File No. 161244 Committee Item No. 4
Board Item No. _____

COMMITTEE/BOARD OF SUPERVISORS

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Committee: Budget & Finance Committee **Date** December 7, 2016

Board of Supervisors Meeting **Date** _____

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Completed by: Linda Wong **Date** December 2, 2016
Completed by: Linda Wong **Date** _____

FILE NO. 161244 RESOLUTION NO.

[Accept and Expend Grant - Water Research Foundation; Water Environment and Reuse Foundation; U.S. Bureau of Reclamation - Implementation of a Decentralized Purified Water Pilot - $400,000]

Resolution authorizing the San Francisco Public Utilities Commission General Manager to accept and expend grants in the amounts of $100,000 from the Water Research Foundation, $100,000 from the Water Environment and Reuse Foundation, and $200,000 from the U.S. Bureau of Reclamation for a total of $400,000 toward the implementation of a decentralized purified water pilot project in San Francisco.

WHEREAS, The San Francisco Public Utilities Commission (SFPUC) remains committed to exploring alternative water supply options; and

WHEREAS, Purified water presents a potential water supply alternative that is drought proof and local; and

WHEREAS, The SFPUC has applied for and been awarded grants from 1) the Water Research Foundation (WRF) ($100,000), 2) the Water Environment & Reuse Foundation (WE&RF) ($100,000), and 3) the U.S. Bureau of Reclamation (USBR) ($200,000); and

WHEREAS, Adoption of this Resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378 because there would be no physical change in the environment; and

WHEREAS, The grant match requirement is $300,000 in cash and $100,000 in in-kind services from the SFPUC, a portion of which will be allocated to public outreach; and

WHEREAS, Services are anticipated to begin in November 2016 and end in August of 2018 and the total duration of this agreement is 21 months; and

WHEREAS, Funds for this agreement will be available at the time of award of the agreement from Project No. CUW278 – Potable Reuse; now, therefore, be it

RESOLVED, That the Board of Supervisors hereby authorizes the General Manager of the SFPUC to accept and expend grants awarded by the Water Research Foundation ($100,000), the Water Environment & Reuse Foundation ($100,000), and the U.S. Bureau of Reclamation ($200,000).

Recommended:

HARLAN L. KELLY, JR.
General Manager of the SFPUC
Acting General Mgr.

Approved:
for EDWIN M. LEE
Mayor

Approved:
BEN ROSENFIELD
Controller

Item 4 File 16-1244	Department: Public Utilities Commission (PUC)

EXECUTIVE SUMMARY

Legislative Objectives

- The proposed resolution would authorize the San Francisco Public Utilities Commission (SFPUC) General Manager to (i) accept and expend grants in the amounts of $100,000 from the Water Research Foundation), $100,000 from the Water Environment & Reuse Foundation, and $200,000 from the U.S. Bureau of Reclamation for a total of $400,000 toward the implementation of a decentralized purified water pilot research project in San Francisco, and (ii) commit the SFPUC to providing $300,000 in cash funds and $100,000 in in-kind services over the 21-month duration of the grant agreement.

Key Points

- In June 2016, the San Francisco Public Utilities Commission (SFPUC) was awarded grants in the amounts of $100,000 from the Water Research Foundation, $100,000 from the Water Environment & Reuse Foundation, and $200,000 from the U.S. Bureau of Reclamation for a total of $400,000 toward the implementation of a decentralized purified water research pilot project in San Francisco.
- Grant funds will support efforts to investigate the technical viability of treating wastewater to be usable as potable water. The SFPUC and consultant team, Carollo Engineers, Inc., will test decentralized, advanced wastewater treatment over an eight-month period. The project will include real-time monitoring technology to ensure the reliability of the treatment system, as well as advanced analytics to regularly evaluate the water quality. Public information, such as online and print educational materials, and tours will be developed as part of the pilot project. Services are anticipated to begin in November 2016 and end in August of 2018 for a total duration of 21 months.

Fiscal Impact

- The total 21-month budget from November 2016 through August 2018 for the decentralized purified water pilot research project administered by SFPUC is $800,000. Of this amount, $400,000, or 50 percent of the budget, will be funded by grants from the Water Research Foundation, $100,000 from the Water Environment & Reuse Foundation, and $200,000 from the U.S. Bureau of Reclamation. SFPUC will contribute $400,000, or 50 percent of the budget, in matching funds. Of the SFPUC matching funds, $300,000 will be in cash and $100,000 will be in-kind services, a portion of which will be allocated to public outreach.

Recommendation

- Approve the proposed resolution.

MANDATE STATEMENT

City Administrative Code Section 10.170-1 states that accepting Federal, State, or third-party grant funds in the amount of $100,000 or more, including any City matching funds required by the grant, is subject to Board of Supervisors approval.

BACKGROUND

In June 2016, the San Francisco Public Utilities Commission (SFPUC) was awarded grants in the amounts of $100,000 from the Water Research Foundation, $100,000 from the Water Environment & Reuse Foundation, and $200,000 from the U.S. Bureau of Reclamation for a total of $400,000 toward the implementation of a decentralized purified water research pilot project in San Francisco. Grant funds will support efforts to investigate the technical viability of treating wastewater to be usable as potable water.

With this pilot project, the SFPUC and consultant team, Carollo Engineers, Inc., will test decentralized, advanced wastewater treatment over an eight-month period. Beginning in 2017, the proposed pilot project will take approximately 30 percent of the effluent produced by the SFPUC's existing tertiary wastewater treatment system and direct it through the advanced treatment system[1]. The project will include real-time monitoring technology to ensure the reliability of the treatment system, as well as advanced analytics to regularly evaluate the water quality. The advanced purification system for Direct Potable Reuse (DPR) will be sited at the SFPUC Headquarters Building, where an existing Living Machine® System treats the building's wastewater to non-potable reuse standards. After performance data is collected, effluent from the purification treatment train[2] will be blended with the living machine effluent for toilet flushing in the building. Public information, such as online and print educational materials, and tours will be developed as part of the pilot project.

Services are anticipated to begin in November 2016[3] and end in August of 2018 for a total duration of 21 months.

DETAILS OF PROPOSED LEGISLATION

The proposed resolution would authorize the San Francisco Public Utilities Commission (SFPUC) General Manager to (i) accept and expend grants in the amounts of $100,000 from the Water Research Foundation), $100,000 from the Water Environment & Reuse Foundation, and $200,000 from the U.S. Bureau of Reclamation for a total of $400,000 toward the implementation of a decentralized purified water pilot research project in San Francisco, and (ii)

[1] The advanced treatment system will treat wastewater with ultrafiltration, reverse osmosis, and ultraviolet light to produce purified water.

2 A treatment train is a sequence of multiple stormwater treatments which are designed to meet the needs of a particular environment, in order to maximize results.

[3] No funds have been expended for the project to date. However, according to Ms. Manisha Kothari, Project Manager at SFPUC, she has been tracking time spent on the project during the planning stages and will report this under the SFPUC in-kind contribution after the agreement is finalized. USBR will allow matching costs to be shown as of July 2016.

commit the SFPUC to providing $300,000 in cash funds and $100,000 in in-kind services over the 21-month duration of the grant agreement.

FISCAL IMPACT

The total budget for the decentralized purified water pilot research project administered by SFPUC is $800,000. Of this amount, $400,000, or 50 percent of the budget, will be funded by grants from the Water Research Foundation, $100,000 from the Water Environment & Reuse Foundation, and $200,000 from the U.S. Bureau of Reclamation. SFPUC will contribute $400,000, or 50 percent of the budget, in matching funds. Of the SFPUC matching funds, $300,000 will be in cash and $100,000 will be in-kind services, a portion of which will be allocated to public outreach. The Table below summarizes the grant budget.

Table: Grant Budget

Sources	
U.S. Bureau of Reclamation	$200,000
Water Research Foundation	100,000
Water Environment and Reuse Foundation	100,000
Subtotal Grant Funds	$400,000
SFPUC Water Enterprise Capital Improvement Funds	$300,000
SFPUC In-Kind Services	100,000
Subtotal SFPUC	$400,000
Total Sources	**$800,000**
Uses	
Project Management	$33,000
Initial Wastewater Treatment	18,000
Purification Facility	237,000
Monitoring and Analytics	281,000
Public Communication and Outreach	116,000
Project Communication and Reporting	115,000
Total Uses	**$800,000**

The grants between the SFPUC and the Water Research Foundation, the Water Environment & Reuse Foundation and the U.S. Bureau of Reclamation require minimum matching funds equal to 100 percent of the grant award. For the Water Research Foundation, and the Water Environment & Reuse Foundation, the matching funds must be met through cash. For the U.S. Bureau of Reclamation, the matching funds may be met through cash, in-kind, or a combination of both. The source of SFPUC matching funds is Water Enterprise Project Code CUW278 under the 10-year Water Enterprise Capital Improvement Program, as appropriated by the Board of Supervisors. According to Ms. Manisha Kothari, Project Manager at SFPUC, there will be no ongoing costs for the pilot project once grant funds expire.

RECOMMENDATION

Approve the proposed resolution.

Table 1. Sources and Uses of Grant Funds for the SFPUC Decentralized Purified Water Pilot Project

	U.S. Bureau of Reclamation (USBR) Grant				Water Research Foundation (WRF) Grant				Water Environment & Reuse Foundation (WE&RF) Grant			
	USBR	**SFPUC, Cash**	**SFPUC, In-kind**	Total	WRF	**SFPUC, Cash**	**SFPUC, In-kind**	Total	WE&RF	**SFPUC, Cash**	**SFPUC, In-kind**	Total
	Distribution of Service Cost				**Distribution of Service Cost**				**Distribution of Service Cost**			
Task Description	Professional Services		**SFPUC, In-kind**	Total	Professional Services		**SFPUC, In-kind**	Total	Professional Services		**SFPUC, In-kind**	Total
Project Management	$11,000	**$0**	**$11,000**	$22,000	$0	**$0**	**$0**	$0	$0	**$11,000**	**$0**	$11,000
Site Preparation and Building Scale Treatment	$0	**$0**	**$18,000**	$18,000	$0	**$0**	**$0**	$0	$0	**$0**	**$0**	$0
Purification Facility Design and Construction	$96,000	**$50,000**	**$20,000**	$166,000	$0	**$0**	**$0**	$0	$52,000	**$19,000**	**$0**	$71,000
Direct Potable Water Reuse Performance Demonstration	$54,000	**$15,000**	**$18,000**	$87,000	$0	**$84,000**	**$0**	$84,000	$48,000	**$62,000**	**$0**	$110,000
Public Communication and Outreach	$0	**$0**	**$0**	$0	$100,000	**$16,000**	**$0**	$116,000	$0	**$0**	**$0**	$0
Project Communication and Reporting	$39,000	**$35,000**	**$33,000**	$107,000	$0	**$0**	**$0**	$0	$0	**$8,000**	**$0**	$8,000
Task Totals	$200,000	**$100,000**	**$100,000**	$400,000	$100,000	**$100,000**	**$0**	$200,000	$100,000	**$100,000**	**$0**	$200,000

File Number: _____
(Provided by Clerk of Board of Supervisors)

Grant Resolution Information Form
(Effective July 2011)

Purpose: Accompanies proposed Board of Supervisors resolutions authorizing a Department to accept and expend grant funds.

The following describes the grant referred to in the accompanying resolution:

1. Grant Title: **(1) Funding Opportunity Announcement (FOA) No. R16-FOA-DO-OIO-Desalination and Water Purification Research Program for Fiscal Year 2016-DWPR 019P from the U.S. Bureau of Reclamation; (2) Tailored Collaboration Program from the Water Research Foundation; and (3) 2016 WRRF TC Program from the Water Environment & Reuse Foundation**

2. Department: **SFPUC**

3. Contact Person: **Manisha Kothari** Telephone: **(415) 554-3256**

4. Grant Approval Status (check one):

   [X] Approved by funding agency [ ] Not yet approved

5. Amount of Grant Funding Approved or Applied for: **(1) $200,000 (2) $100,000 (3) $100,000**

6. a. Matching Funds Required:**(1) $200,000 (in-kind/cash);(2) $100,000 (cash); (3) $100,000 (cash)**
   b. Source(s) of matching funds (if applicable):
   Funds for the SFPUC match will come from the SFPUC Water Enterprise Project Code CUW278.
7. a. Grant Source Agency: **(1) U.S. Bureau of Reclamation (2) The Water Research Foundation (3) Water Environment & Reuse Foundation**
   b. Grant Pass-Through Agency (if applicable): N/A

8. Proposed Grant Project Summary:

SFPUC and consultant team will investigate the technical viability of a decentralized purified water system using real-time monitoring and emerging analytical tools at 525 Golden Gate Avenue. The pilot project will be in operation for approximately 8 months and will include extensive lab analysis and performance monitoring for research purposes. Purified water generated by this pilot effort will be blended with the existing treated effluent system and will continue to be used for toilet flushing. Public information will be available as part of this effort.

Background

Throughout the country and all over California, water purveyors are considering purified water (also referred to as indirect and/or direct potable reuse) as a viable water supply to meet current and future water needs. Orange County has operated a groundwater replenishment program using advanced treated water since 1971. Ventura and Monterey have set up pilot programs and Santa Clara Valley Water District is expanding its South Bay Advanced Recycled Water Treatment Facility to produce up to 40 mgd of water supply. In each of these cases, the advanced treated water is treated again at a conventional water treatment plant and distributed through a centralized system. With no water treatment facility within San Francisco, such a model is not directly relevant here.

As the State Water Resources Control Board (SWRCB) contemplates regulations for direct potable reuse in California, there is a need for additional data to help inform the discussion regarding its viability.

The SFPUC has been successfully using an innovative constructed wetland treatment system to treat wastewater to Title 22 tertiary standards and operate a decentralized system for toilet flushing at its headquarters building at 525 Golden Gate Avenue since 2012. By adding reverse osmosis (RO) and advanced oxidation processes (AOP), the current structure can be augmented to achieve drinking water standards.

With this pilot project, the SFPUC and consultant team will test decentralized, advanced water treatment over an 8-month period. SFPUC staff will also work with the San Francisco Department of Public Health as the planning for this project proceeds. Beginning in early 2017, the proposed pilot project will take approximately 30% of the effluent produced by the existing tertiary treatment system and direct it through the advanced treatment system (1,500 gallons/day). The project will include real-time monitoring technology to ensure the reliability of the treatment system. The pilot project will also include advanced analytics to regularly evaluate the water quality. After testing, the advanced treated water will be blended with the existing outflow and be used for toilet flushing, as it is currently used. Public information and tours will be developed and offered as part of the pilot project.

9. Grant Project Schedule, as allowed in approval documents, or as proposed:

   Start-Date: **November 2016; pilot operation to begin early 2017** End-Date: **September 2018**

10. a. Amount budgeted for contractual services: **$700,000**
    b. Will contractual services be put out to bid? **Not for the pilot**
    c. If so, will contract services help to further the goals of the Department's Local Business Enterprise (LBE) requirements? N/A
    d. Is this likely to be a one-time or ongoing request for contracting out? **One-time**

11. a. Does the budget include indirect costs?
    [X] Yes [ ] No
    b. 1. If yes, how much? **Approximately $35,000**
    b. 2. How was the amount calculated? **22% of SFPUC in-kind labor (estimated)**
    c. 1. If no, why are indirect costs not included?
    [ ] Not allowed by granting agency [ ] To maximize use of grant funds on direct services
    [ ] Other (please explain):
    c. 2. If no indirect costs are included, what would have been the indirect costs?

12. Any other significant grant requirements or comments:

****Disability Access Checklist***(Department must forward a copy of all completed Grant Information Forms to the Mayor's Office of Disability)**

13. This Grant is intended for activities at (check all that apply):

[x] Existing Site(s)	[x] Existing Structure(s)	[ ] Existing Program(s) or Service(s)
[ ] Rehabilitated Site(s)	[ ] Rehabilitated Structure(s)	[ ] New Program(s) or Service(s)
[ ] New Site(s)	[ ] New Structure(s)	

14. The Departmental ADA Coordinator or the Mayor's Office on Disability have reviewed the proposal and concluded that the project as proposed will be in compliance with the Americans with Disabilities Act and all other Federal, State and local disability rights laws and regulations and will allow the full inclusion of persons with disabilities. These requirements include, but are not limited to:

1. Having staff trained in how to provide reasonable modifications in policies, practices and procedures;
2. Having auxiliary aids and services available in a timely manner in order to ensure communication access;
3. Ensuring that any service areas and related facilities open to the public are architecturally accessible and have been inspected and approved by the DPW Access Compliance Officer or the Mayor's Office on Disability Compliance Officers.

If such access would be technically infeasible, this is described in the comments section below:

Comments:

Departmental ADA Coordinator or Mayor's Office of Disability Reviewer:

Arfaraz Khambatta
(Name)

Interim Director, Mayor's Office of Disability
(Title)

Date Reviewed: 10/7/2016

(Signature Required)

Department Head or Designee Approval of Grant Information Form:

Harlan L. Kelly, Jr. by Juliet Ellis Acting General Mgr
(Name)

General Manager, San Francisco Public Utilities Commission
(Title)

Date Reviewed: 10/12/16

(Signature Required)

Grant Expenditures: Budget by Task

	Grant Group											
	U.S. Bureau of Reclamation (USBR) Grant Funding Source and Amount				Water Research Foundation (WRF) Grant Funding Source and Amount				Water Environment & Reuse Foundation (WE&RF) Grant Funding Source and Amount			
	USBR	SFPUC, Cash	SFPUC, In-kind	Total	WRF	SFPUC, Cash	SFPUC, In-kind	Total	WE&RF	SFPUC, Cash	SFPUC, In-kind	Total
	$200,000	$100,000	$100,000	$400,000	$100,000	$100,000	$0	$200,000	$100,000	$100,000	$0	$200,000
	Distribution of Service Cost				Distribution of Service Cost				Distribution of Service Cost			
Task Description	**Professional Services**		**SFPUC, In-kind**	**Total**	**Professional Services**		**SFPUC, In-kind**	**Total**	**Professional Services**		**SFPUC, In-kind**	**Total**
Project Management	$11,000	$0	$11,000	$22,000	$0	$0	$0	$0	$0	$11,000	$0	$11,000
Bldg-Scale Treatment	$0	$0	$18,000	$18,000	$0	$0	$0	$0	$0	$0	$0	$0
Purfication Facility	$96,000	$50,000	$20,000	$166,000	$0	$0	$0	$0	$52,000	$19,000	$0	$71,000
Performance Demo	$54,000	$15,000	$18,000	$87,000	$0	$84,000	$0	$84,000	$48,000	$62,000	$0	$110,000
Public Communication/Outreach	$0	$0	$0	$0	$100,000	$16,000	$0	$116,000	$0	$0	$0	$0
Project Communication/Reporting	$39,000	$35,000	$33,000	$107,000	$0	$0	$0	$0	$0	$8,000	$0	$8,000
Task Totals	**$200,000**	**$100,000**	**$100,000**	**$400,000**	**$100,000**	**$100,000**	**$0**	**$200,000**	**$100,000**	**$100,000**	**$0**	**$200,000**

Multi Funded Research Agreement 04691
Title
"Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring"

This Multi Funded Research Agreement (hereafter "MFRA") is entered into on _____, 20__, (the "Effective Date") by and among the Water Research Foundation ("WRF"), a Colorado non-profit corporation whose principal place of business is located at 6666 W. Quincy Avenue, Denver, Colorado 80235, the organization(s) executing this MFRA as "Co-funder(s)", and San Francisco Public Utilities Commission ("Sub-recipient") whose principal place of business is located at 525 Golden Gate Avenue, 13th Floor, San Francisco, California 94102 in furtherance of their common interest to support research on behalf of the water community.

WRF and the Co-funder(s) have selected said Sub-recipient to receive a research and development grant as more specifically detailed in this MFRA. The parties mutually agree as follows:

I. **DEFINITIONS.** The following defined terms shall apply in this MFRA:

A. "Co-funder Funds" is that portion of the Project Funds which each Co-funder has agreed to provide to fund the Project under this MFRA, as detailed in Exhibit C.

B. "Cost Share" the portion of allowable costs that the sub-recipient, subcontractor, or third-party participant funds toward completing the WRF project. Cost share includes any non-federal cash and non-cash project funding from the sub-recipient and subcontractors, and non-federal cash funding from participants. All Cost Share must meet Code of Federal Regulations (CFR) requirements in 2 CFR Part 200.306.

C. "Co-Principal Investigator-Co-PI" An individual involved with the Principal Investigator in the scientific development or execution of a project. A Co-PI typically devotes a specified percentage of time to the project and is considered "key personnel." but is not a part of the Sub-recipient's organization. The designation of a Co-PI, if applicable, does not affect the Principal Investigator's roles and responsibilities as specified in this agreement.

D. "Educational Purpose" is defined as any non-commercial and non-profit use of Intellectual Property, as defined by Paragraph I.G., including, but not limited to, a WRF owned publication or report utilized as a research tool and/or reference, to inform the water community, water utility personnel, or the general public of the outcome of this Project.

E. "Expenses" Any WRF approved expenses associated with the research and development performed by the Sub-recipient for the project.

F. "Foundation Award" is that portion of the Project Funds which WRF has agreed to provide to fund the Project under this MFRA, as detailed in Exhibit C.

G. "Intellectual Property-IP" is all rights to copyrights, trademarks, service marks, patents, trade secrets, know how, and confidential information, including the right to enforce, divest, license, seek registration, prosecute infringers, and commercially or otherwise exploit such rights.

H. "PAC" is the Project Advisory Committee that consists of independent volunteers selected by WRF and Co-funder(s) to provide technical review, assistance, and/or expertise related to the Project. The number of volunteers to serve on the PAC will be determined by WRF.

I. "Participating Utility" is a utility that provided data or information for the research effort – not survey respondents or workshop participants.

J. "Principal Investigator" is the Sub-recipient employee identified in Exhibit B, who is primarily responsible for ensuring that all terms and conditions of this MFRA are met and to whom WRF shall give all notices intended for the Sub-recipient.

K. "Project" is the work to be completed by the Sub-recipient, as described more specifically in the Project Proposal attached hereto as Exhibit A.

L. "Project (Award) Funds" is the aggregate maximum amount of cash award which WRF and the Co-funder(s) have collectively agreed to provide to Sub-recipient to fund its performance of the Project pursuant to this MFRA.

M. "Project Proposal" is the final and written description of the project to be undertaken by Sub-recipient for which the Project Funds is granted and performance is monitored pursuant to this MFRA.

N. "Proposal Guidelines" is WRF's written guidelines, currently maintained at http://www.waterrf.org/funding/ProposalDocuments/TailoredCollaborationProposalGuidelines.pdf which the procedures, criteria and requirements for eligibility, proposal, performance, administration, reporting, and other matters governing the proposal of and performance of a Project are set forth. The Proposal Guidelines were provided to the Sub-recipient prior to its submission of a Project Proposal, and its terms and requirements are incorporated in this MFRA by this reference. The terms "Deliverable", "Periodic Report", "Draft Report", and "Final Report" appearing in this MFRA shall have the definitions, and be governed by the requirements applicable thereto, as set forth in the Proposal Guidelines.

O. "Reports" are the Periodic Reports, Draft Report, and/or Final Report, collectively.

P. "Subcontractor" is any individual or entity identified by Sub-recipient in the Project Proposal as assisting in the performance of the Project under this MFRA.

Q. "Sub-recipient" is the awarded entity who performs the substantive, programmatic work or an important or significant portion of the Project.

R. "Subject Data" shall mean all non-patented original and raw research data, notes, computer programs, writings, sounds recordings, pictorial reproductions, drawings or other graphical representations and works of any similar nature originated by the Sub-recipient in performance of this MFRA, but specifically excluding WRF Intellectual Property or Sub-recipient Intellectual Property as defined within this MFRA. Subject Data also excludes financial reports, costs, analysis, and similar information incidental to contract administration.

S. "Work Product" is copyrightable works of authorship created by or on behalf of the Sub-recipient or its Subcontractors in the course of performing under this MFRA or the Project, including, without limitation, the Scope of Work, all Deliverables, Periodic Reports, Draft Reports, the Final Report, all interim drafts of the foregoing, and any computer software and related documentation developed under the Project.

II. GENERAL OBLIGATIONS OF THE PARTIES

A. The Sub-recipient.

1. The Sub-recipient agrees to complete the research, prepare written Reports, deliver the Deliverables to WRF, and perform such other functions, all in accordance with the schedules and other requirements set forth in the Exhibits and this MFRA. The Sub-recipient shall itself, and shall require all of its Subcontractors to, perform the Project and all other activities related thereto in full compliance with all laws, regulations, ordinances, and other requirements governing them.

2. Sub-recipient may not use Project Funds received under this MFRA as a match or cost-sharing vehicle to secure U.S. Federal monies or money from any other sources, unless otherwise expressly stated and fully disclosed in the Project Proposal. The Sub-recipient may not use any portion of the Project Funds for any purpose other than as detailed in the Project Proposal, and as is necessary to perform the Project.

3. All disbursements of Project Funds will be paid directly to Sub-recipient. Sub-recipient shall remain solely responsible for payment of its Subcontractors, and for procurement of all equipment, materials, and other resources necessary for performance of the Project hereunder.

B. The Co-funder(s). The Co-funder(s) agree to pay their respective Co-funder funds in accordance with the terms and timelines in this MFRA. The Co-funder(s) shall deliver their full Co-funder funding; by company check made payable to WRF, by no later than the Effective Date.

C. WRF. Provided that WRF has received the full Co-funder funding from each of the Co-funder(s) by following the Effective Date, WRF will disburse the Project Funds to the Sub-recipient as detailed in this MFRA and Exhibit C. WRF's disbursement of the Project Funds shall be subject to WRF first having received full corresponding payment from all of the Co-funder(s), and may further be subject to WRF's receipt of its own funding from appropriate sources. In no event shall WRF be required to disburse the Co-funder funding if WRF itself has not received same from Co-funder(s).

III. DISBURSEMENT OF PROJECT FUNDS

A. Advance Payment. All payments of the Project Funds will be disbursed by WRF directly to the Sub-recipient. Each disbursement shall be deemed to be made by WRF and the Co-funder(s) in proportion to their relative payment to the Project Funds. The amount of Project Funds was determined on the basis of the budget submitted by the Sub-recipient, and set forth in Exhibit C. The Project Funds is a "not to exceed" amount and no payments in excess of such amount are authorized or required. Subject to WRF's prior receipt of the full amount of the Co-funder funding, following the Effective Date WRF will advance to the Sub-recipient 10% of the Project (Award) Funds. No invoice is required from the Sub-recipient for the 10% advance. All subsequent disbursements of the Project Funds shall be governed by the requirements described in Section III.B below and in Exhibit C.

