



New Agreement PIR-16-015 (To be completed by CGL Office)

ERDD	Katharina Snyder	43	916-327-2201
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Lawrence Berkeley National Laboratory	94-2951741
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Characterize Actual and Future Impact of California's Drought on Three-component Ground Deformations and their Influence on the Natural Gas Infrastructure

4/3/2017	3/30/2020	\$ 1,599,584
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ARFVTP agreements under \$75K delegated to Executive Director.

Proposed Business Meeting Date	3/8/2017	<input type="checkbox"/> Consent	<input checked="" type="checkbox"/> Discussion
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Business Meeting Presenter	Yu Hou	Time Needed:	5 minutes
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Please select one list serve. NaturalGas (NG Research Program)

Agenda Item Subject and Description

LAWRENCE BERKELEY NATIONAL LABORATORY. Proposed resolution approving agreement PIR-16-015 with Lawrence Berkeley National Laboratory for a \$1,599,584 grant to fund research that will develop and demonstrate a new 3-D methodology to more accurately characterize areas with high risk of potential natural gas infrastructure damage due to drought-induced subsidence and identify remedial actions.

1. Is Agreement considered a "Project" under CEQA?
 Yes (skip to question 2) No (complete the following (PRC 21065 and 14 CCR 15378)):
 Explain why Agreement is not considered a "Project":
 Agreement will not cause direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment because additionally to data analysis and map development the project includes only few field geophysical measurements (short duration hydrogeological tests and/or installation of passive monitoring sensors) in preexisting boreholes or in one shallow (~20m) hole specifically drilled for the project which in both cases will not cause any direct change in the environment.

2. If Agreement is considered a "Project" under CEQA:
 a) Agreement **IS** exempt. (Attach draft NOE)
 Statutory Exemption. List PRC and/or CCR section number:
 Categorical Exemption. List CCR section number: Cal. Code Regs., tit 14, § 15301 -- Cal. Code Regs., tit 14, § 15306
 Common Sense Exemption. 14 CCR 15061 (b) (3)
 Explain reason why Agreement is exempt under the above section:
 15301 Existing Facilities - This project will include water level measurements that will be conducted in existing water wells or close to natural gas pipelines outside the agricultural areas. For field data collection few boreholes of 20 m in depth will be drilled near existing natural gas pipelines outside of environmentally sensitive areas.
 15306 Information Collection - This project involves data collection and research activities which do not result in a major disturbance to an environmental resource.

b) Agreement **IS NOT** exempt. (Consult with the legal office to determine next steps.)

Check all that apply

- | | |
|---|---|
| <input type="checkbox"/> Initial Study | <input type="checkbox"/> Environmental Impact Report |
| <input type="checkbox"/> Negative Declaration | <input type="checkbox"/> Statement of Overriding Considerations |
| <input type="checkbox"/> Mitigated Negative Declaration | |

GRANT REQUEST FORM (GRF)



Legal Company Name:	Budget
Infra Terra, Inc.	\$ 299,939
	\$
	\$
	\$
	\$
	\$
	\$
	\$
	\$

Exhibit A
Scope of Work

I. ASK ACRONYM/TERM LISTS

A. Task List

Task	CPR ¹	Task Name
1		General Project Tasks
2		Collect and synthesize data on subsidence and infrastructure damage
3	X	Evaluate methods for ground deformation monitoring
4	X	Detailed data collection and field investigation at selected study site
5	X	Coupled groundwater flow and geo-mechanical modeling of subsidence-induced surface deformation and pipeline response
6		Development of mitigation recommendations and costs assessment
7		Evaluation of Project Benefits
8		Technology/Knowledge Transfer Activities

B. Acronym/Term List

Acronym/Term	Meaning
CAM	Commission Agreement Manager
CAO	Commission Agreement Officer
CPR	Critical Project Review
DWR	Department of Water Resources
GPS	Global Positioning System
HPP	High Pressure Protocol
InSAR	Interferometric Synthetic Aperture Radar
JPL	Jet Propulsion Laboratory
LBNL	Lawrence Berkeley National Laboratory
PG&E	Pacific Gas and Electric Company
TAC	Technical Advisory Committee
USGS	United States Geologic Survey

II. PURPOSE OF AGREEMENT, PROBLEM/SOLUTION STATEMENT, AND GOALS AND OBJECTIVES

A. Purpose of Agreement

The purpose of this Agreement is to fund development and demonstration of a new methodology to more accurately identify areas with relatively high risk of potential natural gas infrastructure damage due to drought-induced subsidence and to identify potential remedial actions.

B. Problem/ Solution Statement

Problem

The recent drought has induced substantial increases in groundwater pumping in the Central Valley of California and has resulted in unprecedented rates of land subsidence. Current research and ground deformation monitoring have been focused on vertical component of subsidence and its impact on California's aqueducts. Subsidence impact on natural gas

¹ Please see subtask 1.3 in Part III of the Scope of Work (General Project Tasks) for a description of Critical Project Review (CPR) Meetings.

