Existing Data Review and Monitoring Preparation. Perform a thorough literature review of studies on N_2O emissions and their relationship to fumigant type, rate and application methods in different soils, land uses, and environmental conditions; select important cropping systems and fumigants to be monitored that are most relevant to California agriculture through a public process (workshops and/or public venues); and prepare monitoring systems for field sampling. – (*Goals proposed for Phase 1 were previously submitted to and approved by CARB and will not be covered in this document*).

Phase 2: Emission Monitoring and Data Analysis. Quantify N_2O emissions for selected crops with and without fumigation following seasonal management practices performed by California growers and determine the N_2O emission factors in terms of fertilization and fumigation rates and propose potential mitigation strategies.

The overall goal of this collaborative project is to evaluate the effects of fumigation on N_2O emissions and propose potential mitigation strategies in selected cropping systems in California. In this project, **the specific objectives of the Phase 2** are to: **(1) conduct** field N_2O flux measurements in the selected crop systems that were identified in Phase 1 with and without fumigation application under different management practices (e.g., fertilization and irrigation); **(2) determine** the N_2O emission factors in terms of fertilization and fumigation rates; **(3) propose** potential mitigation strategies based on our field and lab studies by identifying the environmental and microbial controls on the N_2O emissions; **(4) upscale** observed fumigant impacts to statewide emissions; **(5) write** a report and **publish** scientific papers using all the data collected from the field and lab.

Specifically, the field N_2O fluxes collected from the selected cropping systems and management types by the Contractor will be used to fundamentally evaluate the impacts of fumigation on N_2O emission in the specific cropping systems around the State. Subsequently, N_2O emission data and emission factors will be integrated with soil parameters, microbial activities, functional pool and taxonomy profiles to determine the environmental and microbial controls on overall N_2O emissions under fumigation application via multidimensional statistical analyses and linear mixing model. Finally, the results from these metadata analyses will provide well-rounded information to inform potential mitigation strategies under fumigation practices in California. The Contractor believes that the outcomes of Phase 2 in this project will benefit to both the state agencies (CARB, CDFA-FREP, DPR, and CEC), the interdisciplinary research communities (e.g., environmental and soil science, microbiology, modelers) and growers in CA in general.

Rationale and Significance for the State of California

The underlying rationale of this project is to address a key knowledge gap on the impact of fumigant application on nitrous oxide emissions from agricultural soils in the State of California. *This research directly addresses CARB's needs of obtaining N_2O emission data to inform its greenhouse gas portfolio and inventory.* In addition, project results will provide novel information to address fumigant management to be coordinated with the California Department of Pesticide Regulation. This is of particular importance to communities present in close proximity to agricultural fields where fumigants are applied. If necessary, Project PI will work in conjunction with CARB contract managers to provide information to communities and interested stakeholders.

Project Tasks

In this agreement, the Contractor will focus on Phase 2: Emission Monitoring and Data Analysis, which include the following four project tasks numbered from 5 to 8.

Task 5. *Measuring N_2O fluxes from non-fumigated and fumigated soils.*

N_2O flux measurements: Field selection will be carried out according to best practices of minimizing any negative impacts to agricultural communities in close proximity to field fumigation locations. *The Contractor is committed to minimize any influence or effects of the research procedures on local communities, and decrease the carbon footprint of our research work.*

For each crop system identified in **Phase 1 (under tasks 1, 2, 3 and 4)**, the Contractor will conduct N_2O flux measurements in fields planted with selected crops under different fumigation practices (e.g., fumigation vs. control) for one year. In the field, each treatment will be replicated three times (3 blocks) and multiple chambers (depends on crop systems) will be installed within each block. Gas samples for N_2O flux analysis will be determined using one of the following methods, depending on the instrument availability at the start of the field season: 1) gas samples will be collected using a static chamber technique (Hutchinson and Livingston, 1993) and analyzed using a gas chromatograph with an electron capture detector (Model 2014, Shimadzu Scientific Instruments), or 2) N_2O flux will be measured directly in-situ using Portable Gas Analyzer (LICOR, Inc.). Only one method will be adopted and consistently used throughout the field season. Regardless of the sampling method ultimately chosen, the Contractor will capture higher emission episodes, which usually occur when both soil NO_3^-concentrations and water-filled pore space (WFPS) are high, such as during irrigation or rainfall events following N fertilization. The Contractor expects a non-linear increase in N_2O emissions when N fertilizer inputs are more than crop N needs. The Contractor is aware that inorganic fertilizer applications can vary substantially depending on the crop being evaluated. For example, tomato plots may be fertilized at 0, 150, and 225 kg N ha^{-1}, while carrot plots may have fertilizer application rates at 0, 30, and 50 kg N ha^{-1}, based on their N nutrient requirements. The Contractor will follow farmers' practices and will not interfere with their management standards, as the Contractor aims to capture a range of field treatments being carried out in the State of California.

Task 6: *Determination of N_2O emission factors and potential mitigation strategies*.

Emission factors (EF) is expressed as the percentage of N_2O-N emissions compared to applied fertilizer-N, which will be determined the same way for fumigated and non-fumigated treatments. This analysis will also be used for the EF comparison between different crops, fumigants at various applications rates. In addition, the Contractor aims to suggest potential mitigation strategies by identifying the environmental and microbial factors that control the emissions. To achieve this, the Contractor plans to conduct chemical and microbial measurements.

Soil Properties: Soil samples (before and after fumigation, as well as at the fertilization events) will be sampled in triplicates and then stored at 4 °C. All soil samples for soil property analysis will be sieved (2 mm) and air-dried for soil organic C (SOC, %) analysis using dry combustion gas chromatography. Other analyses will include soil pH (1:1 soil: water), water content and dissolved organic C (DOC), total nitrogen (TN) and inorganic N (DIN: NH_4^+ and NO_3^-).

Denitrification process: Denitrification has been recently reported to be the major control on N_2O emissions after fumigation (Fang et al., 2018). Denitrification mostly occurs under oxygen (O_2) limitation, particularly when diffusion of O_2 from the atmosphere into the soil is limited at high soil water content, like a water-filled pore space (WFPS) >60%. In such circumstance, microbes will use NO_3^-instead of O_2 as an electron acceptor, thereby reducing NO_3^- to N_2 via the obligate intermediate of nitrite (NO_2^-), nitric oxide (NO) and N_2O. Particularly, high N_2O emissions will be observed with 60-90% WFPS under low soil carbon conditions. Thus, the Contractor will measure denitrification in fumigated and control soils under different management regimes. This procedure will provide information on specific conditions in which the denitrification process occur after fumigation and allow us to suggest potential mitigation strategies for California growers. Net and potential denitrification rates will be determined for soils (4 °C stored) collected before and after field fumigation using a modified method of Petersen et al. (2012).

Microbial community and Functional genes: The Contractor will quantify changes in the soil microbial community, as well as the members carrying genes associated with the process of denitrification, before and after fumigation, as well as the fertilization events.

(1) Microbial community analysis: Total soil DNA will be extracted from ~0.30 (0-20 cm soil in – 80 °C) of wet soil using the DNeasy Powersoil kits following the manufacturer's instructions (Qiagen, CA, USA) and stored in -80°C for downstream analyses. The primer set of 515F and barcoded primer 806R will be used to amplify the V4 region (~380bp) of the prokaryotic 16S rRNA gene, and will be sequenced on the Illumina MiSeq platform (paired end with 2 × 250 bp) at the DNA Technologies Sequencing Core of the Genome Center at the University of California, Davis (UC Davis). The sequence will be analyzed via the QIIME2 program (Bolyen et al., 2019). To assess how the microbial diversity will be changed before, within and after fumigation, alpha (observed ASVs, Shannon, and Faith's phylogenetic diversities) and beta diversity indices (Bray-Curtis distance based non-metric multidimensional scaling, NMDS) will be obtained using both the 'phyloseq' (McMurdie and Homes, 2013) and 'vegan' packages in R v.4.0.2 (Oksanen et al., 2019) at an even sequence depth for all samples. The environmental factors that significantly fitted the NMDS model will be identified by a permutational test using the 'vegan' package in R v.4.0.2 (Oksanen et al., 2019). The permutational multivariate analysis of variance (PERMANOVA) will be tested for the significance of beta diversity between different depths and treatments via the 'pairwiseAdonis' package in R v.4.0.2 (Martinez Arbizu, 2020). Analysis of Variance (ANOVA) with Tukey's HSD test will be used to identify the significant differences of the alpha diversities and relative abundances of microbial compositions before, within and after fumigation.

(2) Functional gene analysis: The molecular method quantitative PCR (qPCR) will quantify the abundance of denitrifiers in these soils using the functional genes *nirK, nirS, nosZ* as proxies of community structure. Previously described primers and PCR conditions will be employed for quantification of genes nirK/S, nosZ (Throbäck et al., 2004). The calculation of the copy number of functional genes will follow the previous study (Huang et al., 2023).

Finally, the Contractor will perform a correlation analysis, linear mixing model (structural equation modelling) and statistical tests (e.g., one-way ANOVA) to identify key environmental, microbial and management factors affecting N_2O emissions and inform potential mitigation strategies, using the metadata the Contractor collected, which includes emission factors (EF), denitrification rate/functional genes, soil properties, crops, fumigants at various applications rates.

Task 7: *Upscaling observed fumigant impacts to statewide emissions*. The observed emission factors in our study will be upscaled statewide, based on the selected California-specific cropland and activity data, to evaluate the overall impacts of selected fumigant use in agricultural soils on N_2O emissions and to determine if an updated N_2O inventory incorporating fumigant impacts is necessary. The Contractor will upscale N_2O emission values for measured crops using the developed emission factors by multiplying the total area (acre) of each selected crop in the entire California with the same applied fumigant, and then the overall impacts of selected fumigant will be calculated by adding up the upscale values of all selected crop systems. The overall upscaled values will be used to compare with the current measurement of N_2O emissions in these crops from other reports, to decide if an updated N_2O inventory incorporating fumigant impacts is necessary.

Task 8. *Progress and final reports.* Quarterly progress reports will be provided each three months and a final report, summarizing all work completed and results, will be submitted to CARB 6 months before the end of **Phase 2**. The report will provide the dynamics of N_2O emissions, emission factors, and potential mitigation strategies in the selected fumigants and cropping systems, as well as publications, academic and extension activities (meetings, workshops and conferences). A final report can be released to the public only after CARB approval.

In coordination with CARB, the Contract will aim to hold public workshops to facilitate discussion of our findings (Phase 1 and Phase 2) regarding the direct effects of fumigants on N_2O emissions. This will allow us to receive feedback on the value of this research and to discuss our findings in real time with interested partners: local communities, farmers, environmental groups, academia, and state agencies. Meetings will be open to the public as well.

References

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Deliverables

The deliverables submitted from Phase 2 of this project will include **(1) the dynamics of N_2O emission and emission factors** in the selected cropping systems with/without fumigation in California, **(2) a report containing the experimental design and work on the fumigation impacts on N_2O emission and the potential mitigation strategies** in the selected cropping systems in California with Disabilities Act compliant format, and **(3) high-quality publications** to the research community.

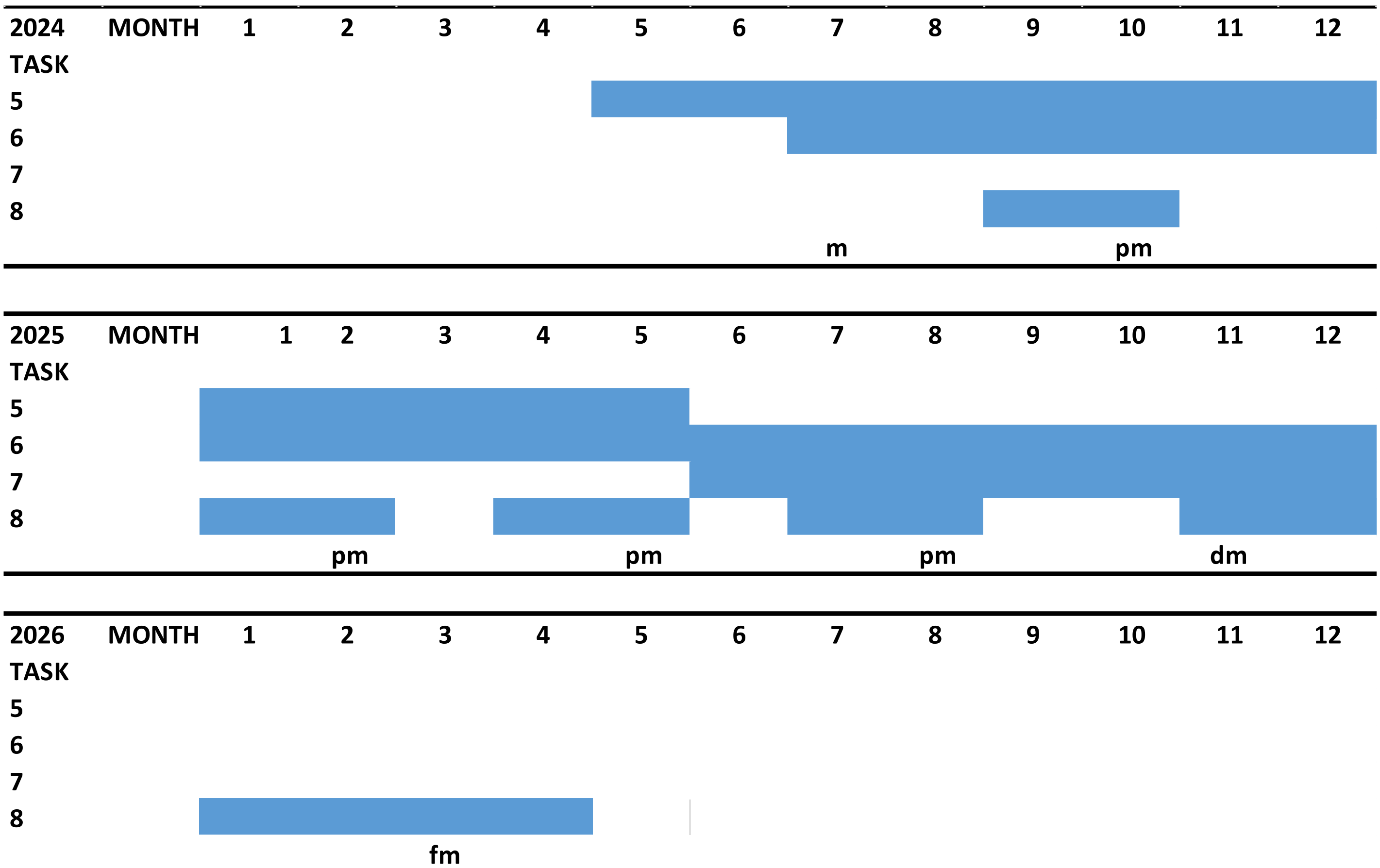
Potential problems, alternative strategies, and benchmarks for success anticipated to achieve the goals and objectives.

The Contractor plans to conduct a field monitoring on N_2O emissions in the selected crops in California. **One of the potential problems for Phase 2** will be comparing different crop systems, given their varying fertilization needs and locations. For example, tomato plots will be fertilized at a range of 0-225 kg N ha^{-1}, while carrot plots will have rates at a range of 0-50 kg N ha^{-1}, depending on their nutrient requirements. It will be difficult to compare the N_2O emission and evaluate the fumigation impacts between different crops at different fertilization rates, particularly when these crops are in different locations. **In this scenario,** the Contractor aims to create emission factors to compare various crops, *assuming that N_2O emissions increase linearly with fertilization rates under fumigation application.* However, the impact of fumigation on microbial-controlled N_2O emissions is intricate and relies heavily on other soil properties such as soil carbon and texture. Therefore, in order to establish a fair comparison, the Contractor may need to select crop systems with comparable soil types, locations and similar intermediate fertilization rates.

To ensure the success of this project composed of field monitoring of N_2O emissions, calculation of emission factors, as well as the investigation of the environmental and microbial controls of N_2O emissions in selected crops in the State of California, the Contractor will exactly follow the four tasks described in the **scope of work in Phase 2**. Additionally, the Contractor will also adjust our field/lab work based on our measurements, climate events (e.g., precipitation and extreme heat) and management practices (e.g., fertilization and irrigation).

Project schedule

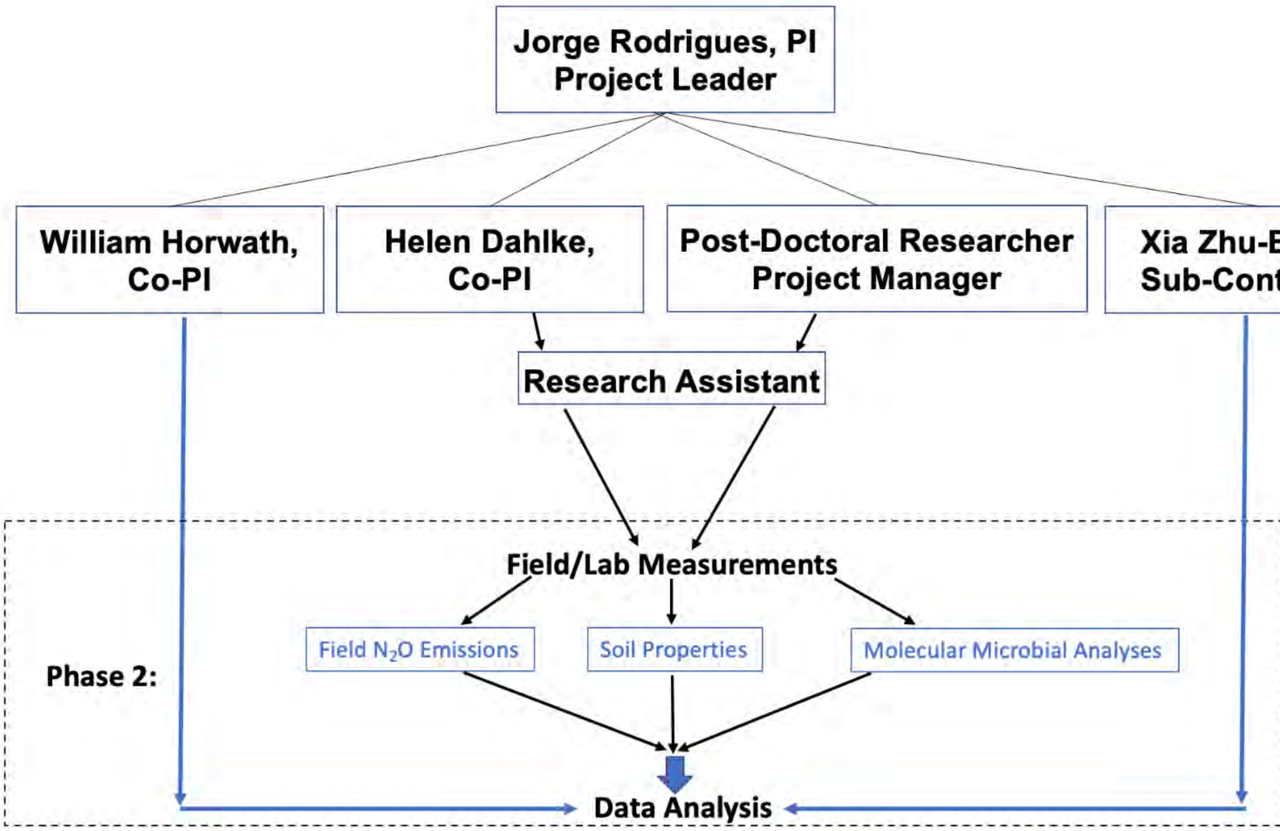
Task 5: *Measuring N2O fluxes from non-fumigated and fumigated soils.*
Task 6: *Determination of N2O emission factors and potential mitigation strategies.*
Task 7. *Upscaling observed fumigant impacts to statewide emissions.*
Task 8. *Progress and final reports.*



p = Quarterly progress report
d = Deliver draft final report (to be submitted 6 months prior to contract expiration)
f = Deliver final report
m = Meeting with CARB staff

Project management plan

(a) Organizational Chart



(b) Responsibilities of Personnel

The Project Leader will supervise the entire project and Project Manager will be responsible for convening monthly meetings with the PI and Co-PIs, Subcontractor (Sub-C) and the research assistant. The Project Leader and the Co-PIs will make the final decisions on the field work, in terms of N fertilizer treatments, fumigation types, cropping systems and overall sampling strategy. The PIs, Project Manager, Sub-C will assist with data analysis and interpretation. Specifically, Sub-C will evaluate the sampling protocol and provide technical guidance for filed N_2O measurements, as well as offering guidance on N_2O flux calculation and data evaluation. The Project Manager and Research Assistant are responsible for field flux measurements, establishing laboratory incubation studies, measurements of particular soil properties and microbial community analyses during the Phase 2 period. The Post-Doctoral Researcher will be responsible for writing quarterly reports to be approved by the PI and Co-PIs, he/she will also draft the final report, and revise the final report. Safety decisions will be made by all the PI and Co-PIs.

(c) Management and Coordination

During **Phase 2**, the major work will be focused on the field and lab measurements, so the meeting will mainly be held between the PI, the Project Manager, and the research assistant to discuss the field/lab work. Project Manager will also organize monthly meetings with all PIs, CARB team, and Sub-C to discuss the field/lab activities, the project progress and potential difficulties based on the field situations and measurements. The timeline of each task will be decided based on the project progress at each meeting. The Project Manager should also ensure that all the tasks are carried out in time, particularly for the field measurements during the whole growing seasons in different crop systems. The Project Manager will meet with all PIs to discuss the timing for presenting the results to CARB team and writing the research manuscripts.

Meetings

A. Initial meeting. Before work on the contract begins, the Principal Investigator and key personnel will meet with the CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, the project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.

B. Stakeholders' meetings. The Principal Investigator and key personnel will meet with pertinent stakeholders, such as California Department of Pesticide Regulation (CDPR), Environmental Justice communities and growers, to discuss the impacts of fumigation on N_2O emissions in the specific cropping systems around the State as well as potential mitigation strategies under fumigation practices in California.

C. Progress review meetings. The Principal Investigator and appropriate members of his or her staff will meet with CARB's Contract Project Manager at quarterly intervals to discuss the progress of the project. This meeting may be conducted by phone.

D. Technical Seminar. The Contractor will present the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte.

HEALTH AND SAFETY

Contractors are required to, at their own expense, comply with all applicable health and safety laws and regulations. Upon notice, Contractors are also required to comply with the state agency's specific health and safety requirements and policies. Contractors agree to include in any subcontract related to performance of this Agreement, a requirement that the subcontractor comply with all applicable health and safety laws and regulations, and upon notice, the state agency's specific health and safety requirements and policies.

EXHIBIT A1

SCHEDULE OF DELIVERABLES

List all items that will be delivered to the State under the proposed Scope of Work. Include all reports, including draft reports for State review, and any other deliverables, if requested by the State and agreed to by the Parties.

If use of any Deliverable is restricted or is anticipated to contain preexisting Intellectual Property with any restricted use, it will be clearly identified in Exhibit A4, Use of Preexisting Intellectual Property & Data.

Unless otherwise directed by the State, the University Principal Investigator shall submit all deliverables to State Contract Project Manager, identified in Exhibit A3, Authorized Representatives.

Deliverable	**Description**	**Due Date**
Initial Meeting	Principal Investigator and key personnel will meet with CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.	Month 1
Progress Reports & Meetings	Quarterly progress reports and meetings throughout the agreement term, to coincide with work completed in quarterly invoices.	Quarterly
Draft Final Report	Draft version of the Final Report detailing the purpose and scope of the work undertaken, the work performed, and the results obtained and conclusions.	Six (6) months prior to agreement end date.
Data	Data compilations first produced in the performance of this Agreement by the Principal investigator or the University's project personnel.	Two (2) weeks prior to agreement end date.
Technical Seminar	Presentation of the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte.	On or before agreement end date.
The following Deliverables are subject to paragraph 19. Copyrights, paragraph B of Exhibit C		
Final Report	Written record of the project and its results. The Final Report shall be submitted in an Americans with Disabilities Act compliant format. The Public Outreach Document, as described in Exhibit A1, Section 2, shall be incorporated into the Final Report.	Two (2) weeks prior to agreement end date.