B. Invoicing and Payments.

1. Beginning three (3) months after the Effective Date, and every three (3) months thereafter during the term of this MFRA, Sub-recipient shall submit to WRF a detailed invoice itemizing the expenses actually incurred in the three (3) months prior to the invoice date by the Sub-recipient in the performance of the Project, and identifying all Cost Share and third party in-kind contributions as well as the contributing parties. The invoice shall be sent to the Project Coordinator identified in Exhibit B.

2. Each invoice should be displayed according to the budget line items in Exhibit A. All invoices must be submitted using the form attached in Exhibit D, must be on the Sub-recipient's letterhead, and must be sent to WRF's Project Coordinator identified in Exhibit B. Only out of pocket costs and expenses actually incurred by the Sub-recipient may be invoiced under this MFRA.

3. WRF will disburse Project Funds conditioned upon the Sub-recipient timely submitting Reports. No portion of the Project Funds will be disbursed by WRF unless and until WRF receives and accepts each corresponding invoice and Report. If the invoices and Reports are accepted, the Sub-recipient will be paid as follows:

   (a) The ten percent (10%) advance payment must be shown on all invoices, including the final invoice, as an advance payment received. Subject to the hold back provision below, invoices will be paid to the extent actual costs incurred exceed the advance payment. **No invoice is required from the Sub-recipient, the advance is paid upon WRF receipt of all signatures of this MFRA.**

   (b) Regardless of the actual amounts invoiced, WRF will at all times during this MFRA hold back twenty percent (20%) of the Project Funds, and will only disburse same as follows: Ten percent (10%) of the Project Funds will be disbursed to the Sub-recipient when WRF receives and accepts the Draft Report. The remaining held back ten percent (10%) of the Project Funds will be disbursed to the Sub-recipient after the Sub-recipient has completely and adequately responded to editor queries on the Final Report, has made all revisions reasonably requested by WRF to finalize the Final Report, submitted a final invoice, and Exhibit E – Assignment of Copyright (if applicable).

   (c) No conditions, notations, acknowledgements, comments, or terms other than the items required to be included and itemized on the Sub-recipient's invoice shall be binding on WRF.

   (d) WRF may deduct amounts or withhold payments invoiced by the Sub-recipient if the Sub-recipient fails to comply with any WRF standard and/or Federal Uniform Administrative Requirements of the Sub-recipient's cognitive agency.

IV. COMPLIANCE MONITORING

A. Financial Management System. The Sub-recipient shall maintain an accounting system and accurate and complete accounting records that, at a minimum but without limitation, allow for the identification, tracking, and verification of costs, expenses, Cost Share, in-kind contributions, invoiced items, and

funding received, all in a manner that is segregated and allocable solely to performance of the Project. All costs incurred must be supported by original receipts and be made available to WRF upon request.

B. U.S. Federal Administrative, Cost and Audit Requirements. The Sub-recipient represents and warrants that the budget disclosures included in the Project Proposal and presented to WRF were prepared by Sub-recipient in full compliance with Water Research Foundation Guidelines and all relevant U.S. laws, regulations and agreement terms and conditions related to U.S. Federal Financial Assistance including, but not limited to, 2 CFR 200 [U.S. Code of Federal Regulations Title 2 (Grants and Agreements) Part 200: Uniform Administrative Requirements, Cost Principles and Audit Requirements for Federal Awards (a/k/a/ Uniform Grants Guidance or UGG). Cost Principles specifically applicable for awards to for-profit organizations are set forth in the Federal Acquisition Regulations System (FARS, at 48 CFR 31.2) to determine allowable costs under WRF project funding agreements. Sub-recipient shall throughout the Project, and in the preparation of every invoice, report, and maintenance of its accounting system, remain in compliance with the above regulations. It shall be Sub-recipient's obligation to determine and comply with its governing cost principles.

C. Indirect Costs and Allocation of Costs:

1. If the Sub-recipient proposes to invoice for indirect costs, substantiation of those charges must be in compliance with WRF's "Tailored Collaboration Proposal Guidelines," which include compliance with the applicable cost principles referenced in Section IV.B.

D. Record Retention. Sub-recipient shall retain all records pertinent to this MFRA and the Project for at least three (3) years from the termination of this MFRA.

E. Audit and Monitoring.

1. The Sub-recipient's use of the Project Funds under this MFRA are to be in compliance with 2 CFR 200, including Subpart F, Audit Requirements, and may be audited by WRF or its designee. Furthermore, WRF shall have the right to itself or through a designee visit the Sub-recipient premises to observe, review, and monitor the Sub-recipient's performance of the Project, as well as its application and use of the Project Funds. Accordingly, following a two (2) business day prior notice from WRF, the Sub-recipient shall provide WRF and its designee access to its premises, technical staff, supervisors, knowledgeable personnel, computer systems and databases, assistance, original documents, including those required to be maintained under this MFRA, and any information related to the Sub-recipient's use of the Project Funds and performance under this MFRA, to enable WRF's audit and monitoring. WRF's audit rights shall survive termination of this MFRA by three (3) years.

2. WRF will keep any of Sub-recipient's proprietary financial, technical and/or scientific proposal information reviewed under this Section in confidence provided that such material is appropriately marked as "Confidential," was not already generally known to the public, is not required to be disclosed as a result of a legal proceeding, or applicable legal requirement, and was not already known to WRF or others without a confidentiality obligation.

3. Any deficiencies or non-compliance in Sub-recipient's systems, procedures, record keeping, finances, and performance of other obligations under this MFRA discovered in the audit, review or monitoring process, or discovered otherwise, may, at WRF's option, require Sub-recipient to

take corrective action that has been detailed by the Sub-recipient and approved by WRF for the Sub-recipient to remedy the deficiency or noncompliance, or may result in WRF exercising its termination rights under Section VII below.

4. If WRF approves of the Sub-recipient's proposed corrective action plan, in connection with such approval it may require the Sub-recipient to submit additional periodic written verification that the corrective action plan has been implemented and continues to correct the targeted deficiencies and noncompliance. If the approved corrective action fails to correct the deficiencies within the time set by WRF in its sole discretion, WRF may exercise its termination rights under Section VII.

5. Nothing herein obligates WRF to accept or approve a corrective action or to forbear from exercising its right to terminate this MFRA. WRF's right to termination shall be in addition to all other rights and remedies available to it at law or in equity.

V. PROCUREMENT STANDARDS

A. Procurement Standards. It is an express requirement under the Proposal Guidelines and this MFRA that the Sub-recipient remain in compliance with the U.S. Federal standards for procurement under 2 CFR 200 Subpart D, Procurement Standards. These standards govern procedures for procurement of supplies, equipment, and other services for which cost is incurred in whole or in part under this MFRA. These standards include but are not limited to the following:

1. Sub-recipient procurement policies must adhere to the minimum standards applicable to its organization type;

2. Sub-recipient shall maintain and enforce with its officers, employees, and agents (including Subcontractors) a code of conduct designed to enhance goodwill, ethics, and compliance with laws while performing under this MFRA; and

3. Sub-contractor shall conduct all procurement transactions in a manner that maximizes open and free competition.

VI. IP RIGHTS AND PUBLICATION

A. Work Product.

1. WRF shall own all worldwide copyrights in all the Work Product including the Scope of Work, All Periodic Reports, All Draft Reports, the Final Report, and all drafts of these works and reports. Sub-recipient shall and hereby does assign exclusively to WRF all right, title, and interest in and to the Work Product and the copyrights embodied therein. And subject to provisions of 2 CFR 200 Subpart D, Property Standards, Intangible Property (200.315); and 37 CFR 401 which are made part of this MFRA by reference except where superseded by this Section VI or the U.S. Federal Grant Agreement. The Sub-recipient may use without restrictions all data from the Work Product such as innovations, creations, processes, designs, methods, formulas, plans, technical data, and specifications. The use of this Intellectual Property will not be utilized by the Sub-recipient or Co-funder, if applicable, before WRF has released the final Work Product.

2. WRF will provide the Sub-recipient with five (5) hardcopies of the Final Report and a PDF. If the Final Report is published in a PDF format only, the Sub-recipient will receive the Final Report in that format. The Work Product may not be copied, published, adapted, posted on an intranet or website, or disclosed in any manner by the Sub-recipient, any Subcontractor or other third party except with WRF's prior written approval. The Sub-recipient shall utilize WRF's *Material Use Permission Request Form* located at http://www.waterrf.org//funding/Pages/project-report-guidelines.aspx for securing the foregoing required permission for WRF.

3. WRF hereby grants the Sub-recipient and Co-funder(s) a royalty free, perpetual, irrevocable, world-wide, nonexclusive license, without the requirement for any accounting, to utilize Foundation's Intellectual Property solely for Educational Purposes.

4. WRF PI and Co-PI Intellectual Property Guidelines are available locate http://www.waterrf.org/funding/ProjectReportGuidelines/IntellectualPropertyGuidelinesforPIsandco-PIs.pdf.

5. PI guidelines for Periodic Report Format/Content and Preparation Research Reports are available at: http://www.waterrf.org/funding/pages/project-report guidelines.aspx.

B. Inventions and Patents.

1. All proprietary or patentable ideas, devices, methods, formulations, designs, and other inventions developed or conceived by or on behalf of the Sub-recipient in the course of performing under the Project, including, but not limited to, the right to apply for patent protection thereon (collectively, "Inventions"), shall remain the property of the Sub-recipient.

2. If the Sub-recipient decides to abandon its rights to the Inventions, or not to seek patent protection on its Inventions, or to abandon any pending patent application or patent issued on the Inventions, Sub-recipient shall notify WRF of the same and promptly assign all rights in the abandoned Inventions to WRF at its request.

3. Sub-recipient shall not withhold any information on or descriptions of Inventions, whether or not patentable, from Work Products or any Report. The Sub-recipient's rights in Inventions shall not limit, delay, restrict, or in any other manner interfere with WRF's right to own, publish, and exercise all other copyrights in the Work Product. If information contained in the Work Product owned by WRF is considered to be and is treated by the Sub-recipient as confidential information and/or trade secrets, the Sub-recipient shall be solely responsible for marking confidential portions of the Work Product as such, and may request that WRF reasonably delay, but in no event by more than one month, publication of a Work Product in order to allow the Sub-recipient to apply for patent protection on Inventions described in the Work Product.

4. All IP rights that were owned and developed by the Sub-recipient or third parties prior to the Effective Date and outside the scope of the Project (collectively, "Preexisting IP"), and which the Sub-recipient will use in the performance of the Project, or incorporate in whole or in part into any Deliverables, has been fully disclosed and identified by the Sub-recipient in the Project Proposal. The Sub-recipient represents and warrants that all Preexisting IP is used with full

authorization and permission from its respective owner, and copies of such permissions and licenses shall be provided to WRF by the Effective Date. The Sub-recipient shall obtain all appropriate permissions on WRF's behalf to the extent necessary to enable WRF to exercise its ownership and publication rights in the Work Product, including the Final Report, such right shall be transferable, sublicenseable, and shall not be subject to any payment or other obligation on the part of WRF. Such agreements to procure rights for WRF shall be subject to WRF's prior approval, in its sole discretion.

5. The Sub-recipient hereby grants WRF a fully paid-up, royalty free, perpetual, irrevocable, world-wide, nonexclusive license, with the right to grant sublicenses, to utilize the Inventions and Preexisting IP for educational or other non-profit purposes.

C. Publication. As the owner of Work Product, all rights to publish, distribute, publicly perform, and publicly present the Reports belong solely to WRF. The Co-funder(s) and Sub-recipient may publish or present based on the Work Product, in whole or in part, and only with the prior written permission of WRF, which may be withheld or conditioned at WRF's sole discretion. Any such request for permission from WRF must be made to WRF at least three (3) weeks prior to the requesting party's proposed date of publication or presentation based on any portion of the Work Product, and the request must be accompanied by copies of the proposed publication or presentation material. All copies of or presentations based on the Work Product authorized to be made by WRF shall furthermore conspicuously display the following notice:

Author, Title of Foundation Work
Copyright [year of publication]
Water Research Foundation Reproduced with permission

D. Participating Utility Review: The PI shall, with each participating utility, (a) grant the participating utility the right to review the Project's use and conclusions concerning that organization's data and/or test results, and (b) provide the participating utility with the reasonable opportunity to correct, or if correction will take an unreasonably long time, to respond to any problems or difficulties uncovered by the data, information, or test results, all of which must occur prior to the publication or use of such information, and (c) send and collect Exhibit F from each utility. This provision shall apply to each water utility participating in any manner with the Project, including, but not limited to, providing services, data, materials for testing, test results, and/or documentation. If the PI has made reasonable efforts but is not able to obtain confirmation from each participating utility, the Principal Investigator may submit documentation to this fact and further state that the participating utility was provided reasonable opportunity to correct or respond to any problems or difficulties as stated above.

E. Student Thesis. In the event a college or graduate student is a part of Sub-recipient work on the project contemplated by this MFRA, and that student completes a thesis, dissertation, or report relating to this project, solely for educational purposes, the student may utilize Subject Data, but may not use any written materials that are substantially similar to WRF Intellectual Property.

F. Acknowledgement. Any public presentation or publication by the Sub-recipient or Co-funder(s), including a student writing a thesis, dissertation, or report, based on the Inventions or any portion of the Work Product, if permitted by WRF, shall include a statement substantially as follows: *"[Sub-recipient] gratefully acknowledges that the Water Research Foundation, [Co-funder(s)] are Co-funder(s) of certain technical information upon which this publication [manuscript] [presentation] is based. [Sub-recipient] thanks the Water Research*

Foundation, [Co-funder(s)] for their financial, technical, and administrative assistance in funding the project through which this information was discovered."

G. Return of IP. The Sub-recipient shall provide to WRF legible copies of all Work Product (including source and object code of any computer software program) and all Inventions abandoned by the Sub-recipient, and shall furthermore provide to WRF and Co-funder(s) legible copies of all Preexisting IP, all within thirty (30) days of any party's delivery of a notice of termination hereunder, whether or not a cure period is provided. Further, at the same time, Sub-recipient shall provide copies and originals shall be delivered in whatever medium and format is reasonably designated by WRF. No further payments will be made unless the Sub-recipient fully complies with the foregoing requirements.

H. Originality. The Sub-recipient represents, warrants, and covenants that it, and its Subcontractors, are the sole creator(s) and originator(s) of all Work Product, Inventions, and Preexisting IP; none of those rights have been bargained, sold, encumbered, licensed or otherwise transferred to any other party in a manner that would limit or interfere with the requirements and covenants of the Sub-recipient under this MFRA. Further, the Sub-recipient shall ensure that no portion of this Project, including any portion completed by Subcontractors, infringes upon the IP rights of any other person or entity or violates the common law or statutory right, title, or interest of any person or entity. The Sub-recipient, shall execute and deliver to WRF, and shall cause its Subcontractors and agents to execute and deliver to WRF, all documents and instruments reasonably requested by WRF, including, without limitation, the Assignment of Copyright attached hereto as Exhibit E, to further evidence or memorialize the assignment of rights to WRF set forth in this MFRA.

I. Trade Secrets. In accordance with the Defend Trade Secrets Act of 2016, Trade Secrets have previously been protected by state laws in the U.S. This bill amends the Economic Espionage Act of 1996 to permit a private federal civil action for misappropriation of a trade secret that is "related to a product or service used in, or intended for use in, interstate or foreign commerce." For further information, go to: https://www.congress.gov/bill/114th-congress/senate-bill/1890/text.

VII. TERM AND TERMINATION

A. Term. This MFRA is effective as of the Effective Date, and shall continue for the duration of the Project, ending on WRF's delivery to the Sub-recipient of the final disbursement of the Project Funds in accordance with Section III.B above, and as further specified in Exhibit C. This MFRA may be terminated earlier for the following reasons:

1. WRF may terminate this MFRA by written notice to the other parties at any time in the event of a breach of this MFRA or any requirements of or timelines in the Project by the Sub-recipient or its agents following Sub-recipient's receipt of WRF's notice of breach.

2. WRF may terminate this MFRA effective immediately by written notice to the other parties in the event WRF after consultation with the Co-funder(s) and the PAC reasonably determines that the Project is no longer feasible or its performance desired, or that if Sub-recipient is not likely to complete the requirements of the Project on time.

3. Co-funder(s) may terminate this MFRA by a ninety (90) day prior written notice to the other parties if either the Sub-recipient or WRF materially breaches this MFRA.

4. Upon receipt of any written notice of termination, the Sub-recipient shall cease all work associated with this MFRA as of the date of receipt of the notice, but shall continue to prepare whatever reports, accounting statements, and invoices that are necessary to support receipt of any payments and deliver existing Work Product as required under the MFRA.

5. If the Sub-recipient, after reasonable consultation with WRF and sufficient exploration of other options and possible mutual agreements to amend this MFRA, determines that circumstances beyond its control prevent it from continuing the Project, the Sub-recipient may terminate this MFRA at any time by written notice to WRF.

6. Any change in legal requirements or entitlements which materially alter Sub-recipient's performance under this MFRA, or any change in the availability of funds to WRF, shall warrant good faith renegotiation of the provisions of this MFRA impacted by such change. If the parties cannot agree to an amendment to this MFRA, at WRF's option the Sub-recipient's performance of the Project may be suspended, or this MFRA may be terminated effective immediately by WRF's written notice.

7. If termination occurs under this Section, the Sub-recipient shall prepare and submit to WRF a final invoice and accounting of expended and non-cancellable funds as of the date of receipt of the notice of termination. Any portion of the Project Funds that was prepaid to the Sub-recipient but which remains unspent shall be returned to WRF with the final invoice. WRF shall pay any amount owed under the final invoice, if reasonably accepted by WRF, and shall return to the Co-funder(s) any remaining and unspent funds in proportion to the Co-funder funding. The Sub-recipient shall be entitled to compensation for all satisfactory and authorized work completed as of the termination date, provided that all Work Product corresponding to the invoiced amounts have been delivered to WRF, and further provided that funds are available (i.e., a reduction in granted funds as stated above).

VIII. DISPUTE RESOLUTION

A. In the event of a dispute between WRF and the Co-funder(s) with respect to the Sub-recipient's performance, or other acts or omissions in performing the Project or under this MFRA, WRF's final determination, following reasonable consultation with the PAC, shall govern.

B. All other disputes arising under this MFRA by or among the parties shall be resolved by binding arbitration conducted in accordance with the then effective rules of expedited commercial arbitration of the American Arbitration Association ("AAA") in Denver, Colorado U.S.A. There shall be one Arbitrator selected in accordance with such rules. The Arbitrator shall have subpoena powers. Any final binding determination issued by the Arbitrator shall be in writing within thirty (30) days of the final mediation session. Such written decision may be enforced in any court having proper jurisdiction.

IX. STANDARD TERMS AND CONDITIONS

A. Survival. All terms which by their nature and intent are required to be performed after termination of this MFRA shall survive to the extent necessary to enable their fulfillment.

B. Quality Assurance. The Sub-recipient shall use its best efforts to ensure that all data and test results developed during the course of this MFRA and included, or relied upon, in the Final Report are accurate to the best of its knowledge, information, and belief. In the event the Sub-recipient obtains any data, test results, information derived from such data or test results, or other information to be included in the

Project from water utilities or any Subcontractor, the Sub-recipient will utilize reasonable and customary efforts to ensure the accuracy of the information obtained.

C. Co-funder(s) Review. The Co-funder(s) shall have the right and reasonable opportunity prior to submission of the Final Report, to review the data, results and conclusions derived from the Project, and to correct or comment upon any discrepancies in the reviewed materials. The Sub-recipient shall be responsible for providing letters for review and execution by each Co-funder confirming that they have reviewed the submitted materials. Such confirmation letters, signed by each Co-funder, shall be submitted to WRF with the Final Report. If the Sub-recipient has made reasonable efforts but is not able to obtain signed confirmation letters, the Principal Investigator may submit a signed letter stating this fact and further stating that the Co-funder(s) were provided reasonable opportunity to review and comment upon the materials as required.

D. Standard of Performance. At all times, all obligations performed by the Sub-recipient or by any Subcontractors pursuant to this MFRA shall be performed in a manner consistent with or exceeding the professional standards governing such activities. Further, the Sub-recipient shall be responsible for, and shall hold harmless and indemnify WRF, Co-funder(s), and their officers, directors, affiliated organizations, employees, agents, volunteers, and publisher, if any, from any and all liability, obligation, damage, loss, cost, claim, lawsuit, cause of action, or demand whatsoever of any kind or nature, including, but not limited to, attorneys' fees and costs, arising from (i) any actions taken by, or omissions of, the Sub-recipient, its officers, directors, Subcontractors, employees independent contractors, agents, or other related entities or individuals, (ii) any use or misuse of IP claimed to be owned by another, or (iii) any material breach of this MFRA by the Sub-recipient.

E. Governmental Entities. If the Sub-recipient or any Subcontractor is a governmental or quasi-governmental entity that is by law prohibited from indemnifying others, Section IX.D is modified to the extent that will impose the maximum available liability and responsibility on Sub-recipient. Sub-recipient shall require all parties involved in the performance of this MFRA that are not prohibited from indemnifying others to so indemnify WRF and the Co-funder(s) through a written agreement acceptable to WRF and the Co-funder(s).

F. Insurance. The Sub-recipient shall maintain a financially sound program of self-insurance or commercially purchased liability insurance covering unfair competition claims and all reckless, intentional, knowing, and negligent actions or omissions of any and all of Sub-recipient's officers, directors, employees, agents, and independent contractors and/or Subcontractors in the amount of one million dollars ($1,000,000.00). Proof of such insurance shall be presented to WRF pursuant to the schedule detailed by Exhibit B and to the Co-funder(s) upon request. The proof of insurance document shall clearly specify the Project by number and title on the insurance certificate.

G. Worker's Compensation. The Sub-recipient and all Subcontractors shall maintain Worker's Compensation Insurance which complies with the applicable state laws. Proof of such insurance shall be presented to WRF pursuant to the schedule detailed by Exhibit B.

H. Authority. The individuals executing this MFRA on behalf of their respective parties hereby represent and warrant that they have the right, power, legal capacity, and appropriate authority to enter into this MFRA on behalf of the entity for which they sign below.

I. Modifications: No provision, requirement, or term of this MFRA may be modified, supplemented or amended, nor may it be waived or discharged, except in writing, signed by all parties. A written waiver of a breach of one provision in this MFRA shall not operate as a waiver of a subsequent breach of the same provision.

1. Examples of items requiring WRF's prior written approval include, but are not limited to, the following:

    - Deviations from the Project plan.
    - Change in scope or objective of the Project.
    - Change in a key person specified in the application.
    - The absence for more than three months or a 25% reduction in time by the principal investigator.
    - Need for additional funding.
    - Inclusion of costs that require prior approvals as outlined in the Uniform Grants Guidance and 48 CFR 31.2, as applicable.
    - Any changes in budget line item(s) as described in Exhibit A of greater than ten percent (10%) of the total.

J. No Assignment. The Sub-recipient shall not assign this MFRA in whole or in part, including by operation of law, merger, reorganization, or change in ownership or control. Any unauthorized assignments shall be void.

K. Sub-Contracting: The Sub-recipient may only utilize Subcontractors under this MFRA that have been disclosed in the Project Plan and are pre-approved by WRF.

1. Sub-recipient shall require any and all Subcontractors to comply with all applicable and material terms of this MFRA prior to working on the Project in any manner. All obligations of the Sub-recipient apply equally to the Subcontractor(s). Sub-recipient shall at all times remain primarily responsible and liable to WRF and the Co-funder(s) for the acts and omissions and performance of this MFRA by its Subcontractors.

2. Payment for services of any and all Subcontractors shall be the Sub-recipient's sole obligation and responsibility. The Sub-recipient hereby indemnifies and holds WRF and Co-funder(s) harmless for any liability concerning such payment. In furtherance of the foregoing, and to safeguard WRF if Sub-recipient or any Subcontractors is legally prohibited from indemnifying others, Sub-recipient shall in all its Subcontractor agreements specify that WRF and Co-funder(s) shall have no liability or obligation to the Subcontractor, and that the Subcontractor agrees to look solely to the Sub-recipient for payment and enforcement of its rights under its agreement with the Sub-recipient.

3. Subcontractor shall conduct all procurement transactions in a manner that maximizes open and free completion.

4. WRF shall require for Sub-recipient to notify WRF, within two (2) months of the project start date pursuant to the schedule detailed in Exhibit B, that all Subcontractor agreements have been executed between the Sub-recipient and any Subcontractors set forth in the Project Proposal (if

applicable). Send notification to Peg Falor, WRF Manager – Contracts & Project Administration, Email: pfalor@WaterRF.org.

L. Integration. This MFRA, including all attachments hereto and the documents and requirements referenced herein, contains the entire understanding between the parties relating to this MFRA. This MFRA supersedes all prior and contemporaneous understandings, representations, negotiations, and agreements between the parties whether written or oral. In the event of a conflict between the terms of an Exhibit or other document referenced herein and this MFRA, the terms of this MFRA shall control.

M. Severability. The provisions of this MFRA shall be severable, and the invalidity, illegality or unenforceability of any provision of this MFRA shall not affect the validity or enforceability of any other provisions. If any provision of this MFRA is found to be invalid, illegal, or unenforceable, such provision shall be modified to the extent necessary to render it enforceable, and as modified, this MFRA shall remain in full force and effect.

N. WRF Right of Approval. WRF and Co-funder(s) shall have the right, in their sole discretion, to refuse to permit any employee of the Sub-recipient, or employee of an approved agent, assignee, or subcontractor of the Sub-recipient, to be located at a WRF or Co-funder(s) work location, or to provide services to WRF, Co-funder(s) or their clientele pursuant to this MFRA.

O. Notices. Any notice, request, demand, or communication required or allowed under this MFRA shall be sent in writing to the addresses and contact information for the parties set forth in Exhibit B, and shall be deemed sufficiently given upon delivery, if delivered by hand (signed receipt obtained), or three (3) days after posting if properly addressed and sent certified mail return receipt requested, or upon receipt if sent via facsimile or email, if delivery can be confirmed by the sender. Notices shall become effective on the date of receipt or the date specified within the notice, whichever comes later.

P. Captions for Convenience. All captions, fonts, underlining, or footers used in this MFRA are for convenience only and shall have no meaning in the interpretation or effect of this MFRA.

Q. Construction. This MFRA, and any and all amendments to it, shall not be construed against the drafter.

R. Force Majeure. None of the parties hereto will be liable for damages for any delay or default in performance during the term hereof if such delay or default is caused by conditions beyond its control, including, but not limited to, acts of God, Government restrictions, continuing domestic or international problems such as wars, threats of terrorism, or insurrections, strikes, fires, floods, work stoppages and embargoes; provided, however, that any party will have the right to terminate this MFRA upon thirty (30) days prior written notice if another party's delay or default due to any of the above-mentioned causes continues for a period of two (2) months.