Exhibit A Scope of Work

infrastructure, such as gas transmission lines, is not fully understood yet. It is important to consider impacts from both, vertical and lateral ground deformations on the pipelines integrity. There is a lack of knowledge on exactly how local pumping-induced reservoir compaction translates into three-component (one vertical and two horizontal) land-surface deformation around gas transmission lines of different types with different orientations. Better understanding of the exact mechanisms of pipeline damage due to recent drought-induced subsidence are needed in order to estimate the likelihood of pipeline damage for future drought scenarios. Moreover, current ground subsidence monitoring is insufficient as it does not extend over the broad areas of potential future drought-related gas infrastructure damage.

Solution

The Lawrence Berkeley National Laboratory (LBNL) and InfraTerra, Inc., in collaboration with the Jet Propulsion Laboratory (JPL), Pacific Gas and Electric Company (PG&E), and Natural Resources Canada, will conduct a study to characterize the impact of California's drought-related subsidence on natural gas infrastructure. The main innovation and advantages of this project are the combination of large-scale state-of-the-art remote sensing surveys linked to advanced modeling and inverse analysis of three-component ground deformation. Specifically, the study involves ground deformation monitoring, infrastructure damage evaluation, pumping and geologic data evaluation, testing of new soil three-dimensional deformation monitoring techniques, and coupled groundwater flow and geomechanical modeling for prediction of potential future drought related-subsidence and damage to natural gas infrastructure.

C. Goals and Objectives of the Agreement

Agreement Goals

The goal of this Agreement is to:

- To develop and demonstrate a new methodology to more accurately identify areas with relatively high risk of potential natural gas infrastructure damage due to subsidence and the identification of potential remedial actions.

Ratepayer Benefits: This Agreement will result in ratepayer benefit by improving the safety of natural gas pipelines and reducing the costs related to pipeline damage and mitigating efforts. The development and testing of the technology to closely monitor three-component ground deformations, and to be able to relate those ground deformations to potential damage of pipelines, will help to provide an early warning of increased risk of pipeline failure at specific segments. This will allow more cost-effective preventative action, i.e. engineering measures around the pipeline to reduce the impact of expected land surface deformation on the pipeline itself.

Technological Advancement and Breakthroughs: This Agreement will lead to technological advancement and breakthroughs to overcome barriers to the achievement of the State of California's statutory energy goals by developing and testing novel technologies to monitor and evaluate three-component ground deformations from groundwater extraction and how such land surface deformations could impact natural gas infrastructure. The technology will enable earlier detection of areas of relatively high risk from drought-related subsidence and thereby will enable preventative actions to be taken to increase safety at reduced cost.

Agreement Objectives

The objectives of this Agreement are to:

Exhibit A
Scope of Work

- Establish the relationship between ground water extraction, subsidence, and natural gas infrastructure damage from remote sensing surveys and basin-scale to state-wide data collection.
- Develop and test methods for using Interferometric Synthetic Aperture Radar (InSAR) subsidence (range change) data to calculate three-component ground surface deformation that are critical for evaluating potential damage to gas transmission lines.
- Quantify the links between water pumping, consolidation, ground surface deformation and potential damage to natural gas infrastructure.
- Predict potential future drought-related subsidence and damage to natural gas infrastructure.
- Evaluate and test ground deformation monitoring techniques and suggest improvements that will help to monitor for potential damage to natural gas infrastructure.
- Develop mitigation recommendations and costs related to future drought-related damage to natural gas infrastructure.

III. TASK 1 GENERAL PROJECT TASKS PRODUCTS

Subtask 1.1 Products

The goal of this subtask is to establish the requirements for submitting project products (e.g., reports, summaries, plans, and presentation materials). Unless otherwise specified by the Commission Agreement Manager (CAM), the Recipient must deliver products as required below by the dates listed in the **Project Schedule (Part V)**. Products that require a draft version are indicated by marking “**(draft and final)**” after the product name in the “Products” section of the task/subtask. If “(draft and final)” does not appear after the product name, only a final version of the product is required. With respect to due dates within this Scope of Work, “**days**” means working days.

The Recipient shall:

For products that require a draft version, including the Final Report Outline and Final Report

- Submit all draft products to the CAM for review and comment in accordance with the Project Schedule (Part V). The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt, unless otherwise specified in the task/subtask for which the product is required.
- Consider incorporating all CAM comments into the final product. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final product.
- Submit the revised product and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period, or approves a request for additional time.

For products that require a final version only

- Submit the product to the CAM for acceptance. The CAM may request minor revisions or explanations prior to acceptance.

Exhibit A
Scope of Work

For all products

- Submit all data and documents required as products in accordance with the following:

Instructions for Submitting Electronic Files and Developing Software:

○ **Electronic File Format**

- Submit all data and documents required as products under this Agreement in an electronic file format that is fully editable and compatible with the Energy Commission's software and Microsoft (MS)-operating computing platforms, or with any other format approved by the CAM. Deliver an electronic copy of the full text of any Agreement data and documents in a format specified by the CAM, such as memory stick or CD-ROM.