EXHIBIT A2

KEY PERSONNEL

List Key Personnel as defined in the Agreement starting with the PI, by last name, first name followed by Co-PIs. Then list all other Key Personnel in alphabetical order by last name. For each individual listed include his/her name, institutional affiliation, and role on the proposed project. Use additional consecutively numbered pages as necessary.

Last Name, First Name	Institutional Affiliation	Role on Project
Principal Investigator (PI):		
Rodrigues, Jorge	University of California Davis	Principal Investigator/ Project Leader
Co-PI(s) – if applicable:		
Horwath, William	University of California Davis	Co-Principal Investigator
Dahlke, Helen	University of California Davis	Co-Principal Investigator
Other Key Personnel:		
Zhu-Barker, Xia	University of Wisconsin-Madison	Co-Principal Investigator, Subcontractor

EXHIBIT A3

AUTHORIZED REPRESENTATIVES & NOTICES

The following individuals are the authorized representatives for the State and the University under this Agreement. Any official Notices issued under the terms of this Agreement shall be addressed to the Authorized Official identified below, unless otherwise identified in the Agreement.

State Agency Contacts	**University Contacts**
Agency Name: **CARB**	University Name: UNIVERSITY OF CALIFORNIA, DAVIS
Contract Project Manager (Technical) Name: Lei Guo Address: Research Division 1001 I Street, 5th Floor Sacramento, CA 95814 Telephone: (279) 208-7831 Fax: (916) 322-4357 Email: @arb.ca.gov	***Principal Investigator (PI)*** Name: Jorge Rodrigues Address: One Shields Ave. 3308 PES Building Davis CA 95616 Telephone: 530-341-4355 Fax: Email: JMRODRIGUES@UCDAVIS.EDU Designees to certify invoices under Section 14 of Exhibit C on behalf of PI: 1. <Name>, <Title>, <EmailAddress> 2. <Name>, <Title>, <EmailAddress> 3. <Name>, <Title>, <EmailAddress>

<table>
<tr>
<td>Authorized Official (contract officer)

Name: Brandy Hunt, Chief
Address: Contracts, Procurement, and Grants Branch
1001 I Street, 19th Floor
Sacramento, CA 95814

Send notices to (if different):

Name:
Address: Research Division
1001 I Street, 5th Floor
Sacramento, CA 95814

Telephone: (916)
Fax: (916) 322-4357
Email: @arb.ca.gov</td>
<td>Authorized Official

Name: Grace Liu
Associate Director
Address: Sponsored Programs
1850 Research Park Drive
Davis, CA 95618
Telephone: 530-754-7700
Fax: 530-752-0333
Email: awards@ucdavis.edu

Send notices to (if different):

Name:
Contracts & Grants Analyst
Address: Sponsored Programs
1850 Research Park Drive
Davis, CA 95618
Telephone: 530-754-7700</td>
</tr>
<tr>
<td>Administrative Contact

Name: Renee Carnes
Address: Research Division
1001 I Street, 5th Floor
Sacramento, CA 95814

Telephone: (279) 208-7754
Fax: (916) 322-4357
Email: Renee.Carnes@arb.ca.gov</td>
<td>Administrative Contact

Name:]
Contracts & Grants Analyst
Address: Sponsored Programs
1850 Research Park Drive
Davis, CA 95618
Telephone: 530-754-7700
Email: awards@ucdavis.edu</td>
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<tr>
<td>Financial Contact/Accounting

Name: Accounts Payable
Address: P.O. Box 1436
Sacramento, CA 95814

Email: AccountsPayable@arb.ca.gov

Send courtesy copy to Renee Carnes:

Fax: (916) 322-4357
Telephone: (279) 208-7754
Email: Renee.Carnes@arb.ca.gov</td>
<td>Authorized Financial Contact/Invoicing

Name: Francisco Andrade
Assistant Manager
Address: Contracts & Grants Accounting
1441 Research Park Drive
Davis, CA 95618
Telephone: (530) 754-0604
Fax: (530) 757-8721
Email: efa-invoices@ucdavis.edu

Designees for invoice certification in accordance with Section 14 of Exhibit C on behalf of the Financial Contact:
1. Tammy Castelli, Fund Mgr. Supervisor, tacastelli@ucdavis.edu
2. Lenora Bruce, Fund Mgr. Supervisor, labruce@ucdavis.edu</td>
</tr>
</table>

EXHIBIT A4

USE OF PREEXISTING INTELLECTUAL PROPERTY & DATA

If either Party will be using any third-party or pre-existing intellectual property (including, but not limited to copyrighted works, known patents, trademarks, service marks and trade secrets) "IP" and/or Data with restrictions on use, then list all such IP and the nature of the restriction below. If no third-party or pre-existing IP/Data will be used, check "none" in this section.

A. State: Preexisting Intellectual Property (IP)/Data to be provided to the University from the State or a third party for use in the performance in the Scope of Work.

☒ None or ☐ List:

Owner (State Agency or 3rd Party)	Description	Nature of restriction:

B. University: Restrictions in Preexisting IP/Data included in Deliverables identified in Exhibit A1, Deliverables.

☒ None or ☐ List:

Owner (University or 3rd Party)	Description	Nature of restriction:

C. Anticipated restrictions on use of Project Data.
If the University PI anticipates that any of the Project Data generated during the performance of the Scope of Work will have a restriction on use (such as subject identifying information in a data set), then list all such anticipated restrictions below. If there are no restrictions anticipated in the Project Data, then check "none" in this section.

☒ None or ☐ List:

Owner (State Agency or 3rd Party)	Description	Nature of restriction:

EXHIBIT A5

RÉSUMÉ / BIOSKETCH

Attach 2-3 page Résumé/Biosketch for Key Personnel listed in Exhibit A2.

JORGE LUIZ MAZZA RODRIGUES

EDUCATION

University of São Paulo	Agronomical Engineering (*Summa cum laude*)	B.S.	1989
University of São Paulo	Microbiology/Biochemistry (*Summa cum laude*)	M.Sc.	1992
Michigan State University	Crop and Soil Sciences and Environ. Tox.	Ph.D.	2000
University of São Paulo	Soil Microbiology	Postdoctoral	2001-2002
Michigan State University	Microbial Genomics	Postdoctoral	2003-2007

ACADEMIC AWARDS AND HONORS

2022 University of California Davis Faculty Leadership Fellow
2021 *Soil Science Society of America Journal* Outstanding Associate Editor Award
2017 Faculty Fellowship Summer Institute – Israel
2010 International Professorship Award – American Society for Microbiology - Ecuador
1989 "*Luiz de Queiroz*" award (Highest College Award for an Agronomical Engineering Graduate)
"*Grande Oficial Mário Dedini*" award
"*Prof. Francisco Tito de Souza Reis*" award
"*Instituto de Engenharia*" award
"*ADEALQ*" award

RESEARCH AND PROFESSIONAL EXPERIENCE

2020/present – Professor (*with tenure*): Department of Land, Air and Water Resources, University of California - Davis.
2016/present – Joint Faculty Member - Environmental Genomics and Systems Biology Division, Lawrence Berkeley National Laboratory, Berkeley.
2014/2019 – Associate Professor (*with tenure*): Department of Land, Air and Water Resources, University of California - Davis.
2008/2013 – Assistant Professor: Department of Biology, University of Texas at Arlington.

RESEARCH ADVISORY AND MENTORING

Visiting Professors: 6
Research Associate Mentees: 8 (1 current)
Graduate Student Advisees: 15 (6 current)
Undergraduate Student Advisees: 43 (3 current)

SYNERGISTIC ACTIVITIES

1. National level services: NSF Panelist for both programs: (1) Ecosystems Science, (2) Organism-Environment Interactions, (3) EPSCoR Research Infrastructure Improvement. *Ad hoc* NSF Proposal Reviewer: (1) Population and Community Ecology, (2) Biodiversity Inventories, (3) Ecosystems Science, (4) Office of International Science and Engineering. US Department of Energy – Joint Genome Institute Panels (2014, 2016, and 2017). US Department of Agriculture (2020)

2. Reviewing services: Applied and Environmental Microbiology (***Editorial Board***), Frontiers in Systems Microbiology (***Associate Editor***), Soil Science Society of America Journal (***Associate Editor***), mSphere (***Associate Editor***).
3. Public outreach: Microbiology Summer Science Camp, U. Texas (Two weeks hands-on activity for high school from low-income families).
4. 2020 New Voices Story Telling Initiative – Children's Book "The Secret Lives of Scientists, Engineers and Doctors". Publisher: Mascot Books. National Academies of Science, Engineering and Medicine.
5. 2016 Environmental Defense Fund Science Day Speaker, New York, NY.

PUBLICATIONS (*past 4 years*)

1. Danielson RE, ***JLM Rodrigues***. 2022. Impacts of land use change on soil microbial communities in the Amazon. *Advances in Agronomy.* https://doi.org/10.1016/bs.agron.2022.04.001
2. Alves KJ, VS Pylro, CR Nakayama, VG Vital, RG Taketani, DG Santos, ***JLM Rodrigues***, SM Tsai, FD Andreote. 2022. Methanogenic communities and methane emissions from enriched Amazonia soil under land-use change. *Microbiological Research* https://doi.org/10.1016/j.micres.2022.127178
3. Wang D, JY Lin, JM Sayre, R Schmidt, SJ Fonte, ***JLM Rodrigues***, K Scow. 2022. Compost amendment and cover cropping maintains soil structure and associated C storage by increasing available C and microbial biomass in agricultural soil – a six year field study. *Geoderma* https://doi.org/10.1016/j.geoderma.2022.116117
4. Venturini AM, JB Gontijo, A Franca, J Moura, K Nusslein, B Bohannan, ***JLM Rodrigues***, SM Tsai. 2022. Metagenomes from Eastern Brazilian Amazonian floodplains in wet and dry seasons. *Microbiology Research Announcements* https://doi.org/10.1128/mra.00432-22
5. Goss-Souza D, SM Tsai, ***JLM Rodrigues***, O Klauberg-Filho, P Sousa, D Baretta, LW Mendes. 2022. Biogeographic responses and niche occupancy of microbial communities following long-term land-use change. *Antonie van Leeuvenhoek* https://doi.org/10.1007/s10482-022-01761-5
6. Souza L, DA Obregon, L Domeignoz-Horta, F Gomes, C Almeida, L Merloti, L Mendes, FD Andreote, B Bohannan, ***JLM Rodrigues***, K Nusslein, SM Tsai. 2022. Maintaining grass coverage increases methane uptake in Amazonian pasture soils. *Science of the Total Environment.* http://dx.doi.org/10.1016/j.scitotenv.2022.156225
7. Venturini AM, NMS Dias, JB Gontijo, CA Yoshiura, FS Paula, FM Nakamura, KM Meyer, AG Franca, CD Borges, J Barlow, E Beringer, KR Nusslein, ***JLM Rodrigues***, BJM Bohannan, SM Tsai. 2022. Increased soil moisture exacerbates the impacts of forest-to-pasture conversion on methane emissions and methane-cycling communities in the Eastern Amazon. *Environmental Research.* https://doi.org/10.1016/j.envres.2022.113139
8. Ghotbi M, A Durrer, K Frindte, WR Horwath, ***JLM Rodrigues***, I Danso, C Knief. 2022. Topographic attributes override impacts of agronomic practices on prokaryotic community structure. *Appl. Soil Ecol.* https://doi.org/10.1016/j.apsoil.2022.104446
9. Lazicki P, ***JLM Rodrigues***, D Geisseler. 2022. Acid stress and compost differentially affect microbial carbon and nitrogen cycling functions in an agricultural soil. *Appl. Soil Ecol.* **169:** https://doi.org/10.1016/j.apsoil.2021.104219
10. Hodson AK, JM Sayre, MCCP Lyra, ***JLM Rodrigues***. 2021. Influence of recycle compost on soil food webs, nutrient cycling, and tree growth in a young almond orchard. *Agronomy* https://doi.org/10.3390/agronomy11091745
11. Yoshiura CA, LPP Braga, AM Venturini, AG da Franca, MCCP de Lyra, SM Tsai, ***JLM Rodrigues***. 2021. Influence of inputs combination on the microbial structure of the maize rhizosphere for greenhouse gas fluxes mitigation. *Frontiers in Plant Science.* doi:10.3389/fpls.2021.683658
12. Durrer A, AJ Margenot, LCR Silva, BJM Bohannan, K Nusslein, FD Andreoti, J van Haren, SJ Parikh,

and ***JLM Rodrigues***. 2021. Beyond total carbon costs: Land use change alters soil carbon cycling in the Amazon. *Biogeochemistry* https://doi.org/10.1007/s10533-020-00743-x

13. Lazicki P, ***JLM Rodrigues***, D Geisseler. 2021. Sensitivity and variability of soil health indicators in a Mediterranean crop system. *Soil Science Society of America J* doi: 10.1002/saj2.20278
14. Gontijo J, A Venturini, C Yoshiura, C Borges, JM Moura, B Bohannan, K Nusslein, ***JLM Rodrigues***, FS Paula, SM Tsai. 2021. Seasonal dynamics of methane cycling microbial communities in Amazonian floodplain sediments. *Mol. Ecol.* https://doi.org/10.1111/mec.15912
15. Jesus HE, A Enrich-Prast, SSM Paiva, RS Peixoto, RS Carreira, C Massone, ***JLM Rodrigues***, CK Lee, C Craig, AS Rosado. 2021. Microbial succession under freeze-thaw cycle events for hydrocarbon degradation in a nutrient-amended Antarctic soil. *Microorganisms* https://doi.org/10.3390/microorganisms9030609
16. Wang L, H Chen, J Wu, L Huang, PC Brookes, ***JLM Rodrigues***, J Xu, X Liu. 2021. Effects of magnetic biochar-microbe composite of Cd remediation and microbial responses in paddy soil. *J. Hazardous Materials* https://doi.org/10.1016/j.jhazmat.2021.125494
17. Zhang L, B Ma, C Tang, H Yu, X Lv, ***JLM Rodrigues***, RA Dahlgren, J Xu. 2021. Habitat heterogeneity induced by pyrogenic organic matter in wildfire-perturbed soils mediates bacterial community assembly processes. *ISME J.* https://www.nature.com/articles/s41396-021-00896-z
18. He Liyuan, DA Lipson, ***JLM Rodrigues***, M Mayes, RG Bjork, B Glaser, J Rinklebe, X Xu. 2021. Simulating fungal and bacterial biomass dynamics in natural ecosystems: site-level applications of the CLM-Microbe model. *J Adv. Model. Earth Syst.* https://doi.org/10.1029/2020MS002283
19. Nayfach S, S Roux, R Seshadri, D Udwary, N Varghese, F Schulz, D Wu, D Paez-Espino, IMG/M Data Consortium (***JLM Rodrigues***). 2020. A genomic catalogue of Earth's microbiome. *Nature Biotechnology.* https://doi.org/10.1038/s41587-020-0718-6
20. Kroeger ME, L Meredith, KM Meyer, K Webster, J van Haren, S Saleska, BJM Bohannan, ***JLM Rodrigues***, K Nusslein. 2020. Rainforest-to-pasture conversion activates soil methanogenesis across the Brazilian Amazon. *ISME J.* https://doi.org/10.1038/s41396-020-00804-x
21. Allard S, M Costa, A Bulseco, V Helfer, L Wilkins, C Hassenruck, K Zengler, M Zimmer, N Eraso, ***JLM Rodrigues***, N Duke, V Melo, I Vanworterghem, H Junka, H Makonde, D Jimeniz, T Tavares, M Fusi, D Daffonchio, C Duarte, R Peixoto, A Rosado, J Gilbert, J Bowman. 2020. Introducing the Mangrove Microbiome Initiative: Setting research priorities for mangrove preservation and rehabilitation. *mSystems* https://doi.org/10.1128/mSystems.00658-20
22. Meyer KM, AH Morris, K Webster, A Klein, M Kroeger, L Meredith, A Braendholt, FM Nakamura, AM Venturini, LF de Souza, KL Shek, R Danielson, J van Haren, PB de Camargo, SM Tsai, F Dini-Andreote, J Souza de Moura, K Nusslein, S Saleska, ***JLM Rodrigues***, BJM Bohannan. 2020. Belowground changes to community structure alter methane-cycling dynamics in Amazonia. *Environment International* https://doi.org/10.1016/j.envint.2020.106131
23. He L, ***JLM Rodrigues***, NA Soudzilovskaia, M Barcelo, PA Olsson, C Song, L Tedersoo, F Yuan, D Lipson, X Xu. 2020. Global biogeography of fungal and bacterial biomass carbon in topsoil. *Soil Biol. Biochem*. https://doi.org/10.1016/j.soilbio.2020.108024
24. Lin JY and ***JLM Rodrigues***. 2020. Genus *Geminisphaera*. *In:* Oren A. Bergey's Manual of Systematics of Archaea and Bacteria. John Wiley & Sons, Inc. New Jersey
25. Mirza BS, DJ McGlinn, BJM Bohannan, K Nusslein, JM Tiedje, ***JLM Rodrigues***. 2020. Diazotrophs show sign of restoration in Amazon rainforest soils with ecosystem rehabilitation. *Appl. Environ. Microbiol.* 10:e000195-20. https://doi.org/10.1128/AEM.00195-20
26. Schmidt JE, ***JLM Rodrigues***, VL Brisson, A Kent, ACM Gaudin. 2020. Impacts of maize evolution on rhizobiome assembly in contrasting agricultural soils. *Soil. Biol. Biochem.* https://doi.org/10.1016/j.soilbio.2020.107794

27. Hoda R, M Sattler, MDS Houssain, ***JLM Rodrigues***. 2020. Boosting landfill gas production from lignin-containing wastes via termite hindgut microorganism. *Waste Management* https://www.sciencedirect.com/science/article/pii/S0956053X20300659
28. Parsons LS, JM Sayre, C Ender, ***JLM Rodrigues***, A Barberan. 2020. Plant-soil microbial feedbacks in restored and unrestored coastal dune ecosystems in California. *Restoration Ecol.* **28:**S311-S321. https://onlinelibrary.wiley.com/doi/full/10.1111/rec.13101
29. Kotak M, JY Lin, J Isanapong, ***JLM Rodrigues*****.** 2020. Draft genome sequences of two *Opitutaceae* bacteria strains TAV3 and TAV4 isolated from a wood feeding termite and bioinformatics characterization of their lignocellulolytic enzymes. *Microbiol. Res. Announ.* https://mra.asm.org/content/9/2/e01192-19
30. Goss-Souza D, LW Mendes, ***JLM Rodrigues***, SM Tsai. 2019. Ecological processes shaping bulk and rhizosphere microbiome assembly in a long-term Amazon forest-to-agriculture conversion. *Microb. Ecol.* https://doi.org/10.1007/s00248-019-01401-y
31. Sjöling S, van Elsas JD, Andreote FD, ***JLM Rodrigues***. 2019. **Soil metagenomics: deciphering the soil microbial gene pool.** Book Chapter *In:* van Elsas, Trevors, Rosado, and Nanniplerl. Modern Soil Microbiology, 3rd Edition, CRC Press.
32. Goss-Souza D, LW Mendes, ***JLM Rodrigues***, SM Tsai. 2019. Amazon forest-to-agriculture conversion alters rhizosphere microbiome composition while functions are kept constant. *FEMS Microbiol. Ecol*. *https://doi.org/10.1093/femsec/fiz009*
33. Khan Md AW, BJM Bohannan, K Nusslein, JM Tiedje, SG Tringe, E Parlade, A Barberan, and ***JLM Rodrigues***. 2018. Network analysis reveals substantial alteration of microbial co-occurrence patterns due to deforestation in the Amazon rainforest. *FEMS Microbiol. Ecol.* *https://academic.oup.com/femsec/article/95/2/fiy230/5211045*
34. Ren H, Q Zhou, J He, Y Hou, ***JLM Rodrigues***, AB Cobb, GWT Wilson, Y Zhang. 2019. Determining landscape-level drivers of variability for over 50 elements. *Sci. Total. Enviro*n. **657:**279-286.
35. Bresciani L, LN Lemos, N Wale, J Lin, A Strauss, M Duffy, and ***JLM Rodrigues***. 2018. Draft genome sequence of the *Candidatus* Spirobacillus cienkowskii, a pathogen of freshwater *Daphnia* species, reconstructed from hemolymph metagenomic reads. *Microbiol. Res. Announ.* **22:**e01175-18.
36. Dai Z, A Enders, ***JLM Rodrigues***, KL Hanley, PC Brookes, J Xu, and J Lehmann. 2018. Fungal taxonomic and functional community composition affected by pyrogenic organic matter in soil ecosystems. *Soil Biol. Biochem.* **126:**159-167.
37. Potisap C, AW Khan, A Boonmee, ***JLM Rodrigues***, S Wongratanacheewin, RW Sermswan. 2018. *Burkholderia pseudomallei*-absent soil bacterial community results in secondary metabolites that kill this pathogen. *Appl. Microbiol. Biotechnol. Express* **8:**136 doi: *10.1186/s13568-018-0663-7* (*Featured Article selected by the Editor*)
38. Kroeger M, T Delmont, AM Eren, J Guo, KM Meyer, K Khan, ***JLM Rodrigues***, BJM Bohannan, JM Tiedje, TM Tsai, CD Borges, K Nusslein. 2018. New biological insights into how deforestation in Amazonia affects soil microbial communities using metagenomics and metagenome-assembled genomes. *Frontiers in Microbiol.* doi: 10.3389/fmecb.2018.01635
39. Larson CA, B Mirza, ***JLM Rodrigues***, SI Passy. 2018. Iron limitation effects on nitrogen-fixing organisms with implications for cyanobacterial harmful algal blooms. *FEMS Microbiol. Ecol.* doi: 10.1093/femsec/fiy046
40. Ren H, W Gui, Y Bai, C Stein, ***JLM Rodrigues***, GWT Wilson, AB Cobb, Y Zhang, G Yang. 2018. Long-term effects of grazing and topography on arbuscular mycorrhizal fungi in semi-arid grasslands. *Mycorrhiza* **28:**117-127.

WILLIAM RICHARD HORWATH

Chair and Distinguished Professor of Soil Biogeochemistry
J. G. Boswell Endowed Chair in Soil Science
Department of Land, Air and Water Resources
3226 Plant & Environmental Science Building
One Shields Ave.
Davis, California 95616-8626
Telephone: (530) 752-2199 Office
FAX: (530) 752-1552 FAX
E-mail:wrhorwath@ucdavis.edu

Education

1993 Ph.D. Soil Science, College of Agriculture, Department of Crop and Soil Sciences, Michigan State Univ., E. Lansing, MI.
1993 Ph.D. Forest Ecology, College of Agriculture, Department of Forestry, Michigan State Univ., E. Lansing, MI.
1979 B.S. Forestry Environmental Impact Assessment, College of Agriculture, Department of Forestry, Southern Illinois University, Carbondale, IL.