S. Limitation of Liability. IN NO EVENT SHALL WRF OR ANY OF ITS OFFICERS, DIRECTORS, EMPLOYEES, AFFILIATES, AGENTS OR REPRESENTATIVES BE LIABLE TO ANY OTHER PARTY, OR ANY THIRD PARTY FOR ANY SPECIAL, INDIRECT, INCIDENTAL, EXEMPLARY OR CONSEQUENTIAL DAMAGES OR LOSS OF GOODWILL OR EXPECTED PROFITS OR REVENUES, IN ANY WAY RELATING TO THIS MFRA, INCLUDING, WITHOUT LIMITATION, THE FAILURE OF ESSENTIAL

PURPOSE, EVEN IF IT HAS BEEN NOTIFIED OF THE POSSIBILITY OR LIKELIHOOD OF SUCH DAMAGES OCCURRING, AND WHETHER SUCH LIABILITY IS BASED ON CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY, STATUTE, PRODUCTS LIABILITY OR OTHERWISE. IN NO EVENT SHALL WRF'S OR THE CO-FUNDER(S)' LIABILITY HEREUNDER EXCEED THEIR RESPECTIVE FUNDING ALREADY MADE UNDER THIS MFRA.

T. Applicable Law/Venue. This MFRA is written and shall be construed in accordance with and governed by the laws of Colorado unless U.S. Federal law applies. However, if legal action is taken against Sub-recipient and U.S. Federal or state laws which exist that govern Sub-recipient (as a quasi-public or public entity) exclusively, this MFRA shall be construed and interpreted in accordance with such laws to the extent if such exclusivity. Any action under this MFRA must be brought in a Colorado State Court or U.S. Federal District Court located in Denver, Colorado.

U. Counterparts. This MFRA may be executed and delivered in counterparts, and by facsimile and email, and each shall be valid as if all parties had executed the same document.

V. Relationship. The parties are independent contractors, and no agency, employer-employee, partnership, or joint venture relationship is intended or created by this MFRA. No party shall have any right or authority to assume or create any obligation, commitment or responsibility for or on behalf of the others except as the other may expressly authorize in writing. No party shall be eligible to participate in another's benefit program. Sub-recipient shall be solely responsible for the performance and compensation of its employees, for withholding taxes and providing unemployment and other benefits.

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Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

IN WITNESS WHEREOF, the parties have caused this MFRA to be signed and dated as shown below.

Water Research Foundation

By: Robert C. Renner, PE, BCEE
Title: Chief Executive Officer

Date: _____

San Francisco Public Utilities Commission

By: Steven R. Ritchie
Title: Assistant General Manager-Water Enterprise

Date: _____

Water Research Foundation

By: Kathryn Henderson
Title: Research Manager

Date: _____

Above signed has read and understands the terms, conditions, and deliverables of this MFRA.

San Francisco Public Utilities Commission

By: Paula Kehoe
Title: Principal Investigator

Date: _____

Above signed has read and understands the terms, conditions, and deliverables of this MFRA.

DRAFT AGREEMENT – DO NOT SIGN

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

SPONSOR/Co-funder

San Francisco Public Utilities Commission

_____

By: Steven R. Ritchie
Title: Assistant General Manager, Water Enterprise

Date: _____

Above signed has read and understands the terms, conditions, and deliverables of this MFRA.

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

NOTE: EXHIBIT A WILL CONSIST OF THE PROJECT PROPOSAL IN THE FINAL DOCUMENT, IT IS NOT INCLUDED IN THE DRAFT DOCUMENT]

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Project proposal, & all subsequent correspondence.

Exhibit B
Project 04691

NOTE– EXHIBIT B SHOWN IS THE STANDARD DRAFT SCHEDULE, ACTUAL SCHEDULE WILL BE MUTUALLY DECIDED UPON BETWEEN THE RM AND PI AT FINAL AGREEMENT STAGE.

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

TASK	DUE DATE (1st or 15th of Month)
Project Start	Start date
Scope of Work	30 days after start date
Proof of Insurance (Ref. IX.F)	30 days after start date
Notification of Subcontractor(s) Agreement(s) executed (Ref. IX.K.4)	30 days after start date 2 months after start date
Periodic Report 1 – electronic copy & Invoice (Periodic Reports-Ref. II.A.1, Invoices – Ref. III.B)	3 months after start date
Periodic Report 2 (incl. Technical Summary & Web Update) - electronic copy & Invoice	6 months after start date
Periodic Report 3 – electronic copy & Invoice	9 months after start date
Periodic Report 4 (incl. Technical Summary & Web Update) – electronic copy & Invoice	12 months after start date
Periodic Report 5 – electronic copy & Invoice	15 months after start date
Periodic Report 6 (incl. Technical Summary & Web Update) – electronic copy & Invoice	18 months after start date
Draft Report – electronic copy & Invoice	21 months after start date
Final Report – electronic copy (Ref. III.B.3.b)	5 months after draft report
Exhibit E – Complete & Submit – Assignment of Copyright (Ref. VI.I)	5 months after draft report
Exhibit F – Submission of each participating utility IK (Ref. VI.F)	5 months after draft report
Final Invoice (Ref. III.B.3.b)	5 months after draft report
Project End & Foundation Publication Date (Ref. VI.C)	12 months after draft report

Note: Please submit one electronic copy of each Periodic Report and Draft Report. Submit the Final Report in electronic copy in *MSWord format.* For each report an invoice shall be submitted for payment using Exhibit D – printed on your company letterhead. All Reports and Invoices should be sent to the Research Manager and Project Coordinator identified in Exhibit B WRF Key Contacts.

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

WRF Key Contacts:

Project Management

- Katie Henderson, Research Manager, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: 303. 347.6108, and Email: khenderson@WaterRF.org.

Contract Administration

- Peggy Falor, Manager Contracts and Project Administration, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: 303-734-3424, and Email: pfalor@WaterRF.org.
- Corina Santos, Project Coordinator, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: 303.347.6125, and Email: csantos@WaterRF.org.
- Lisa Rather, Contract Administrative Assistant, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: 303.347.6211, and Email: lrather@WaterRF.org.

Sponsoring Utility/Co-funder and Sub-recipient Contact:

Principal Investigator

- Paula Kehoe, Manager Water Resources Planning, Water, San Francisco Public Utilities Commission, 525 Golden Gate Avenue, 10th Floor, San Francisco, CA 94102, Phone: 415.554.3256, and Email: pkehoe@sfwater.org.

Authorized Representative

- Steven R. Ritchie, Assistant General Manager-Water Enterprise, San Francisco Public Utilities Commission, 525 Golden Gate Avenue, 13th Floor, San Francisco, CA 94102, Phone: 415.934.5736, and Email: sritchie@sfwater.org.

Contracting/Accounting Contact

- Manisha Kothari, Regulatory Specialist, San Francisco Public Utilities Commission, 1657 Rollins Road, Burlingame, CA 94010, Phone: 415.554.3256, and Email: mkothari@sfwater.org.

Co-Principal Investigators:

- Manisha Kothari, Regulatory Specialist, San Francisco Public Utilities Commission, 1657 Rollins Road, Burlingame, CA 94010, Phone: 415.554.3256, and Email: mkothari@sfwater.org.
- Andy Salveson, Associate, Carollo Engineers, 2700 Ygnacio Valley Road, #200, Walnut Creek, CA 94598, Phone: 925.932.1710, and Email: asalveson@carollo.com.

Each party shall provide written notice of changes in contact persons, addresses, telephone, fax, and email addresses. The Principal Investigator, Co-Principal Investigator, or any Subcontractor may only be changed with the prior written approval of WRF.

BUDGET SUMMARY

Exhibit C
Project 04691

Sub-recipient: San Francisco Public Utilities Commission
525 Golden Gate Avenue
13th Floor
San Francisco, CA 94102

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Neither WRF nor the Co-funder(s) shall have any obligation for payment of invoices for costs incurred by the Sub-recipient after the foregoing end date.

Payments to the Sub-recipient will be issued to the Sub-recipient organization and mailed to the address shown in the first paragraph and shown above of this funding agreement unless otherwise noted below:

- Manisha Kothari, Regulatory Specialist, San Francisco Public Utilities Commission, 1657 Rollins Road, Burlingame, CA 94010, Phone: 415.554.3256, and Email: mkothari@sfwater.org.

Project Start Date TBD **End Date:** TBD

Financial Obligations for Project

a. WRF agrees to provide Award Funds:	$100,000.00
b. Sub-recipient agrees to provide Cost Share:	$13,475.00
c. Sub-recipient agrees to provide in-kind:	$5,000.00
d. Co-funder(s) agree to provide to WRF:	$100,000.00
e. Total Project budget is:	$218,475.00

All amounts are in U.S. dollars.

ORGANIZATION	Award Amount	Cost Share	In-Kind Amount
Sponsor/Co-funders			
San Francisco Public Utilities Commission	$100,000.00	$13,475.00	$0.00
Participants			
Data Instincts	$0.00	$0.00	$5,000.00
Co-PI			
Carollo Engineers	$0.00	$0.00	$0.00
Sub-recipient			
San Francisco Public Utilities Commission	$0.00	$0.00	$0.00
Water Research Foundation	$100,000.00	$0.00	$0.00
Continued on next page			

ORGANIZATION	Award Amount	Cost Share	In-Kind Amount
TOTALS	$200,000.00	$13,475.00	$5,000.00
Total Project Budget	$218,475.00		

Award Funds Not to Exceed:	$200,000.00
10% of Project Funds Advance: (Ref. III.B.3.a)	$20,000.00
Draft Report & Invoice Retainage: (Ref. III.B.3.b)	$20,000.00
Final Report & Invoice Retainage: (Ref. III.B.3.b)	$20,000.00

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Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Exhibit D – Invoice Form

For access to the Water Research Foundation website please see:
http://www.waterrf.org

To download Exhibit D – Invoice Form please see WRF's website:
http://www.waterrf.org/funding/ContractMaterials/Invoice_ExhibitD.pdf

Exhibit E
Project 04691

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Assignment of Interest in Copyrighted Works

Whereas, _____ whose address is _____ ["Assignor"] makes this assignment having full ownership and authority to make such assignment [or being authorized to make such assignment by _____ _____].

Whereas, Assignor has created and authored the original, tangible expressions of ideas described as follows: _____ _____ _____ (hereafter the "Works"); and

Whereas, the Assignor warrants and represents to own all right, title and interest in and to the Works, including the copyright; and

Whereas, the Water Research Foundation (Foundation) whose principal place of business is located at 6666 W. Quincy Avenue, Denver, Colorado 80235 U.S.A. ["Assignee"] is desirous of obtaining all rights in and to the Works, including the copyright.

NOW, THEREFORE, in return for grants provided to Assignor by Assignee for research, said Assignor does hereby assign unto the said Assignee all world-wide right, title and interest in and to the said Works, including the right to transfer any registration of copyright, or file application for copyright registration for such Works as Owner.

By: Date	Approved and authorized individual by Date
Title For	Title for Legal Department For
Assignor Name/Entity	Assignor Name/Entity

State of _____ }
} ss
County of _____ }

On this _____ day of _____, 201_, _____ [Assignor or authorized agent] appeared before me, the person who signed this instrument, and of his/her own free will executed this document [on behalf of the identified corporation or other entity with authority to do so].

_____
Notary Public Comm'n. Exp.

Water Research Foundation®
Celebrating 50 Years 1966–2016

P 303.347.6100 F 303.730.0851
www.WaterRF.org
6666 W. Quincy Ave., Denver CO 80235-3098

MEMORANDUM

DATE: June 10th, 2016

TO: SFPUC sponsors - Paula Kehoe and Monisha Kothari

FROM: Mike Dirks, Water Research Foundation

SUBJECT: WRF Board Approval of the SFPUC Tailored Collaboration Proposal.

Dear esteemed SFPUC colleagues,

The WRF board reviewed and approved (TC-16-007), *Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring*. The WRF board agreed with the PACs assessment that the proposal was generally well-planned for a very attractive demonstration project with a robust, multi-barrier approach including extensive online monitoring and notable in-kind contribution. The study covers an exciting topic and has a strong project team that certainly has very knowledgeable people who are highly capable of meeting project objectives. Each team member has a good reputation for these particular tasks. Please continue your work addressing the PAC comments you responded to for the Board.

For next steps, we will host a coordination call with you WE&RF 06/14/16 to inform subsequent project phase logistics. Further, a Multi Funded Research Agreement (MFRA) must be established between WRF, the sponsoring utility, and co-funding organization(s). The research organization, Carollo Engineers, (a.k.a. Sub-recipient) will also enter in to the MFRA. It is encouraged that the submitting utility, all co-funders and Principal Investigator review the Tailored Collaboration Multi Funded Research Agreement (MFRA) found on the WRF website in advance:
http://www.waterrf.org/funding/Pages/contract-materials.aspx

Preliminarily, we would like to host the pre-call for contracting and questions about the MFRA during the week of June 27th and will arrange a specific date and time for the team call.

Sincerely,

Mike Dirks
303.347.6104
mdirks@waterrf.org

CC: Research Manager, Kathryn Henderson; Contracting Manager, Peggy Falor; Project Coordinator, Corina Santos.

TAILORED COLLABORATION PROPOSAL COVER WORKSHEET

Proposal Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Sponsoring Utility (Foundation Subscriber submitting proposal): San Francisco Public Utilities Commission, California

Contact at Sponsoring Utility:
Name: Manisha Kothari
Address: 525 Golden Gate Ave, 10th Floor San Francisco, CA 94102

Phone: 415-554-3256 Fax: 415-934-5770 e-mail: mkothari@sfwater.org

Co-Funding and In-kind Summary: (attach additional sheet if needed)

Organization Name	Cash Co-fund Amount	In-Kind Contribution Amount
1. SFPUC	$100,000 (match to WRF)	$0
3. RMC/Data Instincts	$0	$5,000
4. WRF	$100,000	$0
	Total cash $200,000	**In-Kind $5,000**

Project Personnel
Principal Investigator (i.e., researcher responsible for conducting research)
Name: Paula Kehoe
Address: 525 Golden Gate Ave, 10th Floor San Francisco, CA 94102

Phone: 415-554-0792 Fax: 415-934-5770 e-mail: pkehoe@sfwater.org

Name: Manisha Kothari
Address: 525 Golden Gate Ave, 10th Floor San Francisco, CA 94102

Phone: 415-554-3256 Fax: 415-934-5770 e-mail: mkothari@sfwater.org

Co- Principal Investigator
Name: Andrew Salveson, P.E.
Organization: Carollo Engineers, Inc.
Address: 2700 Ygnacio Valley Road, Suite 200, Walnut Creek, CA 94598

Phone: 925-932-1710 Fax: 925-930-0208 email: salveson@carollo.com

Person responsible for finalizing *Funding Agreement* (i.e., research contract)
Name: Steve Ritchie
Address: 525 Golden Gate Ave, 13th Floor San Francisco, CA 94102

Phone: 415-934-5736 Fax: 415-934-5770 e-mail: sritchie@sfwater.org

Person responsible for accounting matters of contractor:
Name: Manisha Kothari (see above)

Foundation Funds Requested: $USD 100,000

Amount of Funds eligible for Foundation match: $USD 100,000

Total Cash Budget: $USD 200,000

Total In-kind Contributions: $USD 5,000

Total Project Budget (Cash + In-kind): $USD 205,000

TC CO-FUNDING SUPPORT FORM

Note: Each co-funding organization (including the sponsoring utility) must complete a separate Co-Funding Support Form and include it in the proposal.

Co-Funding Organization: San Francisco Public Utilities Commission (SFPUC)

Type of Organization: _X_water utility ____consulting firm ____ manufacturer ____other (describe)

Is your organization eligible to participate in one of The Foundation's subscription programs? _X_ Yes ____ No

Is your organization requesting that The Foundation match its funds? _X_ Yes ____No

Is your organization eligible for The Foundation matching funds? _X_ Yes ____No

Cash co-funding amount being provided by your organization (in USD) $ 324,670_____

Person responsible for contract matters for your organization:
Name: Steve Ritchie, Assistant General Manager, Water

Address at which FedEx packages can be received: 525 Golden Gate Avenue, 13th Floor, San Francisco, CA 94102

Phone/Fax/e-mail: (415 934-5736/sritchie@sfwater.org

Person responsible for accounting matters for your organization:

Name: Manisha Kothari

Address at which FedEx packages can be received: 525 Golden Gate Avenue, 10th Floor, San Francisco, CA 94102

Phone/Fax/e-mail: (415) 554-3256/(415) 934-5770/mkothari@sfwater.org

What approvals will be required in order for your funds to be released to the Foundation? (e.g., City Council, Board of Commissioners)
SFPUC Commission

Have these approvals been obtained? ____ Yes _X_ No

Can approvals be obtained and co-funding agreements be signed within 120 days of award? _X_Yes _____No
(**Note:** 120 days after award notification the Foundation may cancel the award--see TC proposal guidelines for details.)

Are there any conditions of the Foundation Co-Funding Agreement that would prevent you from signing it as it is currently worded? _____Yes _X__No
If yes, please explain: (attach additional pages if required)

The person signing below acknowledges they are authorized to commit their organization to the proposed work.

Signature_____ Print Name Steven R. Ritchie_____

Title Assistant General Manager, Water_____ Organization SFPUC_____

Date April 7, 2016_____ Phone (415) 934-5736_____

Mailing Address 525 Golden Gate Avenue, 13th Floor, San Francisco, CA 94102_____

PROJECT ABSTRACT

This proposed research project is intended as a collaborative effort between the SFPUC and WRF. The SFPUC is seeking $100,000 cash contribution from WRF, and the budget detailed in this proposal reflects the funding request. As a research project intended to provide valuable information to the industry regarding the efficacy and reliability of treatment processes for Direct Potable Reuse (DPR), we value a partnership with WRF for the credibility it lends to this research in addition to the funding, and hope that you will support this project.

Overview and Objectives. DPR starts with raw wastewater and ends with purified water that is protective of public health. This project will use innovative building-scale treatment, proven purification processes, real time online monitoring, and advanced analytical tools to demonstrate water quality and public health protection in real time. The advanced purification system for DPR will be sited at the San Francisco Public Utilities Commission Headquarters Building, where an existing Living Machine® System treats the building's wastewater to non-potable reuse standards. Using this location allows for broad visibility and public access to potable water reuse.

Technical Approach and Anticipated Results. The treatment train will use the existing tertiary treatment system, followed by ultrafiltration (UF), reverse osmosis (RO), and ultraviolet light with an advanced oxidation process (UV AOP) to produce purified water. State-of-the-art advanced analytics, including bioassays and non-target analyses, will be used in conjunction with Critical Control Point (CCP) monitoring to prove the safety of the purification facility. Finally, the viability of DPR will be demonstrated while educating the public on the importance and safety of potable water reuse.

Submitting Organization and Budget. San Francisco Public Utilities Commission (SFPUC) is submitting this proposal in collaboration with Carollo Engineers. The research effort is being led by Principal Investigators Paula Kehoe and Manisha Kothari at the SFPUC and Co-Principal Investigator Andrew Salveson, PE at Carollo Engineers.

A contribution of $100,000 is requested from Water Research Foundation with a cash contribution of $100,000 from the SFPUC and a $5,000 in-kind contribution from RMC/Data Instincts for a total cash award of $200,000. The total project budget will be $205,000 covering the total cost of outreach efforts and 90% of the analytical cost of the project.

PROJECT DESCRIPTION

Background and Introduction

Advanced treatment of wastewater for direct potable reuse (DPR) is operational at one facility in the United States, the Colorado River Municipal Water District's Raw Water Production Facility in Big Spring Texas. Ongoing research of that facility is demonstrating the production of a high quality water that is protective of public health (Steinle-Darling *et al.,* 2015). These results demonstrated the effective use of multiple barriers for reduction of trace pollutants and pathogens. While providing high quality water, the "Big Spring" facility relies upon monitoring systems designed for indirect potable reuse (IPR) applications. Nationally, the National Water Research Institute (NWRI) recently published a 173-page "how to" document on DPR, titled *Framework for Direct Potable Reuse* (NWRI, 2015). ***Central to this document was the use of precise and accurate monitoring technologies for public health protection in DPR applications***. Within California, an extensive research program (>$6M), the California DPR Initiative, has been undertaken to define the necessary level of treatment for a DPR project in California, and inform the discussion of DPR nationally. The Division of Drinking Water (DDW) is part of this Initiative, providing third party review of all research as they consider the possibility of regulating DPR in California. Even with the success of "Big Spring," with the development of clear guidelines for safe DPR implementation, and with extensive funding for research, the public and regulatory concern over "unknown unknowns" remains. What is that next pollutant? How do we find it? Are trace levels of pollutants harmful? The State Water Resources Control Board recently conducted an expert workshop to lay the groundwork for tracking down these questions (SWRCB, 2015). ***The expert workshop team recommended the use of non-target analysis (NTA) and bioassays to better grasp the significance of the "unknown unknowns."***

These key research needs, the ability to document real time precise and accurate monitoring technologies and the use of advanced analytics to understand the impact of the "unknown unknowns," are the primary objectives of this proposed research project. There is a secondary value of this project, which is the integration of DPR methodologies into building-scale treatment. The proposed project would use the existing constructed wetlands with tertiary treatment that harvests wastewater from the building and treats it to non-potable water reuse standards, and then purify the water to potable standards.

In total, the goals of the demonstration are:

- Demonstrate innovative building-scale treatment of wastewater for DPR.
- Procure purification processes that produce potable water in accordance with health criteria established in National documents (NWRI, 2015).
- Use leading edge online analytical techniques to demonstrate the performance of each treatment process.
- Use advanced analytical monitoring to understand the potential impact of unknown trace level pollutants.
- Clearly document the costs of a potential future DPR system for utilities in California.
- Educate regulators and community members about the safety of properly engineered potable water reuse treatment systems.

This ambitious project will span one year, and includes a substantial work effort which is supported by funding from the San Francisco Public Utilities Commission (SFPUC) and Carollo Engineers.

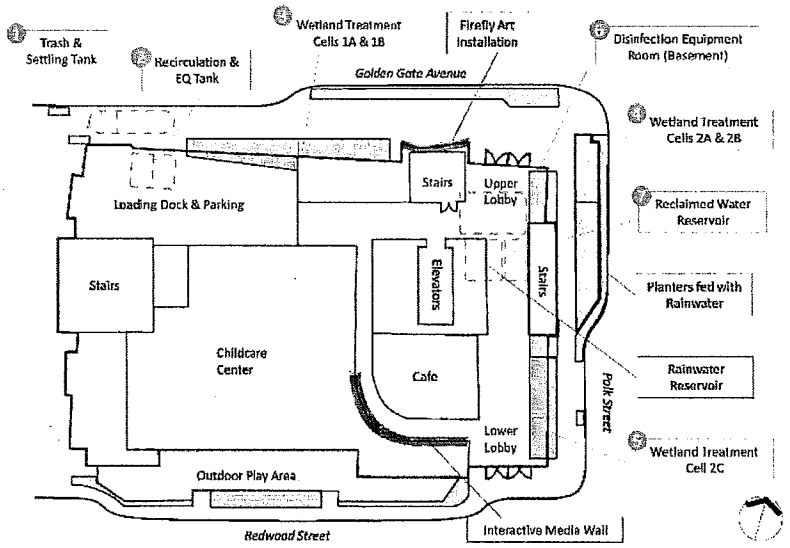
Research Approach

1.0 Building-Scale Treatment for Non-Potable Water Reuse

This project starts with raw wastewater, harvested from the 13-story, 900 employee SFPUC headquarters building. The advanced, ecologically based Tertiary treatment system currently collects and treats wastewater for non-potable reuse inside the structure. The Tertiary treatment system consists of a two-stage, recirculating, engineered wetland system with subsequent filtration and disinfection units (collectively called a tertiary treatment system henceforth in this proposal) and is housed in landscaped planters on the interior and exterior of the structure.

The tertiary treatment system can treat a maximum flow of 5,000 gallons per day. As shown in Figure 1, the system consists of primary treatment and flow equalization followed by a wetland system, denitrification, polishing and disinfection and a reclaimed water reservoir. The system has proven capable of treating raw wastewater with a small physical footprint, appropriate to an urban setting.

The value of de-centralized wastewater treatment cannot be overstated. Water can be treated and used within one watershed, eliminating the need for sewers, pump stations, and wasted conveyance energy. Demonstrating advanced purification of the reclaimed water to potable water standards is possible and safe may lead to a radical revolution in the water industry.



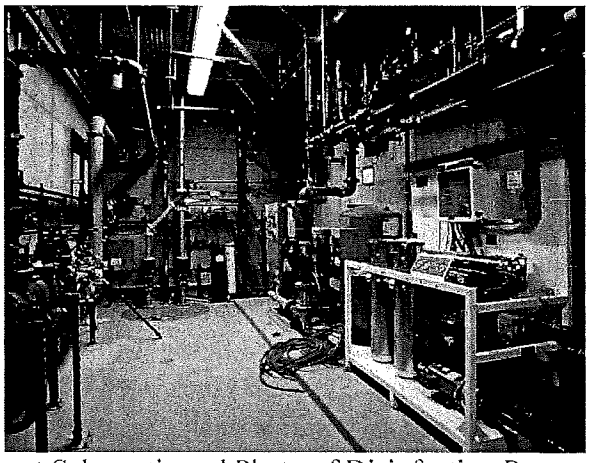


Figure 1. Wetland Treatment Schematic and Photo of Disinfection Room at SFPUC

2.0 Purification Processes for Potable Water Reuse

There are numerous treatment trains that could be used for potable water reuse. Within California, the particular processes that could be employed for this type of project are more limited (CDPH, 2014). In particular, IPR projects in California that include 100 percent purified water (no dilution) and do not benefit from surface spreading (soil aquifer treatment), must have reverse osmosis (RO) and advanced oxidation processes (AOP) within the treatment train. Using these two processes as a starting point, and relying upon the NWRI Framework for Direct Potable Reuse (NWRI, 2015), the purification process proposed for this treatment train are ultrafiltration (UF), RO, ultraviolet light (UV) AOP, and an engineered storage buffer (ESB) with free chlorine during storage (Figure 2, shown on the next page). These processes will provide multiple barriers to both pollutants and pathogens, as shown in Table 1 on the next page.

When coupled together, the proposed processes meet all pathogen and pollutant requirements for potable water reuse as defined by CDPH (2014).