The following describes the accepted formats for electronic data and documents provided to the Energy Commission as products under this Agreement, and establishes the software versions that will be required to review and approve all software products:

- Data sets will be in MS Access or MS Excel file format (version 2007 or later), or any other format approved by the CAM.
- Text documents will be in MS Word file format, version 2007 or later.
- Documents intended for public distribution will be in PDF file format.
- The Recipient must also provide the native Microsoft file format.
- Project management documents will be in Microsoft Project file format, version 2007 or later.

○ **Software Application Development**

Use the following standard Application Architecture components in compatible versions for any software application development required by this Agreement (e.g., databases, models, modeling tools), unless the CAM approves other software applications such as open source programs:

- Microsoft ASP.NET framework (version 3.5 and up). Recommend 4.0.
- Microsoft Internet Information Services (IIS), (version 6 and up) Recommend 7.5.
- Visual Studio.NET (version 2008 and up). Recommend 2010.
- C# Programming Language with Presentation (UI), Business Object and Data Layers.
- SQL (Structured Query Language).
- Microsoft SQL Server 2008, Stored Procedures. Recommend 2008 R2.
- Microsoft SQL Reporting Services. Recommend 2008 R2.
- XML (external interfaces).

Any exceptions to the Electronic File Format requirements above must be approved in writing by the CAM. The CAM will consult with the Energy Commission's Information Technology Services Branch to determine whether the exceptions are allowable.

MEETINGS

Subtask 1.2 Kick-off Meeting

Exhibit A
Scope of Work

The goal of this subtask is to establish the lines of communication and procedures for implementing this Agreement.

The Recipient shall:

- Attend a “Kick-off” meeting with the CAM, the Commission Agreement Officer (CAO), and any other Energy Commission staff relevant to the Agreement. The Recipient will bring its Project Manager and any other individuals designated by the CAM to this meeting. The administrative and technical aspects of the Agreement will be discussed at the meeting. Prior to the meeting, the CAM will provide an agenda to all potential meeting participants. The meeting may take place in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The administrative portion of the meeting will include discussion of the following:

- Terms and conditions of the Agreement;
- Administrative products (subtask 1.1);
- CPR meetings (subtask 1.3);
- Match fund documentation (subtask 1.7);
- Permit documentation (subtask 1.8);
- Subcontracts (subtask 1.9); and
- Any other relevant topics.

The technical portion of the meeting will include discussion of the following:

- The CAM's expectations for accomplishing tasks described in the Scope of Work;
 - An updated Project Schedule;
 - Technical products (subtask 1.1);
 - Progress reports and invoices (subtask 1.5);
 - Final Report (subtask 1.6);
 - Technical Advisory Committee meetings (subtasks 1.10 and 1.11); and
 - Any other relevant topics.
- Provide an *Updated Project Schedule*, *List of Match Funds*, and *List of Permits*, as needed to reflect any changes in the documents.

The CAM shall:

- Designate the date and location of the meeting.
 - Send the Recipient a *Kick-off Meeting Agenda*.

Recipient Products:

- Updated Project Schedule (*if applicable*)
- Updated List of Match Funds (*if applicable*)
- Updated List of Permits (*if applicable*)

CAM Product:

- Kick-off Meeting Agenda

Subtask 1.3 Critical Project Review (CPR) Meetings

The goal of this subtask is to determine if the project should continue to receive Energy Commission funding, and if so whether any modifications must be made to the tasks, products, schedule, or budget. CPR meetings provide the opportunity for frank discussions between the Energy Commission and the Recipient. As determined by the CAM, discussions may include project status, challenges, successes, advisory group findings and recommendations, final

Exhibit A
Scope of Work

report preparation, and progress on technical transfer and production readiness activities (if applicable). Participants will include the CAM and the Recipient, and may include the CAO and any other individuals selected by the CAM to provide support to the Energy Commission.

CPR meetings generally take place at key, predetermined points in the Agreement, as determined by the CAM and as shown in the Task List on page 1 of this Exhibit. However, the CAM may schedule additional CPR meetings as necessary. The budget will be reallocated to cover the additional costs borne by the Recipient, but the overall Agreement amount will not increase. CPR meetings generally take place at the Energy Commission, but they may take place at another location, or may be conducted via electronic conferencing (e.g., WebEx) as determined by the CAM.

The Recipient shall:

- Prepare a *CPR Report* for each CPR meeting that: (1) discusses the progress of the Agreement toward achieving its goals and objectives; and (2) includes recommendations and conclusions regarding continued work on the project.
- Submit the CPR Report along with any other *Task Products* that correspond to the technical task for which the CPR meeting is required (i.e., if a CPR meeting is required for Task 2, submit the Task 2 products along with the CPR Report).
- Attend the CPR meeting.
- Present the CPR Report and any other required information at each CPR meeting.

The CAM shall:

- Determine the location, date, and time of each CPR meeting with the Recipient's input.
- Send the Recipient a *CPR Agenda* and a *List of Expected CPR Participants* in advance of the CPR meeting. If applicable, the agenda will include a discussion of match funding and permits.
- Conduct and make a record of each CPR meeting. Provide the Recipient with a *Schedule for Providing a Progress Determination* on continuation of the project.
- Determine whether to continue the project, and if so whether modifications are needed to the tasks, schedule, products, or budget for the remainder of the Agreement. If the CAM concludes that satisfactory progress is not being made, this conclusion will be referred to the Deputy Director of the Energy Research and Development Division.
- Provide the Recipient with a *Progress Determination* on continuation of the project, in accordance with the schedule. The Progress Determination may include a requirement that the Recipient revise one or more products.