Positions Held:

- Editor, Soil Science Society of America Journal, 2019-present
- Chair, Department of Land, Air and Water Resources, UC Davis, 2018-present
- Editor Developments in Soil Science, Elsevier 2016- present
- Board of Directors, Soil Science Society of America, 2016 to present
- Vice Chairman, Soils and Biogeochemistry Program, 2016 to 2018
- Editor, Elsevier Development in Soil Science Series, 2015 to present
- Technical Editor, Soil Science Society of America Journal 2014 to 2019
- Master Faculty Advisor, Sustainable Agriculture and Food Systems major 2014 to present
- Faculty track advisor Sustainable Agriculture and Food Systems major 2011 to present
- Chairman of the Board, Protected Harvest, 2012 to 2019
- Chairman Agriculture and Environmental Chemistry Graduate Group 7/10 to 2016
- J. G. Boswell Endowed Chair in Soil Science, 2008 to present
- Associate Editor, Soil Science Society of America Journal 2006 to 2012 to present
- Vice Chairman Dept. Land, Air and Water Resources, 2007 to2010
- Associate Editor, Environmental Soil Science Journal 2006 to 2009
- Professor of Soil Biogeochemistry, University of California, Davis, CA. 7/04 to present
- Assoc. Professor of Soil Biogeochemistry, University of California, Davis, CA.7/00 to 6/04
- Assist. Professor of Soil Biogeochemistry, University of California, Davis, CA.7/96 to 6/00
- Research Soil Microbiologist, USDA ARS, Corvallis, OR.10/94 to 5/96
- Faculty Research Associate, Oregon State University, Corvallis, OR. 11/92 to 9/94
- Graduate Research Assistant, Michigan State University, E. Lansing, MI. 9/88 to 10/92
- Research Specialist, Michigan State University. 11/85 to 9/88
- Staff Research Associate, University of California at Berkeley, CA 4/83 to 10/85
- Forestry Apprentice, German Academic Exchange Service, Munich, Germany. 6/79 to 6/80

Awards and Distinctions

- Patrick Henry Memorial Lectureship, Soil Science Society of America, 2019
- Distinguished Visiting Scholar, Chinese Academy of Science, 2016 to present

- Professor Pran Kumar De Memorial Lecturer and Award, Indian Soil Science Society, 2013
- Soil Science Society of America, Fellow, 2009
- J. G. Boswell Endowed Chair in Soil Science, 2008
- NSM/MARC Scholar 2002 California State University
- Outstanding Conduct and Merit 1996, USDA Agricultural Research Service
- Outstanding Conduct and Merit 1995, USDA Agricultural Research Service

Publications (out of 277)

1. Mitra Ghotbi, Ademir Durrer, Katharina Frindte, William R. Horwath, Jorge L. Mazza Rodrigues, IsaacDansoe, Claudia Knief. 2022. Topographic attributes override impacts of agronomic practices on prokaryotic community structure. Applied Soil Ecol. 175: 104446.
2. Rongzhong Ye, William R Horwath. 2022. Greenhouse gas emissions in wetland rice systems. In: Multi-Scale Biogeochemical Processes in Soil Ecosystems: Critical Reactions and Resilience to Climate Changes. Eds., Yu Yang, Marco Keiluweit, Nicola Senesi, Baoshan Xing. John Wiley and Sons. Pp. 141-155.
3. Ellison, RJ and WR Horwath. 2021. Reducing greenhouse gas emissions and stabilizing nutrients from dairy manure using chemical coagulation. Journal of Environmental Quality 50 (2), 375-383
4. Ding, X, B Zhang, Q Chen, H He, WR Horwath, X Zhang. 2021. Grassland conversion to cropland decreased microbial assimilation of mineral N into their residues in a Chernozem soil. Biology and Fertility of Soils 57, 913-924
5. Cynthia M Crézé, William R Horwath. 2021. Cover Cropping: A Malleable Solution for Sustainable Agriculture? Meta-Analysis of Ecosystem Service Frameworks in Perennial Systems. Agronomy 11: 862 https://doi.org/10.3390/agronomy11050862
6. Hannah Waterhouse, Bhavna Arora, Nicolas F Spycher, Peter S Nico, Craig Ulrich, Helen E Dahlke, William R Horwath. 2021. Influence of Agricultural Managed Aquifer Recharge (AgMAR) and Stratigraphic Heterogeneities on Nitrate Reduction in the Deep Subsurface. Water Resources Research https://doi.org/10.1029/2020WR029148
7. Mengyang You, Xia Zhu-Barker, Timothy A Doane, William R Horwath. 2021. Decomposition of Carbon Adsorbed on Iron (III)-Treated Clays and Their Effect on the Stability of Soil Organic Carbon and External Carbon Inputs. Biogeochemistry https://doi.org/10.21203/rs.3.rs-300654/v1
8. Ruoya Ma, Jianwen Zou, Zhaoqiang Han, Kai Yu, Shuang Wu, Zhaofu Li, Shuwei Liu, Shuli Niu, William R Horwath, Xia Zhu-Barker. 2021. Global soil-derived ammonia emissions from agricultural nitrogen fertilizer application: A refinement based on regional and crop-specific emission factors. Global Change Biology 27: 855-867.
9. Mengyang You, Lu-Jun Li, Qing Tian, Peng He, Guiping He, Xiang-Xiang Hao, William R Horwath. 2020. Residue decomposition and priming of soil organic carbon following different NPK fertilizer histories. Soil Sci. Soc. AM. J. https://doi.org/10.1002/saj2.20142
10. Hannah Waterhouse, Sandra Bachand, Daniel Mountjoy, Joseph Choperena, P Bachand, H Dahlke, W Horwath. 2020. Agricultural managed aquifer recharge—water quality factors to consider. California Agriculture 74: 144-154.
11. Zheng, Yajing, Yaguo Jin, Ruoya Ma, Delei Kong, Xia Zhu-Barker, William R Horwath, Shuli Niu, Hong Wang, Xin Xiao, Shuwei Liu, Jianwen Zou. Drought shrinks terrestrial upland resilience to climate change. Global Ecology and Biogeography 29: 1840-1851.
12. Ding, X, S Chen, B Zhang, H He, TR Filley, WR Horwath. 2020. Warming yields distinct accumulation patterns of microbial residues in dry and wet alpine grasslands on the Qinghai-Tibetan Plateau

- Biology and Fertility of Soils. https://doi.org/10.1007/s00374-020-01474-9

13. Correa-Díaz, A, A Gómez-Guerrero, JJ Vargas-Hernández, P Rozenberg, WR Horwath. 2020. Long-Term Wood Micro-Density Variation in Alpine Forests at Central México and Their Spatial Links with Remotely Sensed Information. Forests 11:452
14. McDaniel, MD, DT Walters, LG Bundy, X Li, RA Drijber, John E Sawyer, Michael J Castellano, CAM Laboski, PC Scharf, WR Horwath. 2020. Combination of biological and chemical soil tests best predict maize nitrogen response. Agronomy Journal. https://doi.org/10.1002/agj2.20129.
15. Correa-Díaz, A., LCR Silva, WR Horwath, A Gómez-Guerrero, J Vargas-Hernández, J Villanueva-Díaz, J Suárez-Espinoza, A Velázquez-Martínez. 2020. From trees to ecosystems: Spatiotemporal scaling of climatic impacts on montane landscapes using dendrochronological, isotopic and remotely-sensed data. Global Biogeochemical Cycles. e2019GB006325
16. You, M., X. Han X., Chen J., Yan N., Li W., Zou X., Lu Y. Li and W. R. Horwath. 2019. Effect of reduction of aggregate size on the priming effect in a Mollisol under different soil managements. European Journal of Soil Science. https://doi.org/10.1111/ejss.12818.
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20. Xu, Chen, Xiao-zeng Han, Meng-yang You, YAN Jun, Xin-chun Lu, William R Horwath, Wen-xiu Zou. 2019. Soil macroaggregates and organic-matter content regulate microbial communities and enzymatic activity in a Chinese Mollisol. 18:2605-2618.
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35. Liang, YL, TEC Kraus, LCR Silva, PAM Bachand, SM Bachand, TA Doane, WR Horwath. 2019. Effects of ferric sulfate and polyaluminum chloride coagulation enhanced treatment wetlands on Typha growth, soil and water chemistry. Science of the total environment 648, 116-124.
36. Williams, SR, X Zhu-Barker, S Lew, BJ Croze, KR Fallan, WR Horwath. 2019. Impact of Composting Food Waste with Green Waste on Greenhouse Gas Emissions from Compost Windrows. Compost Science & Utilization, 1-11.
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39. Kuzyakov, Y, WR Horwath, M Dorodnikov, E Blagodatskaya. 2018. Review and synthesis of the effects of elevated atmospheric CO2 on soil processes: No changes in pools, but increased fluxes and accelerated cycles. Soil Biology and Biochemistry https://doi.org/10.1016/j.soilbio.2018.10.005.
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41. Maxwell, TM, LCR Silva, WR Horwath. 2018. Predictable Oxygen Isotope Exchange Between Plant Lipids and Environmental Water: Implications for Ecosystem Water Balance Reconstruction. Journal of Geophysical Research: Biogeosciences 123 (9), 2941-2954.
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44. Deng, J, C Li, M Burger, WR Horwath, D Smart, J Six, L Guo, W Salas, ...2018. Assessing Short-Term Impacts of Management Practices on N2O Emissions From Diverse Mediterranean Agricultural

Ecosystems Using a Biogeochemical Model. Journal of Geophysical Research: Biogeosciences 123 (5), 1557-1571.
45. Maxwell, TM, LCR Silva, WR Horwath. 2018. Integrating effects of species composition and soil properties to predict shifts in montane forest carbon–water relations. Proceedings of the National Academy of Sciences 115 (18), E4219-E4226.
46. Hansen, AM, TEC Kraus, SM Bachand, WR Horwath, PAM Bachand. 2018. Wetlands receiving water treated with coagulants improve water quality by removing dissolved organic carbon and disinfection byproduct precursors. Science of the Total Environment 622, 603-613.
47. Li, LJ, X Zhu-Barker, R Ye, TA Doane, WR Horwath. 2018. Soil microbial biomass size and soil carbon influence the priming effect from carbon inputs depending on nitrogen availability. Soil Biology and Biochemistry 119, 41-49.
48. Wade, J, H Waterhouse, LM Roche, WR Horwath. 2108. Structural equation modeling reveals iron (hydr) oxides as a strong mediator of N mineralization in California agricultural soils. Geoderma 315, 120-129.
49. Wolf, KM, EE Torbert, D Bryant, M Burger, RF Denison, I Herrera, WR Horwath...2018. The century experiment: the first twenty years of UC Davis' Mediterranean agroecological experiment. Ecology 99 (2), 503-503.
50. Stumpner, EB, TEC Kraus, YL Liang, SM Bachand, WR Horwath, ...2018. Sediment accretion and carbon storage in constructed wetlands receiving water treated with metal-based coagulants. Ecological Engineering 111, 176-185.
51. Kuzyakov, Y, WR Horwath, M Dorodnikov, E Blagodatskaya. 2018. Effects of Elevated CO2 in the Atmosphere on Soil C and N Turnover. Developments in Soil Science 35, 207-219.
52. Horwath, WR, Y Kuzyakov. 2018. The Potential for Soils to Mitigate Climate Change Through Carbon Sequestration. Developments in Soil Science 35, 61-92.
53. Correa-Diaz, Arian, Armando Gomez-Guerrero, Jose Villanueva-Diaz, Lucas CR Silva, William R Horwath, Luis U Castruita-Esparza, Tomas Martinez-Trinidad, Javier Suarez-Espinosa. 2018. Physiological Response of *Taxodium mucronatum Ten.* to the Increases of Atmospheric CO2 and Temperature in the Last Century. Agroncencia. 52:129-149.
54. Lu-Jun Li, Xia Zhu-Barker, Rongzhong Ye, Timothy A. Doane, William R. Horwath. 2018. Soil microbial biomass size and soil carbon influence the priming effect from carbon inputs depending on nitrogen availability. Soil Biology and Biochemistry, 119: 41-49.
55. Wolf, Kristina M., Emma E. Torbert, Dennis Bryant, Martin Burger, R. Ford Denison, Israel Herrera, Jan Hopmans, Will Horwath, Stephen Kaffka, Angela Y. Y. Kong, R. F. Norris, Johan Six, Thomas P. Tomich, Kate M. Scow. 2018. The century experiment: the first twenty years of UC Davis' Mediterranean agroecological experiment. Ecology. 99:503-503.
56. Hansen, Angela M, Tamara EC Kraus, Sandra M Bachand, William R Horwath, Philip AM Bachand. 2108. Wetlands receiving water treated with coagulants improve water quality by removing dissolved organic carbon and disinfection byproduct precursors. Science of The Total Environment, 622: 603-613.
57. Wade, Jordon, Hannah Waterhouse, Leslie M Roche, William R Horwath. 2018. Structural equation modeling reveals iron (hydr) oxides as a strong mediator of N mineralization in California agricultural soils. Geoderma, 315: 120-129.

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Education and Training

College/University	*Major*	*Degree, Year*
Cornell University, Biological and Environmental Engineering	Environmental Engineering	PhD 2011
Friedrich-Schiller University of Jena, Germany	Physical Geography	MSc 2004

Research and Professional Experience

Associate Professor in Integrated Hydrologic Sciences — 04/ 2017 – present
Land, Air and Water Resources, University of California, Davis

Assistant Professor in Integrated Hydrologic Sciences — 04/ 2013 – 03/207
Land, Air and Water Resources, University of California, Davis

Postdoctoral Research Associate, Stockholm University, Sweden — 10/2010 – 04/2013

Leadership positions

- Leader of the Strategic Initiative for Water Quantity, Quality, and Security for the Agricultural and Natural Resources Division of the University of California
- Vice-Chair, Department of Land, Air and Water Resources, UC Davis

Synergistic Activities

Panelist for the following research programs: National Science Foundation Graduate Research Fellowship Program (GRFP); National Science Foundation - Hydrologic Sciences Program; USDA NIFA Inter-Disciplinary Engagement in Animal Systems (IDEAS); Water for Agriculture

Technical Advisor: Association of California Water Agency (ACWA) on AB 1427; Association of California Water Agency (ACWA) Groundwater Recharge Workgroup; Sacramento Area Council of Governments (SACOG) to develop a Sustainable Water Management Strategy for Specialty Crop Expansion; State Water Resources Control Board's Division of Water Rights (Division) for the development of a Groundwater Storage and Aquifer Recharge Streamlined Water Rights Permitting; Flood-MAR Research and Data Development (R&DD) Advisory Committee, Water Quality Subcommittee, Cropping System Suitability Subcommittee; Incentives for Groundwater, Wheeler Water Institute, Center for Law, Energy & the Environment at the UC Berkeley School of Law

Associate Editor

Vadose Zone Journal (2017-present), Academic Editor for PLoS ONE (2015-2016)

Honors and Awards

UC Davis Graduate Program Advising and Mentoring Award (2022)
Vadose Zone Journal Outstanding Associate Editor award (2021)
LEAD21 Program Fellow (2020-2021)
USDA ThinkWater Fellow (2017)

Scientific and Public Outreach

- Congressional science briefing titled 'Water security in the West: A science briefing on water for people and nature' in Washington D.C to inform members of congress, DOI, USDA, Office of Management and

Budget, Congressional Research Service, U.S. Global Change Research Program on water, climate change and agricultural groundwater banking in California (25-26 Oct. 2016)
- I have given over 100 presentations on agricultural managed aquifer recharge in the past 5 years

Publications last 4 years

1. Levintal, E., Huang, L., Garcia C.P., Coyotl, A., Fidelibus, M.W., Horwath, W.R., Rodrigues, J.L.M. and **H.E. Dahlke**. 2023. Nitrogen fate during agricultural managed aquifer recharge: Linking plant response, hydrologic, and geochemical processes. Science of the Total Environment. http://dx.doi.org/10.1016/j.scitotenv.2022.161206
2. Ma, X., **Dahlke, H.E.**, Duncan, R., Doll, D., Martinez, P., Lampinen, B., and A. Volder. 2022. Winter flooding recharges groundwater in almond orchards with limited effects on tree root dynamics, growth and yield. California Agriculture, 76(2): 7.
3. Levintal, E., Kniffin, M.L., Ganot, Y., Marwaha, N., Murphy, N.P., and **H.E. Dahlke**. Agricultural managed aquifer recharge (Ag-MAR)—a method for sustainable groundwater management: A review. Critical Reviews in Environmental Science and Technology, 1-24.
4. Levintal, E., Ganot, Y., Taylor, G., Freer-Smith, P., Suvocarev, K., and **H.E. Dahlke.** 2022. An underground, wireless, open-source, low-cost system for monitoring oxygen, temperature, and soil moisture. Soil, 8(1): 85-97.
5. Devine, S.M., **Dahlke, H.E.**, and A.T. O'Geen. 2022. Mapping time-to-trafficability for California agricultural soils after dormant season deep wetting. Soil and Tillage Research, 218: 105316
6. Dymond, S.F., Richardson, P.W., Webb, L.A., Keppeler, E.T., Arismendi, I., Bladon, K.D., Cafferata, P.H., **Dahlke, H.E.**, Longstreth, D.L., Brand, P., Ode, P.R. Surfleet, C.G., and J.W. Wagenbrenner. 2021. A field-based experiment on the influence of stand density reduction on watershed processes at the Caspar Creek Experimental Watersheds in Northern California. Frontiers in Forests and Global Change, 4: 99.
7. Levintal, E.,Suvocarev, K., Taylor, G., and **H.E. Dahlke**. 2021. Embrace open-source sensors for local climate studies. Nature, 599(7883): 32.
8. Murphy, N.P., H. Waterhouse, and **H.E. Dahlke**. Influence of Agricultural Managed Aquifer Recharge on nitrate transport – the role of soil type and flooding frequency. Vadose Zone Journal, https://doi.org/10.1002/vzj2.20150.
9. Ganot, Y. and **H.E. Dahlke**. A model for estimating Ag-MAR flooding duration based on crop tolerance, root depth, and soil texture data. Agricultural Water Management, https://doi.org/10.1016/j.agwat.2021.107031.
10. Grinshpan, M., Furman, A., **Dahlke, H.E.**, Raveh, E., and Weisbrod, N. 2021. From Managed Aquifer Recharge to Soil Aquifer Treatment on Agricultural Soils: Concepts and Challenges. Agricultural Water Management https://doi.org/10.1016/j.agwat.2021.106991.
11. Ganot, Y. and **Dahlke, H.E.**, 2021. Natural and forced soil aeration during agricultural managed aquifer recharge. Vadose Zone Journal, p.e20128, https://doi.org/10.1002/vzj2.20128.
12. Waterhouse, H., Arora, B., Spycher, N.F., Nico, P.S., Ulrich, C., **Dahlke, H.E.** and Horwath, W.R., 2021. Influence of Agricultural Managed Aquifer Recharge (AgMAR) and Stratigraphic Heterogeneities on Nitrate Reduction in the Deep Subsurface. Water Resources Research, p.e2020WR029148, https://doi.org/10.1029/2020WR029148.
13. Marwaha, N., Kourakos, G., Levintal, E., and **Dahlke, H.E.** 2021. Identifying agricultural managed aquifer recharge locations to benefit drinking water supply in rural communities. Water Resources Research, https://doi.org/10.1029/2020WR028811.
14. Liu, Z. Yin, J., **H.E. Dahlke**. 2020. Enhancing Soil and Water Assessment Tool Snow Prediction Reliability with Remote-Sensing-Based Snow Water Equivalent Reconstruction Product for Upland Watersheds in a Multi-Objective Calibration Process. Water, 12(11), p.3190, https://doi.org/10.3390/w12113190.

15. Liu, Z., Herman, J.D., Huang, G., Kadir, T. and **Dahlke, H.E.**, 2021. Identifying climate change impacts on surface water supply in the southern Central Valley, California. Science of The Total Environment, p.143429, https://doi.org/10.1016/j.scitotenv.2020.143429.
16. Waterhouse, H., Bachand, S., Bachand, P.A.M., Mountjoy, D., Choperena, J., **Dahlke, H.E.**, Horwath, W.R. 2020. Agricultural managed aquifer recharge — water quality factors to consider. California Agriculture 74(3):144-154. https://doi.org/10.3733/ca.2020a0020.
17. Pauloo, R., Escriva-Bou, A., **Dahlke, H.**, Fencl, A., Guillon, H. and Fogg, G., 2020. Domestic well vulnerability to drought duration and unsustainable groundwater management in California's Central Valley. Environmental Research Letters. https://doi.org/10.1088/1748-9326/ab6f10.
18. Wang, C., Wang, R., Huo, Z., Xie, E., **Dahlke, H.E.** 2020. Colloid transport through soil and other porous media under transient flow conditions - a review. WIREs Water, https://doi.org/10.1002/wat2.1439.
19. Waterhouse, H., Bachand, S., Bachand, P.A.M., Mountjoy, D., Choperena, J., **Dahlke, H.E.**, Horwath, W.R. 2020. Considerations for Agricultural Managed Aquifer Recharge on Nitrate and Salt Movement Below the Root Zone in the Kings Groundwater Basin. California Agriculture, https://doi.org/10.3733/ca.2020a0020.
20. Devine, S.D, O'Geen, A.T., Liu, H., Jin, Y., **Dahlke, H.E.**, and R.A. Dahlgren. 2020. Terrain attributes and forage productivity predict catchment-scale soil organic carbon stocks. Geoderma, https://doi.org/10.1016/j.geoderma.2020.114286.
21. Kourakos, G., **Dahlke, H.E.**, Harter, T. 2019. Increasing Groundwater Availability and Baseflow through Agricultural Managed Aquifer Recharge in an Irrigated Basin. Water Resources Research, https://doi.org/10.1029/2018WR024019.
22. Devine, S.D, O'Geen, A.T., Larsen, R.E., **Dahlke, H.E**., Liu, H., Jin, Y., and R.A. Dahlgren. 2019. Microclimate-forage growth linkages across two strongly contrasting precipitation years in a Mediterranean catchment. Ecohydrology, https://doi.org/10.1002/eco.2156.
23. Markovich, K.H., **Dahlke, H.E.**, ArumíJ.L., Maxwell, R.M., Fogg, G.E. 2019. Bayesian hydrograph separation in a minimally gauged alpine volcanic watershed in central Chile. Journal of Hydrology. https://doi.org/10.1016/j.jhydrol.2019.06.014.
24. Ghasemizade, M., Asante, K., Peterson, C., Kocis, T.N., **Dahlke, H.E.**, Harter, T. 2019. An integrated approach toward groundwater banking in the southern Central Valley, California. Water Resources Research, https://doi.org/10.1029/2018WR024069.
25. Wang, C., McNew, C.P., Lyon, S.W., Walter, M.T., Volkmann, T.H.M., Abramson, N., Meira, A., Sengupta, A., Wang, Y., Pangle, L., Troch, P.A., Kim, M. Harman, C., and **Dahlke, H.E.** 2018. Particle tracer transport in a sloping soil lysimeter under periodic, steady state conditions. Journal of Hydrology 569(2): 61-76, doi:10.1016/j.jhydrol.2018.11.050.
26. Brunetti, G., Šimůnek, J., Bogena, H., Baatz, R., Huisman, J.A., **Dahlke, H.E.**, Vereecken, H. 2018. On the information content of cosmic-ray neutron data in the inverse estimation of soil hydraulic properties. Vadose Zone Journal 18(1), doi:10.2136/vzj2018.06.0123.
27. **Dahlke, H.E.**, LaHue, G.T., Mautner, M.R.L., Murphy, N.P., Patterson, N.K., Waterhouse, H., Yang, F. and Foglia, L. 2018. Managed Aquifer Recharge as a tool to enhance sustainable groundwater management in California: examples from field and modeling studies. In Friesen, J., Sinobas, L.R. (eds.), *Advances in Chemical Pollution, Environmental Management and Protection: Advanced Tools for Integrated Water Resources Management Volume 3*', Elsevier Publishing, 66 pp. https://doi.org/10.1016/bs.apmp.2018.07.003.
28. **Dahlke, H.E.** and Kocis, T.N. 2018. Streamflow availability rating identifies high-magnitude flows for groundwater recharge in the Central Valley. California Agriculture Journal, 72(3):162-169. https://doi.org/10.3733/ca.2018a0032.
29. Lane, B.A., Sandoval-Solis, S., Stein, E., Yarnell, S., Pasternack, G.B., and **Dahlke, H.E.** 2018. Beyond Metrics? The role of hydrologic baseline archetypes in environmental water management. Environmental Management, 62(4): 678–693.