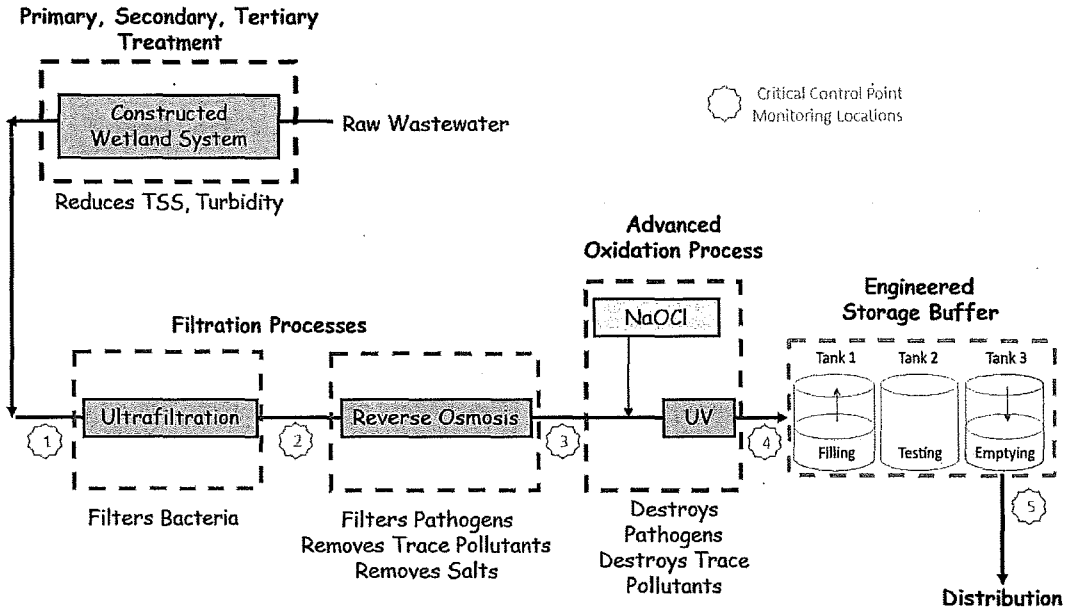


Figure 2. Proposed Advanced Treatment Train for Direct Potable Reuse

Table 1. Use of Multiple Barriers for Purification

	Bulk Organic Removal	Trace Organic Removal	Virus Removal	Protozoa Removal	Bacteria Removal
Primary, Secondary, and Tertiary Treatment	•	•	•	•	•
UF	•	–	–	•	•
RO	–	•	•	•	•
UV AOP	–	•	•	•	•
ESB with free chlorine	–	Partial	•	Partial	•

This proposed treatment train will have online monitoring at critical control points (CCPs), as detailed further on below.

Ultrafiltration

Recent work with Clean Water Services (CWS) (Oregon), as part of DPR demonstration testing, indicates that a well-functioning UF (0.01 μm nominal pore size) can attain 4.7-log reduction of

seeded virus (CWS, 2014) without chemical use (such as alum or polymer) ahead of the membrane. Equivalent or greater reduction of protozoa can be assumed based upon this data, and is directly supported by NSF (2012). Furthermore, MF or UF membrane integrity testing (MIT), confirms system performance and demonstrates how MIT data can be used to track and ensure continued membrane performance (CWS, 2014). Therefore, both MF and UF membranes can be relied upon for 4+ log reduction of protozoa.

Reverse Osmosis

The RO is the primary treatment process that addresses the removal of total dissolved solids (TDS), hardness, and trace levels of organic and inorganic contaminants. The RO trains also help to remove trace organic compounds, total organic carbon (TOC), and pathogens from the tertiary effluent.

Studies have found virus removal by RO to be from 3 to >6-log (Reardon *et al.*, 2005, NRMMC/EPHC/NHMRC 2008, CWS 2014). Equal or greater removal is expected for protozoa. Unfortunately, RO process performance for pathogen rejection is not governed by the ability of an intact membrane to reject pathogens; it is governed by the ability to monitor process integrity (Reardon et al., 2005 and Schäfer et al., 2005). The monitors currently used, electrical conductivity (EC) meters and total organic carbon (TOC) meters, can measure 99 percent or less removal of both parameters through the RO process. Recently, the DDW granted 1.5 log reduction credit for all pathogens for RO (WRD, 2013), based upon a requirement to continuously monitor TOC reduction across RO. Alternative technologies, such as online fluorescent dye monitoring, have been shown to have higher accuracy in assessing membrane efficiency (3+ log based upon new research as part of Water Research Foundation project 4536), with other research showing similar results (Kitis et al., 2003; Henderson et al., 2009; Pype et al., 2013). Using traditional monitoring technology, we recommend using the 1.5-log reduction value for all pathogens for RO at this time.

UV AOP

In the event of pathogens passing through RO, the UV process provides for a high level of disinfection. NDMA, with a DDW notification level (NL) of 10 ng/L, can pass through RO at low concentrations (typically 20 to 100 ng/L), requiring destruction by UV photolysis (Sharpless and Linden, 2003). Therefore, it is common to set the UV dose at 800+ millijoule per square centimeter (mJ/cm^2). This high UV dose photolyzes NDMA as well as many other smaller chemicals that may have passed through the RO train. Adding H_2O_2 before the high dose UV, typically in the range of 3 to 5 mg/L, results in the generation of hydroxyl radicals throughout the UV process. This turns the treatment into an AOP. Hydroxyl radicals are nonselective and break down most chemicals with which they come in contact, destroying a range of trace level pollutants.

At a dose of 800+ mJ/cm^2, as would be applied for this project, the high UV dose will result in 6+ log reductions of all target pathogens (USEPA, 2006; Hijnen et al., 2006; Rochelle et al., 2005), including *Cryptosporidium, Giardia*, and adenovirus. Higher reductions are theoretically possible, but the DDW allows only a maximum of 6-log reduction credits per any one treatment technology (CDPH, 2014).

ESB with Free Chlorine

DPR forgoes the environmental buffer in lieu of an Engineered Storage Buffer (ESB, Tchobanoglous *et al.*, 2011). The ESB would be applied for any DPR application in California.

Eliminating the environmental buffer leads to the loss of several benefits, including contaminant reduction, dilution, and, perhaps most importantly, time to detect and respond to a treatment failure. Recent potable reuse reports suggest that these are limitations that can be overcome. These studies include the WateReuse Research Foundation's 2011 report entitled "Direct Potable Reuse: A Path Forward" (Tchobanoglous et al., 2011), the National Research Council's 2012 report entitled "Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater" (NRC, 2012), the Australian Academy of Technological Sciences and Engineering's 2013 report entitled "Drinking Water through Recycling: The benefits and costs of supplying direct to the distribution system" (ATSE, 2013), and the WateReuse Research Foundation Project 11-10, Application of Risk Reduction Principles to Direct Potable Reuse (Salveson et al., 2014). They suggest that a higher level of treatment at the Advanced Water Treatment (AWT) facility can compensate for the treatment and dilution provided by the groundwater aquifer or surface water reservoir. The ESB can be designed to provide time to hold and test the treated water to ensure its safety before distribution. No further treatment is added in the ESB (except, perhaps further contact time), and therefore no log-removal credits for pathogens should be expected from this treatment process.

The ESB provides several key benefits over the environmental buffer. For communities without available environmental buffers such as rivers or aquifers (which are often in the most dire need), water reuse is still a possibility with ESBs. Second, ESBs eliminate the need for costly pumps and pipes to and from environmental buffers. Much of the treated water is also lost in the environmental buffer, either washed downstream or dispersed through an aquifer. Finally, advanced treated water is typically higher in quality than groundwater or surface water. Environmental sources can be easily contaminated with runoff and other influences. Keeping the treated water separate from these sources can lower contamination and decrease further treatment costs.

For this project, the ESB would follow the recommendations in Salveson et al. (*in press*) for ESB application. For each unit process and its associated monitoring method, a failure and response time (FRT) is defined. The process FRT is the maximum possible time between when a failure occurs and when the system has reacted such that the final product water quality is no longer affected. The FRT is a sum of the sampling interval, the sample turnaround time (TAT), and the system reaction time, as shown in Figure 3 on the next page. For a unit process monitored by a traditional sampling technique, the sampling interval may range from continuous online monitoring to periodic sampling. In this pilot project, key process monitoring will be done online determine the minimum acceptable FRT for this type of advanced treatment system.

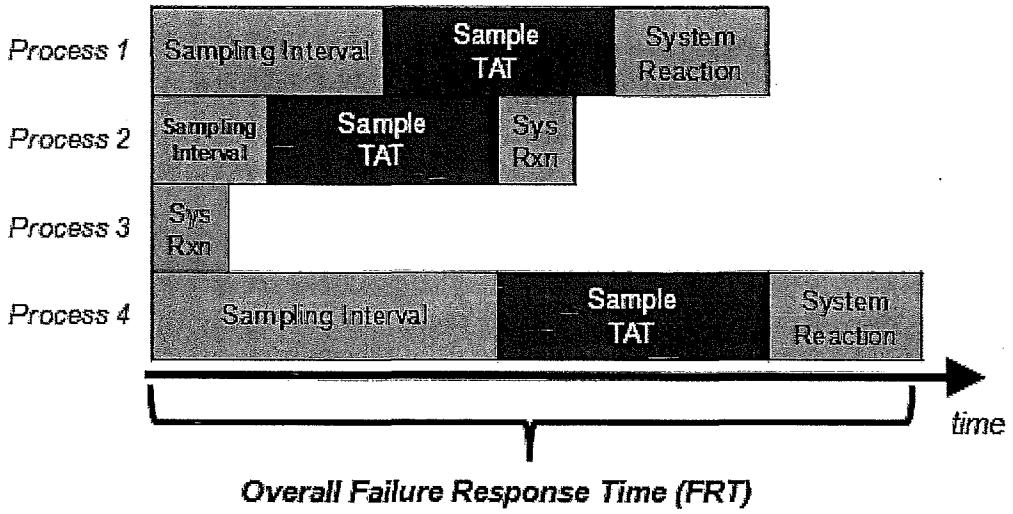


Figure 3. Determination of Failure and Response Time for ESB

In addition to the FRT value of the ESB, the ESB provides for substantial disinfection treatment by free chlorine. A future ESB would have free chlorine dosing and be controlled to maintain a target free chlorine *Ct* sufficient to attain 3-log for *Giardia* and 4-log for viruses, based upon a 4 hour contact time with a 1 mg/L free chlorine residual, with an RO permeate pH of 6. The pathogen credits are based upon the 1990 SWTR Guidance Manual (USEPA, 1990).

3.0 Monitoring Technologies

Conventional potable reuse trains have repeatedly met EPA drinking water standards, as documented by long term compliance with California regulations by the Orange County Water District, among many others. Demonstration testing of similar advanced treatment trains has shown similar performance (CWS, 2014; Trussell, 2013). Emerging pollutants will be evaluated for this project, focusing on the following trace level pollutants:

- A suite of pharmaceuticals and personal care products (PPCPs)
- A suite of perfluorinated compounds (PFCs)
- NDMA
- NDMA formation potential
- THM and HAA formation potential
- Fluorescence

Pathogens will also be evaluated for this project, documenting with grab sampling the pathogen levels after secondary treatment and thus allowing an analysis of sufficient reduction of such pathogens through the purification processes. Pathogens (and surrogate organisms) to be evaluated include: male specific and somatic coliphage, *enterococci, E. coli,* total coliform, *Giardia*, *Cryptosporidium*, enterovirus, and norovirus.

The ability for these processes to produce high quality water in accordance with regulations is not in question. What this project looks to define is the ability to continuously monitor the performance of the advanced treatment systems in real time. This will be done through the use of precise and accurate metering of the critical control points in the purification process. To that end, we have secured the use of two ZAPs LiquID stations to perform such monitoring, as shown in Table 2, on the next page. These parameters will be used to demonstrate process by process performance; as follows:

- **UF** - UF filtrate turbidity and *E. coli* concentrations will closely track UF performance. These continuous measurements will be paired with daily pressure decay test (PDT) results to provide real-time confidence in protozoa and bacteria removal performance.
- **RO** - TOC values collected pre and post RO allow for clear determination of a conservative surrogate for pathogen removal by RO as well as consistent reduction in TOC. TOC values will be paired with online electrical conductivity (EC) to verify TOC performance values.
- **UV AOP** - Destruction of total chlorine across UV systems has now been shown to correlate directly with UV dose, which then correlates directly to pathogen removal and destruction of pollutants such as NDMA (work in press). Free chlorine measurements and UV absorbance (UVA) can be used to develop a "chlorine weighted UV dose," which has recently been shown to correlate directly with destruction of trace pollutants by UV AOP (work in press).
- **ESB** - Free chlorine residual after the ESB will be used to calculate a Ct and show disinfection credit in accordance with EPA standards.

Table 2. Online Real Time Monitoring for Demonstration Project

Measurement	Post UF	Post RO	Pre UV	Post UV
Chloramines	•		•	•
Free Chlorine	•		•	•
E. coli	•			
TOC	•	•		
UVA			•	•
Turbidity	•			

The information from the ZAPs systems will be logged for the duration of the 6-month demonstration and used to evaluate overall reliability in system performance. These values will also be used to monitor system performance remotely, available 24/7/365.

The research will take one further step, the investigation of the "unknown unknowns." While hundreds of chemicals have been detected in water, thousands more likely occur at very low concentrations but have not yet been detected. Chemical surrogates and indicators are often used to gauge the efficacy and efficiency of a particular treatment process and/or multibarrier train

(Yu et al., 2015; Merel et al., 2015; Anumol et al., 2015; Gerrity et al., 2012). However, these measures do not provide any reference to biological effects and thus do not account for the potential additive or synergistic effects of chemical mixtures. Bioassay-based monitoring complements chemical analysis by providing a comprehensive assessment of the mixture of substances present in a particular water sample (Escher et al., 2014). A limitation of bioassays is the ability to determine what substance, or substances, were responsible for the bioactivity observed. Therefore, non-targeted analysis (NTA) will also be performed using high-resolution mass spectrometry (HRMS) with both gas chromatography (GC) and liquid chromatography (LC) interfaces for volatile and non-volatile organic compounds, respectively. National experts convened in California recently to examine two promising techniques for such investigation (SWRCB, 2015). In that two-day workshop, the expert group concluded that these two methods, non-target analysis (NTA) and bioassays, should be paired.

In order to accomplish both the bioassays and NTA methods proposed below, we will use 4L of water (approximately one gallon) for each sample. Technically, two liters of water is required; however, we recommend providing additional water for replicates (3) to improve statistical accuracy of the NTA work, and allows for repeat analyses if necessary. Two one-liter samples will be extracted using a comprehensive two-SPE system previously shown to capture the majority of organic contaminants occurring in water systems (Escher et al. 2014; Jia et al., 2015). Positive controls for bioassays will be used for matrix spikes to ensure acceptable recovery (greater than 70 percent) of bioactive substances.

Assays selected were those recently demonstrated to address relevant endpoints, displayed significant activity using water samples, and were reliable in multiple laboratories (Escher et al., 2015).

1) Non-specific Toxicity: Cytotoxicity. Cytotoxicity will be assessed using the MTS assay. The MTS reagent will be purchased from Promega (CellTiter 96® AQueous One Solution Cell Proliferation Assay, #G3580). MTS (tetrazolium) is bioreduced by cells in culture into a colored formazan product that is soluble in tissue culture medium, and this conversion is presumably accomplished by NADPH or NADH produced by dehydrogenase enzymes in metabolically active cells. Assays are performed by adding a small amount of the MTS Reagent directly into culture wells, incubating for 2 hours, and then recording the absorbance at 490 nm with a 96-well plate reader.

2) Specific (Receptor-mediated) Toxicity: Glucocorticoid Receptor (GR) and Estrogen Receptor (ER). Estrogens and glucocorticoids have been reported to occur widely in WWTP effluents (Escher et al., 2014; Snyder et al. 2001; Stavreva et al., 2012). Based on previous testing of multiple ER and GR assays, our team has elected to use the Invitrogen platform as it also was selected by the State of California funded project on which Snyder is a Co-PI. The ER/GR assay uses GeneBLAzer® HEK 293T cells which contain an estrogen receptor/glucocorticoid receptor (ER/GR) ligand-binding domain/Gal4 DNA binding domain chimera stably integrated into the GeneBLAzer® UAS-*bla* HEK 293T cell line. GeneBLAzer® UAS-*bla* HEK 293T contains a beta-lactamase reporter gene under control of a UAS response element stably integrated into HEK 293T cells. Fluorescence Resonance Energy Transfer (FRET) substrate that generates a ratiometric reporter response and dual-color (blue/green)

reading is used to minimize experimental noise. The ER and GR assay will help to identify potential for endocrine disruption effects caused by estrogenic and glucocorticoid hormones, respectively, as well as contaminants that mimic these hormones.

3) Xenobiotic Metabolism: Aryl Hydrocarbon Receptor (AhR). A well-known example of a xenobiotic receptor is the arylhydrocarbon receptor (AhR), which responds to exposure to dioxin-like chemicals. The AhR assay has been used to gauge remediation of PCB and dioxin in environmental spill scenarios (Giesy et al., 2002). For the proposed research, rat hepato-carcinoma cells (H4IIE-luc) which have been stably transfected with the luciferase gene under control of the AhR will be used (Giesy et al., 2002; Sanderson et al., 1996; Jarosov et al., 2012).

4) p53 reporter gene. The p53 protein is known for its major role in the prevention of cancer. It acts as a tumor suppressant, recognizing damaged DNA and triggering DNA repair. This pathway also plays a role in cell cycle arrest and apoptosis. Our team has chosen to use the CellSensor *p53RE-bla HCT-116* cell line, which operates very similarly to GeneBLAzer® HEK 293T cells, to represent stress response. The CellSensor *p53RE-bla HCT-116* cell line contains a p53 receptor ligand-binding domain/Gal4 binding domain, as well as a beta-lactamase reporter gene under control of a UAS response element. CCF4-AM substrate will be used to measure fluorescence, as it emits a green in the absence of betalactamase and blue in the presence. The primary difference between the CellSensor *p53RE-bla HCT-116* cell line and to GeneBLAzer® HEK 293T cells is that the p53 cell line uses human colorectal carcinomacells, where the ER/GR cell lines use human embryonic kidney cells. The p53 assay will help determine the quality of the water since the ability of a cell to repair itself may be more sensitive than actual damage done.

NTA of unknown compounds will be performed using the latest generation quadrupole-time-of-flight (QTOF) mass spectrometers. The LC-QTOF will use an aliquot of methanol extracts prepared for bioassay and analyzed using both positive and negative electrospray ionization (ESI). These extracts will also be analyzed by GC-QTOF by injection of the methanol extracts and analyzed with electron impact ionization. Samples will be analyzed in auto-MS/MS mode in both instruments, where instruments record all the mass to charge ratios (m/z). Between acquisitions of MS spectra, the instrument is programmed to isolate the most abundant ions and fragment them to acquire their corresponding MS/MS spectra. These analyses generate large amounts of data, which will be processed using software specifically designed for this purpose.

Using the QTOF data, our team is able to statistically "fingerprint" different water qualities based on their mass profile. In previous preliminary studies, our team has demonstrated that HRMS could discriminate water exposed to different treatments or different doses of the same oxidant. Resulting HRMS data is evaluated initially through heatmaps, revealing multiple classes of compounds such as recalcitrant, those removed, and transformation products (including intermediates). Each sample profile will be paired both with water treatment variable and with bioassay results. Therefore, while bioassays indicate if a treatment leads to an increase or decrease in toxicity, QTOF data will provide information on which compounds or group of compounds correlate statistically to the biological observation.

The second value of this approach consists in being able to identify compounds of interest among the list of molecular features. For example, if sample toxicity increases after a specific

treatment, the transformation products formed by such treatment will be isolated from the molecular features enclosed in the sample profile for further identification. Based on their high resolution mass spectra, transformation products will be searched against libraries of compounds available in Dr. Snyder's laboratory. While some of these products may not be registered in the library, a first identification of chemical formula can be proposed based on the accurate mass. Such molecular formula would then be further evaluated based on MS/MS spectra. In addition, these data produce a lasting electronic record of what substances were present, thus if a new contaminant is identified, these spectra can be retroactively mined to determine if the substance was present and its relative abundance.

For this initial research, the NTA and bioassay analysis will be taken across the treatment train as detailed in the Scope of Work. These two tools, when used in combination, will present a powerful picture of water quality through different levels of treatment over the duration of the study. These tools will supplement the previously detailed analysis for regulated and unregulated pollutants and pathogens and begin to answer the questions about the "unknown unknowns" frequently raised by opponents to water reuse projects.

4.0 Data Analysis

Three distinct sets of data will be collected. What those data are, and how they will be utilized, is defined below:

- **Online Data** - online data will be logged and performance probability distribution functions (PDFs) will be created, which document the statistical reliability of each process to provide the desired results (for pathogen and pollutant reduction)
- **Grab Sample Data** - trace pollutant data will be collected and compared against industry standards, and then used to compare pollutant levels with the results from the advanced analytics. Pathogen data will be used to set a baseline of pathogen levels in the purification feed water, and then document the levels of reduction of those pathogens to the new potable water supply, clearly documenting compliance (or lack thereof) with published health standards (CDPH, 2014; NWRI, 2015).
- **Advanced Analytics** - NTAs and bioassays will be paired together and compared/contrasted with the trace pollutant data.

Scope of Work and Evaluation Criteria

Task 1: Project Management

As Principal Investigator (PI) for this project, Manisha Kothari, will serve as the contact PI on this project and work closely with PI Paula Kehoe. As such, Ms. Kothari and Ms. Kehoe will be responsible for overall project management, including oversight of Carollo as the contractor, communication with WRF and WRRF, and review of the technical progress of the research and ensure that results are applicable to the water community. Ms. Kothari and Ms. Kehoe, in conjunction with Carollo, will monitor the progress of the research through review of progress reports, participation in project calls and face-to-face meetings, and review of all project final deliverables.

The Co-PI for this project, Andrew Salveson, will manage the day-to-day and long-term objectives of this project. That includes the review and guidance of Carollo staff in the performance of their duties and the coordination of subconsultant team members. The project management responsibilities extend to the management of the project budget and the billings. Additionally, Andrew Salveson will meet with the funding parties and the project team during the project. Finally, project management includes quality assurance/quality control, which is a period review of project progress from outside the core project team by experts in the relevant field(s).

Schedule: N/A.

Deliverables: The management team will be available for weekly check-in calls for the duration of the project. Any issues that arise during the management of this project will be documented in progress reports. Further details of communication with WRF and WRRF and of the dissemination of this work are outlined in the Communication Plan.

Task 2: Site Preparation

Small modifications will be made to the existing tertiary treatment system. These changes will require coordination efforts with the building staff, minor equipment adjustments, and piping modifications.

Task 3: Purification Facility Design and Construction

For potable water reuse, the project team will select and install a series of advanced processes to purify the Tertiary treatment system effluent and to monitor the water quality online. The proposed technologies to be applied are ultrafiltration (UF), reverse osmosis (RO), ultraviolet light disinfection (UV) with sodium hypochlorite addition to result in an advanced oxidation process (AOP), with a final treatment/storage step using an engineered storage buffer (ESB). Online monitoring includes turbidity, *E. coli*, total organic carbon (TOC), electrical conductivity (EC), total and free chlorine, and ultraviolet transmittance (UVT). These online monitoring parameters will be done by the ZAPs LiquiD, as shown in Table 3 below.

Table 3. Online Monitoring Parameters

Measurement	Post UF	Post RO	Pre UV	Post UV
Chloramines	•		•	•
Free Chlorine	•		•	•
E. coli	•			
TOC	•	•		
UVA			•	•
Turbidity	•			

For this Task, the project team will do the following:

- Select and rent (or purchase) small-scale advanced treatment processes (as listed above), with capacities in the range of 1 to 3 gpm[1].
- Select and purchase online monitoring processes (as listed above).
- Start up the purification and monitoring systems
- Collect and store all online data in a centralized control system, allowing for later analysis.
- Summarize all process, monitoring, and startup procedures in a TM.

Schedule: Selection of equipment, installation of equipment, and startup of equipment would be expected to start within 30 days of the receipt of grant funding and will be completed within 4 months of the notice to proceed.

Deliverables and Evaluation Criteria: A TM will be completed in draft form that details the treatment and monitoring processes as well as any details related to operation and startup. The TM will document the purification treatment train meets all pathogen and pollutant requirements for potable water reuse as required by CDPH. The TM will also document the costs of equipment procurement, installation, and expected analytics to understand the costs of DPR treatment at the building scale.

Task 4: Direct Potable Water Reuse Performance Demonstration

To date, no potable water reuse system (indirect or direct), provides a comprehensive real-time monitoring of overall performance. For potable water reuse, the treatment targets include virus, protozoa, bacteria, total organic carbon, salts, and trace level pollutants. This project will build a treatment system that tracks and records performance of each system, and most importantly of the entire system for the removal of pathogens and pollutants. This will be the first real-time "smart" potable water reuse treatment system, operating for 6 consecutive months, which will be used to demonstrate the long term reliability of advanced water purification processes.

To that end, we have broken up the 6-month demonstration into the following work efforts.

Operation. The facility will be run continuously for 6 months. The system will be run automatically, with twice-weekly inspections and calibration of online devices.

Conventional Parameters, PPCPs, Pathogens, and Advanced Analytics. Over the 6-month timeframe, the system will be continuously monitored using the online technologies discussed previously. This online monitoring will be supplemented by three different analytical chemistry approaches, as shown in the bullets and Table 4 on the next page.

- **Conventional Parameters:** TOC (twice monthly), ATP (weekly), turbidity, UVA, total and free chlorine (twice weekly).
- **CECs[2]:** pharmaceuticals and personal care products (PPCPs), perfluorinated compounds (PFCs), NDMA, NDMA FP, THM/HAA FP, and fluorescence EEM, all monthly. This

[1] The current plan is to rent UF and RO systems and purchase small UV and ESB treatment systems. For monitoring systems, the project team will need to purchase online monitoring equipment.
[2] The CEC list and pathogen list are identical to WaterRF 4536 and WateReuse Research Foundation 14-16, which are both run by this current project team.

work will be done by (monthly) work will be done by the Dr. Eric Dickenson at the Southern Nevada Water Authority.

- **Pathogens:** male specific and somatic coliphage, enterococci, *E. coli*, total coliform, *Giardia*, *Cryptosporidium*, enterovirus, and norovirus. Biological analysis will be done (monthly) by Dr. Rick Danielson at BioVir.
- **Advanced Analytics:** non-target analysis and bioassays. Advanced analytics will be done (monthly) by Dr. Shane Snyder at the University of Arizona.

Table 4. Online Monitoring - Analytical Chemistry Approaches

Measurement	Tertiary Effluent	Post UF	Post RO	Post UV
Conventional Parameters		•	•	•
CECs		•	•	•
Pathogens	•			
Advanced Analytics		•	•	•

Schedule: Testing will be done periodically over a 6 month time period.

Deliverables and Evaluation Criteria: Prior to the start of testing, a test protocol will be developed which includes detailed sampling methods, lab testing methods, and quality control. Conventional parameters will be compared against similar DPR demonstrations (CWS, Big Springs, TX), while CECs and pathogens will be compared to established health criteria standards (NWRI 2015). The Advanced Analytic testing will demonstrate the feasibility of monitoring the unknown toxicity of DPR treatment trains. These novel results will evaluated for the first time to demonstrate the safety of DPR. All results will be compiled in the draft report as described below and may be published via research journals to share the state of the art with academics, regulators, and the public.