Recipient Products:

- CPR Report(s)
- Task Products (draft and/or final as specified in the task)

CAM Products:

- CPR Agenda
- List of Expected CPR Participants
- Schedule for Providing a Progress Determination
- Progress Determination

Subtask 1.4 Final Meeting

Exhibit A Scope of Work

The goal of this subtask is to complete the closeout of this Agreement.

The Recipient shall:

- Meet with Energy Commission staff to present project findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement. This meeting will be attended by the Recipient and CAM, at a minimum. The meeting may occur in person or by electronic conferencing (e.g., WebEx), with approval of the CAM.

The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be divided into two separate meetings at the CAM's discretion.

- The technical portion of the meeting will involve the presentation of findings, conclusions, and recommended next steps (if any) for the Agreement. The CAM will determine the appropriate meeting participants.
- The administrative portion of the meeting will involve a discussion with the CAM and the CAO of the following Agreement closeout items:
 - Disposition of any state-owned equipment.
 - Need to file a Uniform Commercial Code Financing Statement (Form UCC-1) regarding the Energy Commission's interest in patented technology.
 - The Energy Commission's request for specific "generated" data (not already provided in Agreement products).
 - Need to document the Recipient's disclosure of "subject inventions" developed under the Agreement.
 - "Surviving" Agreement provisions such as repayment provisions and confidential products.
 - Final invoicing and release of retention.
- Prepare a *Final Meeting Agreement Summary* that documents any agreement made between the Recipient and Commission staff during the meeting.
- Prepare a *Schedule for Completing Agreement Closeout Activities*.
- Provide *All Draft and Final Written Products* on a CD-ROM or USB memory stick, organized by the tasks in the Agreement.

Products:

- Final Meeting Agreement Summary (*if applicable*)
- Schedule for Completing Agreement Closeout Activities
- All Draft and Final Written Products

REPORTS AND INVOICES

Subtask 1.5 Progress Reports and Invoices

The goals of this subtask are to: (1) periodically verify that satisfactory and continued progress is made towards achieving the project objectives of this Agreement; and (2) ensure that invoices contain all required information and are submitted in the appropriate format.

The Recipient shall:

- Submit a monthly *Progress Report* to the CAM. Each progress report must:
 - Summarize progress made on all Agreement activities as specified in the scope of work for the preceding month, including accomplishments, problems, milestones, products, schedule, fiscal status, and an assessment of the ability to complete the

Exhibit A
Scope of Work

Agreement within the current budget and any anticipated cost overruns. See the Progress Report Format Attachment for the recommended specifications.

- Submit a monthly or quarterly *Invoice* that follows the instructions in the “Payment of Funds” section of the terms and conditions, including a financial report on Match Fund and in-state expenditures.

Products:

- Progress Reports
- Invoices

Subtask 1.6 Final Report

The goal of this subtask is to prepare a comprehensive Final Report that describes the original purpose, approach, results, and conclusions of the work performed under this Agreement. The CAM will review the Final Report, which will be due at least **two months** before the Agreement end date. When creating the Final Report Outline and the Final Report, the Recipient must use the Style Manual provided by the CAM.

Subtask 1.6.1 Final Report Outline

The Recipient shall:

- Prepare a *Final Report Outline* in accordance with the *Style Manual* provided by the CAM. (See Task 1.1 for requirements for draft and final products.)

Recipient Products:

- Final Report Outline (draft and final)

CAM Product:

- Style Manual
- Comments on Draft Final Report Outline
- Acceptance of Final Report Outline

Subtask 1.6.2 Final Report

The Recipient shall:

- Prepare a *Final Report* for this Agreement in accordance with the approved Final Report Outline, Style Manual, and Final Report Template provided by the CAM with the following considerations:
 - Ensure that the report includes the following items, in the following order:
 - Cover page (**required**)
 - Credits page on the reverse side of cover with legal disclaimer (**required**)
 - Acknowledgements page (optional)
 - Preface (**required**)
 - Abstract, keywords, and citation page (**required**)
 - Table of Contents (**required**, followed by List of Figures and List of Tables, if needed)
 - Executive summary (**required**)
 - Body of the report (**required**)
 - References (if applicable)

Exhibit A Scope of Work

- Glossary/Acronyms (If more than 10 acronyms or abbreviations are used, it is required.)
- Bibliography (if applicable)
- Appendices (if applicable) (Create a separate volume if very large.)
- Attachments (if applicable)
- Ensure that the document is written in the third person.
- Ensure that the Executive Summary is understandable to the lay public.
 - Briefly summarize the completed work. Succinctly describe the project results and whether or not the project goals were accomplished.
 - Identify which specific ratepayers can benefit from the project results and how they can achieve the benefits.
 - If it's necessary to use a technical term in the Executive Summary, provide a brief definition or explanation when the technical term is first used.
- Follow the Style Guide format requirements for headings, figures/tables, citations, and acronyms/abbreviations.
- Ensure that the document omits subjective comments and opinions. However, recommendations in the conclusion of the report are allowed.
- Include a brief description of the project results in the Abstract.
- Submit a draft of the report to the CAM for review and comment. The CAM will provide written comments to the Recipient on the draft product within 15 days of receipt
- Consider incorporating all CAM comments into the Final Report. If the Recipient disagrees with any comment, provide a written response explaining why the comment was not incorporated into the final product
- Submit the revised Final Report and responses to comments within 10 days of notice by the CAM, unless the CAM specifies a longer time period or approves a request for additional time.
- Submit one bound copy of the *Final Report* to the CAM along with *Written Responses to Comments on the Draft Final Report*.