30. McNew, C.P., Wang, C., Walter, M.T., **H.E. Dahlke**. 2018. Fabrication, Detection, and Analysis of DNA-labeled PLGA Particles for Environmental Transport Studies. Journal of Colloid and Interface Science, https://doi.org/10.1016/j.jcis.2018.04.059.
31. Wang, C., Parlange, J.-Y., Schneider, R.L., **Dahlke, H.E.**, M.T. Walter. 2018. Explaining and modeling the concentration and loading of Escherichia coli in a stream—A case study. Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2018.04.036.
32. **Dahlke, H.E.**, Brown, A.G., Orloff, S., Putnam, S., A. O'Geen. 2018. Managed winter flooding of alfalfa recharges groundwater with minimal crop damage. California Agriculture, 72(1).

XIA ZHU-BARKER

Assistant Professor of Soil Biogeochemistry

Dept. of Soil Science, University of Wisconsin-Madison, Madison, WI. zhubarker@wisc.edu

(a) Professional Preparation

College/University	*Major*	*Degree, Year*
Northeast Agricultural University	Agricultural Resources and Environment	B.S. 2006
Chinese Academy of Sciences	Ecology	M.Sc. 2009
Chinese Academy of Sciences	Soil Biogeochemistry & Nutrient Cycling	Ph.D. 2013
University of California-Davis	Nitrogen Cycling and Greenhouse Gas	Postdoc 2013-2015

(b) Employment

2022-	Assistant Professor. Department of Soil Science, University of Wisconsin-Madison, Madison, WI
2019- 2022	Professional Researcher. Department of Land, Air and Water Resources, University of California-Davis
2015- 2019	Project Scientist. Department of Land, Air and Water Resources, University of California-Davis
2013 – 2015	Postdoctoral Researcher. Department of Land, Air and Water Resources, University of California-Davis

(c) Synergistic Activities

Panelist for the following research programs: National Science Foundation Graduate Research Fellowship Program (GRFP); CDFA Healthy Soil Program; CDFA Specialty Crop Block Grant.

Board member: Soil Science Society of America. Associate editor of the Journal of Environmental Quality; Guest editor of Soil Science Society of America Journal; The Journal of Frontiers Agronomy

Other Services: Geoscience Congressional Visit; Journal Reviewer; Committee member for SSSJ outstanding paper award, SSSA society-wide competition; SSSA early career award; SSSA-SSSC workshop; SSSA science policy; SSSA Encompass scholars diversity program; SSSA stand-alone meeting.

(d) Fellowships & Awards

1. Excellent Young Scientist Award *2016*. Association of Soil Plant Scientists in America.
2. Ministry of Agriculture China Talents Travel Award, *2014*. $5,000.
3. Chinese Academy of Sciences President Award, *July 2013*. $ 1000.
4. Outstanding Student Paper Award *in American Geophysical Union, December 2012.*
5. The first-place winner of poster competition at the *WSSSA, June 2012.* $200.
6. Chinese Oversea Scholarship, *June 2010*. $40,000.

PUBLICATIONS IN PAST FOUR YEARS:

1. Li, N., L. Li, X. Zhu-Barker, Y. Cheng, J. Liu, and S. Chang. 2022. Foreward: Degradation and evolu- tion of Mollisols under different management practices and climate change. ***Soil Sci. Soc. Am. J.,*** 1-4. http://doi.org/10.1002/saj2.20481
2. Quantifying biological processes producing nitrous oxide in soil using a mechanistic model. Baoxuan Chang, Zhifeng Yan, Xiaotang Ju, Xiaotong Song, Yawei Li, Siliang Li, Pingqing Fu, <u>Xia Zhu-Barker</u>[+]. 2022. ***Biogeochemistry***: 1-14.
3. Mengyang You, <u>Xia Zhu-Barker</u>[*+], Timothy Doane, William Horwath. Decomposition of Carbon Adsorbed on Iron (III)-Treated Clays and Their Effect on the Stability of Soil Organic Carbon and External Carbon Inputs. 2022. ***Biogeochemistry***. 157(2): 259-270.
4. Cristina Lazcano, <u>Xia Zhu-Barker</u>, Charlotte Decock. Effects of Organic Fertilizers on the Soil Microorganisms Responsible for N_2O Emissions: A Review. 2021. ***Microorganisms***, 9(5).

5. Mengyang You, Xia Zhu-Barker, Xiang-Xiang Hao, Lu-Jun Li. Profile distribution of soil organic carbon and its isotopic value following long term land-use changes. 2021. ***Catena***. 207.
6. Xiaoyun Zhan, Jun Zhao, Xia Zhu-Barker, Junfeng Shui, Baoyuan Liu, Minghang Guo. An instrument with constant volume approach for in-situ measurement of surface runoff and suspended sediment concentration. ***Water Resources Research***. e2020WR028210. 2021
7. Ruoya Ma, Jianwen Zou, Zhaoqiang Han, Kai Yu, Shuang Wu, Zhaofu Li, Shuwei Liu, Shuli Niu, William R Horwath, Xia Zhu-Barker[+]. Global soil-derived ammonia emissions from agricultural nitrogen fertilizer application: a refinement based on regional and crop-specific emission factors. ***Global Change Biology***, 2021. https://doi.org/10.1111/gcb.15437
8. BJL Pitton, RY Evans, X Zhu-Barker[+], LR Oki. Greenhouse Gas Emissions and Global Warming Potential from a Woody Ornamental Production System Using a Soilless Growing Substrate. ***ACS Agricultural Science & Technology,*** 2021. https://doi.org/10.1021/acsagscitech.0c00039
9. Xu Chen; Xiaozeng Han; Jun Yan; XinChun Lu; Xiangxiang Hao; Wei Wang; Asim Biswas; Xia Zhu-Barker[+], Wenxiu Zhou. Land use and mineral fertilization influence soil microbial biomass and residues: A case study of a Chinese Mollisol. ***European Journal of Soil Biology***, 2020, 103216
10. Zheng, Yajing; Jin, Yaguo; Ma, Ruoya; Kong, Delei; Zhu-Barker, Xia; Horwath, William; Niu, shuli; Wang, Hong; Xiao, Xin; Liu, Shuwei; Zou, Jianwen. Drought shrinks the terrestrial upland resilience to climate change. ***Global Ecology and Biogeography***, 2020, 00: 1-12. DOI: 10.1111/geb.13160
11. R Ma, W Zhao, Y Zhao, Z Wang, X Zhu-Barker[+], AL Wright, X Jiang. Land use pattern effects after 30 years of shifting cropland to fallow land on soil ammonia-oxidizer community. ***Applied Soil Ecology***, 2020, 156, 103707
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EXHIBIT A6

CURRENT & PENDING SUPPORT

University will provide current & pending support information for Key Personnel identified in Exhibit A2 at time of proposal and upon request from State agency. The "Proposed Project" is this application that is submitted to the State. Add pages as needed.

PI: JORGE RODRIGUES					
Status (currently active or pending approval)	**Award #** (if available)	**Source** (name of the sponsor)	**Project Title**	**Start Date**	**End Date**
PROPOSED PROJECT		CARB	NITROUS OXIDE EMISSIONS FROM FUMIGATED AGRICULTURAL SOILS IN CALIFORNIA	7/01/2024	06/30/2026
Active	21-21SBPS_2-0037	NASA	Growing Food on Mars: Determining the impact of radiation, atmospheric composition, and rock substrate on plant growth in a Space Rock Garden Experiment	2023	2024
Active	23-0447	Sandia Natl. Laboratory	Volatile organic carbon in Amazon pastures under warmer climate conditions	2022	2023
Active	2022-2722	American Vineyard Foundation	Soil Health in Vineyards	2022	2023
Active	58-2032-1-037	US Department of Agriculture	Acquisition of Goods and Services	2022	2023
Active	2021-67021-34493	US Department of Agriculture	Breaking the lignin barrier with termite TAV5 treatment technology (T4)	2021	2023
Active	2121-38420-34070-0	US Department of Agriculture	Science to Practice Leadership training in the Soil-Plant Health Continuum	2021	2026
Co-PI: Willian Horwath					

Status (currently active or pending approval)	**Award #** (if available)	**Source** (name of the sponsor)	**Project Title**	**Start Date**	**End Date**
PROPOSED PROJECT		CARB	NITROUS OXIDE EMISSIONS FROM FUMIGATED AGRICULTURAL SOILS IN CALIFORNIA	7/01/2024	06/30/2026
Active		CDFA	Developing cover cropping systems for California walnut to tighten N cycle, save water and increase soil health.	2019	2023
Active		CDFA	Evaluation of certified organic fertilizer mineralization for long-term nutrient planning.	2022	2023
Active		CARB	Liquid and Soil Sample Collection and Analyses of Dairy Digestate and Lagoon Effluent during Storage and Land Application Phases.	2022	2025
Active		US Department of Agriculture	Application of vermicompost to improve agricultural soil health and reduce greenhouse gas emissions.	2020	2023
Active		CDFA	Improving N management guidelines for super-high-intensive olive orchards to use compost.	2022	2024
Active		US Department of Agriculture	Assessing GHG emissions from dairy compost in almond crops	2022	2025

Co-PI: Helen Dahlke

Status (currently active or pending approval)	**Award #** (if available)	**Source** (name of the sponsor)	**Project Title**	**Start Date**	**End Date**
PROPOSED PROJECT		CARB	NITROUS OXIDE EMISSIONS FROM FUMIGATED AGRICULTURAL SOILS IN CALIFORNIA	7/01/2024	06/30/2026
Active	2021-69012-35916	US Department of Agriculture	*Securing a Climate Resilient Water Future for Agriculture and Ecosystems through Innovation in*	2021	2025

			Measurement, Management, and Markets.		
Active	2021680124	US Department of Agriculture	*Sustainability of Groundwater and Irrigated Agriculture in the Western United States under a Changing Climate.*	2021	2025
Active	4600014606	CDWR	*Upper watershed hydrology assessment using GIS and Remote Sensing*	2021	2025
Active	84046301	US EPA	*Life-cycle Analysis to Support Cost-effective Enhanced Aquifer Recharge*	2021	2025
Active	NR203A7500 23C017	US Department of Agriculture	*Managed Aquifer Recharge Strategies to Sustain Irrigated Agriculture*.	2020	2024
Active	1716130	NSF	*The dynamics of rural poverty, land use, and water in California's changing Central Valley*	2017	2023
Co-PI: Xia					
Status (currently active or pending approval)	**Award #** (if available)	**Source** (name of the sponsor)	**Project Title**	**Start Date**	**End Date**
PROPOSED PROJECT		CARB	NITROUS OXIDE EMISSIONS FROM FUMIGATED AGRICULTURAL SOILS IN CALIFORNIA	7/01/2024	06/30/2026
Active		CDFA	Nitrogen Management Guidelines for Olive Growers to Improve Soil Health and Sustain Production.	2021	2024
Active		CDFA	California walnut orchards using cover crops to increase soil health and reduce greenhouse gas emissions.	2020	2023
Active		CARB	Liquid and Soil Sample Collection and Analyses of Dairy Digestate and Lagoon Effluent during Storage and Land Application Phases.	2022	2025

Active		US Department of Agriculture	Application of vermicompost to improve agricultural soil health and reduce greenhouse gas emissions.	2020	2023

EXHIBIT A7

THIRD PARTY CONFIDENTIAL INFORMATION REQUIREMENT

CONFIDENTIAL NONDISCLOSURE AGREEMENT

(Identified in Exhibit A, Scope of Work – will be incorporated, if applicable)

Exhibit A7 is not applicable for this Agreement.

EXHIBIT B2

BUDGET PERTAINING TO SUBAWARDEE(S)

Use same formatting as Exhibit B and B1 for each subrecipient.

EXHIBIT D

ADDITIONAL REQUIREMENTS ASSOCIATED WITH FUNDING SOURCES

If the Agreement is subject to any additional requirements imposed on the funding State agency by applicable law (including, but not limited to, bond, proposition and federal funding), then these additional requirements will be set forth in Exhibit D. If the University is a subrecipient, as defined in 2 CFR 200 (Uniform Guidance on Administrative Requirements, Audit Requirements and Cost Principles for Federal Financial Assistance), and the external funding entity is the federal government, the below table must be completed by the State agency. (Please see sections 10.A and 10.B of the Exhibit C.)

State Agency to Complete (Required for Federal Funding Source):

Federal Agency	
Federal Award Identification Number	
Federal Award Date	
Catalog of Federal Domestic Assistance (CFDA) Number and Name	
Amount Awarded to State Agency	
Effective Dates for State Agency	
Federal Award to State Agency is Research & Development (Yes/No)	

University to Complete:

Research and Development (R&D) means all research activities, both basic and applied, and all development activities that are performed by non-Federal entities. The term research also includes activities involving the training of individuals in research techniques where such activities utilize the same facilities as other R&D activities and where such activities are not included in the instruction function.

This award ☐ does ☑ does not support Research & Development.

OR

Exhibit D is not applicable for this Agreement.

EXHIBIT E

SPECIAL CONDITIONS FOR SECURITY OF CONFIDENTIAL INFORMATION

Exhibit E is not applicable for this Agreement.

ATTACHMENT 1

STATE OF CALIFORNIA
STANDARD AGREEMENT
STD 213 (Rev 02/20)

AGREEMENT NUMBER **22RD036**	
STATE CONTROLLER'S OFFICE IDENTIFIER **3900-22RD036**	REGISTRATION NUMBER

1. This Agreement is entered into between the State Agency and the Contractor named below:

STATE AGENCY'S NAME
California Air Resources Board (CARB or State)

CONTRACTOR'S NAME
The Regents of the University of California, Davis (UCD, University, or Contractor)

2.	The term of this Agreement is:	June 1, 2023	through	July 31, 2024

3.	The maximum amount of this Agreement is:	$200,129.00 Two Hundred Thousand, One Hundred Twenty-Nine Dollars and Zero Cents

4. The Parties agree to comply with the terms and conditions of the following Exhibits, which by this reference are made a part of the Agreement.

Exhibit A – A7: A–Scope of Work; A1–Deliverables; A2–Key Personnel; A3–Authorized Representatives; A4–Use of Intellectual Property & Data; A5–Resumes/Biosketch; A6–Current & Pending Support; A7-Third Party Confidential Information (if applicable)	40 pages
Exhibit B – B–Budget; B1–Budget Justification; B2– Subawardee Budgets (if applicable); B3–Invoice Elements	7 pages
Exhibit C* – University Terms and Conditions	UTC-220

Check mark additional Exhibits below, and attach applicable Exhibits or provide internet link:

☐ **Exhibit D –** Additional Requirements Associated with Funding Sources	1 page
☐ **Exhibit E –** Special Conditions for Security of Confidential Information	1 page
☐ **Exhibit F –** Access to State Facilities or Computing Resources	1 page
☒ **Exhibit G –** Negotiated Alternate UTC Terms	1 page

Items shown with an Asterisk (*) are hereby incorporated by reference and made part of this agreement as if attached hereto. You can find these documents on the University of California, Office of the President and the California Department of General Services websites.

IN WITNESS WHEREOF, this Agreement has been executed by the Parties hereto.

CONTRACTOR

CONTRACTOR'S NAME *(if other than an individual, state whether a corporation, partnership, etc.)*
The Regents of the University of California, Davis

BY *(Authorized Signature)* Grace Liu — Digitally signed by Grace Liu Date: 2023.05.12 16:10:22 -07'00'	DATE SIGNED *(Do not type)*

PRINTED NAME AND TITLE OF PERSON SIGNING
Grace Liu, Associate Director

ADDRESS
1850 Research Park Drive, Suite 330, Davis, CA 95616

STATE OF CALIFORNIA

AGENCY NAME
California Air Resources Board

BY *(Authorized Signature)* Alice Kindarara	DATE SIGNED *(Do not type)* 5/16/2023

PRINTED NAME AND TITLE OF PERSON SIGNING
Alice Kindarara, Branch Chief

ADDRESS
1001 I Street, 19th Floor, Sacramento, CA 95814

California Department of General Services Use Only

APPROVED
MAY 31 2023
NLR:skb
OFFICE OF LEGAL SERVICES
DEPT. OF GENERAL SERVICES

EXHIBIT A

SCOPE OF WORK

☒ Contract ☐ Grant

Does this project include Research (as defined in the UTC)? ☒ Yes ☐ No

PI Name: Jorge L. Mazza Rodrigues

Project Title: Quantifying and Identifying the Potential Causes of Nitrous Oxide Emissions in California Soils under Fumigation (Phase 1)

Project Summary/Abstract

Agroecosystems both contribute to and are affected by global climate change. As the world's fifth largest supplier of agricultural commodities (California Department of Food and Agriculture [CDFA] report 2019) and the top agricultural producer in the United States (US) (US Department of Agriculture [USDA] Economic Research Service [ERS], 2022), this situation is of particular concern to California. In 2016, the State of California adopted legislation to help growers reduce emissions of greenhouse gases, explicitly including nitrous oxide (N2O) that has a global warming potential 298 times that of carbon dioxide (CO2). It has been estimated that ~50% N2O emissions in California results from agricultural soils (California Energy Commission [CEC], 2005; Smart et al., 2011). N2O emissions can vary widely due to environmental and agronomic factors (fertilization, irrigation, fumigation, etc.), particularly fumigation has been shown to significantly increase the N2O emissions worldwide (Spokas and Wang, 2003; Fang et al., 2018). There is, however, a dearth of evaluation of the fumigation impacts on N2O emissions under different management regimes in the cropping systems commonly found in California's Mediterranean climate.

The long-term goal of this collaborative project is to evaluate the effects of soil fumigation on N2O emissions and propose potential mitigation strategies in selected cropping systems in California. This project will be divided into two phases (Phase 1-literature/data review and preparation for field monitoring; Phase 2-field monitoring and analysis). This agreement will focus on the Phase 1. The specific aims of Phase 1 are to understand the effects of soil fumigation on N2O emissions globally and identify common fumigants and cropping systems in California to be studied in this project. The objectives of the Phase 1 are to (1) perform a comprehensive literature review of studies on N2O emissions as affected by the practice of soil fumigation globally, to understand the effects of soil fumigation on N2O emissions; (2) conduct metadata analyses to build a selection criterion and evaluate the importance of fumigant types, cropping systems, management practices, and soil types on N2O emissions; (3) collect the fumigation application information in different cropping systems to identify common fumigants and cropping systems in California to be studied in this project; (4) present the results in the conferences, meetings and workshops and facilitate discussions regarding the selection of fumigants and cropping systems, as well as the challenges for future field monitoring in these events; (5) investigate the field configuration to develop N2O emission monitoring protocol for the selected agroecosystem with fumigation practices in California; (6) write a report and publish scientific paper using all the data collected from literature/data review.

If Third-Party Confidential Information is to be provided by the State:

☐ Performance of the Scope of Work is anticipated to involve use of third-party Confidential Information and is subject to the terms of this Agreement; ***OR***

☐ A separate CNDA between the University and third-party is required by the third-party and is incorporated in this Agreement as Exhibit A7.

Scope of Work

Statement of Significance

Nitrous oxide is one of the most potent greenhouse gases in the atmosphere, playing a key role in climate outcomes and atmospheric chemistry (Oertel et al., 2016). This potent greenhouse gas not only accounts for a global warming potential of 298 times that of CO2 over a period of 100 years, but also it is the major cause for the depletion of the ozone layer in the stratosphere, through the formation of nitric oxide (NO) and nitrogen dioxide (NO2) (Ravishankara et al., 2009).

In agricultural systems, N2O emissions are substantially increased following the intensive use of nitrogen (N) fertilizers and agrochemicals to achieve high production (Syakila and Kroeze, 2011). N2O emissions have been reported to increase ~8-fold following chloropicrin (CP) fumigation in agricultural soils in Minnesota, US (Spokas and Wang, 2003), with 82% contributed from microbial activities (fungal dominant activities) and 18% from abiotic processes (Spokas et al., 2005 and 2006). In contrast, a recent study by Fang et al. (2018) shows much larger (23-25 times) emissions in CP fumigated agricultural soils in China than observed by Spokas and Wang (2003), being primarily controlled by bacterial denitrification. Fang's group further demonstrates that biochar would be an option to mitigate N2O emissions (> 50% reduction) in fumigated soil, but this option is dependent on the timing and biochar types (Fang et al., 2022). These few studies highlight how complex the processes associated with N2O emissions in agricultural soils are and likely to vary due to soil processes and agronomic management practices, such as irrigation practices, timing of fertilization, soil N mineralization, residual soil N availability and fumigation.

As the world's fifth largest supplier of agricultural commodities (CDFA report 2019) and the top agricultural producer in the U.S. (USDA ERS, 2022.), this situation is of particular concern to California, where ~50% N2O emissions are emitted from agricultural soils (CEC, 2005; Smart et al., 2011). Many growers rely on the use of fumigants, such as a combination of 1,3-dichloropropene and chloropicrin, to control weeds, soilborne diseases and nematodes. In general, these fumigants are either applied by bed injection or through a drip system, at rates up to 180 pounds of the active ingredient per acre at the pre-plant stage for crops like strawberries, tomatoes, lettuce, and almonds. However, the N2O release mechanisms and the implications for California agriculture are unknown: First, it is not known how fumigation, a chemical operation known to decrease soil biodiversity, results in increased emissions of N2O, a biogeochemical process mainly driven by microorganisms. Second, it is not known to what extent fumigation-induced denitrification occurs in agricultural soils of California, given that the N2O is regulated by carbon and nitrogen substrate availability, temperature, pH and soil moisture content (Zhu et al., 2013).

To fill the aforementioned knowledge gaps, the Regents of the University of California, Davis (Contractor) will employ a stepwise approach, consisting of two phases (Phase 1 and Phase 2), to identify the potential impacts of soil fumigation on N2O emissions and to develop potential mitigation strategies for California agricultural soils subject to fumigation as follows:

Phase 1: Existing Data Review and Monitoring Preparation. The Contractor will perform a thorough literature review of studies on N2O emissions and their relationship to fumigant type, rate and application methods in different soils, cropping systems, management practices, and environmental conditions, as well as prepare monitoring systems for field sampling in California.

Phase 2: Emission Monitoring and Data Analysis. The Contractor will quantify N2O emissions for selected crops following seasonal management practices performed by California growers and identify the key environmental and management factors controlling N2O emissions under soil fumigation practices and propose potential mitigation strategies.

The long-term goal of this collaborative project is to evaluate the effects of soil fumigation on N2O emissions and propose potential mitigation strategies in selected cropping systems in California. This project will be divided into two phases (Phase 1-literature/data review and preparation; Phase 2-field monitoring and analysis). This agreement will focus on the Phase 1. The specific aims of Phase 1 are to understand the effects of fumigation on N2O emissions globally and identify common fumigants and cropping systems in California to be studied in this project. The long-term objectives of the Phase 1 are to (1) perform a comprehensive literature review of studies on N2O emissions as affected by the practice of fumigation globally, to understand the effects of soil fumigation on N2O emissions; (2) conduct metadata analyses to build a selection criterion and evaluate the importance of fumigant types, cropping systems, management practices, and soil types on N2O emissions; (3) collect the fumigation application information in different cropping systems to identify common soil fumigants and cropping systems in California to be studied in this project; (4) present the results in the conferences, meetings and workshops and facilitate discussions regarding the selection of soil fumigants and cropping systems, as well as the challenges for future field monitoring in these events; (5) investigate the field configuration to develop an N2O emission monitoring protocol for the selected agroecosystem with soil fumigation practices in California; (6) write a report and publish scientific papers using all the data collected from literature/data review.

Specifically, the comprehensive literature/data review will provide in-depth understanding of the effects of soil fumigation on N2O emissions. These metadata will serve a valuable criterion for the selection of representative cropping systems and management practices to study the effects of soil fumigation on N2O emissions in California in terms of fumigant types, soil types and soil physiochemical conditions, management practices, as well as the regional climates (e.g., precipitation). The Contractor believes that the outcomes of Phase 1 will mostly benefit to the state agencies (California Air Resources Board [CARB], CDFA Fertilizer Research and Education Program [FREP], and CEC), Pesticide Action Network, Californians for Pesticide Reform, by evaluating the effects of soil fumigation on N2O emissions globally under different management scenarios including N fertilization, irrigation, and fumigation.