Task 5: Public Communication and Outreach

Multiple outreach efforts, provided by RMC/Data Instincts, will be developed as part of the demonstration project.

Development of Online Materials

RMC/Data Instincts will develop dedicated web pages to describe the demonstration project and engage the public about this research effort, as well as Direct Potable Reuse more broadly. The web interface will include updates on the demonstration project as it is proceeding.

Development of Print Materials

This task will include the development of various forms of print media to supplement online material on the demonstration project. It will include a pocket brochure describing the demonstration project, as well as fact sheets for various audiences, information on Frequently Asked Questions, and the preparation of pre- and post- tour surveys to help measure the effectiveness of the demonstration project.

Virtual Tour

A video production that provides a virtual tour of the pilot demonstration, the virtual tour will be showcased online and will provide information on the objectives and processes associated with the demonstration project.

Digital Wall

The SFPUC Headquarter building includes a large public space / café at its entry level. A large digital wall provides a venue for information to be displayed in a large and very visible format to people working in and visiting the building. The wall is also visible from public streets outside. In this task, we will prepare and display key messages and images to convey about the demonstration project and Direct Potable Reuse.

Develop/Distribute Educational Materials

The objective of this task is to create specific educational materials and disseminate them to targeted audiences including schoolchildren, media, public officials, and special groups.

Schedule: The outreach work would begin prior to the start of testing and run through the completion of the project.

Deliverables and Evaluation Criteria: Final report, survey results, and any other outreach materials will be shared with the funding agencies. The final report will document the outreach campaign efforts, survey results, and will provide documentation of public acceptance. Project results will be submitted for peer-review publications and conference proceedings.

Task 6: Project Communication and Reporting

The project team will prepare quarterly reports for the duration of this project, one draft report, and one final report. At a minimum, the project team will meet with the Project Advisory Committee (PAC) and Research Advisory Committee (RAC), the WRF and WRRF research managers in person. Additional meetings can be conducted remotely on a monthly basis as needed.

Schedule: Reporting will be done throughout the duration of the project, with quarterly reports done after the first three months of work and done every three months thereafter. An on-site project meeting will occur at the start of the 6 month DPR testing period. One draft report and one final report will be completed after the end of the 6 month demonstration period. Near the completion of the project, one member of the project team will travel to Denver to present the results to Reclamation staff.

Deliverables and Evaluation Criteria: Quarterly reports, one draft report, and one final report, and one on-site project meeting with the advisory committees and WRF/WRRF research managers. The report will compile the results of all tasks, including operational startup, detailed analytic sampling methods, conventional and analytic results, and work through the public outreach campaign.

APPLICATIONS POTENTIAL

Practical Benefits

This novel project examines two innovative concepts: DPR at the building-scale coupled with advanced analytical monitoring and a "smart" control system that verifies the performance of each process and the collective water quality online in real time, which would be a first for potable reuse systems anywhere.

The treatment technologies employed are standard processes for indirect potable reuse (IPR), with tertiary treatment followed by UF, RO, and UV AOP. **The advanced online and grab sampling analytics, done over an extended period of time, is the true value of this project and have broad application to both future DPR systems as well as to existing IPR systems.** Multi-point online meters will record process performance in real time allowing for continuous calculation of performance "credit" for pathogens and pollutants. State-of-the-art advanced analytics, including bioassays and non-target analyses, will be used during the demonstration to prove the safety of the purification facility. These analytics allow researchers to understand the impact of the "unknown unknowns," chemicals of unknown type at trace levels that may have some degree of toxicity.

Products of Research

The product of this research is water confidence through advanced monitoring. This project t is a "proof of concept" study based upon the following two hypotheses:

- We now have advanced online monitoring to effectively monitor process performance to potable water standards.
- We currently have advanced offline tests that demonstrate a continued lack of toxicological effects of purified water.

Utility Perspective

The SFPUC will be intimately involved in this project as a principal investigator. SFPUC understands keenly the need for high quality water and community involvement and participation, both cornerstones of this project. Broader industry perspective will be gained from Jeff Mosher of the National Water Research Institute and on this project's Technical Advisory Committee. Mr. Mosher represents utilities nationally that are implementing potable water reuse.

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance and Quality Control (QA/QC) are necessary aspects of any research project, and particularly so for this project as it pertains to the protection of public health. The test plan proposed for this effort includes duplicate sampling of advanced analytics (CECs, fluorescence, non-target analysis, and bioassays) in six different sampling events. The project team will work closely with certified laboratories running accepted standard methods to ensure data precision and accuracy (defined below). Method Detection limits (MDLs) will be used to determine the statistical significance of any detectable response.

Three certified laboratories will be performing the analysis in this project and will be responsible for internal QA/QC for each sampling parameter.

- Southern Nevada Water Authority (SNWA) will be providing analysis for: Contaminants of Emerging Concern (CECs), Total Organic Carbon (TOC), and Fluorescence (EEM).
- BioVir Laboratories will provide all pathogen analysis, including Phage, Enteroccoci, E. coli , Total Coliform, Giardia, Cryptosporidium, Enterovirus, and Norovirus.
- University of Arizona will perform advanced analytics using bioassays, Gas Chromatography Non-Target Analysis (GC-NTA), and Liquid Chromatography Non-Target Analysis LGC-NTA).

Precision

The precision of duplicate samples is assessed by calculating the relative percent difference (RPD) according to:

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} \times 100\%$$

where,

S = Sample concentration and

D = Duplicate sample concentration.

If calculated from three or more replicates, the precision is determined using the relative standard deviation (RSD):

$$RSD = \frac{SD}{Average} \times 100\%$$

where,

SD = Standard deviation for the replicate samples.

Sample Replicates

The demonstration facility will run for a minimum of 6 months, with online monitoring of a range of parameters, daily inspection of online equipment, and with monthly or more frequent sampling for a wide range of offline laboratory analysis (see Table 1, below). Routine sampling is expected with Turbidity, UVA, total and free chlorine being tested bi-weekly. ATP and TOC will be tested more frequently, once per week and twice per week, respectively. Online monitoring tools (Turbidity, UVA, Total and Free Chlorine, TOC, *E. coli*) will verify performance conditions and provide additional confidence in the laboratory analysis.

Table 1. Replicates and Associated Number of Sampling Events

Sample Location	Parameter to Analyze	Frequency of Sampling Events	Number of Sampling Events
Tertiary Influent	Pathogens[1]	Monthly	6
UF Effluent (RO Influent)	Turbidity, UVA, Total Chlorine, Free Chlorine	Bi-weekly (online)	48
	ATP	Weekly	24
	TOC	Bi-monthly	12
	Pathogens[1], CECs[2], EEMs[3], Bioassays[4], NT Analysis[5]	Monthly	8 (includes 2 duplicates)
		Monthly	4
RO Effluent (UV AOP Influent)	Turbidity, UVA, Total Chlorine, Free Chlorine	Bi-weekly (online)	48
	ATP	Weekly	24
	TOC	Bi-monthly	12
	Pathogens[1], CECs[2], EEMs[3], Bioassays[4], NT Analysis[5]	Monthly	8 (includes 2 duplicates)
UV AOP Effluent (Finished Water)	Turbidity, UVA, Total Chlorine, Free Chlorine	Bi-weekly (online)	48
	ATP	Weekly	24
	TOC	Bi-monthly	12
	Pathogens[1], CECs[2], EEMs[3], Bioassays[4], NT Analysis[5]	Monthly	8 (includes 2 duplicates)

NOTES:

1) Pathogens include Coliphage, Enterococci, E. *coli* , Total Coliform, Giardia, Cryptosporidium, Enterovirus, and Norovirus. Samples will be analyzed at the BioVir laboratory.
2) CECs include Gemfibrozil, Naproxen, Triclosan, Ibuprofen, Acetaminophen, Sucralose, Triclocarban, Sulfamethoxazole, Atenolol, Trimethoprim, Caffeine, Fluoxetine, Meprobamate, Carbamazepine, Primidone, DEET, TCEP, PFBA, PFHxS, PFHxA, PFOA, PFOS, PFNA, PFDA, PFUdA, PFDoA, PFPnA, PFHpA, NDMA, Nitrosomethylethylamine, Nitrosodiethylamine, Nitrosodipropylamine, Nitrosomorpholine, Nitrosopyrrolidine, Nitrosopiperidine, Nitrosodibutylamine, Nitrosodiphenylamine, Estrone, Estradiol, Ethynylestradiol, Testosterone, Progesterone, NDMA FP, and THM/HAA FP. Samples will be analyzed at the Southern Nevada Water Authority.
3) Fluorescence (EEMs) grab samples will be analyzed at the Southern Nevada Water Authority in parallel with all other sampling events.
4) Select and TBD bioassays will be run by the University of Arizona.
5) Non-Target (NT) analysis will be performed in parallel with bioassay analysis when sampled on the same date.

Accuracy

For measurements where matrix spikes (constituent seeding) are used, accuracy is evaluated by calculating the percent recovery (R):

$$R(\%) = \frac{S - U}{C_{SA}} \times 100\%$$

where,

S = Measured concentration in spiked sample,

U = Measured concentration in unspiked sample, and

C_{SA} = Calculated concentration of spike in sample.

When a standard reference material (SRM) is used, the percent recovery is determined by:

$$R(\%) = \frac{C_m}{C_{SRM}} \times 100\%$$

where,

C_m = Measured concentration of SRM and C_{SRM}:= Actual concentration of SRM.

Matrix spiking will only occur when necessary for analytical recovery or in the event of additional benchtop testing.

Method Detection Limit (MDL)

To determine the MDL, at least seven replicates of a laboratory fortified blank at a concentration of three to five times the estimated instrument detection limit is analyzed through the entire analytical method. The MDL for each constituent tested will be determined by the laboratory in accordance with the standard method listed for each constituent. It is important to show that the detection limit for each chemical parameter is sensitive enough such that it can measure below the regulatory limit, and show appropriate removal of each compound in question. The MDL is calculated using the following equation:

$$MDL = (t) \times (SD)$$

where,

t = Student's *t* value for 99 percent (*t* for 7 replicates= 3.14) and

SD = Standard deviation for the replicates samples.

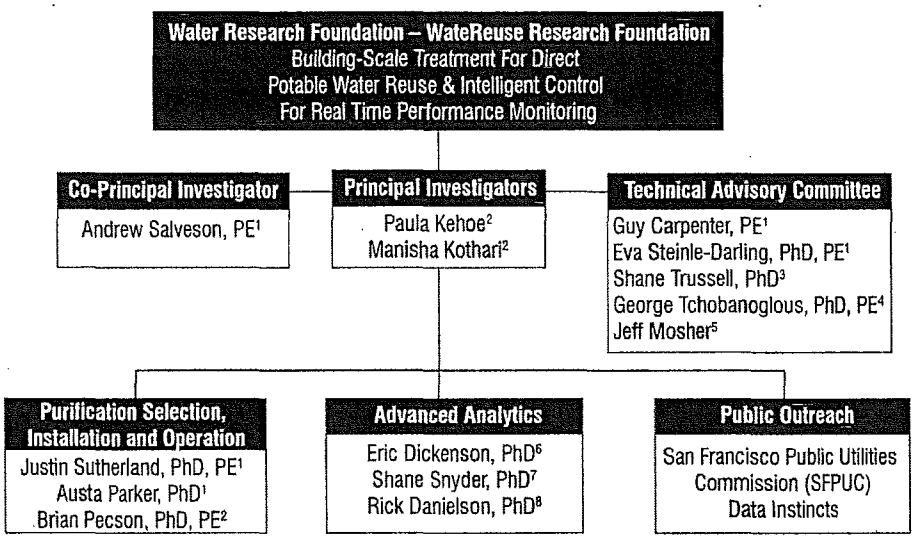
Comparability

Much of the critical data will be analyzed by on-site online monitors and field kits, and outside laboratory analysis will take place at SNWA, Biovir and the University of Arizona. It is therefore important to prove consistency between laboratories and have a common practice to ensure quality control across various laboratories. Comparability is the degree of consistency between a data set obtained at one laboratory and data sets from another. It is achieved by use of consistent methods and materials (i.e., standards). Comparability of data will be promoted by adherence to the standard and certified analytical methods decided by each outside laboratory.

MANAGEMENT PLAN

The proposed project is intended as a collaboration between SFPUC, WRF, and WRRF. Both WRF and WRRF are being asked to participate as equal partners. Should WRF or WRRF wish to have specific deliverables tied to their cash contributions, the team can provide such a breakout.

SFPUC will be responsible for overall project management, coordination, and communications with WRF and WRRF, and facilitation with the research team. Carollo will be the technical leader for this project and will manage it as it manages all of its research projects. We have assembled a team of professionals experienced in municipal reuse and leading-edge water technology. They offer strength in their core technical specialties and have a proven track-record of delivering projects on time and within budget. The core project team and its lines of communication are depicted in the org chart.



1. Carollo Engineers, Inc.
2. San Francisco Public Utilities Commission
3. Trussell Technologies
4. University of California Davis
5. National Water Research Institute
6. Southern Nevada Water Authority
7. University of Arizona
8. IEH-BioVir Laboratories

Key Team Members

Paula Kehoe – Principal Investigator

Paula Kehoe is the Director of Water Resources for the San Francisco Public Utilities Commission (SFPUC). She is responsible for diversifying San Francisco's local water supply portfolio through the development and implementation of conservation, groundwater, and recycled water programs. Paula spearheaded the landmark legislation allowing for the collection, treatment, and use of alternate water sources for non-potable end uses in buildings and districts within San Francisco.

Manisha Kothari – Principal Investigator

Manisha Kothari is a Project Manager with the Water Resources Division of the San Francisco Public Utilities Commission. Manisha represents the SFPUC in the planning of water reuse projects that the SFPUC is developing through regional partnerships in order to diversify its water supply portfolio and meet future demands. She works with water agencies throughout the Bay Area to evaluate and develop recycled water and desalination opportunities for San Francisco's customers. Manisha has over 10 years of experience managing infrastructure projects from concept to implementation.

Andrew Salveson, PE – Co-Principal Investigator

Andy Salveson has 22 years of environmental consulting experience serving public and private-sector clients in the research and design of water and wastewater treatment systems. He is a nationally recognized expert in water reuse, including IPR and DPR. Mr. Salveson provides guidance and expertise on state-of-the-art technologies on the latest industry issues regarding reuse, including extensive projects for the Water Research Foundation and WateReuse Research Foundation related to Potable Reuse. Andy was named to a national panel of 7 experts to develop national guidance on Direct Potable Reuse (NWRI Framework for Direct Potable Reuse) and was named to a panel of experts to develop potable water reuse for the World Health Organization.

Justin Sutherland; PhD, PE – Purification Selection, Installation, and Operation

Dr. Justin Sutherland is a member of Carollo's Research Group with 16 years of experience in applied research, bench- and pilot-scale process design and testing. He has extensive experience in water reuse. He served as Project engineer for the Texas Water Development Board-funded project, "Testing Water Quality in a Municipal Wastewater Effluent Treated to Drinking Water Standards." He was responsible for the review of historical RO performance data and sampling water quality (EDC, pharmaceuticals, etc.) around the MF, RO, and AOP processes at the Direct Potable Reuse Plant and led a pilot scale evaluation of a direct integrity monitor (Nalco's Trasar technology) for potable reuse RO systems.

Eric Dickenson, PhD – Advanced Analytics

Dr. Dickenson serves as R&D project manager for the Southern Nevada Water Authority. His experience includes the fate of emerging contaminants (e.g., EDCs and pharmaceuticals) in natural systems (e.g., aquifer recharge, riverbank filtration) and conventional and advanced engineered systems (e.g., RO, nanofiltration, GAC, ozone, AOP, MBR). Additionally he is experienced in the utilization of state-of-the-art characterization methods for natural and effluent organic matter for water quality characterization and optimization of disinfection processes.

Shane Snyder, PhD – Advanced Analytics

Dr. Snyder is a Professor of Chemical and Environmental Engineering at the University of Arizona. He holds a PhD in Environmental Toxicology and Zoology and a BA in Chemistry. He is a microconstituents expert who participated in the "Blue Ribbon Panel" for the California Water Resources Control Board to consider Constituents/Contaminants of Emerging Concern in Recycled Water. He is also Co-director of the Arizona Laboratory for Emerging Contaminants, a state-of-the-art analytical facility that identifies and quantifies emerging contaminants, such as pharmaceutical compounds, endocrine disrupting compounds, and nanoparticles.

Rick Danielson, PhD – Advanced Analytics

Dr. Danielson has a broad background in environmental health microbiology including: the development and application of bio-technology (PCR, ELISA, monoclonal antibodies, plasmid analysis, etc.); microbiological risk assessment; environmental virology and parasitology (certified USEPA Principal Analyst for protozoans and viruses); providing information and consultation on agents of bioterrorism; expert testimony in environmental microbial contamination cases; and, the establishment of certified environmental microbiological testing laboratories. He is a lecturer of microbiology at the U.C. Berkeley School of Public Health (1993 to present) and has served on several national public health (US FDA & NMFS, ASTM) and research review committees (WERF, AWWA, Sea Grant, USDA).

REFERENCES

Anumol, T., Sgroi, M., Park, M., Roccaro, P., Snyder, S.A. 2015. Predicting Trace Organic Compound Breakthrough in Granular Activated Carbon using Fluorescence and UV Absorbance as Surrogates. *Water Research*, 76:76-87.

Australian Academy of Technological Sciences and Engineering (ATSE), 2013. Drinking Water through Recycling: The Benefits and Costs of Supplying Direct to the Distribution System." Australian Water Recycling Centre of Excellence. Melbourne, Australia.

CDPH 2014. Groundwater Replenishment Using Recycled Water (Water Recycling Criteria. Title 22, Division 4, Chapter 3, California Code of Regulations). California State Water Resources Control Board Division of Drinking Water.

Clean Water Services 2014. Direct Potable Reuse Water Reuse Demonstration. Carollo Engineers for Clean Water Services, Oregon.

Escher, B.I. , Allinson, M. Altenburger, R., Bain, P.A., Balaguer, P., Busch, W., Crago, J., Denslow, N.D., Dopp, E., Hilscherova, K. *et al* 2014. Benchmarking Organic Micropollutants in Wastewater, Recycled Water and Drinking Water with In Vitro Bioassays. *Environmental Science and Technology*, 48(3):1940-1956.

Gerrity, D., Gamage, S., Jones, D., Korshin, G.V., Lee, Y., Pisarenko, A., Trenholm, R.A., von Gunten, U., Wert, E.C., Snyder, S.A. 2012. Development of Surrogate Correlation Models to Predict Trace Organic Contaminant Oxidation and Microbial Inactivation during Ozonation. *Water Research*, 46(19):6257-6272.

Giesy, J.P., Hilscherova, K., Jones, P.D., Kannan, K., Machala, M. 2002. Cell Bioassays for Detection of Aryl Hydrocarbon (AhR) and Estrogen Receptor (ER) Mediated Activity in Environmental Samples. *Marine Pollution Bulletin*, 45(1-12):3-16.

Henderson, R. K., Baker, A., Murphy, K. R., Hambly, A., Stuetz, R. M., and Khan, S. J. 2009. Fluorescence as a Potential Monitoring Tool for Recycled Water Systems: A Review. *Water Research*, *43*(4), 863–881. http://doi.org/10.1016/j.watres.2008.11.027.

Hijnen, W., Beerendonk, E. and Medema, G. 2006. Inactivation Credit of UV Radiation for Viruses, Bacteria and Protozoan (oo) Cysts in Water: A Review. *Water Research*, 40, 1, 3-22.

Jarosova, B., Blaha, L., Vrana, B., Randak, T., Grabic, R., Giesy, J.P., Hilscherova, K. 2012. Changes in Concentrations of Hydrophilic Organic Contaminants and of Endocrine-Disrupting Potential Downstream of Small Communities Located Adjacent to Headwaters. *Environment International*, 45:22-31.

Jia, A., Escher, B.I., Leusch, F.D.L., Tang, J.Y.M., Prochazka, E., Dong, B., Snyder, E.M., Snyder, S.A. 2015 In Vitro Bioassays to Evaluate Complex Chemical Mixtures in Recycled Water. *Water Research*, 80(0):1-11.

Kitis, M., Lozier, J.C., Kim, J.H., Mi, B., and Marinas, B.J, 2003. Microbial Removal and Integrity Monitoring of RO and NF Membranes." *AWWA*, 95, 12, 105-119.

Merel, S., Anumol, T., Park, M., Snyder, S.A. 2015. Application of Surrogates, Indicators, and High-Resolution Mass Spectrometry to Evaluate the Efficacy of UV Processes for Attenuation of Emerging Contaminants in Water. *Journal of Hazardous Materials*, 282:75-85. 2 NRMMC/EPHC/NHMRC 2008. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Augmentation of Drinking Water Supplies, Australia.

NRMMC/EPHC/NHMRC 2008. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Augmentation of Drinking Water Supplies, Australia.

NRC 2012. Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater. National Academies Press, Washington, D.C.

NSF 2012. Siemens Industry, Inc. L10N and L20N Ultrafiltration Modules, Product-Specific Challenge Tests for Cryptosporidium and Virus Removal Credits under LT2ESWTR. NSF Certification for Public Drinking Water Equipment Performance. Ann Arbor, Michigan. September 2012.

NWRI 2015. Report of an NWRI Expert Panel for Developing a Direct Potable Reuse Framework." Alexandria, VA. Co-sponsored by American Water Works Association and the Water Environment Foundation.

Pype, M. L., Patureau, D., Wery, N., Poussade, Y., and Gernjak, W. 2013. Monitoring Reverse Osmosis Performance: Conductivity vs Fluorescence Excitation–Emission Matrix (EEM). *Journal of Membrane Science*, *428*, 205–211.

Reardon, R., DiGiano, F., Aitken, M., Paranjape, S., Kim, J., and Chang, S. 2005. "Membrane Treatment of Secondary Effluent for Subsequent Use." Water Environmental Research Foundation Project 01-CTS-6 Final Report, Washington, DC.

Rochelle, P., Upton S., Montelone, B., and Woods, K. 2005. The Response of Cryptosporidium Parvum to UV Light: Trends in Parasitology. 21, 2, 81-87.

Salveson, A., Mackey, E., Salveson, M., Flynn, M. 2014. Application of Risk Reduction Principles to Direct Potable Reuse, Final Report for WateReuse Research Foundation Project No. 11-10, Alexandria, VA.

Sanderson J.T., Aarts J, Brouwer A, Froese K.L., Denison M.S., and Giesy J.P. 1996. Comparison of Ah Receptor-Mediated Luciferase and Ethoxyresorufin-O-Deethylase Induction in H4IIE Cells: Implications for Their Use as Bioanalytical Tools for the Detection of Polyhalogenated Aromatic Hydrocarbons. *Toxicology and Applied Pharmacology*, 137(2):316- 325

Schäfer, A.I., Fane, A.G. and Waite, T.D. 2005. Nanofiltration, Principles and Applications. Elsevier.

Sharpless, C. and Linden, K. 2003. Experimental and Model Comparisons of Low- and Medium-Pressure Hg Lamps for the Direct and H2O2 Assisted UV Photodegradation of N-Nitrosodimethylamine in Simulated Drinking Water. *Environmental Science and Technology*, *37*, 1933-1940.

Snyder, S.A, Villeneuve, D.L., Snyder, E.M., Giesy, J.P. 2012. Identification and Quantification of Estrogen Receptor Agonists in Wastewater Effluents. *Environmental Science and Technology* 2001, 35(18):3620-3625.

Stavreva, D.A., George A.A., Klausmeyer, P., Varticovski, L., Sack, D., Voss, T.C., Schiltz, R.L., Blazer, V.S., Iwanowicz, L.R., Hager, G.L. 2012. Prevalent Glucocorticoid and Androgen Activity in US Water Sources. *Scientific Reports*, 2:937. 3 SWRCB 2015. California Water Boards: Recycled Water Research Workshop." Costa Mesa CA,

Steinle-Darling, E., Juby, G.; Salveson, A. 2015. "Direct Potable Reuse - Full-Scale Demonstrations Testing Results from Big Spring, Texas. Proceedings from California Water Environment Association Conference.

SWRCB 2015. California Water Boards: Recycled Water Research Workshop." Costa Mesa CA,

Tchobanoglous, G., Leverenz, H.L., Nellor, M.H. and Crook, J. 2011. Direct Potable Reuse: A Path Forward. WateReuse Research Foundation and WateReuse California, Alexandria, VA.

Trussell, R. R.; Salveson, A.; Snyder, S. A.; Trussell, R. S.; Gerrity, D.; Pecson, B. M. 2013. Potable Reuse: State of the Science Report and Equivalency Criteria for Treatment Trains. WateReuse Research Foundation, Alexandria, VA.

USEPA 1990. Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public water Systems Using Surface Water Sources, Office of Drinking Water, prepared by Malcolm Pirnie, Inc. and HDR Engineering, Inc. under EPA Contract no. 68-01- 6989, Washington, DC.

USEPA 2006. Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule, EPA Office of Water (4601), EPA 815-R-06-007, Washington, DC.

Water Replenishment District. 2013. Amended Title 22 Engineering Report for the Leo. J. Vander Lans Water Treatment Facility Expansion: Alamitos Barrier Recycled Water Project.

Yu, H-W., Anumol, T., Park, M., Pepper, I., Scheideler, J., Snyder, S.A. 2015. On-line Sensor Monitoring for Chemical Contaminant Attenuation During UV/H2O2 Advanced Oxidation Process. *Water Research*, 81(0):250-260.