Products:

- Final Report (draft and final)
- Written Responses to Comments on the Draft Final Report

CAM Product:

- Written Comments on the Draft Final Report

MATCH FUNDS, PERMITS, AND SUBCONTRACTS

Subtask 1.7 Match Funds

The goal of this subtask is to ensure that the Recipient obtains any match funds planned for this Agreement and applies them to the Agreement during the Agreement term.

While the costs to obtain and document match funds are not reimbursable under this Agreement, the Recipient may spend match funds for this task. The Recipient may only spend match funds during the Agreement term, either concurrently or prior to the use of Energy Commission funds. Match funds must be identified in writing, and the Recipient must obtain any associated commitments before incurring any costs for which the Recipient will request reimbursement.

Exhibit A
Scope of Work

The Recipient shall:

- Prepare a *Match Funds Status Letter* that documents the match funds committed to this Agreement. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state this in the letter.

If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter:

- A list of the match funds that identifies:
 - The amount of cash match funds, their source(s) (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied.
 - The amount of each in-kind contribution, a description of the contribution type (e.g., property, services), the documented market or book value, the source (including a contact name, address, and telephone number), and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient must identify its owner and provide a contact name, address, telephone number, and the address where the property is located.
 - A copy of a letter of commitment from an authorized representative of each source of match funding that the funds or contributions have been secured.
- At the Kick-off meeting, discuss match funds and the impact on the project if they are significantly reduced or not obtained as committed. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide a *Supplemental Match Funds Notification Letter* to the CAM of receipt of additional match funds.
- Provide a *Match Funds Reduction Notification Letter* to the CAM if existing match funds are reduced during the course of the Agreement. Reduction of match funds may trigger a CPR meeting.

Products:

- Match Funds Status Letter
- Supplemental Match Funds Notification Letter *(if applicable)*
- Match Funds Reduction Notification Letter *(if applicable)*

Subtask 1.8 Permits

The goal of this subtask is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track. Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement, with the exception of costs incurred by University of California recipients. Permits must be identified and obtained before the Recipient may incur any costs related to the use of the permit(s) for which the Recipient will request reimbursement.

The Recipient shall:

- Prepare a *Permit Status Letter* that documents the permits required to conduct this Agreement. If no permits are required at the start of this Agreement, then state this in the letter. If permits will be required during the course of the Agreement, provide in the letter:
 - A list of the permits that identifies: (1) the type of permit; and (2) the name, address, and telephone number of the permitting jurisdictions or lead agencies.
 - The schedule the Recipient will follow in applying for and obtaining the permits.

Exhibit A Scope of Work

The list of permits and the schedule for obtaining them will be discussed at the Kick-off meeting (subtask 1.2), and a timetable for submitting the updated list, schedule, and copies of the permits will be developed. The impact on the project if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in progress reports and will be a topic at CPR meetings.

- If during the course of the Agreement additional permits become necessary, then provide the CAM with an *Updated List of Permits* (including the appropriate information on each permit) and an *Updated Schedule for Acquiring Permits*.
- Send the CAM a *Copy of Each Approved Permit*.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the CAM within 5 days. Either of these events may trigger a CPR meeting.

Products:

- Permit Status Letter
- Updated List of Permits (*if applicable*)
- Updated Schedule for Acquiring Permits (*if applicable*)
- Copy of Each Approved Permit (*if applicable*)

Subtask 1.9 Subcontracts

The goals of this subtask are to: (1) procure subcontracts required to carry out the tasks under this Agreement; and (2) ensure that the subcontracts are consistent with the terms and conditions of this Agreement.

The Recipient shall:

- Manage and coordinate subcontractor activities in accordance with the requirements of this Agreement.
- Incorporate this Agreement by reference into each subcontract.
- Include any required Energy Commission flow-down provisions in each subcontract, in addition to a statement that the terms of this Agreement will prevail if they conflict with the subcontract terms.
- If required by the CAM, submit a draft of each *Subcontract* required to conduct the work under this Agreement.
- Submit a final copy of the executed subcontract.
- Notify and receive written approval from the CAM prior to adding any new subcontractors (see the discussion of subcontractor additions in the terms and conditions).