Project Tasks

Task 1: Literature Review.
The Contractor will develop a comprehensive literature review to evaluate the impacts of soil fumigation on N2O emissions in agricultural soils globally, thereafter the Contractor will narrow and/or crosswalk studies to California agroecosystems based on common traits (e.g., soil, crop, pest pressure, climate). The review will include published research articles in different journals via searching Web of Science and machine-learning assisted platforms, such as Colandr (https://www.colandrcommunity.com/) using key words like N2O emissions, fumigants, agricultural soil. The Contractor will also include technical reports, and pesticide databases relevant to fumigant registration and use in California, such as the pesticide registration forms and the Pesticide Use Report of the California Department of Pesticide Regulation (CDPR). Based on this information, the Contractor will provide an analysis of N2O emissions affected by soil fumigation, and their relationship with fumigant types, cropping systems and management practices, soil types, soil physiochemical and biological conditions, as well as the region climates (e.g., precipitation and temperature). With all these datasets, the Contractor will then build a selection criterion to evaluate the importance of fumigant types, cropping systems, management practices, and soil types on N2O emissions.

Task 2: Identifying Fumigants and Cropping Systems for Field Monitoring.
The importance levels built in Task 1 will serve as an index to identify common soil fumigants and cropping systems to be studied in the project. The Contractor will present information obtained in Task 1 at different venues (e.g., United Nations (UN) Climate Change Conference) and CARB public workshops. Meetings will be open to all interested stakeholders, including other state agencies (CDFA-FREP and CEC), Pesticide Action Network, Californians for Pesticide Reform, California Crop Improvement Association, Specialty Crop Industry, Cooperative Extension Personnel, Farm Advisors, and Cash Crop Producers, etc. The Contractor will facilitate discussions in these meetings regarding the selection of soil fumigants and cropping systems for future field monitoring of N2O emissions. Selection parameters will be determined by critical soil

physicochemical parameters, including soil C and N content, soil moisture and texture, bulk density, and pH, that have been proven to strongly influence N2O emissions.

Task 3. Developing N_2O Emission Monitoring Protocol.
The Contractor will develop field site selection criteria and detailed sampling methodology and procedures based on Tasks 1 and 2 taking into consideration fumigant types, cropping systems, management practices, soil types, sampling time, frequency, gas measurement methods (chambers or portable gas analyzer), locations (e.g., root area and bulk soil), sample numbers and replicates, sample storage and analytical methods. All samples will be georeferenced. For each cropping system, subplots (≥3) will be set up in an assigned block design (at least 3 blocks for each treatment). In each block, the Contractor will set up soil sensors to monitor the soil conditions including temperature, moisture, and redox potential. In each subplot, the Contractor will install a soil collar for chamber or gas analyzer placement. Gas samples and or direct readings will be collected during the crop season following fumigation, with higher frequency when N2O emissions are expected to be high, like after fertilization, rainfalls, and irrigation, but with less frequently when N2O emissions are expected to be low. In addition, soil samples will be collected before and after fumigation events, and any other relevant events for soil physicochemical and microbial analyses.

Task 4. Reporting and Publication.
The Contractor will provide quarterly progress reports to CARB. The Contractor will also prepare an interim report, summarizing all work completed and results, to be submitted to CARB six (6) months before agreement end date. The report will provide information on literature review, academic and extension activities (meeting, workshops and conferences), selected fumigants and cropping systems as well as the protocols of sampling procedure and monitoring systems. The Contractor will work with CARB to make edits to the draft report as requested. The interim report can be released to the public only after CARB's approval. A review paper will be prepared for publication.

Deliverables
The deliverables will include (1) N2O emission monitoring protocols for the selected cropping systems in California, (2) a report on how soil fumigation affects N2O emission globally to the public in an Americans with Disabilities Act compliant format, and (3) A review paper based on item (2) to be published to the research community.

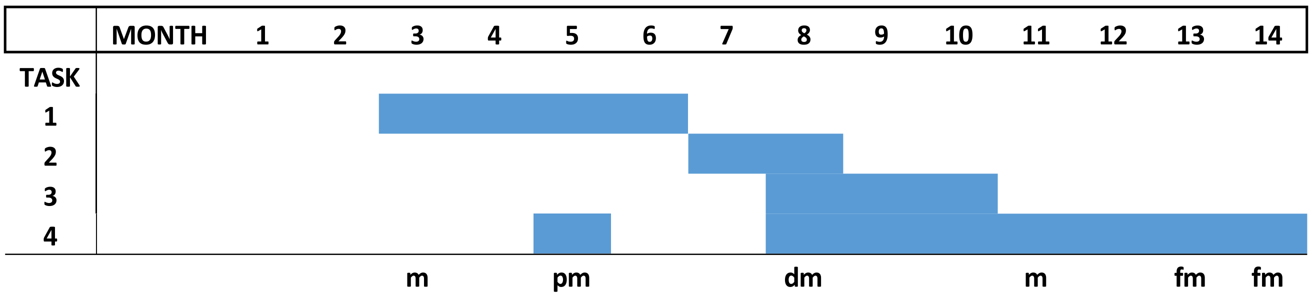
Potential problems, alternative strategies, and benchmarks for success anticipated to achieve the goals and objectives.

The Contractor expects to conduct a comprehensive literature review that will cover all the crops grown in California, including some grown elsewhere. One of the potential problems for Phase 1 will be the collection of studies on specialty crops that are only grown in California. California is documented by far as the number one US producer of specialty crops, with many of them (such as almonds, artichokes, and broccoli) are grown almost nowhere else in the country. The Contractor probably won't have enough data to build the selection criteria and detailed sampling methodology and procedures for these specialty crops based on literature review with a focus on the fumigation impacts. In this case, the Contractor may need to use the normal N2O emissions data that is published for these crops as our baseline to build criteria and methodology.

To ensure our success in selecting the final fumigant types and crop systems for future field monitoring of N2O emissions in California, the Contractor will exactly follow the four tasks described in the scope of work, and meanwhile, will also either measure the selection parameters in the monitored fields or collect the annual dynamics of the soil properties from published data first, which include soil C and N content, soil moisture and texture, bulk density, and pH, that have been proven to strongly influence N2O emissions. The final list will be determined by discussing findings with the key stakeholders such as state agencies (e.g., CDFA, CDPR, and CARB) and local growers (e.g., Cash Crop Producers, California Crop Improvement Association, Specialty Crop Industry).

Project Schedule

Task 1: Literature Review.
Task 2: Identifying Fumigants and Cropping Systems for Field Monitoring.
Task 3. Developing N2O Emission Monitoring Protocol.
Task 4. Reporting and Publication.



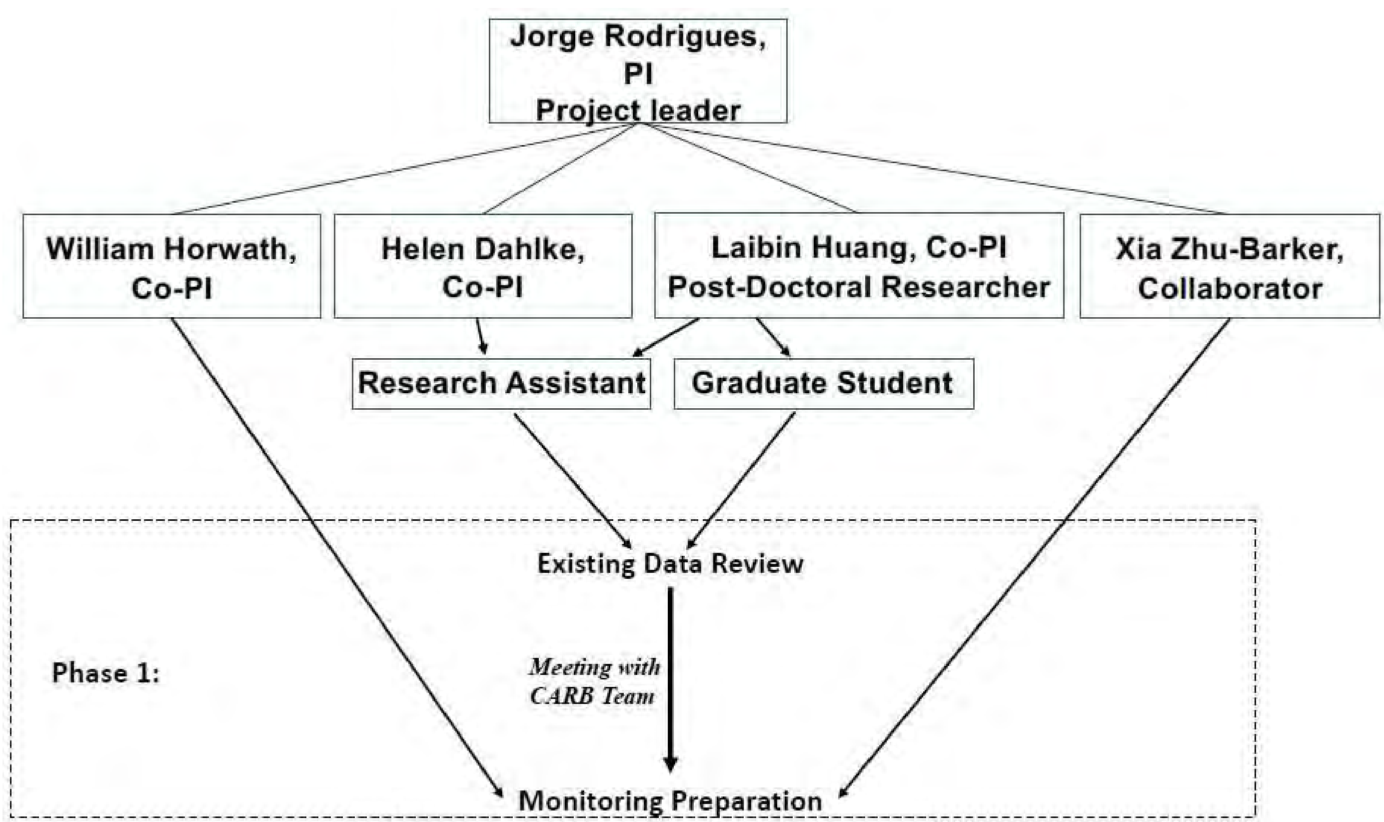
p = Quarterly progress report

d = Deliver draft final report (to be submitted 6 months prior to contract expiration)

f = Deliver final report

m = Meeting with CARB staff

Project Management Plan



Responsibilities of Personnel

The PI will supervise the entire project and Project Manager will be responsible for convening monthly meetings with the PIs, Collaborator and the Project Technicians (Research Assistant and GSR). The Project Leader and the Co-PIs make the final decisions on site selections after discussion with CARB Team, in terms of N fertilizer treatments, fumigation types, cropping systems and overall sampling strategy. The PIs, Project Manager, Collaborator evaluate data analysis and interpretation. The Project Technicians and Collaborator are responsible for field flux chamber design, establishing sampling protocols based on the results from literature review during the Phase 1 period. Project Technicians will set the field stations for gas sampling. PIs are responsible for writing quarterly reports, the draft interim report, and the interim report. Safety decisions will be made by the PIs and the Project Technicians.

Management and Coordination

In the first 6 months during Phase 1, the meeting will mainly be held between the Project Manager and PIs to discuss the results of the literature review. After 4 months, Project Manager will organize Monthly meetings with all PIs, CARB team, Collaborator, and the Project Technicians to discuss the future activities, the project progress and potential difficulties based on the results of literature review. The timelines of the tasks will be decided based on the project progress at these meetings. The Project Manager should also ensure that all the tasks are carried out in time. The Project Manager will meet with all PIs to discuss the timing for presenting the results to CARB team and organizing workshop to coordinate the selected monitoring cropping systems.

In the next, the Project Manager will work closely with the Project Technicians, especially in setting up the field gas station and sensors, as well as in establishing sampling protocols and routines in the field for the Phase 2 work.

Meetings

A. Initial meeting. Before work on the contract begins, the Principal Investigator and key personnel will meet with the CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, the project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.

B. Progress review meetings. The Principal Investigator and appropriate members of his or her staff will meet with CARB's Contract Project Manager at quarterly intervals to discuss the progress of the project. This meeting may be conducted by phone.

C. Technical Seminar. The Contractor will present the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte.

HEALTH AND SAFETY

Contractors are required to, at their own expense, comply with all applicable health and safety laws and regulations. Upon notice, Contractors are also required to comply with the state agency’s specific health and safety requirements and policies. Contractors agree to include in any subcontract related to performance of this Agreement, a requirement that the subcontractor comply with all applicable health and safety laws and regulations, and upon notice, the state agency’s specific health and safety requirements and policies.

EXHIBIT A1

SCHEDULE OF DELIVERABLES

If use of any Deliverable is restricted or is anticipated to contain preexisting Intellectual Property with any restricted use, it will be clearly identified in Exhibit A4, Use of Preexisting Intellectual Property & Data.

Unless otherwise directed by the State, the University Principal Investigator shall submit all deliverables to State Contract Project Manager, identified in Exhibit A3, Authorized Representatives.

Deliverable	Description	Due Date
Initial Meeting	Principal Investigator and key personnel will meet with CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.	Month 1
Progress Reports & Meetings	Quarterly progress reports and meetings throughout the agreement term, to coincide with work completed in quarterly invoices.	Quarterly
N_2O Emission Monitoring Protocols	N2O emission monitoring protocols for the selected cropping systems in California	Two (2) weeks prior to agreement end date.
Draft Interim Report	Draft version of the Interim Report detailing the purpose and scope of the work undertaken, the work performed, and the results obtained and conclusions.	Six (6) months prior to agreement end date.
Data	Data compilations first produced in the performance of this Agreement by the Principal investigator or the University's project personnel.	Two (2) weeks prior to agreement end date.
Technical Seminar	Presentation of the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte.	On or before agreement end date.
The following Deliverables are subject to paragraph 19. Copyrights, paragraph B of Exhibit C		
Final Report	Written record of the project and its results. The Final Report shall be submitted in an Americans with Disabilities Act compliant format. The Public Outreach Document, as described in Exhibit A1, Section 2, shall be incorporated into the Final Report.	Two (2) weeks prior to agreement end date.

1. **Reports and Data Compilations**

   A. With respect to each invoice period University shall submit, to the CARB Contract Project Manager, one (1) electronic copy of the progress report. When emailing the progress report, the "subject line" should state the contract number and the billing period. Each progress report must accompany a related invoice covering the same billing period. Each progress report will begin with the following disclaimer:

The statements and conclusions in this report are those of the University and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

B. Each progress report will also include:

1. A brief summary of the status of the project, including whether the project is on schedule. If the project is behind schedule, the progress report must contain an explanation of reasons and how the University plans to resume the schedule.

2. A brief narrative account of project tasks completed or partially completed since the last progress report.

3. A brief discussion of problems encountered during the reporting period and how they were or are proposed to be resolved.

4. A brief discussion of work planned, by project task, before the next progress report. and

5. A graph or table showing percent of work completion for each task.

C. Six (6) months prior to Agreement expiration date, University will deliver to CARB an electronic copy of the draft final report in both PDF and Microsoft Word formats. The draft final report will conform to Exhibit A1, Section 2 – Research Final Report Format.

D. Within forty-five (45) days of receipt of CARB's comments, University will deliver to CARB's Contract Project Manager an electronic copy of the final report incorporating all reasonable alterations and additions. Within two (2) weeks of receipt of the revised report, CARB will verify that all CARB comments have been addressed. Upon acceptance of the amended final report approved by CARB in accordance to Exhibit A1, Section 2 – Research Final Report Format, University will within two (2) weeks, deliver to CARB an electronic copy of the final report in both PDF and Microsoft Word formats.

E. As specified in Exhibit A1, Section 2, Final Report will be submitted in an Americans with Disabilities Act compliant Format.

F. Together with the final report, University will deliver a set of all data compilations as specified in Exhibit A1 – Schedule of Deliverables.

G. University's obligation under this Agreement shall be deemed discharged only upon submittal to CARB of an acceptable final report in accordance to Exhibit A1, Section 2 – Research Final Report Format, all required data compilations, and any other project deliverables.

2. Final Report Format

The research contract Final Report (Report) is as important to the contract as the research itself. The Report is a record of the project and its results and is used in several ways. Therefore, the Report must be well organized and contain certain specific information. This Exhibit outlines the requirements that must be met when producing the Report.

Note: In partial fulfillment of the Final Report requirements, the Contractor shall submit a copy of the Report in PDF format and in a word-processing format, preferably in Word –

Version 6.0 or later. The electronic copy file name shall contain the CARB contract number, the words "Final Report", and the date the report was submitted.

Accessibility. To maintain compliance with California Government Code Sections 7405 and 11135, and Web Content Accessibility Guidelines, Assembly Bill No. 434, the final Report must be submitted in an Americans with Disabilities Act compliant format. The final Report will be posted on the CARB website and therefore must but be in an accessible format so that all members of the public can access it.

Watermark. Each page of the draft Report must include a watermark stating “DRAFT.” The revised report should not include any watermarks.

Title. The title of the Report should exactly duplicate the title of the contract. However, minor changes to the title may be approved provided the new title does not deviate from the old title. These minor changes must be approved in writing by the contract manager. Significant changes to the title would require a formal amendment.

Page size. All pages should be of standard size (8 ½" x 11") to allow for photo-reproduction.

Corporate identification. Do not include corporate identification on any page of the Final Report, except the title page.

Unit notation. Measurements in the Reports should be expressed in metric units. However, for the convenience of engineers and other scientists accustomed to using the British system, values may be given in British units as well in parentheses after the value in metric units. The expression of measurements in both systems is especially encouraged for engineering reports.

Section order. The Report should contain the following sections, in the order listed below:

Title page
Disclaimer
Acknowledgment (1)
Acknowledgment (2)
Table of Contents
List of Figures
List of Tables
Abstract
Public Outreach Document
Executive Summary
Body of Report
References
List of inventions reported and copyrighted materials produced
Glossary of Terms, Abbreviations, and Symbols
Appendices

Page numbering. Beginning with the body of the Report, pages shall be numbered consecutively beginning with “1”, including all appendices and attachments. Pages preceding the body of the Report shall be numbered consecutively, in ascending order, with small Roman numerals.

Title page. The title page should include, at a minimum, the contract number, contract title, name of the principal investigator, contractor organization, date, and this statement:

"Prepared for the California Air Resources Board and the California Environmental Protection Agency"

Disclaimer. A page dedicated to this statement must follow the Title Page:

> The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

Acknowledgment (1). Only this section should contain acknowledgments of key personnel and organizations who were associated with the project. The last paragraph of the acknowledgments must read as follows:

> This Report was submitted in fulfillment of [CARB contract number and project title] by [contractor organization] under the [partial] sponsorship of the California Air Resources Board. Work was completed as of [date].

Acknowledgment (2). Health reports should include an acknowledgment to the late Dr. Friedman. Reports should include the following paragraph:

> This project is funded under the CARB's Dr. William F. Friedman Health Research Program. During Dr. Friedman's tenure on the Board, he played a major role in guiding CARB's health research program. His commitment to the citizens of California was evident through his personal and professional interest in the Board's health research, especially in studies related to children's health. The Board is sincerely grateful for all of Dr. Friedman's personal and professional contributions to the State of California.

Table of Contents. This should list all the sections, chapters, and appendices, together with their page numbers. Check for completeness and correct reference to pages in the Report.

List of Figures. This list is optional if there are fewer than five illustrations.

List of Tables. This list is optional if there are fewer than five tables.

Abstract. The abstract should tell the reader, in nontechnical terms, the purpose and scope of the work undertaken, describe the work performed, and present the results obtained and conclusions. The purpose of the abstract is to provide the reader with useful information and a means of determining whether the complete document should be obtained for study. The length of the abstract should be no more than about 200 words. Only those concepts that are addressed in the executive summary should be included in the abstract.

Example of an abstract:

A recently developed ground-based instrument, employing light detecting and ranging (lidar) technology, was evaluated, and found to accurately measure ozone concentrations at altitudes of up to 3,000 meters. The novel approach used in this study provides true vertical distributions of ozone concentrations aloft and better temporal coverage of these distributions than other, more common methods, such as those using aircraft and ozonesonde (balloon) techniques. The ozone and aerosol measurements from this study, in conjunction with temperature and wind measurements, will provide a better characterization of atmospheric conditions aloft and the processes involved in the formation of unhealthful ozone concentrations than can be achieved with traditional ground-based monitors.

Public Outreach Document. The public outreach document is a one-page document that will be widely used to communicate, in clear and direct terms, the key research findings from the study to the public. CARB will be translating the document into other languages. This document must adhere to the following guidelines:

- Single space, limited to one-page or about 500 words.
- Use narrative form and active voice.
- Incorporate a graphic that it is easy to interpret and captures the results' central message.
- Avoid jargon and technical terms. Use a style and vocabulary level comparable to that of sixth grade reading level.
- The document should contain a title and the following five sections: Issue/s, Main Question, Key Research Findings, Conclusion/s, and More Information. Guidance on how to write these sections is described below.

  TITLE: Adopt a short, non-technical title to make the topic clear and concise. The title will likely differ from the original title of the contract.

  ISSUE/S: In one to two paragraphs, describe why the project was needed. In this section, identify the problem leading to this study and what the study was set to accomplish to help address the problem. Reference any history that is relevant such as a regulation, legislation, program, law, or other. Without going into detail and disclosing the research findings, mention the methods used in the study and how it informed the results.

  MAIN QUESTION: Present a concise central research question driving this project.

  KEY RESEARCH FINDING/S: This section covers the key research findings. List key points and or findings.

  CONCLUSION/S: In one to two paragraphs, discuss how the results could be used. Mention its relevance to policies, rules, regulations, legislations, or CARB programs. Include suggestions for next steps, additional research, or other actions.

  MORE INFORMATION: In two to three short sentences provide specifics about the study. This section should include the full title of the study, sponsor, authors, and where the full report can be found (the final report will be posted on the CARB website). In addition to a direct contact to gain more information (author and CARB contract manager).

Executive Summary. The function of the executive summary is to inform the reader about the important aspects of the work that was done, permitting the reader to understand the research without reading the entire Report. It should state the objectives of the research and briefly describe the experimental methodology[ies] used, results, conclusions, and recommendations for further study. All of the concepts brought out in the abstract should be expanded upon in the Executive Summary. Conversely, the Executive Summary should not contain concepts that are not expanded upon in the body of the Report.

The Executive Summary will be used in several applications as written; therefore, please observe the style considerations discussed below.

Limit the Executive Summary to two pages, single spaced.

Use narrative form. Use a style and vocabulary level accessible to the general audience. Assume the audience is being exposed the subject for the first time.

Do not list contract tasks in lieu of discussing the methodology. Discuss the results rather than listing them.

Avoid jargon.

Define technical terms.

Use passive voice if active voice is awkward.

Avoid the temptation to lump separate topics together in one sentence to cut down on length.

The Executive Summary should contain four sections: Background, Objectives and Methods, Results, and Conclusions, described below.

THE BACKGROUND SECTION. For the Background, provide a one-paragraph discussion of the reasons the research was needed. Relate the research to the Board's regulatory functions, such as establishing ambient air quality standards for the protection of human health, crops, and ecosystems; the improvement and updating of emissions inventories; and the development of air pollution control strategies.

THE OBJECTIVES AND METHODS SECTION. At the beginning of the Objectives and Methods section, state the research objectives as described in the contract. Include a short, one or two sentences, overview of what was done in general for this research.

The methodology should be described in general, nontechnical terms, unless the purpose of the research was to develop a new methodology or demonstrate a new apparatus or technique. Even in those cases, technical aspects of the methodology should be kept to the minimum necessary for understanding the project. Use terminology with which the reader is likely to be familiar. If it is necessary to use technical terms, define them. Details, such as names of manufacturers and statistical analysis techniques, should be omitted.

Specify when and where the study was performed if it is important in interpreting the results. The findings should not be mentioned in the Objectives and Methods section.

THE RESULTS SECTION. The Results section should be a single paragraph in which the main findings are cited, and their significance briefly discussed. The results should be presented as a narrative, not a list. This section must include a discussion of the implications of the work for the Board's relevant regulatory programs.