LICENSES AND INVENTIONS

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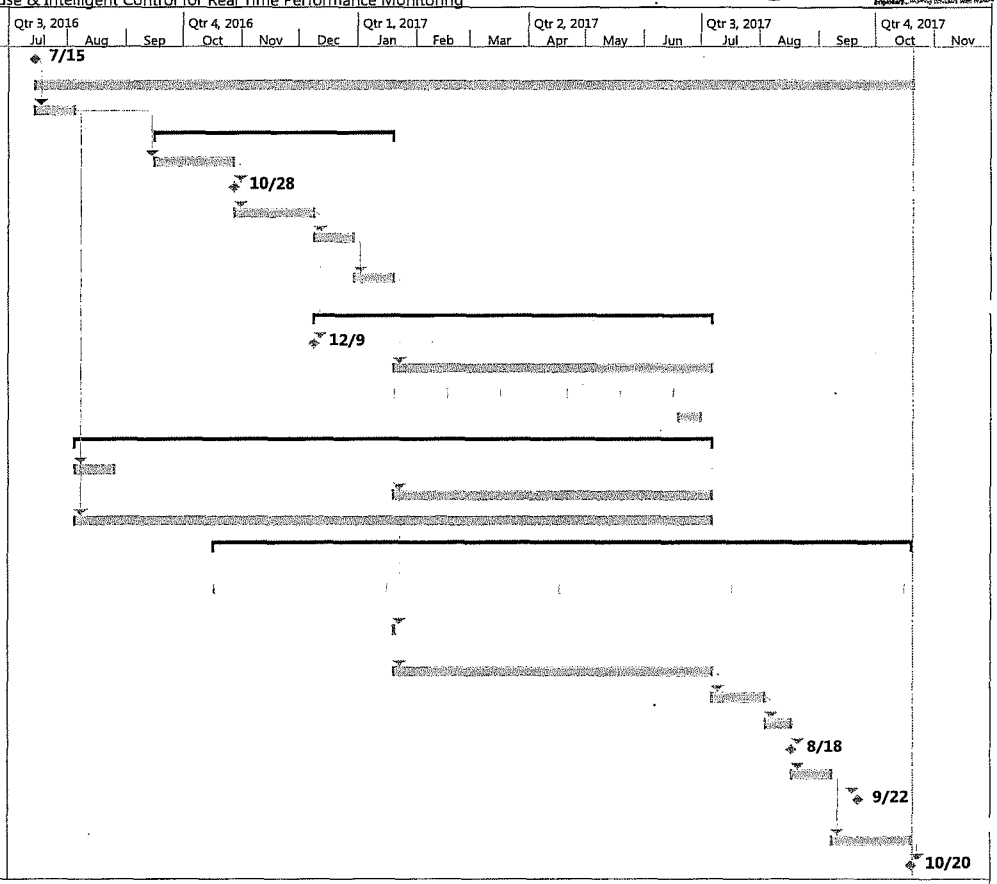
RESEARCH WORK PLAN AND SCHEDULE

The work to be carried out in the demonstration study is described in task descriptions of the Scope of Work Section. The project schedule, including all major tasks and subtasks, is shown below. The schedule details the elapsed time for the entire pilot testing project. Estimates of equipment delivery dates, pilot construction and commissioning, and dates of all deliverables are included. The total project duration is expected to be 15 months.

Building Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

ID	Task Name	Duration	Start	Finish	Predecessors
1	DPR Demonstration	0 days	Fri 7/15/16	Fri 7/15/16	
2	**Task 1: Project Management**	331 days	Fri 7/15/16	Fri 10/20/17	
3	**Task 2: Site Preparation**	15 days	Fri 7/15/16	Thu 8/4/16	1
4	**Task 3: Purification Facility Design and Construction**	**90 days**	**Fri 9/16/16**	**Thu 1/19/17**	
5	Purchase UF/RO/UV AOP from Suppliers	30 days	Fri 9/16/16	Thu 10/27/16	3FS+30 days
6	Submit Treatment and Monitoring TM	0 days	Fri 10/28/16	Fri 10/28/16	5
7	Deliver UF/RO/UV AOP to Site	30 days	Fri 10/28/16	Thu 12/8/16	5
8	Advanced Purification Pilot Installation, Testing, and Commissioning	15 days	Fri 12/9/16	Thu 12/29/16	7
9	Advanced Monitoring/Intelligent Control Installation, Testing, and Commissioning	15 days	Fri 12/30/16	Thu 1/19/17	8
10	**Task 4: DPR Performance Demonstration**	**150 days**	**Fri 12/9/16**	**Thu 7/6/17**	
11	Submit Test Protocol	0 days	Fri 12/9/16	Fri 12/9/16	7
12	DPR Pilot Operation	6 mons	Fri 1/20/17	Thu 7/6/17	9
13	**Advanced Analytics**	**106 days**	**Fri 1/20/17**	**Fri 6/16/17**	
20	Decommission and Site Clean-Up	10 days	Mon 6/19/17	Fri 6/30/17	13
21	**Task 5: Public Outreach**	**240 days**	**Fri 8/5/16**	**Thu 7/6/17**	
22	Install Banners	15 days	Fri 8/5/16	Thu 8/25/16	3
23	Provide Educational Tours	6 mons	Fri 1/20/17	Thu 7/6/17	9
24	Create/Maintain Demonstration Website	12 mons	Fri 8/5/16	Thu 7/6/17	3
25	**Task 6: Project Communication and Reporting**	**264 days**	**Mon 10/17/16**	**Fri 10/20/17**	
26	**Prepare and Submit Progress Reports**	**261 days**	**Mon 10/17/16**	**Mon 10/16/17**	
32	Onsite Project Meeting with Advisory Committees/Research Managers	1 day	Fri 1/20/17	Fri 1/20/17	9
33	Compile Pilot Plant Data	6 mons	Fri 1/20/17	Thu 7/6/17	9
34	Prepare Draft Report	20 days	Fri 7/7/17	Thu 8/3/17	33
35	Internal Review of Draft Report	10 days	Fri 8/4/17	Thu 8/17/17	34
36	Submit Draft Report to WRF/WRRF for Review	0 days	Fri 8/18/17	Fri 8/18/17	35
37	WRF/WRRF Review of Report	15 days	Fri 8/18/17	Thu 9/7/17	36
38	Presentation to Advisory Committess/Research Managers	0 days	Fri 9/22/17	Fri 9/22/17	37FS+10 days
39	Prepare Final Report	30 days	Fri 9/8/17	Thu 10/19/17	37
40	Submit Final Report to WRF/WRRF	0 days	Fri 10/20/17	Fri 10/20/17	39



Project: DPR Demonstration
Date: Thu 4/7/16

Task	Project Summary	Manual Task	Start-only	Deadline			
Split	Inactive Task	Duration-only	Finish-only	Progress			
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress			
Summary	Inactive Summary	Manual Summary	External Milestone				

Carollo
Engineers...Working Wonders With Water®

WATER
OUR FOCUS
OUR BUSINESS
OUR PASSION

April 6, 2016

Ms. Paula Kehoe
San Francisco Public Utilities Commission
525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102

Subject: WRF and WRRF TC Study: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Dear Ms. Kehoe:

Carollo Engineers, Inc. is pleased to provide this Letter of Commitment to confirm our support to the City of San Francisco, acting through the Public Utilities Commission, for our services (both paid and in-kind) related to the proposed project to pilot test building scale direct potable reuse with intelligent control systems and advanced performance monitoring. Carollo is committed to providing the following services for this project:

- Provide 10 percent of contractual hours as an in-kind service (an in-kind contribution of $20,530).
- Vehicular travel to and from the pilot site and to one trip to Denver to present findings to the WRF as an in-kind service, not quantified here.

Carollo commits to providing identified staff and resources for the duration of the project. The services include approximately 1,300 hours of time, equipment, chemicals and consumable supplies, and analytical services. Carollo commits to providing $20,530 as in-kind contributions and, should the proposal be successful, will contract with SFPUC for $430,232 to perform other services.

If you have any questions regarding our participation, please contact me at 925-788-9857.

Sincerely,

CAROLLO ENGINEERS, INC.

Andrew Salveson, P.E.
Vice-President

AS:MS

2700 Ygnacio Valley Road, Suite 300, Walnut Creek, California 94598
P. 925.932.1710 F. 925.930.0208
carollo.com

Data instincts
Public Outreach Consultants
239 Windsor River Road, Windsor, CA 95492
Tel: 707.836.0300 Fax: 707.836.0842

April 6, 2016

Paula Kehoe
San Francisco Public Utilities Commission
525 Golden Gate Ave
San Francisco, CA 12345

Subject: **In-kind Commitment for Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring**

Dear Paula,

We are in full support of San Francisco Public Utilities Commission's (SFPUC) proposed study regarding the use of Direct Potable Reuse (DPR). Potable reuse as a water supply alternative is receiving greater interest as an approach to augment potable water supplies and maximizing recycled water use. We believe this study is critical to both expanding effective treatment knowledge and educating people about this vital resource and to ultimately bolster acceptance of DPR.

We are pleased to participate in this research effort in support of *Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring* and are pledging to provide in-kind services totaling $5,000. Specifically, the in-kind services will be in the form of labor (approximately 25 labor hours at an average rate of $185 per hour distributed over the project period not exceeding one year in duration). We anticipate the contributed labor will include, but not be limited to, the following:

- Including previous findings for effective communication regarding DPR
- Coordination of developing outreach materials

We are committed and supportive of this priority research project proposed by the SFPUC and believe it will foster further public acceptance and a better understanding of DPR.

Very truly yours,

Mark Millan
Principal, Data Instincts

Paula A. Kehoe
525 Golden Gate Ave, 10th Floor San Francisco, CA 94102
(415) 554-0792/pkehoe@sfwater.org

EMPLOYMENT

City and County of San Francisco, Public Utilities Commission — *San Francisco, CA*
Director of Water Resources — **May 2004- Present**

- Manage the development of new local water supplies, including groundwater, recycled water, desalinated water and alternate water sources.
- Develop and implement water shortage allocation plans, drought polices, and water shortage measures.
- Prepare ordinances to streamline regulatory pathways to develop new non-potable water supplies to offset potable supplies.
- Lead innovative water strategies, including installing composting toilets in urban areas and treating blackwater to flush toilets in new commercial and multi-family buildings.
- Identify water conservation measures, prepare ordinances and implement tools to reduce and track consumption among residential, commercial and industrial sectors.
- Identify partnerships and negotiate agreements with external governmental and non-governmental agencies to develop and implement new water supply projects.
- Direct long-range water demand studies, integrated water resource plans, groundwater management plans, recycled water plans, desalinated water plans and water efficiency plans.
- Conduct research on public perceptions and acceptance of new water supplies, such as groundwater, recycled water and desalinated water.
- Prepare operations plans to document water system facilities, operating strategies, water quality and permitting requirements.
- Participate in U.S. Department of State, Bureau of International Information Programs, to share technical assistance on Water Management in Brazil, including Sao Paulo, Brasilia, and Rio de Janeiro.
- Prepare water resources management Memorandum of Understanding between San Francisco and Bangalore, India.
- Develop and track performance measures for SFPUC Sustainability Plan.
- Manage staff, produce publications and technical reports, administer contracts and manage $9 million annual budget.

City and County of San Francisco, Public Utilities Commission — *San Francisco, CA*
Chief of Staff and Public Affairs Manager — **Oct 1999- May 2004**

- Developed educational programs and served as a liaison with commissioners, elected officials, media and stakeholders to increase awareness of the SFPUC's water system improvements and water resource issues.
- Assisted with the development and public outreach for the SFPUC $3.6 billion capital improvement program designed to rebuild and repair the third largest water delivery system in California.
- Managed the bottling and distribution of Hetch Hetchy Mountain Water™ to promote

high quality municipal drinking water.

- Coordinated a strategic management system (Balanced Scorecard) to identify organization goals, objectives, and performance measures specific to water, wastewater, and power operations.
- Directed multifaceted communications and government affairs programs and staff, created coalitions and resolved disputes.
- Produced publications, administered contracts, prepared annual work plans and managed a $400,000 annual budget.

City and County of San Francisco, Public Utilities Commission ***San Francisco, CA***
Pollution Prevention Public Education Director **Dec 1991-Oct 1999**

- Developed and managed water resource programs for the Water Pollution Prevention Program to reduce pollutant loadings to the San Francisco Bay and Pacific Ocean from point and non-point sources.
- Prepared technical reports, including source identification studies, waste minimization plans and influent and effluent mass loading studies.
- Conducted market research, developed marketing strategies and implemented innovative public education campaigns for targeted audiences.
- Developed publications and programs shown to change behaviors among targeted populations.
- Designed and implemented educational outreach programs through public-private partnerships.
- Awarded six state and national awards for excellence in water pollution prevention public education.
- Received grant funding to develop an integrated pest management and green gardening program.
- Obtained significant media coverage on pollution prevention and water conservation issues.
- Assisted with the development of an *Effluent Management Training Course* for the Water Environment Federation and U.S. AID in Cairo and Alexandria, Egypt, March-April 1998

EDUCATION

University of San Francisco, San Francisco, CA
Master of Science, Environmental Management
September 1990-December 1993
University of Colorado, Boulder, CO
Bachelor of Arts Degree, Geography
September 1983-May 1987

PUBLICATIONS

Kehoe, P. *Drought, San Francisco, and Innovation Though Local Water and Alternative Water Projects*, Green Technology Magazine, August 2015.
Kehoe, P., Rhodes, S., Scarpulla, J. *Blueprint for Onsite Water Systems Shifts Traditional Views on Water Use*. Trim Tab The Magazine for Transformative People + Design. February 2015.
Kehoe, P., Rhodes, S., Scarpulla, J. *Moving from Building-scale to District-scale – San Francisco 's Non-potable Water Program.*
Alternative Water Supply Systems. London. IWA Publishing. 2015.
Elmer, V., Kehoe, P. *The Tricky Business of Onsite Water Treatment and Reuse.* Planning Magazine. American Planning Association. December 2014.
Kehoe, P., Rhodes, S., Scarpulla, J. *San Francisco Takes the Lead in Setting Standards for Onsite Reuse*. Source Magazine. AWWA. Vol 28, No 4. Fall 2014.
Kehoe, P., Rhodes, S. *Innovations for Water in Urban Areas Require Rethinking and Reuse*. ECOHOME Magazine. Winter 2013. Beck, S., Goel, N., Kehoe, P., Linden, K., Rhodes, S., Rodriguez, R., Salveson, A. *Disinfection Methods for Treating Low TOC, Light Graywater to California Title 22 Water Reuse Standard.* Journal of Environmental Engineering. Volume 139, Issue 9. September 2013.
Kehoe, P., Rhodes, S. *Pushing the Conservation Envelope Through the Use of Alternate Water Sources*. Journal of the American Water Works Association. Vol. 105:2. February 2013.
Kehoe, P., Rhodes, S. *Regulatory Pathway Streamlined for Onsite Non-potable Reuse in San Francisco.* Water Reuse and Desalination. Vol. 3:3. Autumn 2012.
Kehoe, P., O'Rorke, M. *An Educated Approach to Educating the Public.* Wastewater Technology Showcase, Water Environment Federation. 2000.
Kehoe, P., O'Rorke, M. *Targeted Research and Marketing Put Muscle into Pollution Prevention Education Campaigns.*
Utility Executive, Water Environment Federation. 2000.
Kehoe, P., O'Rorke, M. *Targeted Research and Marketing Put Muscle into Pollution Prevention Education Campaigns.*
Watershed & Wet Weather, Water Environment Federation. 2000.
Mass Loadings of Used Motor Oil and Latex Paints to the Sewerage System. City and County of San Francisco, Department of Public Works, Bureau of Environmental Regulation and Management, Water Pollution Prevention Program, San Francisco, California. 1993. *A Community of Land.* Gildea Review. 1988.

PROFESSIONAL ORGANIZATIONS

Alliance for Water Efficiency, Project Advisory Committee Member: *Net Blue Development*, 2015-Present
WaterReuse Research Foundation, Project Subcommittee Member: *A Framework for the Successful Implementation of Onsite Industrial Water Reuse*, 2014- Present
Water Research Foundation, Project Subcommittee Member: *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities*, 2014-Present
One Water Council, U.S. Water Alliance, Committee Member, 2013-Present **California Urban Water Agencies**, Water Reuse Committee Member, 2013-Present **Vision 2020, ECOHOME, Hanley Wood,** Water Efficiency Chair, 2013
Water Research Foundation, Project Subcommittee Member: *Institutional Issues for Green-Grey Infrastructure based on integrated "OneWater" Management and Resource Recovery,* 2013- 2015

WateReuse Foundation, Project Advisory Committee Member: *Evaluating Long and Short Term Planning Under Climate Change Scenarios to Better Assess the Role of Water Reuse,* 2009-2012
Water Environment Federation, member, Public Education Committee 2006- 2012
WateReuse Foundation, Project Advisory Committee Member: *Talking About Water: Vocabulary and Images that Support Informed Decisions about Water Recycling and Desalination,* 2008-2011
WateReuse Foundation, Project Advisory Committee Member: *Feasibility Study of Offshore Desalination Plants,* 2007-2010
Bay Area Clean Water Agencies, Chair, Water Recycling Committee, 2005-2009
American Water Works Association, Vice Chair, Water Resources Planning & Management Committee, 2006-2007
Water Environment Research Foundation, Member, Peer Review Committee for WERF Project: *Communicating Risks with Your Local Government and Community,* 2004-2006

MANISHA KOTHARI
525 Golden Gate Avenue, 10th Floor, San Francisco, CA, 94102
Tel: (415) 554-3256 (direct); E-mail: mkothari@sfwater.org

PROFESSIONAL EXPERIENCE

Project Manager
San Francisco, CA

San Francisco Public Utilities Commission (www.sfwater.org), *a department of the City and County of San Francisco that provides water and wastewater services in San Francisco; wholesale water to three Bay Area counties; and green hydroelectric and solar power to San Francisco's municipal departments*

5602 Utility Specialist
2007-Present

5620 Regulatory Specialist
2006-2007

Key responsibilities and achievements include:

- Manage project planning, environmental review, design and implementation activities for complex capital improvement projects in the areas of recycled water, desalination and potable reuse.
- Manage water supply planning effort for the evaluation of key decisions affecting the SFPUC's post-2018 supply obligations (WaterMAP).
- Deliver project milestones on-time and within budget, including the successful implementation of the SFPUC's first two recycled water projects.
- Initiate, build and manage long-term regional partnerships with other water and wastewater service providers in the Bay Area to develop strategic, collaborative, cost-effective water supplies.
- Lead public outreach efforts working with environmental groups, schools, local communities and regulatory agencies on behalf of multiple agencies to evaluate the potential for regional desalination and recycled water projects.
- Prepare and manage project reporting of the alternative local water supply portfolio
- Secured over $6 million in grant funds to support water supply projects.
- Successfully advanced projects that faced significant challenges from various groups through effective education and public outreach campaigns.

Sr Environmental Planner
2002-2006

URS Corporation (now part of AECOM www.aecom.com), *a global environmental and engineering consulting firm with expertise in the planning, assessment, design, and implementation of projects in over 65 countries worldwide.*

Key responsibilities and achievements include:

- Managed the environmental review, including stakeholder engagement and public outreach activities, for California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) compliance for various public and private capital projects in water, wetland restoration, natural resource development and transportation.
- Assisted with the development of corporate policies and initiatives for U.S. companies working in developing countries to address environmental justice and labor concerns.
- Prepared and won several competitive project and grant proposals.
- Contributed to the development of strategic business plans, identifying key growth areas and opportunities with the U.S. federal government and in Asial

Program Manager, Asia
Arlington, VA

U.S. Trade and Development Agency (USTDA) (www.ustda.gov), *a foreign assistance agency of the U.S. federal government that grants seed capital for priority infrastructure projects in low and middle-income countries, while promoting job creation in the United States*

Key responsibilities and achievements included:

- Managed grant program for South and Southeast Asian countries, supporting the development of infrastructure in sectors including, banking, technology, transportation, environment, telecommunications, energy, and security
- Worked with the U.S. Departments of State and Commerce to re-engage political discourse on the subjects of human rights and nuclear non-proliferation through new trade initiatives in China, India and Pakistan
- Reviewed, assessed, and successfully recommended over 100 projects for federal grant assistance
- Worked with U.S. companies to ensure compliance with U.S. laws and policies, and the promotion of U.S. goods and services while working overseas
- Partnered with U.S. government agencies (including the Department of Commerce, OPIC, Ex-Im Bank, the FAA, DOE, and USAID), multilateral development banks (Asian Development Bank and World Bank) and other regional players to structure and implement projects
- Monitored performance of past investments and the associated impact on U.S. jobs and exports for annual Congressional and agency reports and to develop regional strategic priorities for the future
- Planned and executed roundtable discussions, conferences and study tours for Asian project sponsors
- Drafted marketing materials, public information briefs, presidential and congressional briefs, and press releases

EDUCATION

Georgetown University — Washington, DC

- Master of Science in Foreign Service (International/Public Policy) — 1998
  Landeggar Program in International Business-Government Relations

University of California, Berkeley — Berkeley, CA

- Bachelor of Arts, cum laude, in Political Science — 1996
- Bachelor of Arts in Mass Communications — 1996
- Semester-long internship with the United Nations High Commissioner for Refugees (UNHCR)
- (Political Communications position at headquarters in Geneva, Switzerland) — 1995

LANGUAGE SKILLS

Languages: Native speaker of ***English***, ***Hindi***; fluent in ***Thai***; working knowledge of ***French***

Andrew T. Salveson

Education

MS Water and Wastewater Engineering, University of California, Davis, 1994

BS Civil Engineering, San Jose State University, San Jose, California, 1993

Licenses

Civil Engineer, California

Professional Engineer, Texas, New Mexico

Professional Affiliations

International UV Association

Water Environment Foundation

Expert Services

Contributing Author, MOP 8, Design of Municipal Wastewater Treatment Plants

Editor of Reuse Treatment, EPA's 2012 Guidelines for Water Reuse

Contributing Author, National Water Research Institute, 2012 UV Guidelines

Contributing Author, National Water Research Institute DPR Framework

Contributing Author, World Health Institute Potable Water Reuse Guidelines

Mr. Salveson has 21 years of environmental consulting experience serving public and private-sector clients in the research and design of water and wastewater treatment systems. He is a nationally recognized expert in water reuse and disinfection. Mr. Salveson provides guidance and expertise on state-of-the-art technologies on the latest industry issues regarding reuse, as has led numerous planning, design, and research projects for various organizations, utilities, and corporations. In recognition of his contributions to the industry, Mr. Salveson was honored with the 2007 WateReuse Person of the Year Award for bringing innovative technologies to market.

Predesign/Design/Planning/ Permitting

- Project manager for the analysis of indirect and direct potable reuse feasibility for the Encina Wastewater Authority.
- Project manager for the analysis of indirect potable reuse treatment technologies for the Water Replenishment District, with Carollo as a subconsultant to CH2M HILL.
- Process engineer for the 30% design of MBR, UF, Ozone, UV, and chlorination membrane and UV disinfection for water reuse for the Barwon Water of Victoria Australia (Carollo teamed with SKM).
- Project manager for the potable reuse feasibility analysis for the Santa Clara Valley Water District, San Jose, California. Work includes expert services related to regulations, treatment, and the creation of a feasibility report for potable reuse.
- Project manager for the preliminary design of a microfiltration (MF)/reverse osmosis (RO)/advanced oxidization process (AOP) for streamflow augmentation with reclaimed water for the Southwest Florida Water Management District, Florida.
- Process advisor for the research and design of advanced membrane and carbon treatment technologies for the Synderville Basin Water Reclamation District, Utah.
- Technical assistance for the Santa Clara Valley Water District, California, Potable Reuse Grant Funding Program.
- Project manager for the City of Los Angeles Bureau of Sanitation for the analysis of alternative advanced oxidation technologies for potable reuse and subsequent permitting with the DDW for those technologies.
- Project engineer for the permitting of IPR for the City of Oxnard, California.
- Technical specialist for the IPR Design/Build for the City of Los Angeles Terminal Island Water Purification Facility.

Testing and Research

• Co-principal Investigator for the 2013 Texas Water Development Board Priority Research Topic Study, "Testing Water Quality in a Municipal Wastewater Effluent Treated to Drinking Water Standards." This study will develop and implement a detailed testing protocol at the Colorado River Municipal Water District's Raw Water Production Facility (RWPF) at Big Spring. This advanced treatment facility constitutes the nation's first instance of direct potable reuse (DPR). The project will also develop monitoring guidelines, based on in-depth parallel study of pathogens, chemicals, and appropriate surrogates, for use at DPR facilities like RWPF and others across the nation. The WateReuse Research Foundation

• Principal investigator for the WateReuse Research Foundation WERF Project 12-06, "Guidelines for Engineered Storage for Direct Potable Reuse" Work includes an evaluation of how to integrate Engineered Storage treatment and monitoring into Direct Potable Reuse Treatment trains.

• Principal investigator for the WateReuse Research Foundation Project 10-06, "Challenge Projects on Low Energy Treatment Schemes for Water Reuse" Work includes an evaluation of emerging treatment technologies for low energy treatment for water reuse.

• Co-principal investigator for the WERF project ENER4R12 – Low Energy Alternatives for Activated Sludge, Advancing AnMBR Research, Work includes the design and construction of three AnMBR treatment trains utilizing flat sheet, hollow fiber, and ceramic membranes.

• Co-principal investigator for the WateReuse Foundation's 11-02 "Equivalency of Advanced Treatment Trains for Potable Reuse). Work includes the search for lower energy and lower cost treatment technologies has increased the depth and breadth of this work through their tailored collaboration process.

• Principal investigator for Water Research Foundation Project 4536, Blending Requirements for Water from Direct Potable Reuse Treatment Facilities. This project examines the pathogens, pollutants, and subsequent water quality impacts to drinking water quality due to blending reclaimed water with other raw water supplies.

• Principal investigator for the WERF project CEC4R08, examining the most cost efficient method to reduce microconstituents. The project includes investigations of the secondary treatment process and comparisons with various tertiary methods to destroy microconstituents.

that meet the public health objectives for potable water reuse.

• Project manager for the treatment and analysis of Clean Water Services (Oregon) Direct Potable Reuse Demonstration Facility.

• Principal investigator for the WateReuse Foundation Project 10-10, "Filtration and Disinfection Compliance through Soil Aquifer Treatment." Work included detailed water quality monitoring pre and post SAT to prove treatment to Title 22 Standards.

• Principal investigator for the WateReuse Foundation Project 11-10, "Evaluation of Risk Reduction Principles for Direct Potable Reuse." This important project is examining the methods to modify our current approach to IPR design and operation for direct potable reuse systems.

• Project manager for the WateReuse Foundation's 06-019 "Monitoring for Microcontaminants in an Advanced Wastewater Treatment (AWT) Facility and Modeling Discharge of Reclaimed Water to Surface Canals for Indirect Potable Use " study. Work includes detailed trace organic

(EDC, etc.) analysis and in-vivo and in-vitro bioassays to determine hormonal impact, as well as surface water modeling to track fate and transport of trace organics.

- Co-principle investigator for the Australian Water Quality Center of Excellence Pasteurization Demonstration in Melbourne, Australia.

- Co-principal investigator for the WateReuse Foundation's 02-009 "Innovative Treatments for Reclaimed Water" study. Work includes detailed pathogen and micropollutant analysis and the investigation of innovative, but market ready, advanced oxidation technologies.

- Lead investigator for the performance evaluation of pasteurization for reclaimed water disinfection, a sustainable approach to harnessing waste energy for reclaimed water disinfection. Work resulted in the approval of pasteurization by the State of California for wastewater reuse. Demonstration testing has been completed at Santa Rosa, Ventura, and Graton, California.

- Project manager for the research and analysis of a microfiltration, reverse osmosis, and UV disinfection use for the potable reuse of wastewater at Dublin San Ramon Services District, California. The analysis addressed NDMA, standard DBPs, and endocrine disrupting compounds. This project received the 1999 California Water Environment Association Research Achievement Award.