Products:

- Subcontracts (*draft if required by the CAM*)

TECHNICAL ADVISORY COMMITTEE

Subtask 1.10 Technical Advisory Committee (TAC)

The goal of this subtask is to create an advisory committee for this Agreement. The TAC should be composed of diverse professionals. The composition will vary depending on interest, availability, and need. TAC members will serve at the CAM's discretion. The purpose of the TAC is to:

Exhibit A Scope of Work

- Provide guidance in project direction. The guidance may include scope and methodologies, timing, and coordination with other projects. The guidance may be based on:
 - Technical area expertise;
 - Knowledge of market applications; or
 - Linkages between the agreement work and other past, present, or future projects (both public and private sectors) that TAC members are aware of in a particular area.
- Review products and provide recommendations for needed product adjustments, refinements, or enhancements.
- Evaluate the tangible benefits of the project to the state of California, and provide recommendations as needed to enhance the benefits.
- Provide recommendations regarding information dissemination, market pathways, or commercialization strategies relevant to the project products.

The TAC may be composed of qualified professionals spanning the following types of disciplines:

- Researchers knowledgeable about the project subject matter;
- Members of trades that will apply the results of the project (e.g., designers, engineers, architects, contractors, and trade representatives);
- Public interest market transformation implementers;
- Product developers relevant to the project;
- U.S. Department of Energy research managers, or experts from other federal or state agencies relevant to the project;
- Public interest environmental groups;
- Utility representatives;
- Air district staff; and
- Members of relevant technical society committees.

The Recipient shall:

- Prepare a *List of Potential TAC Members* that includes the names, companies, physical and electronic addresses, and phone numbers of potential members. The list will be discussed at the Kick-off meeting, and a schedule for recruiting members and holding the first TAC meeting will be developed.
- Recruit TAC members. Ensure that each individual understands member obligations and the TAC meeting schedule developed in subtask 1.11.
- Prepare a *List of TAC Members* once all TAC members have committed to serving on the TAC.
- Submit *Documentation of TAC Member Commitment* (such as Letters of Acceptance) from each TAC member.

Products:

- List of Potential TAC Members
- List of TAC Members
- Documentation of TAC Member Commitment

Subtask 1.11 TAC Meetings

The goal of this subtask is for the TAC to provide strategic guidance for the project by participating in regular meetings, which may be held via teleconference.

Exhibit A
Scope of Work

The Recipient shall:

- Discuss the TAC meeting schedule with the CAM at the Kick-off meeting. Determine the number and location of meetings (in-person and via teleconference) in consultation with the CAM.
- Prepare a *TAC Meeting Schedule* that will be presented to the TAC members during recruiting. Revise the schedule after the first TAC meeting to incorporate meeting comments.
- Prepare a *TAC Meeting Agenda* and *TAC Meeting Back-up Materials* for each TAC meeting.
- Organize and lead TAC meetings in accordance with the TAC Meeting Schedule. Changes to the schedule must be pre-approved in writing by the CAM.
- Prepare *TAC Meeting Summaries* that include any recommended resolutions of major TAC issues.

Products:

- TAC Meeting Schedule (draft and final)
- TAC Meeting Agendas (draft and final)
- TAC Meeting Back-up Materials
- TAC Meeting Summaries

Exhibit A
Scope of Work

TECHNICAL TASKS

*Products that require a draft version are indicated by marking “(draft and final)” after the product name in the “Products” section of the task/subtask. If “(draft and final)” does not appear after the product name, only a final version of the product is required. **Subtask 1.1 (Products)** describes the procedure for submitting products to the CAM.*

TASK 2 Collect and synthesize data on subsidence and infrastructure damage

The goals of this task are to develop generic geomechanical stratigraphic models of subsidence areas and historic and future groundwater level scenarios to be used for simulations in Task 6.

The Recipient shall:

- Identify subsidence areas upon which to base development of generic models
- Collect hydrogeomechanical stratigraphy data and models for these areas, such as available from the United States Geologic Survey (USGS) for the Central Valley Model
- Enhance these models as necessary through the addition of data from selected well reports available from the Department of Water Resources (DWR) and geotechnical data from various sources, such as PG&E
- Abstract the models to generic cases
- Collect historic groundwater level data for the areas, such as available from DWR, and meteorological data
- Acquire future climate scenarios for the selected areas
- Acquire sustainable groundwater management plans for those areas as available
- Develop generic historic hydrographs and suites of future hydrographs
- Produce *Representative Hydrogeomechanical Models and Hydrographs for Groundwater Extraction-Driven Subsidence Study Report*

Products:

- Representative Hydrogeomechanical Models and Hydrographs for Groundwater Extraction-Driven Subsidence Study Report (draft and final)

TASK 3 Evaluate methods for ground deformation monitoring

The goals of this task are to (i) assess the ability and the resolution of current techniques to monitor the full three-dimensional displacement field, including horizontal strains in a cost-effective and timely manner, (ii) evaluate how a new extensometer developed at the LBNL to monitor borehole breathing may be applied to monitor the full three-dimensional strain tensor variations and (iii) suggest improvements to the protocols for monitoring surface deformation.