THE CONCLUSIONS SECTION. The Conclusions section should be a single short paragraph in which the results are related to the background, objectives, and methods. Again, this should be presented as a narrative rather than a list. Include a short discussion of recommendations for further study, adhering to the guidelines for the Recommendations section in the body of the Report.

Body of Report. The body of the Report should contain the details of the research, divided into the following sections:[1]

INTRODUCTION. Clearly identify the scope and purpose of the project. Provide a general background of the project. Explicitly state the assumptions of the study.

Clearly describe the hypothesis or problem the research was designed to address. Discuss previous related work and provide a brief review of the relevant literature on the topic.

MATERIALS AND METHODS. Describe the various phases of the project, the theoretical approach to the solution of the problem being addressed, and limitations to the work. Describe the design and construction phases of the project, materials, equipment, instrumentation, and methodology.
Describe quality assurance and quality control procedures used. Describe the experimental or evaluation phase of the project.

RESULTS. Present the results in an orderly and coherent sequence. Describe statistical procedures used and their assumptions. Discuss information presented in tables, figures, and graphs. The titles and heading of tables, graphs, and figures, should be understandable without reference to the text. Include all necessary explanatory footnotes. Clearly indicate the measurement units used.

DISCUSSION. Interpret the data in the context of the original hypothesis or problem. Does the data support the hypothesis or provide solutions to the research problem? If appropriate, discuss how the results compare to data from similar or related studies. What are the implications of the findings?
Identify innovations or development of new techniques or processes. If appropriate, discuss cost projections and economic analyses.

SUMMARY AND CONCLUSIONS. This is the most important part of the Report because it is the section that will probably be read most frequently. This section should begin with a clear, concise statement of what, why, and how the project was done. Major results and conclusions of the study should then be presented, using clear, concise statements. Make sure the conclusions reached are fully supported by the results of the study. Do not overstate or overinterpret the results. It may be useful to itemize primary results and conclusions. A simple table or graph may be used to illustrate.

RECOMMENDATIONS. Use clear, concise statements to recommend (if appropriate) future research that is a reasonable progression of the study and can be supported by the results and discussion.

References. Use a consistent style to fully cite work referenced throughout the Report and references to closely related work, background material, and publications that offer additional information on aspects of the work. Please list these together in a separate section, following the body of the Report. If the Report is lengthy, you may list the references at the end of each chapter.

List of inventions reported and publications produced. If any inventions have been reported, or publications or pending publications have been produced as a result of the project, the titles, authors, journals or magazines, and identifying numbers that will assist in locating such information should be included in this section.

Glossary of terms, abbreviations, and symbols. When more than five of these items are used in the text of the Report, prepare a complete listing with explanations and definitions. It is expected that every abbreviation and symbol will be written out at its first appearance in the Report, with the abbreviation or symbol following in parentheses [i.e., carbon dioxide (CO2)]. Symbols listed in table and figure legends need not be listed in the Glossary.

Appendices. Related or additional material that is too bulky or detailed to include within the discussion portion of the Report shall be placed in appendices. If a Report has only one appendix, it should be entitled "APPENDIX". If a Report has more than one appendix, each should be designated with a capital letter (APPENDIX A, APPENDIX B). If the appendices are too large for inclusion in the Report, they should be collated, following the binding requirements for the Report, as a separate document.

The contract manager will determine whether appendices are to be included in the Report or treated separately. Page numbers of appendices included in the Report should continue the page numbering of the Report body. Pages of separated appendices should be numbered consecutively, beginning at “1”.

3. Other Deliverables

A. Any other deliverables shall be provided in a mutually agreed upon format unless the deliverable format is already specified in Exhibit A.

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[1] Note that if the research employs multiple distinct methods, analyses, etc., the final report can include separate materials/methods, results, and discussion sections to allow for coherent discussion of each set of analyses and findings. However, the executive summary and conclusions sections should synthesize the collective findings of the entire study.

EXHIBIT A2

KEY PERSONNEL

Last Name, First Name	**Institutional Affiliation**	**Role on Project**
Principal Investigator (PI):		
Rodrigues, Jorge	UCD	PI
Co-PI(s) – if applicable:		
Dahlke, Helen	UCD	Co-PI
Horwath, William	UCD	Co-PI
Huang, Laibin	UCD	Project Manager
Other Key Personnel:		
Zhu-Barker, Xia	University of Wisconsin – Madison	Collaborator

EXHIBIT A3

AUTHORIZED REPRESENTATIVES & NOTICES

The following individuals are the authorized representatives for the State and the University under this Agreement. Any official Notices issued under the terms of this Agreement shall be addressed to the Authorized Official identified below, unless otherwise identified in the Agreement.

State Agency Contacts Agency Name: CARB	**University Contacts** University Name: UCD
Contract Project Manager (Technical) Name: Lei Guo Address: Research Division 1001 I Street, 5th Floor Sacramento, CA 95814 Telephone: (279) 208-7831 Email: lei.guo@arb.ca.gov	***Principal Investigator (PI)*** Name: Jorge Rodrigues Address: One Shields Ave. 3308 PES Building Davis, CA 95616 Telephone: (530) 341-4355 Email: jmrodrigues@ucdavis.edu
Authorized Official (contract officer) Name: Alice Kindarara, Branch Chief Address: Acquisitions Branch 1001 I Street, 19th Floor Sacramento, CA 95814 Telephone: (279) 216-0406 Email: alice.kindarara@arb.ca.gov ***Send notices to (if different):*** Name: Renee Carnes Address: Research Division 1001 I Street, 7th Floor Sacramento, CA 95814 Telephone: (279) 208-7754 Email: renee.carnes@arb.ca.gov	***Authorized Official*** Name: Grace Liu, Associate Director Address: Sponsored Programs Office 1850 Research Park Drive, Suite 300 Davis, CA 95618 ***Send notices to (if different):*** Name: Contracts & Grants Analyst Address: Sponsored Programs Office 1850 Research Park Drive, Suite 300 Davis, CA 95618 Telephone: (530) 754-7700 Email: awards@ucdavis.edu

Administrative Contact Name: Renee Carnes Address: Research Division 1001 I Street, 7th Floor Sacramento, CA 95814 Telephone: (279) 208-7754 Email: renee.carnes@arb.ca.gov	***Administrative Contact*** Name: Contracts & Grants Analyst Address: Sponsored Programs Office 1850 Research Park Drive, Suite 300 Davis, CA 95618 Telephone: (530) 754-7700 Email: awards@ucdavis.edu
Financial Contact/Accounting Name: Accounts Payable Address: P.O. Box 1436 Sacramento, CA 95814 Email: AccountsPayable@arb.ca.gov **Send courtesy copy to:** Email: RD.Invoices@arb.ca.gov	***Authorized Financial Contact/Invoicing*** Name: Francisco Andrade, Assistant Manager Address: Contracts & Grants Accounting 1441 Research Park Drive, Suite 206 Davis, CA 95618 Telephone: (530) 754-0604 Email: efa-invoices@ucdavis.edu Designees for invoice certification in accordance with Exhibit C – University Terms and Conditions, Section 14 on behalf of the Financial Contact: 1. Tammy Castelli, tacastelli@ucdavis.edu 2. Lenora Bruce, labruce@ucdavis.edu

EXHIBIT A4

USE OF PREEXISTING INTELLECTUAL PROPERTY & DATA

A. State: Preexisting Intellectual Property (IP)/Data to be provided to the University from the State or a third party for use in the performance in the Scope of Work.

☒ None

B. University: Restrictions in Preexisting IP/Data included in Deliverables identified in Exhibit A1, Deliverables.

☒ None or ☐ List:

C. Anticipated restrictions on use of Project Data.
If the University PI anticipates that any of the Project Data generated during the performance of the Scope of Work will have a restriction on use (such as subject identifying information in a data set), then list all such anticipated restrictions below. If there are no restrictions anticipated in the Project Data, then check “none” in this section.

☒ None or ☐ List:

EXHIBIT A5

RÉSUMÉS / BIOSKETCH

JORGE LUIZ MAZZA RODRIGUES

EDUCATION

University of São Paulo	Agronomical Engineering (*Summa cum laude*)	B.S.	1989
University of São Paulo	Microbiology/Biochemistry (*Summa cum laude*)	M.Sc.	1992
Michigan State University	Crop and Soil Sciences and Environ. Tox.	Ph.D.	2000
University of São Paulo	Soil Microbiology	Postdoctoral	2001-2002
Michigan State University	Microbial Genomics	Postdoctoral	2003-2007

ACADEMIC AWARDS AND HONORS

2022 University of California Davis Faculty Leadership Fellow
2021 *Soil Science Society of America Journal* Outstanding Associate Editor Award
2017 Faculty Fellowship Summer Institute – Israel
2010 International Professorship Award – American Society for Microbiology - Ecuador
1989 "*Luiz de Queiroz*" award (Highest College Award for an Agronomical Engineering Graduate)
"*Grande Oficial Mário Dedini*" award "*Prof. Francisco Tito de Souza Reis*" award
"*Instituto de Engenharia*" award
"*ADEALQ*" award

RESEARCH AND PROFESSIONAL EXPERIENCE

2020/present – Professor (*with tenure*): Department of Land, Air and Water Resources, University of California - Davis.
2016/present – Joint Faculty Member - Environmental Genomics and Systems Biology Division, Lawrence Berkeley National Laboratory, Berkeley.
2014/2019 – Associate Professor (*with tenure*): Department of Land, Air and Water Resources, University of California - Davis.
2008/2013 – Assistant Professor: Department of Biology, University of Texas at Arlington.

RESEARCH ADVISORY AND MENTORING

Visiting Professors: 6
Research Associate Mentees: 8 (1 current)
Graduate Student Advisees: 15 (6 current)
Undergraduate Student Advisees: 43 (3 current)

SYNERGISTIC ACTIVITIES

1. National level services: NSF Panelist for both programs: (1) Ecosystems Science, (2) Organism-Environment Interactions, (3) EPSCoR Research Infrastructure Improvement. *Ad hoc* NSF Proposal Reviewer: (1) Population and Community Ecology, (2) Biodiversity Inventories, (3) Ecosystems Science, (4) Office of International Science and Engineering.
   US Department of Energy – Joint Genome Institute Panels (2014, 2016, and 2017).
   US Department of Agriculture (2020)

2. Reviewing services: Applied and Environmental Microbiology (***Editorial Board***), Frontiers in Systems Microbiology (***Associate Editor***), Soil Science Society of America Journal (***Associate Editor***), mSphere (***Associate Editor***).
3. Public outreach: Microbiology Summer Science Camp, U. Texas (Two weeks hands-on activity for high school from low-income families).
4. 2020 New Voices Story Telling Initiative – Children's Book "The Secret Lives of Scientists, Engineers and Doctors". Publisher: Mascot Books. National Academies of Science, Engineering and Medicine.
5. 2016 Environmental Defense Fund Science Day Speaker, New York, NY.

PUBLICATIONS (*past 4 years*)

1. Danielson RE, ***JLM Rodrigues***. 2022. Impacts of land use change on soil microbial communities in the Amazon. *Advances in Agronomy.* https://doi.org/10.1016/bs.agron.2022.04.001
2. Alves KJ, VS Pylro, CR Nakayama, VG Vital, RG Taketani, DG Santos, ***JLM Rodrigues***, SM Tsai, FD Andreote. 2022. Methanogenic communities and methane emissions from enriched Amazonia soil under land-use change. *Microbiological Research* https://doi.org/10.1016/j.micres.2022.127178
3. Wang D, JY Lin, JM Sayre, R Schmidt, SJ Fonte, ***JLM Rodrigues***, K Scow. 2022. Compost amendment and cover cropping maintains soil structure and associated C storage by increasing available C and microbial biomass in agricultural soil – a six year field study. *Geoderma* https://doi.org/10.1016/j.geoderma.2022.116117
4. Venturini AM, JB Gontijo, A Franca, J Moura, K Nusslein, B Bohannan, ***JLM Rodrigues***, SM Tsai. 2022. Metagenomes from Eastern Brazilian Amazonian floodplains in wet and dry seasons. *Microbiology Research Announcements* https://doi.org/10.1128/mra.00432-22
5. Goss-Souza D, SM Tsai, ***JLM Rodrigues***, O Klauberg-Filho, P Sousa, D Baretta, LW Mendes. 2022. Biogeographic responses and niche occupancy of microbial communities following long-term land-use change. *Antonie van Leeuvenhoek* https://doi.org/10.1007/s10482-022-01761-5
6. Souza L, DA Obregon, L Domeignoz-Horta, F Gomes, C Almeida, L Merloti, L Mendes, FD Andreote, B Bohannan, ***JLM Rodrigues***, K Nusslein, SM Tsai. 2022. Maintaining grass coverage increases methane uptake in Amazonian pasture soils. *Science of the Total Environment.* http://dx.doi.org/10.1016/j.scitotenv.2022.156225
7. Venturini AM, NMS Dias, JB Gontijo, CA Yoshiura, FS Paula, FM Nakamura, KM Meyer, AG Franca, CD Borges, J Barlow, E Beringer, KR Nusslein, ***JLM Rodrigues***, BJM Bohannan, SM Tsai. 2022. Increased soil moisture exacerbates the impacts of forest-to-pasture conversion on methane emissions and methane-cycling communities in the Eastern Amazon. *Environmental Research.* https://doi.org/10.1016/j.envres.2022.113139
8. Ghotbi M, A Durrer, K Frindte, WR Horwath, ***JLM Rodrigues***, I Danso, C Knief. 2022. Topographic attributes override impacts of agronomic practices on prokaryotic community structure. *Appl. Soil Ecol.* https://doi.org/10.1016/j.apsoil.2022.104446
9. Lazicki P, ***JLM Rodrigues***, D Geisseler. 2022. Acid stress and compost differentially affect microbial carbon and nitrogen cycling functions in an agricultural soil. *Appl. Soil Ecol.* **169:** https://doi.org/10.1016/j.apsoil.2021.104219
10. Hodson AK, JM Sayre, MCCP Lyra, ***JLM Rodrigues***. 2021. Influence of recycle compost on soil food webs, nutrient cycling, and tree growth in a young almond orchard. *Agronomy* https://doi.org/10.3390/agronomy11091745
11. Yoshiura CA, LPP Braga, AM Venturini, AG da Franca, MCCP de Lyra, SM Tsai, ***JLM Rodrigues***. 2021. Influence of inputs combination on the microbial structure of the maize rhizosphere for greenhouse gas fluxes mitigation. *Frontiers in Plant Science.* doi:10.3389/fpls.2021.683658
12. Durrer A, AJ Margenot, LCR Silva, BJM Bohannan, K Nusslein, FD Andreoti, J van Haren, SJ Parikh,

and ***JLM Rodrigues***. 2021. Beyond total carbon costs: Land use change alters soil carbon cycling in the Amazon. *Biogeochemistry* https://doi.org/10.1007/s10533-020-00743-x

13. Lazicki P, ***JLM Rodrigues***, D Geisseler. 2021. Sensitivity and variability of soil health indicators in a Mediterranean crop system. *Soil Science Society of America J* doi: 10.1002/saj2.20278
14. Gontijo J, A Venturini, C Yoshiura, C Borges, JM Moura, B Bohannan, K Nusslein, ***JLM Rodrigues***, FS Paula, SM Tsai. 2021. Seasonal dynamics of methane cycling microbial communities in Amazonian floodplain sediments. *Mol. Ecol.* https://doi.org/10.1111/mec.15912
15. Jesus HE, A Enrich-Prast, SSM Paiva, RS Peixoto, RS Carreira, C Massone, ***JLM Rodrigues***, CK Lee, C Craig, AS Rosado. 2021. Microbial succession under freeze-thaw cycle events for hydrocarbon degradation in a nutrient-amended Antarctic soil. *Microorganisms* https://doi.org/10.3390/microorganisms9030609
16. Wang L, H Chen, J Wu, L Huang, PC Brookes, ***JLM Rodrigues***, J Xu, X Liu. 2021. Effects of magnetic biochar-microbe composite of Cd remediation and microbial responses in paddy soil. *J. Hazardous Materials* https://doi.org/10.1016/j.jhazmat.2021.125494
17. Zhang L, B Ma, C Tang, H Yu, X Lv, ***JLM Rodrigues***, RA Dahlgren, J Xu. 2021. Habitat heterogeneity induced by pyrogenic organic matter in wildfire-perturbed soils mediates bacterial community assembly processes. *ISME J.* https://www.nature.com/articles/s41396-021-00896-z
18. He Liyuan, DA Lipson, ***JLM Rodrigues***, M Mayes, RG Bjork, B Glaser, J Rinklebe, X Xu. 2021. Simulating fungal and bacterial biomass dynamics in natural ecosystems: site-level applications of the CLM-Microbe model. *J Adv. Model. Earth Syst.* https://doi.org/10.1029/2020MS002283
19. Nayfach S, S Roux, R Seshadri, D Udwary, N Varghese, F Schulz, D Wu, D Paez-Espino, IMG/M Data Consortium (***JLM Rodrigues***). 2020. A genomic catalogue of Earth's microbiome. *Nature Biotechnology.* https://doi.org/10.1038/s41587-020-0718-6
20. Kroeger ME, L Meredith, KM Meyer, K Webster, J van Haren, S Saleska, BJM Bohannan, ***JLM Rodrigues***, K Nusslein. 2020. Rainforest-to-pasture conversion activates soil methanogenesis across the Brazilian Amazon. *ISME J.* https://doi.org/10.1038/s41396-020-00804-x
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23. He L, ***JLM Rodrigues***, NA Soudzilovskaia, M Barcelo, PA Olsson, C Song, L Tedersoo, F Yuan, D Lipson, X Xu. 2020. Global biogeography of fungal and bacterial biomass carbon in topsoil. *Soil Biol. Biochem*. https://doi.org/10.1016/j.soilbio.2020.108024
24. Lin JY and ***JLM Rodrigues***. 2020. Genus *Geminisphaera*. *In:* Oren A. Bergey's Manual of Systematics of Archaea and Bacteria. John Wiley & Sons, Inc. New Jersey
25. Mirza BS, DJ McGlinn, BJM Bohannan, K Nusslein, JM Tiedje, ***JLM Rodrigues***. 2020. Diazotrophs show sign of restoration in Amazon rainforest soils with ecosystem rehabilitation. *Appl. Environ. Microbiol.* 10:e000195-20. https://doi.org/10.1128/AEM.00195-20
26. Schmidt JE, ***JLM Rodrigues***, VL Brisson, A Kent, ACM Gaudin. 2020. Impacts of maize evolution on rhizobiome assembly in contrasting agricultural soils. *Soil. Biol. Biochem.* https://doi.org/10.1016/j.soilbio.2020.107794

27. Hoda R, M Sattler, MDS Houssain, ***JLM Rodrigues***. 2020. Boosting landfill gas production from lignin-containing wastes via termite hindgut microorganism. *Waste Management* https://www.sciencedirect.com/science/article/pii/S0956053X20300659
28. Parsons LS, JM Sayre, C Ender, ***JLM Rodrigues***, A Barberan. 2020. Plant-soil microbial feedbacks in restored and unrestored coastal dune ecosystems in California. *Restoration Ecol.* **28:**S311-S321. https://onlinelibrary.wiley.com/doi/full/10.1111/rec.13101
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30. Goss-Souza D, LW Mendes, ***JLM Rodrigues***, SM Tsai. 2019. Ecological processes shaping bulk and rhizosphere microbiome assembly in a long-term Amazon forest-to-agriculture conversion. *Microb. Ecol.* https://doi.org/10.1007/s00248-019-01401-y
31. Sjöling S, van Elsas JD, Andreote FD, ***JLM Rodrigues***. 2019. **Soil metagenomics: deciphering the soil microbial gene pool.** Book Chapter *In:* van Elsas, Trevors, Rosado, and Nanniplerl. Modern Soil Microbiology, 3rd Edition, CRC Press.
32. Goss-Souza D, LW Mendes, ***JLM Rodrigues***, SM Tsai. 2019. Amazon forest-to-agriculture conversion alters rhizosphere microbiome composition while functions are kept constant. *FEMS Microbiol. Ecol*. *https://doi.org/10.1093/femsec/fiz009*
33. Khan Md AW, BJM Bohannan, K Nusslein, JM Tiedje, SG Tringe, E Parlade, A Barberan, and ***JLM Rodrigues***. 2018. Network analysis reveals substantial alteration of microbial co-occurrence patterns due to deforestation in the Amazon rainforest. *FEMS Microbiol. Ecol.* *https://academic.oup.com/femsec/article/95/2/fiy230/5211045*
34. Ren H, Q Zhou, J He, Y Hou, ***JLM Rodrigues***, AB Cobb, GWT Wilson, Y Zhang. 2019. Determining landscape-level drivers of variability for over 50 elements. *Sci. Total. Enviro*n. **657:**279-286.
35. Bresciani L, LN Lemos, N Wale, J Lin, A Strauss, M Duffy, and ***JLM Rodrigues***. 2018. Draft genome sequence of the *Candidatus* Spirobacillus cienkowskii, a pathogen of freshwater *Daphnia* species, reconstructed from hemolymph metagenomic reads. *Microbiol. Res. Announ.* **22:**e01175-18.
36. Dai Z, A Enders, ***JLM Rodrigues***, KL Hanley, PC Brookes, J Xu, and J Lehmann. 2018. Fungal taxonomic and functional community composition affected by pyrogenic organic matter in soil ecosystems. *Soil Biol. Biochem.* **126:**159-167.
37. Potisap C, AW Khan, A Boonmee, ***JLM Rodrigues***, S Wongratanacheewin, RW Sermswan. 2018. *Burkholderia pseudomallei*-absent soil bacterial community results in secondary metabolites that kill this pathogen. *Appl. Microbiol. Biotechnol. Express* **8:**136 doi: *10.1186/s13568-018-0663-7* (*Featured Article selected by the Editor*)
38. Kroeger M, T Delmont, AM Eren, J Guo, KM Meyer, K Khan, ***JLM Rodrigues***, BJM Bohannan, JM Tiedje, TM Tsai, CD Borges, K Nusslein. 2018. New biological insights into how deforestation in Amazonia affects soil microbial communities using metagenomics and metagenome-assembled genomes. *Frontiers in Microbiol.* doi: 10.3389/fmecb.2018.01635
39. Larson CA, B Mirza, ***JLM Rodrigues***, SI Passy. 2018. Iron limitation effects on nitrogen-fixing organisms with implications for cyanobacterial harmful algal blooms. *FEMS Microbiol. Ecol.* doi: 10.1093/femsec/fiy046
40. Ren H, W Gui, Y Bai, C Stein, ***JLM Rodrigues***, GWT Wilson, AB Cobb, Y Zhang, G Yang. 2018. Long-term effects of grazing and topography on arbuscular mycorrhizal fungi in semi-arid grasslands. *Mycorrhiza* **28:**117-127.