- Technical advisor for the SFWMD to evaluate secondary and tertiary processes for microcontaminant removal and disinfection for 100+ mgd of wastewater to be potentially supplied to the Biscayne Bay as part of the Comprehensive Everglades Restoration Project (CERP). The investigation addresses advanced oxidation for microcontaminant destruction and examines standard compounds with drinking water MCLs, as well as numerous research-level compounds.

- Co-principal investigator for the WateReuse Foundation's 03-001 "Pathogen Removal and Inactivation in Reclamation Plants" study, which investigated the ability of various disinfectants to reduce pathogens of concern.

Shane A. Snyder Ph.D.

snyders2@email.arizona.edu

Professor of Chemical and Environmental Engineering *(520) 621-2573*

Education

1994-2000	**Michigan State University, East Lansing, Michigan** – Ph.D. Environ. Toxicology/Zoology
1990-1994	**Thiel College, Greenville, Pennsylvania** – B.A. Chemistry (*Magna Cum Laude*)

Employment

2010-Present	**University of Arizona – Professor of Chemical and Environmental Engineering.**
2010-Present	**Arizona Laboratory for Emerging Contaminants (ALEC) – Co-Director.**
2013-Present	**Water & Energy Sustainable Technology Center (WEST) – Co-Director.**
2000-2010	**Research and Development – Project Manager.** Southern Nevada Water Authority, Las Veg projects related to emerging
1998–Present	**Owner/Consultant.** Total Environmental Solutions Inc., Boulder City, Nevada.

Relevant Research Projects

2015	**CoPI - WateReuse Research Foundation:** "Advancing the Potential for Direct Potable Reuse through Novel Sensor Systems and Effective Decision Tools" Project 14-01
2014	**CoPI - Water Research Foundation**: "Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities"
2014	**CoPI – WateReuse Research Foundation:** "Integrating Sensor Data for Real-Time Decision Management" (Project# 14-01)
2013	**PI – CARD Technologies**: "Chemical Contaminant Attenuation with Catalytic Activated Carbon"
2012	**PI – Suez Environment:** "Advanced Treatment Technologies for RO/NF Brine Streams"
2012	**PI – PWN Technologies:** "Mutagenic Nitrogenous Compounds from UV and Nitrate Treatment"
2010	**PI - WateReuse Research Foundation:** "Use of UV and Fluorescence Spectra as Surrogate Measures for Contaminant Oxidation and Disinfection in the Ozone/H2O2 Advanced Oxidation Process"
2010	**Principal Investigator – Water Sustainability Program (University of Arizona):** "Parallel Evaluation of Ozone and UV Advanced Oxidation for Reducing Toxicity in Reclaimed Water"
2009	**PI - WateReuse Research Foundation:** "Use of Ozone in Water Reclamation for Contaminant Oxidation"

Recent Synergistic Efforts

2011-2016	**Visiting Professor.** National University of Singapore.
2014-Present	**World Health Organization.** Drinking water advisory panel.
2014-Present	**Co-Editor in Chief.** *Chemosphere* (Impact Factor 3.6)
2012-Present	**US EPA Science Advisory Board** Drinking Water Committee member.
2008-2011	**National Research Council**: Member of Water Reuse expert panel
2008-2013	**WateReuse Research Foundation:** Research Advisory Council (RAC) member

Recent Publications (from Google Scholar November 2014: h-index = 48; times cited = 9752)

2015	Anumol T and **Snyder SA.** *Rapid Analysis of Trace Organic Compounds in Water by Automated Online Solid-Phase Extraction Coupled to Liquid Chromatography-Tandem Mass Spectrometry.* Talanta. **132**:77-86.
2014	Sgroi M, Roccaro P, Oelker GL, **Snyder SA.** *N-Nitrosodimethylamine Formation upon Ozonation and Identification of Precursors Source in a Municipal Wastewater Treatment Plant.* Environmental Science & Technology 48(17):10308-10315.
2013	Drewes JE, Anderson P, Denslow N, Olivieri A, Schlenk D, **Snyder SA**, and K.A. Maruya. *Designing monitoring programs for chemicals of emerging concern in potable reuse - what to include and what not to include?* Water Science and Technology. **67**(2): 433-439.
2014	**Snyder SA.** *Emerging Chemical Contaminants: Looking for Better Harmony.* Journal of the American Water Works Association. **106**(8):38-52.
2014	Escher BI, et al. *Benchmarking Organic Micropollutants in Wastewater, Recycled Water and Drinking Water with In Vitro Bioassays.* Environ. Sci. Technol. **48**(3):1940-1956.
2013	Merel S, Walker D, Chicana R, **Snyder SA**, Baurès E, Thomas O. *State of knowledge and concerns on cyanobacterial blooms and cyanotoxins.* Environment International **59**:303-327.
2012	Bull RJ, Kolisetty N, Zhang XL, Muralidhara S, Quinones, Lim KY, Guo ZX, Cotruvo JA, Fisher JW, Yang XX, Delker D, **Snyder SA**, Cummings BS. *Absorption and disposition of bromate in F344 rats.* Toxicology. **300** (1-2):83-91.
2012	Pisarenko AN, Stanford BD, Yan DX, Gerrity D, **Snyder SA.** *Effects of ozone and ozone/peroxide on trace organic contaminants and NDMA in drinking water and water reuse applications.* Water Research. **46**(2):316-326.
2012	Mawhinney DB, Vanderford BJ, **Snyder SA.** Transformation of 1H-Benzotriazole by Ozone in Aqueous Solution. Environmental Science & Technology. 46(13):7102-7111.

2012	Pisarenko AN, Stanford BD, Yan DX, Gerrity D, **Snyder SA**. Effects of ozone and ozone/peroxide on trace organic contaminants and NDMA in drinking water and water reuse applications. Water Research. 46(2):316-326.
2011	Stanford BD, Pisarenko AN, Holbrook RD, **Snyder SA**. Preozonation Effects on the Reduction of Reverse Osmosis Membrane Fouling in Water Reuse. Ozone: Science & Engineering. 33(5):379-388.
2011	Gerrity D and **Snyder SA**. Review of Ozone for Water Reuse Applications: Toxicity, Regulations, and Trace Organic Contaminant Oxidation. Ozone Science and Engineering. 33:253-266.
2011	Sarp S, Stanford B, **Snyder SA**, Cho J. Ozone oxidation of desalinated seawater, with respect to optimized control of boron and bromate. Desalination and Water Treatment. 27:308-312.
2011	Dickenson ERV, **Snyder SA**, Sedlak DL, Drewes JE. Indicator Compounds for Assessment of Wastewater Effluent Contributions to Flow and Water Quality. Water Research 45:1199-1212.
2009	Dickenson ERV, Drewes JE, Sedlak DL, Wert EC, **Snyder SA**. Applying Surrogates and Indicators to Assess Removal Efficiency of Trace Organic Chemicals during Chemical Oxidation of Wastewaters. Environmental Science & Technology 43(16):6242-6247.
2009	Wert EC, Rosario FL, **Snyder SA**. Effect of Ozone Exposure on the Oxidation of Trace Organic Contaminants in Water. Water Research. 43:1005-1014.
2009	Wert EC, Rosario FL, **Snyder SA**. Using UV Absorbance and Color to Assess Pharmaceutical Oxidation during Ozonation of Wastewater. Environmental Science & Technology. 43(13):4858-4863.
2008	Ikehata K, El-Din MG, **Snyder SA**. Ozonation and Advanced Oxidation Treatment of Emerging Organic Pollutants in Water and Wastewater. Ozone Science & Engineering. 30(1):21-26.
2008	Rosario-Ortiz FL, Mezyk SP, Doud DFR, Wert EC, **Snyder SA**. Effect of Ozone Oxidation on the Molecular and Kinetic Properties of Effluent Organic Matter. Journal of Applied Oxidation Technologies. 11(3):529-535
2007	Lei H and **Snyder SA**. 3D QSPR models for the removal of trace organic contaminants by ozone and free chlorine. Water Research 41:3271-3280
2007	Wert EC, Rosario-Ortiz FL, Drury DD, **Snyder SA**. Formation of Oxidation Byproducts from Ozonation of Wastewater. Water Research. 41:1481-1490
2006	**Snyder SA**, Wert EC, Rexing DJ, Zegers RE, Drury DD. Ozone Oxidation of Endocrine Disruptors and Pharmaceuticals in Surface Water and Wastewater. Ozone Science & Engineering. 28:445-460

Water Research Foundation
Research Project Budget

Download instructions for budget preparation at http://www.waterrf.org/funding/Pages/proposal-guidelines.aspx *** Required fields are highlighted in yellow.**

*** Required fields are highlighted in yellow.**

Sub-recipient (organization name): San Francisco Public Utilities Commission
PI Name: Paula Kehoe and Manisha Kothari
Project Title: Building-Scale Treatment For Direct Potable Reuse & Intelligent Control For Real Time Performance
Preparation/Revision Date: 7/10/2016
RFP # (if applicable):

Note: The information above will carry over to subsequent pages/worksheets.

Sources of Award, Cost Share, and Non-Cash In-Kind Contributions (Insert rows to list more third parties.)		Award			Cost Share		Third-Party Non-Cash In Kind
		Foundation Funds	*Sub-recipient*	*Third-Party Cash to Foundation*	*Sub-recipient*	*Third-Party Cash to Sub-recipient*	
Water Research Foundation		100,000	n/a	0	n/a	n/a	n/a
Sub-recipient (including subcontract contributions)		n/a	100,000	n/a	0	n/a	n/a
Third Parties	RMC/Data Instincts						5,000
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
	Subtotal	*100,000*	*100,000*	*0*	*0*	*0*	*5,000*
Total Award, Cost Share, and Third-Party Non-Cash In Kind		**200,000**			**0**		**5,000**
Total Project Value		**205,000**					

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): San Francisco Public Utilities Commission
PI Name: Paula Kehoe and Manisha Kothari
Project Title: Building-Scale Treatment For Direct Potable Reuse & Intelligent Control For Real Time Performance M
Preparation/Revision Date: 7/10/2016
RFP # (if applicable): RFP #

OK
OK

Note: All amounts below will be automatically populated from the following pages/worksheets.

		Total	Award	Cost Share
A	Key Personnel	0	0	0
B	Other Personnel	0	0	0
	Total Direct Labor and Fringe Benefits	*0*	*0*	*0*
C	Equipment Rental	0	0	0
	Special Equipment	0	0	0
D	Materials and Supplies	0	0	0
E	Travel	0	0	0
F	Subcontracts	115,968	115,968	0
G	Other Direct Costs	84,032	84,032	0
	Total Direct Costs	*200,000*	*200,000*	*0*
H	Indirect Costs	0	0	0
I	Fee	0	0	0
J	Surveys	0	0	0
	Total Direct and Indirect Costs	***200,000***	***200,000***	***0***
	Third-Party Non-Cash In Kind	**5,000**	n/a	n/a
	Total Project Value	**205,000**		

Water Research Foundation
Research Project Budget

*** Required fields are highlighted in yellow.**

Sub-recipient (organization name): San Francisco Public Utilities Commission
PI Name: Paula Kehoe and Manisha Kothari
Project Title: Building-Scale Treatment For Direct Potable Reuse & Intelligent Control For Real Time Performance Monitoring
Preparation/Revision Date: 7/10/2016
RFP # (if applicable): RFP #

A. Key Personnel *(PI and Co-PIs. Sub-recipient's employees only. †)*

Name	Project Role	Number of Hours	Direct Hourly Rate	% Time Allocated to Project	Subtotal Direct Labor	Fringe Benefit % of Direct Labor	Subtotal Fringe Benefits	Total	Award	Cost Share
Andrew Salveson	Co-PI	191.00		6.1%	0	50.00%	0	0	0	0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
				Total Key Personnel	**0**		**0**	**0**	**0**	**0**

B. Other Personnel *(Sub-recipient's employees only.)*

Name/Position	Project Role	Number of Hours	Direct Hourly Rate	% Time Allocated to Project	Subtotal Direct Labor	Fringe Benefit % of Direct Labor	Subtotal Fringe Benefits	Total	Award	Cost Share
Assistant Professional 1	Project Support	314.00		10.1%	0	50.00%	0	0	0	0
Assistant Professional 2	Field Testing	720.00		23.1%	0	50.00%	0	0	0	0
Word Processing	Document Formatting	56.00		1.8%	0	50.00%	0	0	0	0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
				Total Other Personnel	**0**		**0**	**0**	**0**	**0**

† PI and co-PIs that are not Sub-recipient's employees must **NOT** be listed here. Describe their project roles and responsibilities in the Budget Narrative under ***Category F, Subcontracts***.

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): San Francisco Public Utilities Commission
PI Name: Paula Kehoe and Manisha Kothari
Project Title: Building-Scale Treatment For Direct Potable Reuse & Intelligent Control For Real Time Performance Monitoring
Preparation/Revision Date: 7/10/2016
RFP # (if applicable): RFP #

C. Equipment Rental and Special Equipment Purchase

Equipment Rental (*List items and dollar amount for each item exceeding $1,000)*	Total	Award	Cost Share
GE MF/UF Skid (5 months)	0	0	0
GE RO Skid (5 months)	0	0	0
			0
			0
			0
Total Equipment Rental	**0**	**0**	**0**

Special Equipment Purchase *(List items and dollar amount for each item exceeding $5,000)*	Total	Award	Cost Share
Membrane Operation and Maintenance Services	0	0	0
Analyzers (turbidity, TOC, e. coli , UVA, total and free chlorine)	0	0	0
Trojan UV Unit	0	0	0
			0
			0
Total Special Equipment Purchase	**0**	**0**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): San Francisco Public Utilities Commission
PI Name: Paula Kehoe and Manisha Kothari
Project Title: Building-Scale Treatment For Direct Potable Reuse & Intelligent Control For Real Time Performance Monitorin
Preparation/Revision Date: 7/10/2016
RFP # (if applicable): RFP #

D. Materials and Supplies	Total	Award	Cost Share
			0
			0
			0
			0
			0
			0
			0
			0
Total Materials and Supplies	**0**	**0**	**0**

E. Travel	Total	Award	Cost Share
			0
			0
			0
			0
			0
			0
			0
			0
Total Travel	**0**	**0**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): San Francisco Public Utilities Commission
PI Name: Paula Kehoe and Manisha Kothari
Project Title: Building-Scale Treatment For Direct Potable Reuse & Intelligent Control For Real Time Performance Monitorin
Preparation/Revision Date: 7/10/2016
RFP # (if applicable): RFP #

F. Subcontracts	Total	Award	Cost Share
RMC and Data Instincts - Outreach	115,968	115,968	0
Carollo Engineers			0
			0
			0
			0
			0
			0
			0
Total Subcontracts	**115,968**	**115,968**	**0**

G. Other Direct Costs	Total	Award	Cost Share
Analytical Analysis	84,032	84,032	0
Additional Equipment	0	0	0
			0
			0
			0
			0
			0
			0
Total Other Direct Costs	**84,032**	**84,032**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): San Francisco Public Utilities Commission
PI Name: Paula Kehoe and Manisha Kothari
Project Title: Building-Scale Treatment For Direct Potable Reuse & Intelligent Control For Real Time Performance Monitoring
Preparation/Revision Date: 7/10/2016
RFP # (if applicable): RFP #

H. Indirect Costs *(Attach copy of federally approved rates or detailed basis for rates)*

Cost Category	Rate %	Base $	Total	Award	Cost Share
A. Key Personnel	126%	0	0	0	0
B. Other Personnel	126%	0	0	0	0
			0		0
			0		0
			0		0
		Total Indirect Costs	**0**	**0**	**0**

I. Fee	%	Base $	Total	Award	Cost Share
			0		0
		Total Fee	**0**	**0**	**0**

J. Survey	Total	Award	Cost Share
Living Machine Data Share	0	0	0
			0
			0
			0
			0
			0
Total Survey Costs	**0**	**0**	**0**

BUDGET NARRATIVE

The SFPUC team is proposing to complete this project in under 2 years (15 months). We estimate that the full $100,000 of the Foundation share of the project will be expended in the first 12 months of the project, with $84,032 being spent on analytical analysis and $115,968 being spent on outreach efforts in conjunction with RMC and Data Instincts. In-kind funding from Data Instincts of $5000 will be spent alongside outreach work applying a $115,968 cash match between the Foundation and SFPUC. The total Foundation project cost amounts to $205,000.

Primary Contractor Budget Justification – SFPUC

Salaries and Wages

Salary and wages for SFPUC employees participating in this project will be covered by separate SFPUC funds.

Materials and Supplies

No materials are expected as part of this proposal for SFPUCs portion of the work. Materials for analytical analysis and pilot testing will be covered by separate SFPUC funds.

Travels

Travel costs, if necessary, will be donated in-kind to the project from all team members.

Subcontract

SFPUC will enter into a subcontract with two entities. The subcontracts include Carollo Engineers (Carollo) for $84,032 and RMC and Data Instincts for $115,968. Carollo will be provided cash funds after being awarded money to SFPUC to manage all project details. Analytical work and costs will be coordinated by Carollo with cash allocation from SFPUC.

See below (Subcontractor Budget Justification) for a detailed description of these costs.

Other Direct Costs

All direct costs will be covered by RMC and Data Instincts and Carollo Engineers with funding allocated by SFPUC and WRF.

Indirect Costs

No indirect costs are expected for this project.

Subcontractor Budget Justification

Carollo Engineers

Salaries and Wages (N/A)

Salary rates for all Carollo project team members will be covered by separate SFPUC funds.

Fringe Benefits

N/A

Equipment Purchase and Rental (N/A)

SFPUC will be covering the equipment costs associated with the project by separate funds.

Materials and Supplies

No materials and supplies are expected beyond those lumped into the analytical analysis fees.

Travel

Any necessary travel costs for Carollo will be covered internally by Carollo.

Other Direct Costs (N/A)

Any additional direct costs are to be covered with separate funding from SFPUC.

Indirect Costs

Indirect costs associated with Carollo salary rates will be covered with separate funding from SFPUC.

RMC/Data Instincts

Direct Costs (Total: $115,968)

RMC/Data Instincts will be responsible for the majority of the public communication and outreach portion of the project. The $119,968 project value will be covered by $115,968 of WRF cash funding, with $5,000 of additional in-kind work from RMC/Data Instincts. RMC AND Data Instincts will be responsible for developing online materials, hard copies of materials, creating a virtual tour of the pilot, a digital wall, and developing and distributing educational materials. All time, travel expenses, materials, and supplies will be covered by this lump sum fee, listed as a direct cost to the project.

Indirect Costs

No indirect costs for the project.

Equipment Rental

No equipment rentals are expected as part of this proposal.

Materials and Supplies

All materials and supplies will be covered in the lump sum direct cost, at the discretion of RMC/Data Instincts.

Travel

All necessary travel will be covered by RMC/Data Instincts lump sum fees.

Additional Funding

WateReuse Research Foundation and SFPUC

Cash Contribution ($224,670)

As part of this tailored collaboration and extensive project, this research proposal was also submitted and approved by the WateReuse foundation for a total cash project cost of $224,670 ($100,000 from WRF and $124,670 from SFPUC). The cash funding will cover additional analytical costs, equipment rental and rental, construction, Carollo salaries and wages, necessary materials and supplies and operation and maintenance for the duration of the pilot. In-kind contributions of $20,530 from Carollo Engineers and $76,300 from SFPUC will contribute to the total WRRF project cost of $321,500.

COMMUNICATION PLAN

The proposed research will benefit the drinking water, wastewater, and reuse industries through demonstration of safe Direct Potable Reuse treatment processes. Regulators, utilities, and the public will have access to both the physical demonstration facility and the analytic results and key outcomes that show the process performance throughout the treatment train. The proposed outreach options to communicate the results of the research include the following:

Periodic Technical Progress Reports

Periodic technical progress reports and a Draft Final Report will be prepared and submitted for ongoing review by the WRF and WRRF, and their respective Advisory Committees. It is estimated that up to six progress reports, occurring every 3 months, will be submitted during the duration of the pilot testing. The reports will be letter-style and will include a summary of the completed activities, activities in progress, and a calculation of the estimated percent of completed work. A Technical Summary, included in each report, will contain sufficient detail for the Foundation and PAC to review the technical findings. The Technical Summary will include descriptions of the materials and methods, results (including tables and figures of data collected to date), and discussion of the results. The reports will also identify areas where delays have occurred and the reason for the delay, planned activities during the next reporting period, and recommendations to get the project back on schedule and/or budget, if necessary.

Conference Presentations

Conference presentations will be used as an interim outreach activity prior to submission of the final report to WRF and WRRF. Several conferences are planned as a forum to disseminate research results to utilities and technical audiences within the reuse industry. The selected conferences for presentation include those targeted to the water reuse industry, such as the annual ACE and WRF conferences as well as WQTC and the WRRF annual conference.

Final Report

This report will be submitted to the WRF and WRRF upon completion of the project. The report will include a description of the research project including research materials and methods, results, discussion, conclusions, and recommendations to meet the objectives for each task outlined in the technical section.

Webcast

Upon completion of the project, the Principal and Co-Principal Investigators will develop and deliver a webcast disseminating the project findings to participants within the water industry, particularly public and private utilities. The key results will be displayed using a PowerPoint presentation. Recommendations and implementation strategies will also be discussed. The webcast will be scheduled within 6 months of the publication of the project report. This webcast will be targeted to both WRF and WRRF subscribers and other stakeholders.

Project Meetings

SFPUC and Carollo will participate in one intermediate project meeting with the Advisory Committees and the WRF/WRRF research managers. Team members may attend via webinar. This meeting will be held at SFPUC's Headquarters and include a visit to the pilot plant site.

PROJECT FUNDING AGREEMENT

(WRRF-16-02)

Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

BETWEEN

THE WATER ENVIRONMENT & REUSE FOUNDATION

1199 North Fairfax Street, Suite 410

Alexandria, VA 22314

and

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

525 Golden Gate Ave, 10th Floor

San Francisco, CA 94102

date

Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

(WRRF-16-02)

Table of Contents

List of Exhibits

I. ADMINISTRATION OF CONTRACT

This Project Funding Agreement (hereafter referred to as the "Agreement") for the Project called ***Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring*** **(WRRF-16-02)** is effective as of the date signed by and between **Water Environment & Reuse Foundation** (hereafter referred to as the "Foundation"), a Virginia nonprofit corporation whose principle place of business is located at 1199 North Fairfax Street, Suite 410, Alexandria, Virginia 22314 and **San Francisco Public Utilities Commission** (hereafter referred to as the "Contractor"), a **water utility** located 525 Golden Gate Ave, 10th Floor, San Francisco, CA 94102.

* * *

The parties hereby agree to the following:

II. DEFINITIONS

For purposes of this Agreement, the terms and definitions detailed below and throughout this Agreement shall control:

A. The term "**Derivative Work**" is defined as a work that is based on any pre-existing written report, study, test result or other work of authorship, and that modifies, transforms, or recasts that pre-existing work so as to create a new or substantially new work.

B. The term "**Educational Purpose**" is defined as use of the Foundation's Intellectual Property that is primarily noncommercial and non-profit in nature including, but not limited to, using the Foundation's Intellectual Property (i) to conduct research, or (ii) to inform the water reuse community, water reuse utility personnel and the general public of the outcome of this Project.

C. The "**Foundation**" shall be defined to include all officers, directors, employees, volunteers, Project Advisory Committees, Research Advisory Committees, affiliates, agents and related entities of the Water Environment & Reuse Foundation.

D. The term "**Foundation's Copyright**" shall be defined as the copyright owned by the Foundation, including, but not limited to, for this Project, all U.S. and worldwide copyrights for all Deliverables as set forth in Exhibit A and all drafts of these Deliverables.

E. The term "**Foundation's Intellectual Property**" shall be defined to include all pre-existing copyrights owned by the Foundation, as well as the Foundation's name, logo and all trade and service marks of the Foundation and the WateReuse Association.

F. The "**Contractor**" shall be defined as **San Francisco Public Utilities Commission** including its trustees, officers, directors, employees and agents.

G. The "**Principal Investigator**" shall be defined as the Contractor's employee or agent, as specifically designated herein, with primary responsibility for ensuring that all terms and conditions of this Agreement are met and to whom Project-related communications, notices and notices of insufficiencies or defaults shall be given by the Foundation.

H. The "**Project**" shall be defined as the work to be completed by the Contractor and any Subcontractors, as defined in Article II, Paragraph K, pursuant to this Agreement and as described more specifically in the

Project Proposal, as discussed in Article II, Paragraph M, and as may be set forth in any attachment or schedule annexed to this Agreement and made a part hereof which is intended to define the scope and nature of the Project.

I. The "**Project Advisory Committee**" or "**PAC**" shall be defined as a group of volunteers assembled by the Foundation to provide technical review, guidance, assistance and expertise to the Foundation during the course of the Project.

J. The "**Project Manager**" shall be defined as the Foundation's employee(s), as specifically designated herein, with responsibility for reviewing all actions undertaken by the Contractor and who has authority to communicate all Foundation decisions concerning the process, procedures, scheduling requirements, funding requirements and deliverables generated by the Contractor.

K. A "**Subcontractor**" shall be defined as any individual or entity, with whom the Contractor has or shall separately contract to complete one or more specific tasks required by the Project and which the Foundation has approved in writing prior to the Contractor's retention of the Subcontractor.

L. The term "**Deliverable**" shall be defined as a written, electronic, or verbal work product that communicates progress, data/results, interpretations, implications, outcomes, and/or application of the Project as defined in Article II, Paragraph H, or any attachment or schedule attached hereto and made a part hereof intended to identify Project Deliverables.

M. The "**Project Proposal**" shall be defined as the initial request by the Contractor for funding and shall include all relevant correspondence and/or other written communications subsequent to that request but prior to the execution of this Agreement.

N. The term "**Subject Data and Information**" shall be defined as all original and raw research data, notes, computer programs or Software, writings, sound recordings, pictorial reproductions, drawings or other graphical representations and works of any similar nature, produced by the Contractor in the performance of its duties and responsibilities under this Agreement, but specifically excluding "Deliverables" as defined in this Article II of the Agreement. Subject Data and Information also excludes financial reports, costs analysis, and similar information incidental to contract administration.

O. The term "**Contractor's Intellectual Property**" shall be defined as the intellectual property owned by the Contractor.

III. AGREEMENT

1. Project Proposal and Scope of Work Document. The Contractor shall diligently and professionally perform research and prepare written reports concerning that research detailed by the Project Proposal attached in Exhibit F and the Scope of Work Document included as Exhibit G.

2. Project Personnel. The Contractor Principal Investigator shall be **Paula Kehoe (415-554-0792 or pkehoe@sfwater.org).** No changes or substitutions for this position shall be made for any reason without the prior written approval of the Foundation including, but not limited to, sabbatical or other extended absences. Further, changes in any essential personnel (co-investigators, subcontractors, etc.) identified in the Project Proposal or in the Budget (Exhibit C), require prior written approval from the Foundation.