The Recipient shall:

- Conduct a comprehensive review of existing methods that are described in the published literature.
- Evaluate the use of the High Pressure Protocol (HPP) tool extensometer developed at the LBNL to characterize full aquifer strain tensor
- Design the best installation protocol(s) to integrate the HPP tool in the existing methods and prepare *HPP Tool Extensometer Application for Aquifer Deformation Monitoring Report*
- Suggest enhancements to current monitoring practices and produce *New Potential Monitoring Practices Report*
- Prepare and provide a *CPR Report* in accordance with Subtask 1.3.
- Participate in a CPR Meeting in accordance with Subtask 1.3.

Exhibit A
Scope of Work

Products:

- HPP Tool Extensometer Application for Aquifer Deformation Monitoring Report (draft and final)
- New Potential Monitoring Practices Report (draft and final)
- CPR Report

TASK 4 Detailed data collection and field investigation at selected study site

The goals of this task are (i) to gather all the available information on the study area, (ii) to test and evaluate the three dimensional extensometer developed at LBNL and (iii) to in-situ calibrate the three-dimensional ground displacements measured at shallow depth with both deep aquifer movements and ground surface displacements (estimated from INSAR data for ex.)

The Recipient shall:

- Acquire geological data from existing maps and cross section from USGS.
- Collect data on borehole logging from the Division of Oil, Gas & Geothermal Resources.
- Obtain hydrological data from the Californian Water Data Library.
- Obtain geotechnical data compiled by PG&E and their consultant.
- Secure data on historical land subsidence measurements including: (i) InSAR datasets (2007-2011, 2014-2015) from JPL and (ii) continuous ground surface deformations monitoring by continuous GPS and by extensometers from USGS.
- Collect information about pipeline properties given by PG&E: depth, coordinate location, orientation, diameter etc.
- Select one or several wells to test the three dimensional extensometer. .
- Synthesize a 3D aquifer model with reliable hydraulic and mechanical properties documented in the *Aquifer Model Report*
- Document the analyses of the three-dimensional deformations and comparison with the other area monitoring data in the *Experimental Report*
- Prepare and provide a *CPR Report* in accordance with Subtask 1.3.
- Participate in a CPR Meeting in accordance with Subtask 1.3.

Products:

- Aquifer Model Report (draft and final)
- Experimental Report (draft and final)
- CPR Report

TASK 5 Coupled groundwater flow and geomechanical modeling of subsidence-induced surface deformation and pipeline response

The goals of this task are to (i) quantify the links between water pumping and potential damage to natural gas infrastructure, and (ii) predict potential future drought related subsidence and damage to natural gas infrastructure.

The Recipient shall:

- Develop and demonstrate the modeling approaches for simplified generic cases of subsidence induced by groundwater production.
- Model typical California subsidence settings that are important for natural gas infrastructure responses
- Conduct site specific modeling of the selected study site using the data from the detailed data collection and site characterization.

Exhibit A
Scope of Work

- Conduct forward modeling of coupled groundwater flow and geomechanics to model different drought scenarios of excessive ground water use.
- Summarize the outcome of the development and demonstration of the modeling approaches in *Modeling Approaches for Generic Cases Report*.
- Summarize results of typical and site specific modeling in *Site Specific Modeling Report*.
- Summarize final modeling results in the *Estimated Future Drought Related Subsidence Effects on Infrastructure Model Report*.
- Prepare and provide a *CPR Report* in accordance with Subtask 1.3.
- Participate in a CPR Meeting in accordance with Subtask 1.3.

Products:

- Modeling Approaches for Generic Cases Report
- Site Specific Modeling Report
- Estimated Future Drought Related Subsidence Effects on Infrastructure Report (draft and final)
- CPR Report

TASK 6 Development of mitigation recommendations and costs assessment

The goals of this task are to estimate the risks of pipeline failure, possible remedial responses, and the associated costs.

The Recipient shall:

- Perform risk analysis to estimate probabilities of damage to the network
- Develop pipeline fragilities between easy to measure parameters such as groundwater extraction rate and probability of damage.
- Identify likely location of potential failure such as locations of potential stress risers such as bends and valves.
- Discuss mitigation options
- Assess costs and benefits of mitigation options
- Produce *Report on Mitigation Options and Costs*

Products:

- Report on Mitigation Options and Costs (draft and final)

TASK 7 EVALUATION OF PROJECT BENEFITS

The goal of this task is to report the benefits resulting from this project.

The Recipient shall:

- Complete three Project Benefits Questionnaires that correspond to three main intervals in the Agreement: (1) *Kick-off Meeting Benefits Questionnaire*; (2) *Mid-term Benefits Questionnaire*; and (3) *Final Meeting Benefits Questionnaire*.
- Provide all key assumptions used to estimate projected benefits, including targeted market sector (e.g., population and geographic location), projected market penetration, baseline and projected energy use and cost, operating conditions, and emission reduction calculations. Examples of information that may be requested in the questionnaires include:
 - For Product Development Projects and Project Demonstrations:
 - Published documents, including date, title, and periodical name.