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Education and Training

College/University	Major	Degree, Year
Cornell University, Biological and Environmental Engineering	Environmental Engineering	PhD 2011
Friedrich-Schiller University of Jena, Germany	Physical Geography	MSc 2004

Research and Professional Experience

Associate Professor in Integrated Hydrologic Sciences — 04/ 2017 – present
Land, Air and Water Resources, University of California, Davis
Assistant Professor in Integrated Hydrologic Sciences — 04/ 2013 – 03/207
Land, Air and Water Resources, University of California, Davis
Postdoctoral Research Associate, Stockholm University, Sweden — 10/2010 – 04/2013

Leadership positions

- Leader of the Strategic Initiative for Water Quantity, Quality, and Security for the Agricultural and Natural Resources Division of the University of California
- Vice-Chair, Department of Land, Air and Water Resources, UC Davis

Synergistic Activities

Panelist for the following research programs: National Science Foundation Graduate Research Fellowship Program (GRFP); National Science Foundation - Hydrologic Sciences Program; USDA NIFA Inter-Disciplinary Engagement in Animal Systems (IDEAS); Water for Agriculture

Technical Advisor: Association of California Water Agency (ACWA) on AB 1427; Association of California Water Agency (ACWA) Groundwater Recharge Workgroup; Sacramento Area Council of Governments (SACOG) to develop a Sustainable Water Management Strategy for Specialty Crop Expansion; State Water Resources Control Board's Division of Water Rights (Division) for the development of a Groundwater Storage and Aquifer Recharge Streamlined Water Rights Permitting; Flood-MAR Research and Data Development (R&DD) Advisory Committee, Water Quality Subcommittee, Cropping System Suitability Subcommittee; Incentives for Groundwater, Wheeler Water Institute, Center for Law, Energy & the Environment at the UC Berkeley School of Law

Associate Editor

Vadose Zone Journal (2017-present), Academic Editor for PLoS ONE (2015-2016)

Honors and Awards

UC Davis Graduate Program Advising and Mentoring Award (2022)
Vadose Zone Journal Outstanding Associate Editor award (2021)
LEAD21 Program Fellow (2020-2021)
USDA ThinkWater Fellow (2017)

Scientific and Public Outreach

- Congressional science briefing titled 'Water security in the West: A science briefing on water for people and nature' in Washington D.C to inform members of congress, DOI, USDA, Office of Management and Budget, Congressional Research Service, U.S. Global Change Research Program on water, climate change and agricultural groundwater banking in California (25-26 Oct. 2016)

- I have given over 100 presentations on agricultural managed aquifer recharge in the past 5 years

Publications last 4 years

- Levintal, E., Huang, L., Garcia C.P., Coyotl, A., Fidelibus, M.W., Horwath, W.R., Rodrigues, J.L.M. and **H.E. Dahlke**. 2023. Nitrogen fate during agricultural managed aquifer recharge: Linking plant response, hydrologic, and geochemical processes. Science of the Total Environment. http://dx.doi.org/10.1016/j.scitotenv.2022.161206
- Ma, X., **Dahlke, H.E.**, Duncan, R., Doll, D., Martinez, P., Lampinen, B., and A. Volder. 2022. Winter flooding recharges groundwater in almond orchards with limited effects on tree root dynamics, growth and yield. California Agriculture, 76(2): 7.
- Levintal, E., Kniffin, M.L., Ganot, Y., Marwaha, N., Murphy, N.P., and **H.E. Dahlke**. Agricultural managed aquifer recharge (Ag-MAR)—a method for sustainable groundwater management: A review. Critical Reviews in Environmental Science and Technology, 1-24.
- Levintal, E., Ganot, Y., Taylor, G., Freer-Smith, P., Suvocarev, K., and **H.E. Dahlke.** 2022. An underground, wireless, open-source, low-cost system for monitoring oxygen, temperature, and soil moisture. Soil, 8(1): 85-97.
- Devine, S.M., **Dahlke, H.E.**, and A.T. O'Geen. 2022. Mapping time-to-trafficability for California agricultural soils after dormant season deep wetting. Soil and Tillage Research, 218: 105316
- Dymond, S.F., Richardson, P.W., Webb, L.A., Keppeler, E.T., Arismendi, I., Bladon, K.D., Cafferata, P.H., **Dahlke, H.E.**, Longstreth, D.L., Brand, P., Ode, P.R. Surfleet, C.G., and J.W. Wagenbrenner. 2021. A field-based experiment on the influence of stand density reduction on watershed processes at the Caspar Creek Experimental Watersheds in Northern California. Frontiers in Forests and Global Change, 4: 99.
- Levintal, E.,Suvocarev, K., Taylor, G., and **H.E. Dahlke**. 2021. Embrace open-source sensors for local climate studies. Nature, 599(7883): 32.
- Murphy, N.P., H. Waterhouse, and **H.E. Dahlke**. Influence of Agricultural Managed Aquifer Recharge on nitrate transport – the role of soil type and flooding frequency. Vadose Zone Journal, https://doi.org/10.1002/vzj2.20150.
- Ganot, Y. and **H.E. Dahlke**. A model for estimating Ag-MAR flooding duration based on crop tolerance, root depth, and soil texture data. Agricultural Water Management, https://doi.org/10.1016/j.agwat.2021.107031.
- Grinshpan, M., Furman, A., **Dahlke, H.E.**, Raveh, E., and Weisbrod, N. 2021. From Managed Aquifer Recharge to Soil Aquifer Treatment on Agricultural Soils: Concepts and Challenges. Agricultural Water Management https://doi.org/10.1016/j.agwat.2021.106991.
- Ganot, Y. and **Dahlke, H.E.**, 2021. Natural and forced soil aeration during agricultural managed aquifer recharge. Vadose Zone Journal, p.e20128, https://doi.org/10.1002/vzj2.20128.
- Waterhouse, H., Arora, B., Spycher, N.F., Nico, P.S., Ulrich, C., **Dahlke, H.E.** and Horwath, W.R., 2021. Influence of Agricultural Managed Aquifer Recharge (AgMAR) and Stratigraphic Heterogeneities on Nitrate Reduction in the Deep Subsurface. Water Resources Research, p.e2020WR029148, https://doi.org/10.1029/2020WR029148.
- Marwaha, N., Kourakos, G., Levintal, E., and **Dahlke, H.E.** 2021. Identifying agricultural managed aquifer recharge locations to benefit drinking water supply in rural communities. Water Resources Research, https://doi.org/10.1029/2020WR028811.
- Liu, Z. Yin, J., **H.E. Dahlke**. 2020. Enhancing Soil and Water Assessment Tool Snow Prediction Reliability with Remote-Sensing-Based Snow Water Equivalent Reconstruction Product for Upland Watersheds in a Multi-Objective Calibration Process. Water, 12(11), p.3190, https://doi.org/10.3390/w12113190.
- Liu, Z., Herman, J.D., Huang, G., Kadir, T. and **Dahlke, H.E.**, 2021. Identifying climate change impacts on surface water supply in the southern Central Valley, California. Science of The Total Environment, p.143429, https://doi.org/10.1016/j.scitotenv.2020.143429.

- Waterhouse, H., Bachand, S., Bachand, P.A.M., Mountjoy, D., Choperena, J., **Dahlke, H.E.**, Horwath, W.R. 2020. Agricultural managed aquifer recharge — water quality factors to consider. California Agriculture 74(3):144-154. https://doi.org/10.3733/ca.2020a0020.
- Pauloo, R., Escriva-Bou, A., **Dahlke, H.**, Fencl, A., Guillon, H. and Fogg, G., 2020. Domestic well vulnerability to drought duration and unsustainable groundwater management in California's Central Valley. Environmental Research Letters. https://doi.org/10.1088/1748-9326/ab6f10.
- Wang, C., Wang, R., Huo, Z., Xie, E., **Dahlke, H.E.** 2020. Colloid transport through soil and other porous media under transient flow conditions - a review. WIREs Water, https://doi.org/10.1002/wat2.1439.
- Waterhouse, H., Bachand, S., Bachand, P.A.M., Mountjoy, D., Choperena, J., **Dahlke, H.E.**, Horwath, W.R. 2020. Considerations for Agricultural Managed Aquifer Recharge on Nitrate and Salt Movement Below the Root Zone in the Kings Groundwater Basin. California Agriculture, https://doi.org/10.3733/ca.2020a0020.
- Devine, S.D, O'Geen, A.T., Liu, H., Jin, Y., **Dahlke, H.E.**, and R.A. Dahlgren. 2020. Terrain attributes and forage productivity predict catchment-scale soil organic carbon stocks. Geoderma, https://doi.org/10.1016/j.geoderma.2020.114286.
- Kourakos, G., **Dahlke, H.E.**, Harter, T. 2019. Increasing Groundwater Availability and Baseflow through Agricultural Managed Aquifer Recharge in an Irrigated Basin. Water Resources Research, https://doi.org/10.1029/2018WR024019.
- Devine, S.D, O'Geen, A.T., Larsen, R.E., **Dahlke, H.E**., Liu, H., Jin, Y., and R.A. Dahlgren. 2019. Microclimate-forage growth linkages across two strongly contrasting precipitation years in a Mediterranean catchment. Ecohydrology, https://doi.org/10.1002/eco.2156.
- Markovich, K.H., **Dahlke, H.E.**, ArumíJ.L., Maxwell, R.M., Fogg, G.E. 2019. Bayesian hydrograph separation in a minimally gauged alpine volcanic watershed in central Chile. Journal of Hydrology. https://doi.org/10.1016/j.jhydrol.2019.06.014.
- Ghasemizade, M., Asante, K., Peterson, C., Kocis, T.N., **Dahlke, H.E.**, Harter, T. 2019. An integrated approach toward groundwater banking in the southern Central Valley, California. Water Resources Research, https://doi.org/10.1029/2018WR024069.
- Wang, C., McNew, C.P., Lyon, S.W., Walter, M.T., Volkmann, T.H.M., Abramson, N., Meira, A., Sengupta, A., Wang, Y., Pangle, L., Troch, P.A., Kim, M. Harman, C., and **Dahlke, H.E.** 2018. Particle tracer transport in a sloping soil lysimeter under periodic, steady state conditions. Journal of Hydrology 569(2): 61-76, doi:10.1016/j.jhydrol.2018.11.050.
- Brunetti, G., Šimůnek, J., Bogena, H., Baatz, R., Huisman, J.A., **Dahlke, H.E.**, Vereecken, H. 2018. On the information content of cosmic-ray neutron data in the inverse estimation of soil hydraulic properties. Vadose Zone Journal 18(1), doi:10.2136/vzj2018.06.0123.
- **Dahlke, H.E.**, LaHue, G.T., Mautner, M.R.L., Murphy, N.P., Patterson, N.K., Waterhouse, H., Yang, F. and Foglia, L. 2018. Managed Aquifer Recharge as a tool to enhance sustainable groundwater management in California: examples from field and modeling studies. In Friesen, J., Sinobas, L.R. (eds.), *Advances in Chemical Pollution, Environmental Management and Protection: Advanced Tools for Integrated Water Resources Management Volume 3*', Elsevier Publishing, 66 pp. https://doi.org/10.1016/bs.apmp.2018.07.003.
- **Dahlke, H.E.** and Kocis, T.N. 2018. Streamflow availability rating identifies high-magnitude flows for groundwater recharge in the Central Valley. California Agriculture Journal, 72(3):162-169. https://doi.org/10.3733/ca.2018a0032.
- Lane, B.A., Sandoval-Solis, S., Stein, E., Yarnell, S., Pasternack, G.B., and **Dahlke, H.E.** 2018. Beyond Metrics? The role of hydrologic baseline archetypes in environmental water management. Environmental Management, 62(4): 678–693.
- McNew, C.P., Wang, C., Walter, M.T., **H.E. Dahlke**. 2018. Fabrication, Detection, and Analysis of DNA-labeled PLGA Particles for Environmental Transport Studies. Journal of Colloid and Interface Science, https://doi.org/10.1016/j.jcis.2018.04.059.

- Wang, C., Parlange, J.-Y., Schneider, R.L., **Dahlke, H.E.**, M.T. Walter. 2018. Explaining and modeling the concentration and loading of Escherichia coli in a stream—A case study. Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2018.04.036.
- **Dahlke, H.E.**, Brown, A.G., Orloff, S., Putnam, S., A. O'Geen. 2018. Managed winter flooding of alfalfa recharges groundwater with minimal crop damage. California Agriculture, 72(1).

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Education

1993 Ph.D. Soil Science, College of Agriculture, Department of Crop and Soil Sciences, Michigan State Univ., E. Lansing, MI.
1993 Ph.D. Forest Ecology, College of Agriculture, Department of Forestry, Michigan State Univ., E. Lansing, MI.
1979 B.S. Forestry Environmental Impact Assessment, College of Agriculture, Department of Forestry, Southern Illinois University, Carbondale, IL.

Positions Held:

- Editor, Soil Science Society of America Journal, 2019-present
- Chair, Department of Land, Air and Water Resources, UC Davis, 2018-present
- Editor Developments in Soil Science, Elsevier 2016- present
- Board of Directors, Soil Science Society of America, 2016 to present
- Vice Chairman, Soils and Biogeochemistry Program, 2016 to 2018
- Editor, Elsevier Development in Soil Science Series, 2015 to present
- Technical Editor, Soil Science Society of America Journal 2014 to 2019
- Master Faculty Advisor, Sustainable Agriculture and Food Systems major 2014 to present
- Faculty track advisor Sustainable Agriculture and Food Systems major 2011 to present
- Chairman of the Board, Protected Harvest, 2012 to 2019
- Chairman Agriculture and Environmental Chemistry Graduate Group 7/10 to 2016
- J. G. Boswell Endowed Chair in Soil Science, 2008 to present
- Associate Editor, Soil Science Society of America Journal 2006 to 2012 to present
- Vice Chairman Dept. Land, Air and Water Resources, 2007 to2010
- Associate Editor, Environmental Soil Science Journal 2006 to 2009
- Professor of Soil Biogeochemistry, University of California, Davis, CA. 7/04 to present
- Assoc. Professor of Soil Biogeochemistry, University of California, Davis, CA.7/00 to 6/04
- Assist. Professor of Soil Biogeochemistry, University of California, Davis, CA.7/96 to 6/00
- Research Soil Microbiologist, USDA ARS, Corvallis, OR.10/94 to 5/96
- Faculty Research Associate, Oregon State University, Corvallis, OR. 11/92 to 9/94
- Graduate Research Assistant, Michigan State University, E. Lansing, MI. 9/88 to 10/92
- Research Specialist, Michigan State University. 11/85 to 9/88
- Staff Research Associate, University of California at Berkeley, CA 4/83 to 10/85
- Forestry Apprentice, German Academic Exchange Service, Munich, Germany. 6/79 to 6/80

Awards and Distinctions

- Patrick Henry Memorial Lectureship, Soil Science Society of America, 2019
- Distinguished Visiting Scholar, Chinese Academy of Science, 2016 to present

- Professor Pran Kumar De Memorial Lecturer and Award, Indian Soil Science Society, 2013
- Soil Science Society of America, Fellow, 2009
- J. G. Boswell Endowed Chair in Soil Science, 2008
- NSM/MARC Scholar 2002 California State University
- Outstanding Conduct and Merit 1996, USDA Agricultural Research Service
- Outstanding Conduct and Merit 1995, USDA Agricultural Research Service

Publications (out of 277)

1. Mitra Ghotbi, Ademir Durrer, Katharina Frindte, William R. Horwath, Jorge L. Mazza Rodrigues, IsaacDansoe, Claudia Knief. 2022. Topographic attributes override impacts of agronomic practices on prokaryotic community structure. Applied Soil Ecol. 175: 104446.
2. Rongzhong Ye, William R Horwath. 2022. Greenhouse gas emissions in wetland rice systems. In: Multi-Scale Biogeochemical Processes in Soil Ecosystems: Critical Reactions and Resilience to Climate Changes. Eds., Yu Yang, Marco Keiluweit, Nicola Senesi, Baoshan Xing. John Wiley and Sons. Pp. 141-155.
3. Ellison, RJ and WR Horwath. 2021. Reducing greenhouse gas emissions and stabilizing nutrients from dairy manure using chemical coagulation. Journal of Environmental Quality 50 (2), 375-383
4. Ding, X, B Zhang, Q Chen, H He, WR Horwath, X Zhang. 2021. Grassland conversion to cropland decreased microbial assimilation of mineral N into their residues in a Chernozem soil. Biology and Fertility of Soils 57, 913-924
5. Cynthia M Crézé, William R Horwath. 2021. Cover Cropping: A Malleable Solution for Sustainable Agriculture? Meta-Analysis of Ecosystem Service Frameworks in Perennial Systems. Agronomy 11: 862 https://doi.org/10.3390/agronomy11050862
6. Hannah Waterhouse, Bhavna Arora, Nicolas F Spycher, Peter S Nico, Craig Ulrich, Helen E Dahlke, William R Horwath. 2021. Influence of Agricultural Managed Aquifer Recharge (AgMAR) and Stratigraphic Heterogeneities on Nitrate Reduction in the Deep Subsurface. Water Resources Research https://doi.org/10.1029/2020WR029148
7. Mengyang You, Xia Zhu-Barker, Timothy A Doane, William R Horwath. 2021. Decomposition of Carbon Adsorbed on Iron (III)-Treated Clays and Their Effect on the Stability of Soil Organic Carbon and External Carbon Inputs. Biogeochemistry https://doi.org/10.21203/rs.3.rs-300654/v1
8. Ruoya Ma, Jianwen Zou, Zhaoqiang Han, Kai Yu, Shuang Wu, Zhaofu Li, Shuwei Liu, Shuli Niu, William R Horwath, Xia Zhu-Barker. 2021. Global soil-derived ammonia emissions from agricultural nitrogen fertilizer application: A refinement based on regional and crop-specific emission factors. Global Change Biology 27: 855-867.
9. Mengyang You, Lu-Jun Li, Qing Tian, Peng He, Guiping He, Xiang-Xiang Hao, William R Horwath. 2020. Residue decomposition and priming of soil organic carbon following different NPK fertilizer histories. Soil Sci. Soc. AM. J. https://doi.org/10.1002/saj2.20142
10. Hannah Waterhouse, Sandra Bachand, Daniel Mountjoy, Joseph Choperena, P Bachand, H Dahlke, W Horwath. 2020. Agricultural managed aquifer recharge—water quality factors to consider. California Agriculture 74: 144-154.
11. Zheng, Yajing, Yaguo Jin, Ruoya Ma, Delei Kong, Xia Zhu-Barker, William R Horwath, Shuli Niu, Hong Wang, Xin Xiao, Shuwei Liu, Jianwen Zou. Drought shrinks terrestrial upland resilience to climate change. Global Ecology and Biogeography 29: 1840-1851.
12. Ding, X, S Chen, B Zhang, H He, TR Filley, WR Horwath. 2020. Warming yields distinct accumulation patterns of microbial residues in dry and wet alpine grasslands on the Qinghai-Tibetan Plateau

- Biology and Fertility of Soils. https://doi.org/10.1007/s00374-020-01474-9

13. Correa-Díaz, A, A Gómez-Guerrero, JJ Vargas-Hernández, P Rozenberg, WR Horwath. 2020. Long-Term Wood Micro-Density Variation in Alpine Forests at Central México and Their Spatial Links with Remotely Sensed Information. Forests 11:452
14. McDaniel, MD, DT Walters, LG Bundy, X Li, RA Drijber, John E Sawyer, Michael J Castellano, CAM Laboski, PC Scharf, WR Horwath. 2020. Combination of biological and chemical soil tests best predict maize nitrogen response. Agronomy Journal. https://doi.org/10.1002/agj2.20129.
15. Correa-Díaz, A., LCR Silva, WR Horwath, A Gómez-Guerrero, J Vargas-Hernández, J Villanueva-Díaz, J Suárez-Espinoza, A Velázquez-Martínez. 2020. From trees to ecosystems: Spatiotemporal scaling of climatic impacts on montane landscapes using dendrochronological, isotopic and remotely-sensed data. Global Biogeochemical Cycles. e2019GB006325
16. You, M., X. Han X., Chen J., Yan N., Li W., Zou X., Lu Y. Li and W. R. Horwath. 2019. Effect of reduction of aggregate size on the priming effect in a Mollisol under different soil managements. European Journal of Soil Science. https://doi.org/10.1111/ejss.12818.
17. Shaaban, M., Qian Peng, Saqib Bashir, Yupeng Wu, Aneela Younas, Xiangyu Xu, Mehran Razaei Rashti, Muhammad Abid, Muhammad Zafar-ul-Hye, Avelino Núñez-Delgado, William R Horwath, Yanbin Jiang, Shan Lin, Ronggui Hu. 2019. Restoring effect of soil acidity and Cu on N_2O emissions from an acidic soil. Journal of environmental management. 250:109535-.
18. Castruita-Esparza, L. U., L. C.R. Silva, A. Gómez-Guerrero, J. Villanueva-Díaz A. Correa-Díaz, W. R. Horwath. 2019. Coping With Extreme Events: Growth and Water-Use Efficiency of Trees in Western Mexico During the Driest and Wettest Periods of the Past One Hundred Sixty Years. JGR Biogeosciences. https://doi.org/10.1029/2019JG005294.
19. Zhu-Barker, X., M. Easter, A. Swan, M. Carlson, L. Thompson, W. R. Horwath, K. Paustian, K. L. Steenwerth. 2019. Soil Management Practices to Mitigate Nitrous Oxide Emissions and Inform Emission Factors in Arid Irrigated Specialty Crop Systems. 3:76-
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34. Wang, Z, Y Meng, X Zhu-Barker, X He, WR Horwath, H Luo, Y Zhao. 2019. Responses of nitrification and ammonia oxidizers to a range of background and adjusted pH in purple soils. Geoderma 334, 9-14.
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36. Williams, SR, X Zhu-Barker, S Lew, BJ Croze, KR Fallan, WR Horwath. 2019. Impact of Composting Food Waste with Green Waste on Greenhouse Gas Emissions from Compost Windrows. Compost Science & Utilization, 1-11.
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39. Kuzyakov, Y, WR Horwath, M Dorodnikov, E Blagodatskaya. 2018. Review and synthesis of the effects of elevated atmospheric CO2 on soil processes: No changes in pools, but increased fluxes and accelerated cycles. Soil Biology and Biochemistry https://doi.org/10.1016/j.soilbio.2018.10.005.
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44. Deng, J, C Li, M Burger, WR Horwath, D Smart, J Six, L Guo, W Salas, 2018. Assessing Short-Term Impacts of Management Practices on N2O Emissions From Diverse Mediterranean Agricultural

Ecosystems Using a Biogeochemical Model. Journal of Geophysical Research: Biogeosciences 123 (5), 1557-1571.
45. Maxwell, TM, LCR Silva, WR Horwath. 2018. Integrating effects of species composition and soil properties to predict shifts in montane forest carbon–water relations. Proceedings of the National Academy of Sciences 115 (18), E4219-E4226.
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47. Li, LJ, X Zhu-Barker, R Ye, TA Doane, WR Horwath. 2018. Soil microbial biomass size and soil carbon influence the priming effect from carbon inputs depending on nitrogen availability. Soil Biology and Biochemistry 119, 41-49.
48. Wade, J, H Waterhouse, LM Roche, WR Horwath. 2108. Structural equation modeling reveals iron (hydr) oxides as a strong mediator of N mineralization in California agricultural soils. Geoderma 315, 120-129.
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50. Stumpner, EB, TEC Kraus, YL Liang, SM Bachand, WR Horwath, ... 2018. Sediment accretion and carbon storage in constructed wetlands receiving water treated with metal-based coagulants. Ecological Engineering 111, 176-185.
51. Kuzyakov, Y, WR Horwath, M Dorodnikov, E Blagodatskaya. 2018. Effects of Elevated CO2 in the Atmosphere on Soil C and N Turnover. Developments in Soil Science 35, 207-219.
52. Horwath, WR, Y Kuzyakov. 2018. The Potential for Soils to Mitigate Climate Change Through Carbon Sequestration. Developments in Soil Science 35, 61-92.
53. Correa-Diaz, Arian, Armando Gomez-Guerrero, Jose Villanueva-Diaz, Lucas CR Silva, William R Horwath, Luis U Castruita-Esparza, Tomas Martinez-Trinidad, Javier Suarez-Espinosa. 2018. Physiological Response of *Taxodium mucronatum Ten.* to the Increases of Atmospheric CO2 and Temperature in the Last Century. Agroncencia. 52:129-149.
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55. Wolf, Kristina M., Emma E. Torbert, Dennis Bryant, Martin Burger, R. Ford Denison, Israel Herrera, Jan Hopmans, Will Horwath, Stephen Kaffka, Angela Y. Y. Kong, R. F. Norris, Johan Six, Thomas P. Tomich, Kate M. Scow. 2018. The century experiment: the first twenty years of UC Davis' Mediterranean agroecological experiment. Ecology. 99:503-503.
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LAIBIN HUANG

Education and Training
University of Florida, USA
Beijing Normal University, China University of Science and Technology Beijing, China

Academic Awards and Honors
PSA Travel Award, *University of California, Davis* ($400)
Water Institute Graduate Fellowship, University of Florida ($100,000/4yrs)
Best Poster Awards, University of Florida ($500)
MAPUNI-Excellent Graduate Student Scholarship, Beijing Normal University ($500) 2011
First-Class Entrance Scholarship, Beijing Normal University ($3,000/2yrs) Posco Scholarship, University of Science and Technology Beijing ($1,000)
Research and Professional Experience
Postdoctoral Research Associate
Departments of Land, Air and Water Resources, University of California, Davis
Postdoctoral Research Associate 01/2019 – 01/2020 Departments of Crop Sciences, University of Illinois Urbana, Champaign
Postdoctoral Research Associate 10/2017 – 01/2019 Departments of Microbiology and Cell Science, University of Florida

Synergistic Activities
Guest Editor:Physics and Chemistry of the Earth; Science of the Total Environment; Water; Ecohydrology & Hydrobiology; Frontiers in Marine Science.
Reviewer: Microbiome; Environmental Microbiology; mSphere; Microbial Ecology; Science of the Total Environment; Journal of Hazardous Materials; GCB Bioenergy, Geoderma; Environmental Pollution; Chemosphere; Ecological Indicators; Wetlands; Journal of Soils and Sediment.

1. **Publications (***past 4 years***)**
   1. Levintal, E., **Huang**, **L**., García, C. P., Coyotl, A., Fidelibus, M. W., ... Rodrigues, J. L. &
2. Dahlke, H. E., 2023. Nitrogen Fate During Agricultural Managed Aquifer Recharge: Linking Plant Response, Hydrologic, and Geochemical Processes. *Science of the Total Environment,* 864:161206
3. **Huang, L**., Bai, J., Wang J., Zhang G., Wang W., Wang X., Zhang L., Wang Y., Liu X., and Cui B. 2022. Different stochastic processes regulate bacterial and fungal community assembly in estuarine wetland soils. *Soil Biology and Biochemistry***,** 167: 108586.
4. Zhang, G., Bai, J., Tebbe, C.C., **Huang, L**., Jia, J., Wang, W., Wang, X., Yu, L. and Zhao, Q., 2022. Plant invasion reconstructs soil microbial assembly and functionality in coastal salt marshes. *Molecular Ecology*, 31:4478–4494.
5. Yu, L., Bai, J., **Huang, L**., Zhang, G., Wang, W., Wang, X., and Yu, Z. 2022. Carbon-rich substrates altered microbial communities with indication of carbon metabolism functional shifting in a degraded salt marsh of the Yellow River Delta, China. Journal of Cleaner *Production*, 331, 129898.
6. ***Huang, L.,*** *Chakrabarti, S., Cooper, J., Perez, A., John, S., Daroub, S., and Martens- Habbena, W. 2021***.** Ammonia-oxidizing archaea are integral to nitrogen cycling in a highly fertile agricultural soil. *ISME Communications, 1(1), 1-12.*
7. **Huang, L**., Bea, H., Young, C., Pain, A., Martin, J.B., and Ogram, A. 2021. *Campylobacterota* dominate the microbial communities in a tropical karst subterranean estuary, with implications for cycling and export of nitrogen to coastal waters. *Environmental Microbiology,* 23(11), 6749–6763.
8. **Huang, L.,** Zhang G., Bai J., Xia Z., Wang W., Jia J., Wang X., Liu X., and Cui B. 2021. "Desalinization via freshwater restoration highly improved microbial diversity, co- occurrence patterns and functions in coastal wetland soils." *Science of the Total Environment,* 765: 142769.

9. Yu, M., Su, W., **Huang, L**., Parikh, S.J., Tang, C., Dahlgren, R.A., and Xu, J. 2021. Bacterial community structure and putative nitrogen-cycling functional traits along a charosphere gradient under waterlogged conditions. *Soil Biology and Biochemistry*, 162, 108420.
10. Wang, L., Chen, H., Wu, J., **Huang, L.,** Brookesa, P., Rodriguesc, J., Xu, J., and Liu, X. 2021. "Effects of magnetic biochar-microbe composite on Cd remediation and microbial responses in paddy soil." *Journal of hazardous materials,* 44: 125494.
11. Zhang, G.L., Bai, J., Tebbe, C.C., **Huang, L.,** Jia, J., Wang, W., Wang, X., Yu, L., and Zhao, Q. 2020. "Spartina alterniflora invasions reduce soil fungal diversity and simplify co- occurrence networks in a salt marsh ecosystem." *Science of The Total Environment,* 143667.
12. **Huang, L.,** Bai, J., Wen, X., Zhang, G., Zhang, C., Cui, B. and Liu, X. 2020. "Microbial resistance and resilience in response to environmental changes under the higher intensity of human activities than global average level". *Global Change Biology,* 26: 2377-2389.
13. Behnke, G. D., Zabaloy, M. C., Riggins, C. W., Rodríguez-Zas, S., **Huang, L.,** and Villamil, M. B. 2020. "Acidification in corn monocultures favor fungi, ammonia oxidizing bacteria, and nirK-denitrifier groups. " *Science of The Total Environment*, 720(10):137514.
13. **Huang, L.,** Riggins C. W., Rodríguez-Zas S., Zabaloy M. C., and Villamil M. B. 2019. "Long-term N fertilization imbalances potential N acquisition and transformations by soil microbes." *Science of the Total Environment,* 691: 562-571.
14. Pain, A., Martin, J.B., Young, C.R., **Huang, L.**, and Valle-Levison, A. 2019. "Organic carbon quantity and quality across salinity gradients in conduit-versus diffuse flow- dominated subterranean estuaries. " *Limnology & Oceanography*, 64(3): 1368-1402.
15. Bae, H., **Huang, L.**, White, J., Wang, J., Delaune, R., and Ogram, A. 2018. "Response of microbial populations regulating nutrient biogeochemical cycles to oiling of coastal saltmarshes from the Deepwater Horizon oil spill." *Environmental pollution,* 241, 136-147.

XIA ZHU-BARKER
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Dept. of Soil Science, University of Wisconsin-Madison, Madison, WI. zhubarker@wisc.edu

(a) Professional Preparation

College/University	*Major*	*Degree, Year*
Northeast Agricultural University	Agricultural Resources and Environment	B.S. 2006
Chinese Academy of Sciences	Ecology	M.Sc. 2009
Chinese Academy of Sciences	Soil Biogeochemistry & Nutrient Cycling	Ph.D. 2013
University of California-Davis	Nitrogen Cycling and Greenhouse Gas	Postdoc 2013-2015

(b) Employment

2022- Assistant Professor. Department of Soil Science, University of Wisconsin-Madison, Madison, WI

2019- 2022 Professional Researcher. Department of Land, Air and Water Resources, University of California-Davis

2015- 2019 Project Scientist. Department of Land, Air and Water Resources, University of California-Davis

2013 – 2015 Postdoctoral Researcher. Department of Land, Air and Water Resources, University of California-Davis

(c) Synergistic Activities

Panelist for the following research programs: National Science Foundation Graduate Research Fellowship Program (GRFP); CDFA Healthy Soil Program; CDFA Specialty Crop Block Grant.

Board member: Soil Science Society of America. Associate editor of the Journal of Environmental Quality; Guest editor of Soil Science Society of America Journal; The Journal of Frontiers Agronomy

Other Services: Geoscience Congressional Visit; Journal Reviewer; Committee member for SSSJ outstanding paper award, SSSA society-wide competition; SSSA early career award; SSSA-SSSC workshop; SSSA science policy; SSSA Encompass scholars diversity program; SSSA stand-alone meeting.

(d) Fellowships & Awards

1. Excellent Young Scientist Award *2016*. Association of Soil Plant Scientists in America.
2. Ministry of Agriculture China Talents Travel Award, *2014*. $5,000.
3. Chinese Academy of Sciences President Award, *July 2013*. $ 1000.
4. Outstanding Student Paper Award *in American Geophysical Union, December 2012.*
5. The first-place winner of poster competition at the *WSSSA, June 2012.* $200.
6. Chinese Oversea Scholarship, *June 2010*. $40,000.

PUBLICATIONS IN PAST FOUR YEARS:

1. Li, N., L. Li, X. Zhu-Barker, Y. Cheng, J. Liu, and S. Chang. 2022. Foreward: Degradation and evolu- tion of Mollisols under different management practices and climate change. ***Soil Sci. Soc. Am. J.*,** 1-4. http://doi.org/10.1002/saj2.20481
2. Quantifying biological processes producing nitrous oxide in soil using a mechanistic model. Baoxuan Chang, Zhifeng Yan, Xiaotang Ju, Xiaotong Song, Yawei Li, Siliang Li, Pingqing Fu, Xia Zhu-Barker[+]. 2022. ***Biogeochemistry***: 1-14.
3. Mengyang You, Xia Zhu-Barker[*+], Timothy Doane, William Horwath. Decomposition of Carbon Adsorbed on Iron (III)-Treated Clays and Their Effect on the Stability of Soil Organic Carbon and External Carbon Inputs. 2022. ***Biogeochemistry***. 157(2): 259-270.
4. Cristina Lazcano, Xia Zhu-Barker, Charlotte Decock. Effects of Organic Fertilizers on the Soil Microorganisms Responsible for N_2O Emissions: A Review. 2021. ***Microorganisms***, 9(5).

5. Mengyang You, Xia Zhu-Barker, Xiang-Xiang Hao, Lu-Jun Li. Profile distribution of soil organic carbon and its isotopic value following long term land-use changes. 2021. ***Catena***. 207.
6. Xiaoyun Zhan, Jun Zhao, Xia Zhu-Barker, Junfeng Shui, Baoyuan Liu, Minghang Guo. An instrument with constant volume approach for in-situ measurement of surface runoff and suspended sediment concentration. ***Water Resources Research***. e2020WR028210. 2021
7. Ruoya Ma, Jianwen Zou, Zhaoqiang Han, Kai Yu, Shuang Wu, Zhaofu Li, Shuwei Liu, Shuli Niu, William R Horwath, Xia Zhu-Barker[+]. Global soil-derived ammonia emissions from agricultural nitrogen fertilizer application: a refinement based on regional and crop-specific emission factors. ***Global Change Biology***, 2021. https://doi.org/10.1111/gcb.15437
8. BJL Pitton, RY Evans, X Zhu-Barker[+], LR Oki. Greenhouse Gas Emissions and Global Warming Potential from a Woody Ornamental Production System Using a Soilless Growing Substrate. ***ACS Agricultural Science & Technology,*** 2021. https://doi.org/10.1021/acsagscitech.0c00039
9. Xu Chen; Xiaozeng Han; Jun Yan; XinChun Lu; Xiangxiang Hao; Wei Wang; Asim Biswas; Xia Zhu-Barker[+], Wenxiu Zhou. Land use and mineral fertilization influence soil microbial biomass and residues: A case study of a Chinese Mollisol. ***European Journal of Soil Biology***, 2020, 103216
10. Zheng, Yajing; Jin, Yaguo; Ma, Ruoya; Kong, Delei; Zhu-Barker, Xia; Horwath, William; Niu, shuli; Wang, Hong; Xiao, Xin; Liu, Shuwei; Zou, Jianwen. Drought shrinks the terrestrial upland resilience to climate change. ***Global Ecology and Biogeography***, 2020, 00: 1-12. DOI: 10.1111/geb.13160
11. R Ma, W Zhao, Y Zhao, Z Wang, X Zhu-Barker[+], AL Wright, X Jiang. Land use pattern effects after 30 years of shifting cropland to fallow land on soil ammonia-oxidizer community. ***Applied Soil Ecology***, 2020, 156, 103707
12. Xia Zhu-Barker*, Mark Easter, Amy Swan, Mary Carlson, Lucas Thompson, William R Horwath, Keith Paustian, Kerri L Steenwerth. Soil Management Practices to Mitigate Nitrous Oxide Emissions and Inform Emission Factors in Arid Irrigated Specialty Crop Systems. ***Soil Systems***, 2019, 3, 76; doi:10.3390/soilsystems3040076
13. Lu-Jun Li, Rongzhong Ye, Xia Zhu-Barker, William R Horwath. Soil Microbial Biomass Size and Nitrogen Availability Regulate the Incorporation of Residue Carbon into Dissolved Organic Pool and Microbial Biomass. ***Soil Science Society of America Journal.*** 2019, doi:10.2136/sssaj2018.11.0446.
14. Shuling Wang, Sarwee J. Faeflen, Alan L. Wright, Xia Zhu-Barker[+], Xianjun Jiang. Redox-driven shifts in soil microbial community structure in the drawdown zone after construction of the Three Gorges Dam. ***Soil Ecology Letters***, 2019, 1-12
15. Zhihui Wang, Yanqiang Cao, Xia Zhu-Barker[+], Graeme W Nicol, Alan L Wright, Zhongjun Jia, Xianjun Jiang. Comammox Nitrospira clade B contributes to nitrification in soil. ***Soil Biology & Biochemistry***. 2019, 135, 392-395.
16. Sequoia Williams, Xia Zhu-Barker*[#], Benjamin James Croze, Kenna R Fallan, Stephanie Lew, William R. Horwath. Impact of Composting Food Waste with Green Waste on Greenhouse Gas Emissions from Compost Windrows. ***Compost Science & Utilization***, 2019, 1-11
17. Zhihui Wang, Yao Meng, Xia Zhu-Barker[+], Xinhua He, William R Horwath, Hongyan Luo, Yongpeng Zhao, Xianjun Jiang. Responses of nitrification and ammonia oxidizers to a range of background and adjusted pH in purple soils. ***Geoderma***. 2019, 334, 9-14.
18. Xueru Huang, Jun Zhao, Jing Su, Zhongjun Jia, Xiuli Shi, Alan L Wright, Xia Zhu-Barker[+], Xianjun Jiang. Neutrophilic bacteria are responsible for autotrophic ammonia oxidation in an acidic forest soil. ***Soil Biology & Biochemistry***. 2018, 119, 83-89.

19. Lu-Jun Li, Xia Zhu-Barker*, Rongzhong Ye, Timothy A. Doane, William R. Horwath. Soil microbial biomass size and soil carbon influence the priming effect from carbon inputs depending on nitrogen availability. ***Soil Biology & Biochemistry***. 2018, 119, 41-49.
20. Xiu-Zhen Shi, Hang-Wei Hu, Xia Zhu-Barker[+], Helen Hayden, Jun-Tao Wang, Helen Suter, Deli Chen, Ji-Zheng He. Nitrifier-induced denitrification is an important source of soil nitrous oxide and can be inhibited by a nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP). ***Environmental Microbiology***. 2017, doi: 10.1111/1462-2920.13872.
21. Shan-Shan Dai, Lu-Jun Li, Rongzhong Ye, Xia Zhu-Barker[+], William R. Horwath. The temperature sensitivity of organic carbon mineralization is affected by exogenous carbon inputs and soil organic carbon content. ***European Journal of Soil Biology.*** 2017, 81, 69-75.
22. Geng Sun, Xia Zhu-Barker, Dongming Chen, Lin Liu, Nannan Zhang, Changguang Shi, Liping He, Yanbao Lei. Responses of root exudation and nutrient cycling to grazing intensities and recovery practices. ***Plant and Soil***. 2017, 1-11.
23. Xia Zhu-Barker*, Shannon Bailey, Kyaw Tha Paw U, Martin Burger, William R Horwath. Greenhouse gas emissions from compost pile. ***Waste Management.*** 2017, 59, 70-79.

EXHIBIT A6

CURRENT & PENDING SUPPORT

PI: Jorge Rodrigues

Status	Award #	Source	Project Title	Start Date	End Date
Proposed Project	22RD036	CARB	Quantifying and Identifying the Potential Causes of Nitrous Oxide Emissions in California Soils Under Fumigation	6/1/2023	7/31/2024
Active	21-21SBPS_2-0037	NASA	Growing Food on Mars: Determining the impact of radiation, atmospheric composition, and rock substrate on plant growth in a Space Rock Garden Experiment	2023	2024
Active	23-0447	Sandia Natl. Laboratory	Volatile organic carbon in Amazon pastures under warmer climate conditions	2022	2023
Active	2022-2722	American Vineyard Foundation	Soil Health in Vineyards	2022	2023
Active	58-2032-1-037	US Department of Agriculture	Acquisition of Goods and Services	2022	2023
Active	2021-67021-34493	US Department of Agriculture	Breaking the lignin barrier with termite TAV5 treatment technology (T4)	2021	2023
Active	2121-38420-34070-0	US Department of Agriculture	Science to Practice Leadership training in the Soil-Plant Health Continuum	2021	2026

Co-PI: Helen Dahlke

Status	Award #	Source	Project Title	Start Date	End Date
Proposed Project	22RD036	CARB	Quantifying and Identifying the Potential Causes of Nitrous Oxide Emissions in California Soils Under Fumigation	6/1/2023	7/31/2024

Active	2021-69012-35916	US Department of Agriculture	Securing a Climate Resilient Water Future for Agriculture and Ecosystems through Innovation in Measurement, Management, and Markets.	2021	2025
Active	2021680124	US Department of Agriculture	Sustainability of Groundwater and Irrigated Agriculture in the Western United States under a Changing Climate.	2021	2025
Active	4600014606	CDWR	Upper watershed hydrology assessment using GIS and Remote Sensing	2021	2025
Active	84046301	US EPA	Life-cycle Analysis to Support Cost-effective Enhanced Aquifer Recharge	2021	2025
Active	NR203A750023C017	US Department of Agriculture	Managed Aquifer Recharge Strategies to Sustain Irrigated Agriculture.	2020	2024
Active	1716130	NSF	The dynamics of rural poverty, land use, and water in California's changing Central Valley	2017	2023

Co-PI: William Horwath					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Proposed Project	22RD036	CARB	Quantifying and Identifying the Potential Causes of Nitrous Oxide Emissions in California Soils Under Fumigation	6/1/2023	7/31/2024
Active		CDFA	Developing cover cropping systems for California walnut to tighten N cycle, save water and increase soil health.	2019	2023
Active		CDFA	Evaluation of certified organic fertilizer mineralization for long-term nutrient planning.	2022	2023
Active		CARB	Liquid and Soil Sample Collection and Analyses of Dairy Digestate and Lagoon Effluent during Storage and Land Application Phases.	2022	2025
Active		US Department of Agriculture	Application of vermicompost to improve agricultural soil health and reduce greenhouse gas emissions.	2020	2023

Active		CDFA	Improving N management guidelines for super-high-intensive olive orchards to use compost.	2022	2024
Active		US Department of Agriculture	Assessing GHG emissions from dairy compost in almond crops	2022	2025

Co-PI: Laibin Huang					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Proposed Project	22RD036	CARB	Quantifying and Identifying the Potential Causes of Nitrous Oxide Emissions in California Soils Under Fumigation	6/1/2023	7/31/2024

Name: William Horwath					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Proposed Project	22RD036	CARB	Quantifying and Identifying the Potential Causes of Nitrous Oxide Emissions in California Soils Under Fumigation	6/1/2023	7/31/2024
Active		CDFA	Nitrogen Management Guidelines for Olive Growers to Improve Soil Health and Sustain Production.	2021	2024
Active		CDFA	California walnut orchards using cover crops to increase soil health and reduce greenhouse gas emissions.	2020	2023
Active		CARB	Liquid and Soil Sample Collection and Analyses of Dairy Digestate and Lagoon Effluent during Storage and Land Application Phases.	2022	2025
Active		US Department of Agriculture	Application of vermicompost to improve agricultural soil health and reduce greenhouse gas emissions.	2020	2023

EXHIBIT A7

THIRD PARTY CONFIDENTIAL INFORMATION REQUIREMENTS

CONFIDENTIAL NONDISCLOSURE AGREEMENT

Exhibit A7 is not applicable for this Agreement.

EXHIBIT B2

BUDGET PERTAINING TO SUBAWARDEE(S)

Exhibit B2 is not applicable for this Agreement.

EXHIBIT B3

INVOICE AND DETAILED TRANSACTION LEDGER ELEMENTS

In accordance with Section 14 of Exhibit C – Payment and Invoicing, the invoice, summary report and/or transaction/payroll ledger shall be certified by the University's Financial Contact and the PI (or their respective designees).

Invoicing frequency

☒ Quarterly ☐ Monthly

Invoicing signature format

☐ Ink ☒ Facsimile/Electronic Approval

Summary Invoice – includes either on the invoice or in a separate summary document – by approved budget category (Exhibit B) – expenditures for the invoice period, approved budget, cumulative expenditures and budget balance available[1]

- Personnel
- Equipment
- Travel
- Subawardee – Consultants
- Subawardee – Subcontract/Subrecipients
- Materials & Supplies
- Other Direct Costs
    - TOTAL DIRECT COSTS (if available from system)
- Indirect Costs
    - TOTAL

Detailed transaction ledger and/or payroll ledger for the invoice period [2]

- University Fund OR Agency Award # (to connect to invoice summary)
- Invoice/Report Period (matching invoice summary)
- GL Account/Object Code
- Doc Type (or subledger reference)
- Transaction Reference#
- Transaction Description, Vendor and/or Employee Name
- Transaction Posting Date
- Time Worked
- Transaction Amount

[1] If this information is not on the invoice or summary attachment, it may be included in a detailed transaction ledger.

[2] For salaries and wages, these elements are anticipated to be included in the detailed transaction ledger. If all elements are not contained in the transaction ledger, then a separate payroll ledger may be provided with the required elements.

EXHIBIT D

ADDITIONAL REQUIREMENTS ASSOCIATED WITH FUNDING SOURCES

Research and Development (R&D) means all research activities, both basic and applied, and all development activities that are performed by non-Federal entities. The term research also includes activities involving the training of individuals in research techniques where such activities utilize the same facilities as other R&D activities and where such activities are not included in the instruction function.

This award ☑ does ☐ does not support Research & Development.

EXHIBIT E

SPECIAL CONDITIONS FOR SECURITY OF CONFIDENTIAL INFORMATION

Exhibit E is not applicable for this Agreement.

EXHIBIT F

ACCESS TO STATE FACILITIES OR COMPUTING RESOURCES

Exhibit F is not applicable for this Agreement.

EXHIBIT G

NEGOTIATED ALTERNATE UTC TERMS

Exhibit C, Section 14 – Payment & Invoicing is hereby amended to incorporate the following:

Add Item A – Section 6:

6) CARB shall withhold payment equal to 10 percent after the contractor has been compensated for 90 percent of the agreement per Exhibit B1, Budget Justification. The 10 percent shall be withheld until completion of all work and submission to CARB by the University of a final report approved by CARB in accordance with Exhibit A1, Schedule of Deliverables, Section 2. It is the University's responsibility to submit one (1) original and one (1) copy of the final invoice.

Modify Item C – Invoicing, 2 is hereby replaced in its entirety with the following:

2) Invoices shall be submitted in arrears not more frequently ~~than monthly and not less frequently~~ than quarterly to the State Financial Contact, identified in Exhibit A3. Invoices may be submitted electronically by email. If submitted electronically, invoice must include the following certification for State certification to the State Controller's Office, in compliance with SAM 8422.1

> This bill has been checked against our records and found to be the original one presented for payment and has not been paid. We have recorded this payment so as to prevent later duplicate payment.
>
> Signed: ______________________________
>
> State Agency Accounting Officer

Add Item E:

E. Advance Payment

1) Nothing herein contained shall preclude advance payments pursuant to Title 2, Division 3, Part 1, Chapter 3, Article 1 of the Government Code of the State of California.

2) Upon termination or completion of this Agreement, Contractor shall refund any excess funds to the CARB. Contractor will reconcile total Agreement costs to total payments received in advance and any remaining advance will be refunded to the CARB's Accounting Office. In the event the Agreement is terminated, total project costs incurred prior to the effective date of termination (including close-out costs) will be reconciled to total project payments received in advance and any remaining advance will be refunded to the CARB. In either event Contractor shall return any balance due to CARB within sixty (60) days, of expiration or earlier termination.