Exhibit A
Scope of Work

- Estimated or actual energy and cost savings, and estimated statewide energy savings once market potential has been realized. Identify all assumptions used in the estimates.
- Greenhouse gas and criteria emissions reductions.
- Other non-energy benefits such as reliability, public safety, lower operational cost, environmental improvement, indoor environmental quality, and societal benefits.
- Data on potential job creation, market potential, economic development, and increased state revenue as a result of the project.
- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Additional Information for Product Development Projects:
 - Outcome of product development efforts, such copyrights and license agreements.
 - Units sold or projected to be sold in California and outside of California.
 - Total annual sales or projected annual sales (in dollars) of products developed under the Agreement.
 - Investment dollars/follow-on private funding as a result of Energy Commission funding.
 - Patent numbers and applications, along with dates and brief descriptions.
- Additional Information for Product Demonstrations:
 - Outcome of demonstrations and status of technology.
 - Number of similar installations.
 - Jobs created/retained as a result of the Agreement.
- For Information/Tools and Other Research Studies:
 - Outcome of project.
 - Published documents, including date, title, and periodical name.
 - A discussion of policy development. State if the project has been cited in government policy publications or technical journals, or has been used to inform regulatory bodies.
 - The number of website downloads.
 - An estimate of how the project information has affected energy use and cost, or have resulted in other non-energy benefits.
 - An estimate of energy and non-energy benefits.
 - Data on potential job creation, market potential, economic development, and increased state revenue as a result of project.

Exhibit A
Scope of Work

- A discussion of project product downloads from websites, and publications in technical journals.
- A comparison of project expectations and performance. Discuss whether the goals and objectives of the Agreement have been met and what improvements are needed, if any.
- Respond to CAM questions regarding responses to the questionnaires.

The Energy Commission may send the Recipient similar questionnaires after the Agreement term ends. Responses to these questionnaires will be voluntary.

Products:

- Kick-off Meeting Benefits Questionnaire
- Mid-term Benefits Questionnaire
- Final Meeting Benefits Questionnaire

TASK 8 TECHNOLOGY/KNOWLEDGE TRANSFER ACTIVITIES

The goal of this task is to develop a plan to make the knowledge gained, experimental results, and lessons learned available to the public and key decision makers.

The Recipient shall:

- Prepare an *Initial Fact Sheet* at start of the project that describes the project. Use the format provided by the CAM.
- Prepare a *Final Project Fact Sheet* at the project's conclusion that discusses results. Use the format provided by the CAM.
- Prepare a *Technology/Knowledge Transfer Plan* that includes:
 - An explanation of how the knowledge gained from the project will be made available to the public, including the targeted market sector and potential outreach to end users, utilities, regulatory agencies, and others.
 - A description of the intended use(s) for and users of the project results.
 - Published documents, including date, title, and periodical name.
 - Copies of documents, fact sheets, journal articles, press releases, and other documents prepared for public dissemination. These documents must include the Legal Notice required in the terms and conditions. Indicate where and when the documents were disseminated.
 - A discussion of policy development. State if project has been or will be cited in government policy publications, or used to inform regulatory bodies.
 - The number of website downloads or public requests for project results.
 - Additional areas as determined by the CAM.
- Conduct technology transfer activities in accordance with the Technology/Knowledge Transfer Plan. These activities will be reported in the Progress Reports.
- When directed by the CAM, develop *Presentation Materials* for an Energy Commission-sponsored conference/workshop(s) on the project.
- When directed by the CAM, participate in annual EPIC symposium(s) sponsored by the California Energy Commission.
- Provide at least (6) six *High Quality Digital Photographs* (minimum resolution of 1300x500 pixels in landscape ratio) of pre and post technology installation at the project sites or related project photographs.
- Prepare a *Technology/Knowledge Transfer Report* on technology transfer activities conducted during the project.

Exhibit A
Scope of Work

Products:

- Initial Fact Sheet (draft and final)
- Final Project Fact Sheet (draft and final)
- Presentation Materials (draft and final)
- High Quality Digital Photographs
- Technology/Knowledge Transfer Plan (draft and final)
- Technology/Knowledge Transfer Report (draft and final)

IV. PROJECT SCHEDULE

Please see the attached Excel spreadsheet.

STATE OF CALIFORNIA

STATE ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

RESOLUTION - RE: LAWRENCE BERKELEY NATIONAL LABORATORY

RESOLVED, that the State Energy Resources Conservation and Development Commission (Energy Commission) adopts the staff CEQA findings contained in the Agreement or Amendment Request Form (as applicable); and

RESOLVED, that the Energy Commission approves Agreement PIR-16-015 from GFO-15-507 with Department of Energy's Lawrence Berkeley National Laboratory for a \$1,599,584 grant to fund research that will develop and demonstrate a new 3-D methodology to more accurately characterize areas with high risk of potential natural gas infrastructure damage due to droughtinduced subsidence and identify remedial actions; and

FURTHER BE IT RESOLVED, that the Executive Director or his/her designee shall execute the same on behalf of the Energy Commission.

CERTIFICATION

The undersigned Secretariat to the Commission does hereby certify that the foregoing is a full, true, and correct copy of a Resolution duly and regularly adopted at a meeting of the California Energy Commission held on March 8, 2017.

AYE: [List of Commissioners]

NAY: [List of Commissioners]

ABSENT: [List of Commissioners]

ABSTAIN: [List of Commissioners]

Cody Goldthrite,
Secretariat