The Foundation's Project Manager shall be **Kristan Cwalina** (571-445-5512, or kcwalina@werf.org). The Foundation, however, may change the Project Manager as deemed necessary without the Contractor's approval. All technical, contractual, or administrative communications by the Contractor to the Foundation shall be conducted through the Principal Investigator and shall be directed to the Project Manager.

3. Time of Performance. All Project tasks, reports and other obligations shall be completed by the Contractor in accordance with the schedule of performance detailed in Exhibit B to this Agreement, unless amended by the mutual written agreement signed by authorized representatives of the parties. Contractor shall inform any and all Subcontractors in writing of this clause and the applicability of the Schedule of Performance (Exhibit B) to the Subcontractor prior to the Subcontractor rendering services or working on the Project.

4. Deliverables. The Contractor shall submit all Deliverables as detailed in Exhibit A pursuant to the schedule detailed in Exhibit B. All Deliverables shall follow the Foundation's *Style Guide for Research Reports* as edited and updated unless specifically exempted in Exhibit A. Contractors who are late on any ongoing WRRF sponsored project deliverables without an approved no-cost extension are not eligible to be a named participant in any proposal.

5. Review of all Written Materials and Changes. All Deliverables shall be reviewed and approved by the Foundation and shall be subject to the following:

a. Requirements for a Re-Submission. Whether a new draft is required shall be determined at the sole and reasonable discretion of the Project Manager.

b. Technical Review Response. As the technical review coordinator, the Foundation shall have the right to require the Contractor to respond to the Foundation's technical review of written material, including the PAC review, either by providing explanations of technical information or by responding to reasonable requests for revisions.

c. Publishing Revisions Requirement. As the publisher, the Foundation shall have the right to require grammatical, stylistic or syntax revisions in any versions of technical reports submitted to the Foundation.

d. Timeliness of Review. All review of work by the Contractor by the Foundation shall be done in a timely manner. The Foundation shall provide written comment(s) within sixty (60) days from the date of receipt of the Deliverable(s) from the Contractor unless a delay outside of the

control of the Foundation occurs. In the event of such a delay, the Contractor will be notified and the parties will establish a new deadline.

e. Timeliness of Response. The Contractor agrees to respond to all technical and/or editorial comments made by the Foundation within the time periods detailed on Exhibit B of this Agreement. In the event that the Foundation requests that the Contractor make changes to any document detailed in Exhibit B other than a quarterly Progress Report, the Contractor shall be required to submit another draft of the requested document, with the requested changes, within six (6) weeks of any such request.

6. Compensation.[KC1]

a. Foundation Contribution. The total to be paid by the Foundation to the Contractor for satisfactory and timely completion of the scope of work in accordance with Article III, Paragraph 1 and specified in Exhibits F and G attached hereto and made a part hereof, shall be **One Hundred Thousand Dollars ($100,000)** in United States currency. The compensation shall not exceed this amount.

b. In-Kind Contributions. As a condition of this funding agreement, the Contractor agrees to provide, at a minimum, **YYY Dollars ($YYY)** of in-kind contributions to this Project. All such contributions and their respective values must be detailed in each Progress Report as specified in Exhibit A.

i. Cash Contributions. Of the total Contractor provided in-kind contributions set forth in the paragraph above, **ZZZ Dollars ($ZZZ)** will be cash contributions to this Project in United States currency that shall be provided directly to the Contractor for use in this project. All such contributions must be detailed in each Progress Report as specified in Exhibit A.

ii. Minimum In-Kind Contribution Match. The Contractor is responsible for coordinating, invoicing, and securing all in-kind contributions documented herein. As a part of the Foundation's Tailored Collaboration program, the Contractor agrees to match, at minimum, the amount to be paid by the Foundation. In the event that the Contractor fails to secure and provide the matching amount pledged, the total to be paid by the Foundation to the Contractor in the first paragraph of Article III, Paragraph 6 shall be reduced accordingly.

c. Subcontractor Notification. Contractor shall inform any and all of its Subcontractors of this paragraph and the binding duties and responsibilities imposed herein in writing prior to the Subcontractor rendering services or working on the Project.

7. Payments.

a. Disbursements. All disbursements shall be utilized solely for the purposes detailed by this Agreement. All disbursements to the Contractor shall be mailed to the following address:

Contactor
Street Address
City, State, Zip Code
Attn: [KC2]

b. Invoicing. Subject to the withholding provisions described below, payments shall be based on the timely submission of **monthly** invoices that are consistent with the budget information provided in the quarterly Progress Reports as referenced in Article III, Paragraph 4. The Contractor shall also document in-kind contributions received to date in an invoice to the Foundation. Except as otherwise described in the following paragraph, payment shall be disbursed to the Contractor within forty-five (45) business days following the receipt of the invoice by the Foundation. The final request for payment must reconcile all payments made, costs incurred, and in-kind contributions received.

i. Fiscal Year Considerations. The fiscal year of the Foundation is the same as the calendar year. No invoice may cover a period containing more than one calendar year and all invoices for the previous calendar year must be received within sixty (60) days of January 1.

c. Withholding Provisions

i. Non-Compliance. If the Contractor is not in full and timely compliance with the requirements and schedule for Deliverables as detailed in Article III, Paragraphs 4 and 5, the Foundation shall be entitled to withhold payment until the Contractor corrects such default(s) to the complete and reasonable satisfaction of the Foundation.

ii. Final Milestones. The Foundation shall also withhold the final twenty percent (20%) of the total compensation from disbursement to the Contractor and shall disburse this final twenty percent (20%) only upon the delivery to the Foundation of a satisfactory Draft Report and Final Report as detailed below. The Foundation shall make payments for the first eighty percent (80%) of the total compensation based on the Contractor's invoices and compliance with the Project performance requirements and schedule for deliverables. The Foundation shall make payments for the final twenty percent (20%) based on the following:

1) Acceptable Draft Report. Once the Draft Report is submitted in the format detailed in Exhibit A and accepted by the Foundation, the Foundation shall make payments for up to an additional ten percent (10%) based on the Contractor's invoices.

2) Acceptable Published Report. Once the Final Report is submitted in the format detailed in Exhibit A and satisfactorily completes the Foundation's internal editing process, and once the Contractor has performed all tasks as detailed in this Agreement, including but not limited to, responding to any editorial questions or revisions required by the Foundation concerning the Final Report, the Foundation shall make payments for the second ten percent (10%) based on the Contractor's invoices at the time the report is sent to the printer to become the Published Report.

d. Payment of Subcontractors. Payment for services of any and all Subcontractors retained by the Contractor shall be and remain the Contractor's sole and exclusive financial and legal responsibility. The Contractor hereby agrees that it shall defend, indemnify and hold harmless the Foundation, its officers, directors, employees and volunteers from and against any and all claims, actions, causes of action, damages, liabilities or judgments arising out of or resulting from any contract between the Contractor and Subcontractor or Supplier and payments made or due there under, as well as from any third party claim(s) arising out of or resulting from the

performance of the Subcontractor's or Supplier's services in connection with the Project. This warranty shall survive the termination of this Agreement for any reason.

e. Property/Equipment. No equipment, material, or test apparatus shall be purchased with Foundation funds, nor shall any improvement, modification or construction of real or personal property be made with Foundation funds, unless such purchase or expenditure has been specifically approved in writing by the Foundation's authorized representative.

f. Subcontractor Notification. Contractor shall inform any and all of its Subcontractors of this paragraph and the binding duties and responsibilities imposed herein in writing prior to the Subcontractor rendering services or working on the Project.

8. Accounting. The Contractor shall maintain accurate accounting information and financial records regarding the Project in conformity with generally accepted accounting principles. The Foundation and/or its agents shall have access to such records at any reasonable time during normal business hours during the entire course of this Agreement and for a reasonable period thereafter, defined here as three (3) years. The Contractor agrees to flow down and incorporate this clause and the duties and responsibilities imposed hereunder into any subcontract issued in connection with this Agreement and the Project.

9. Intellectual Property. Intellectual property shall be determined in accordance with U.S. Intellectual Property Laws and the terms and conditions of this Agreement.

a. Foundation's Copyright. The Foundation's primary purpose in funding the Contractor is to further scientific and technological knowledge in the area of research covered by this Project. The Foundation will be the publisher for the Published Report, as defined in Exhibit A, for this Project and any other publishable deliverables specifically identified for this Project in Exhibit A. As the publisher, the Foundation shall retain the copyright to any Deliverables as identified in Exhibit A, and all drafts of those items. The Parties hereto intend that ownership of all Deliverables and copyrights arising out of or resulting from the Deliverables developed under this Agreement shall be exclusively vested in the Foundation (Article II, Paragraph D). In addition:

i. Contractor's Limited License. The Foundation hereby grants the Contractor a limited, revocable, royalty-free, nonexclusive, license to: reproduce; distribute; prepare Derivative Works based upon the Foundation's Copyright developed under this agreement; publicly display; use; and perform the Foundation's Copyright exclusively for Educational Purposes as defined in Article II, Paragraph B above. Such license shall not extend to or include the use of the Foundation's name, logo, or service or trademarks.

iii. Publications and Presentations Utilizing the Foundation's Copyright. The Foundation encourages the Contractor to publish based on this Project and to utilize the Foundation's Copyright exclusively for Educational Purposes as detailed in Article II, Paragraph B. Any publication of Foundation Intellectual Property must comply with the requirements of Article III, Paragraph 9a (1) and (2) above. The Contractor agrees to fully comply with the following steps prior to any such use, distribution, presentation, or publication:

1) Protection of the Foundation's Copyright. The Contractor agrees and understands that it shall not sell, assign, transfer, compromise, dispose of or injure the Foundation's rights to the Foundation's Copyright, including, but not limited to, any computer software, by any presentation or publication of such

property and shall take all steps necessary to preserve the integrity of the Foundation's Copyright and protect such rights of the Foundation.

2) Disclaimer. Any and all publications and presentations utilizing the Foundation's Copyright shall include the following disclaimer:

The comments and views detailed herein do not necessarily reflect the views of the Water Environment & Reuse Foundation, its officers, directors, employees, affiliates, or agents.

3) Copyright Permission. In the event that the Contractor creates a manuscript or presentation for publication containing any amount of the Foundation's Copyright and is required by another publisher to assign its copyright ownership to that manuscript or presentation for publication, the Contractor shall immediately contact the Project Manager directly for further instruction and permission. Such permission will not be unreasonably withheld, conditioned, or delayed, but will require written authorization from the Foundation as well as an explicit acknowledgment and citation in the manuscript or presentation.

b. Contractor's Intellectual Property. Contractor shall have the right to copyright, publish, disclose, disseminate, and use, in whole or in part, Subject Data and Information, as defined in Article II, Paragraph N, developed by Contractor under this Agreement. The Contractor agrees to make available to the public for public benefit, without license or fee, any scholarly articles which are published from or based in whole or in part on the Subject Data and Information.

i. Contractor agrees to cite, credit, and secure permission for any Intellectual Property outside of its ownership. It is the Contractor's responsibility to request and secure any permission required for the use of material created by others, including images and text quotations. It may be necessary for the Contractor to request permission to reprint previously published work, even if revised. As the Author of a work, the Contractor is responsible for complying with copyright laws and laws of privacy and libel.

c. Inventorship. Inventorship shall be determined in accordance with U.S. Patent Laws. Contractor shall grant Foundation an unconditional, perpetual, non-exclusive, irrevocable, royalty-free, worldwide license to make use of Contractor inventions developed under this Agreement for internal, non-commercial research or Educational Purposes.

d. Assignment. To assure the Foundation's ownership of the Foundation's Copyright above, the Contractor hereby assigns all right, title and interest in and to any and all of the documents detailed in Exhibit A to the Foundation, including, but not limited to, the right to apply for registration of any copyright with the United States Copyright Office or similar official repositories world-wide. The Contractor shall execute whatever documents are required in order to comply with this Agreement including, but not limited to, assignments as necessary for any worldwide copyright protection, as well as Exhibit E, the Copyright Transfer Acknowledgement, that is to be included with all Deliverables as specified in Exhibit A.

e. Student Thesis. In the event a college or graduate student is employed by Contractor to work on the Project contemplated by this Agreement and that student completes a thesis, dissertation or report relating to this Project, solely for Educational Purposes, the student shall own the copyright in that thesis or report. In the event a portion of the Foundation's Copyright is included in that thesis or report, the Foundation hereby grants the student a limited, revocable, nonexclusive

license to utilize the Foundation's Copyright for the specific thesis, dissertation, or report only, conditioned upon the inclusion of an appropriate acknowledgement of the Foundation's ownership of the Foundation's Intellectual Property included within the thesis, dissertation or report.

f. Contractor's Acknowledgment. Any public presentation or publication by the Contractor, including a student writing a thesis, dissertation, or report, based on the Project, shall include the following, or a similar, statement acknowledging the Foundation for providing financial and administrative support:

The [Contractor] gratefully acknowledges the Water Environment & Reuse Foundation's financial, technical, and administrative assistance in funding and managing the project through which this information was discovered, developed, and presented.

g. Subcontracts. The Contractor agrees to flow down and incorporate the binding provisions of Article III, Paragraph 9 (a) through (h) inclusive, into any subcontract entered into in connection with and related to this Agreement. All subcontracts shall include provisions acceptable to the Foundation and necessary to implement the provisions of Article III, Paragraph 9 (a) through (h) inclusive.

10. Publicity, Press Releases, and Surveys.

a. Publicity Releases. No publicity releases, including news or press releases, advertising, or marketing materials relating to this Agreement and the Project shall be issued by the Foundation, Contractor, or by any Subcontractor without the prior written approval of authorized representatives of the Foundation and Contractor. Such approval will not be unreasonably withheld, conditioned or delayed,

b. Name, Logo, and Service Mark(s) Use. The Foundation and the Contractor each agree that they shall not use the name, logo, or service mark(s) of the other party in any advertisement, press or news release or publicity with reference to this research Agreement or any product or service resulting from this research Agreement, without prior written approval of an authorized representative of the other party.

c. Coordination of Response. Any inquiry the Contractor receives from news media concerning this Agreement shall be promptly referred to the Foundation for coordination of an appropriate and Foundation-approved response.

d. Surveys and Questionnaires. Any and all questionnaires and/or survey instruments to be used in this Project must be submitted to the Foundation for review and approval prior to distribution.

e. Subcontractor Inclusion. The Contractor agrees to flow down and incorporate the binding provisions of Article III, Paragraph 10 (a) through (e), inclusive, into any subcontract entered into in connection with or related to this Agreement.

11. Accuracy of Testing. The Contractor shall use its best efforts to ensure that all data, information and documentation developed pursuant to and during the course of this Agreement and that the data, information and beliefs included or relied upon in the Project are accurate to the best of its knowledge and belief. Environmental measurements shall be made in accordance with recognized quality assurance protocols, where applicable. In the event the Contractor obtains any data or information derived from such data, or other information to be included in the Project from in-kind or funding contributors, any Subcontractor, or any other source, the Contractor shall utilize its best efforts to ensure the quality and accuracy of this information. The Contractor agrees to flow down and incorporate the binding provisions of this clause into any subcontract entered into in connection with or related to this Agreement.

12. Originality. The Contractor shall warrant that it is the sole creator and originator of all the Foundation's Copyright developed as a Deliverable under this Project and any Contractor's Intellectual Property developed under this Project as defined herein and that none of those rights and/or any interest in the same have been bargained, assigned, transferred, sold, or conveyed in any other manner to any person or entity, except as detailed and permitted by this Agreement. Further, the Contractor shall use its best efforts to ensure that no portion of the Deliverables developed pursuant to this Project infringes upon the Intellectual Property rights of any other person or entity or violates the common law or statutory right, title, or interest of any person or entity. The Contractor agrees to flow down and incorporate the binding provisions of this clause into any subcontract entered into in connection with or related to this Agreement.

13. Termination.

a. Ordinary Termination. This Agreement, except for those provisions which by their own terms survive the termination hereof or extend beyond the life of this Agreement, shall terminate upon the Foundation's written acknowledgement of receipt and approval for publication of the Final Report and the completion of all scheduled events and Contractor duties and responsibilities as set forth in Exhibit B attached hereto and made a part hereof.

b. Mutual Termination. This Agreement may also be terminated if both parties agree in writing, signed by authorized representatives of both parties, that the Project is no longer practical or feasible.

c. Failure Termination. This Agreement may be terminated by the Foundation if the Contractor has breached or failed to comply with a material term(s) and/or condition(s) of this Agreement and has failed to cure or correct the same within thirty (30) days of the date of the Foundation's written notification to the Contractor setting forth the nature and extent of the failure of compliance or breach.

d. Funding Partner Termination. This Agreement may be terminated by a Party if the funding identified by the Foundation for this Project from the **[Insert Funders Here]** –is canceled or the Foundation receives a notice to stop work from the Project funders. In the event of such termination, the duties and responsibilities of the parties to one another shall terminate.

e. Subcontractor Notification. Contractor shall inform and notify in writing any and all Subcontractors of the binding nature of the duties and responsibilities of this paragraph prior to the Subcontractor working on the Project in any manner.

14. Return of Property. In the case of early termination for any reason, the Contractor shall return any and all property, documents and data owned by the Foundation prior to the execution of this Agreement which were being utilized for the specific purpose of the research conducted in accordance with the Scope of Work Document attached as Exhibit G incorporated in this Agreement, including, but not limited to, all

Foundation's Copyright and any other Foundation's proprietary or confidential information, data, or documentation. Contractor may keep one (1) copy of any of the Foundation's Copyright developed under this Agreement by the Contractor for this Project for archival purposes only.

15. Survival. The duties and responsibilities set for in and/or imposed under this Agreement to protect the parties' respective Intellectual Property rights and proprietary and confidential information, data and documents shall continue throughout this Agreement and shall survive the termination or expiration for any reason.

16. Indemnification and Liability

a. Foundation Indemnification. Foundation agrees to indemnify and hold harmless the Contractor from and against any and all third party claims, actions, causes of action, judgments, liabilities, injuries or damages to persons or property, costs and expenses (including reasonable attorneys' fees) made against the Contractor and arising out of or resulting from the negligent acts, errors or omissions, or intentional or willful misconduct of the Foundation, its officers, directors, employees, and agents, but only to the same extent or limit that the Contractor is permitted by law to indemnify and hold harmless the Foundation, its officers, directors, employees and agents from any third party claims, actions, causes of action, injuries or damages to persons or property, judgments, liabilities, costs and expenses (including reasonable attorneys' fees) made against the Foundation and arising out of or resulting from the negligent acts, errors and omissions, or intentional or willful misconduct of the Contractor, its officers, directors, employees, agent and Subcontractors. In the event of such action brought or claim made against the Contractor and the subsequent undertaking of the indemnification provisions set forth herein by the Foundation, the Contractor shall at all times cooperate fully and in good faith with the Foundation and its counsel in the defense of such claim and shall not settle or agree to settle any such action or claim nor make any admission of fault, liability or damages without the prior knowledge and written consent of an authorized representative of the Foundation.

b. Contractor Indemnification. To the fullest extent permitted by law, Contractor agrees to indemnify and hold harmless the Foundation, its officers, directors, employees, agents and volunteers from and against any and all third party claims, actions, causes of action, judgments, liabilities, injuries or damages to persons or property, costs and expenses (including reasonable attorneys' fees) made against the Foundation and arising out of or resulting from the negligent acts, errors or omissions, or intentional or willful misconduct of the Contractor, its officers, directors, employees, agents and Subcontractors. In the event of such action brought or claim made against the Foundation and the subsequent undertaking of the indemnification provisions set forth herein by the Contractor, the Foundation shall at all times cooperate fully and in good faith with the Contractor and its counsel in the defense of such claim and shall not settle or agree to settle any such action or claim nor make any admission of fault, liability or damages without the prior knowledge and written consent of an authorized representative of the Contractor. At all times, all obligations performed by Contractor pursuant to this Agreement shall be performed in a manner consistent with reasonable standards of care and performance governing such services.

c. Subcontractor Inclusion. The Contractor agrees to flow down the indemnification provisions of this Art. III, Paragraph 16 into any and all subcontracts entered into in connection with or related to this Agreement.

i. Subcontractor Modification. In the event that a Subcontractor is an entity prohibited by statute or law from contractually obligating itself to the duty of indemnification, the Subcontractor agrees to be responsible to the fullest extent permitted by law, for any and

all liability, claims, actions, causes of action, judgments, damages or injuries to persons or property, reasonable attorneys' fees and court costs, arising out of or resulting from the negligence, intentional or willful misconduct or breach or failure of performance of a material term, condition, duty or responsibility under this Agreement by the Subcontractor, its officers, directors, employees, and authorized agents.

17. Insurance.

a. Contractor's Insurance The Contractor shall, at its sole cost and expense, maintain a program of self-insurance or in the alternative, current errors and omissions liability and comprehensive commercial general liability insurance, which shall include coverage for libel and slander, copyright and trademark infringement and the negligent actions, errors or omissions of any and all of Contractor's officers, directors, employees, agents and independent contractors and/or Subcontractors in the amount of not less than one million dollars ($1,000,000) per occurrence. Proof of such insurance shall be presented to the Foundation pursuant to the schedule detailed by Exhibit B.

b. Subcontractor's Insurance. In the event the Contractor utilizes Subcontractors during the course of this Project, the Contractor shall obtain proof that such Subcontractors maintain self-insurance or current errors and omissions liability and comprehensive commercial general liability insurance, which shall include coverage for libel and slander, copyright and trademark infringement, and all negligent actions, errors or omissions of any and all of Subcontractor's officers, directors, employees, agents and independent contractors in the amount of not less than one million dollars ($1,000,000) per occurrence. Proof of such insurance for the Subcontractors shall be presented to the Foundation pursuant to the schedule detailed by Exhibit B. The Contractor agrees to flow down and incorporate the binding requirements and provisions of Article III, Paragraph 17 a. and b. into any subcontract issued in connection with the performance of this Agreement and the Project.

18. Worker's Compensation. The Contractor shall, at its sole cost and expense, maintain Worker's Compensation insurance which complies with the applicable state laws. Proof of such insurance shall be presented to the Foundation pursuant to the schedule detailed by Exhibit B. In the event the Contractor utilizes Subcontractors during the course of this Project, the Contractor shall obtain proof that such Subcontractors maintain current Worker's Compensation as required by the applicable state laws, which proof shall also be provided to the Foundation. The Contractor agrees to flow down this clause into any subcontract issued hereunder.

19. Breach/Damages. The specific remedies detailed in this Agreement shall not operate as a waiver of any and all other rights and remedies available to the Foundation at law or equity. In the event the Contractor fails to comply with or breaches a material term or condition of this Agreement, or one of the Contractor's Subcontractors fails to comply with or is in breach of a material term or condition of its agreement with the Contractor, and thus causes a breach of this Agreement and/or damages to the Foundation, the Foundation may, in its sole and absolute discretion, remove the Contractor, or where applicable, the Subcontractor, from eligibility for receiving any and all funding for future research projects. Contractor shall inform any and all Subcontractors of the binding nature of the terms and conditions of this Paragraph 19 prior to the Subcontractor being retained and performing any service or work related to this Agreement and the Project.

20. Equal Opportunity. The Foundation is an equal opportunity employer and, as such, does not discriminate on the basis of age, sex, race, religion, color, national origin, physical or mental disability or veteran status. Upon execution of this Agreement, the Contractor agrees to: (a) support the policy of not

discriminating on the basis of age, sex, race, religion, color, national origin, physical or mental disability, or veteran status and requires all Subcontractors to support this policy; and (b) abide by all laws, rules, and executive orders governing equal employment opportunity. The Contractor also agrees to make available to the Foundation, upon reasonable request, proof of its efforts to comply with this Paragraph. The Contractor agrees to flow down and incorporate the binding requirements/provisions of this clause into any subcontract entered into by the Contractor and issued hereunder.

21. Relationship of the Parties. The Parties agree that the Contractor is and shall at all times remain an independent contractor with respect to the Foundation. Nothing in this Agreement shall be construed or implied create a partnership, joint venture or employment relationship between the Parties. Any and all relationships created relating to Subcontractors shall be between the Contractor and such Subcontractors only, and shall not create any relationship, contractual, employment or otherwise, between such Subcontractor(s)and the Foundation. Contractor shall inform any and all Subcontractors of the binding nature of the terms and conditions of this Paragraph 21 prior to the Subcontractor being retained and performing any service or work related to this Agreement and the Project.

22. Modification in Writing. This Agreement shall not be modified, supplemented or amended, nor may any term or provision be waived or discharged, including this particular Paragraph 22, except in writing, signed and executed by authorized representatives of both parties. Any modification must be executed by both the Foundation and the Contractor to be effective. Contractor shall inform any and all Subcontractors of this Paragraph prior to the Subcontractor working on the Project in any manner.

23. Transferability. This Agreement and/or the duties, responsibilities and obligations imposed hereunder shall not be assigned or transferred by the Contractor without the prior written authorization of an authorized representative of the Foundation. Contractor shall inform any and all Subcontractors of the binding nature of requirements/provisions of this Paragraph 23 prior to the Subcontractor being retained and performing any service or work related to this Agreement and the Project.

24. Exhibits. All Exhibits attached hereto and made a part of this Agreement are hereby incorporated by reference and agreed upon by the parties. In the event a conflict occurs between the terms of any Exhibit and this Agreement, the terms of this Agreement shall control. Contractor shall inform any and all Subcontractors of the binding nature of the requirements/provisions of this Paragraph 24 prior to the Subcontractor being retained and performing any service or work related to this Agreement and the Project.

25. Authority. The individuals executing this Agreement on behalf of their respective parties hereby represent and warrant that they have the right, power, legal capacity, and appropriate authority to enter into this Agreement on behalf of the entity for which they sign below.

26. Governing Law. This Agreement shall be governed by and construed in accordance with the laws of the Commonwealth of Virginia, excluding choice of law provisions. The Contractor agrees to flow down and incorporate the binding terms and conditions of this Paragraph 26 into any subcontract entered into by the Contractor in connection with this Agreement and the Project.

27. Subcontractor Acceptance of Agreement. The Contractor shall execute a signed statement, as detailed by Exhibit D, certifying that any and all Subcontractors have executed a written, reviewable agreement with the Contractor confirming the Subcontractor's agreement to be bound by and comply with the provisions of this Agreement that flow down and are binding upon the Subcontractor in the performance of its services in connection with this Agreement and the Project.

a. Subcontractor Compliance: Contractor shall require any and all Subcontractors to fully comply with the following Paragraphs of Article III of this Agreement in the performance of their services or work rendered in connection with this Agreement and the Project, and the Contractor agrees to flow down and incorporate the binding terms and conditions of the following paragraphs of Article III into any subcontract entered into by the Contractor in connection with this Agreement and the Project:.

8. Accounting;
9. Intellectual Property;
10. Publicity, Press Releases, and Surveys.
11. Accuracy of Testing;
12. Originality;
16. Indemnification and Liability;
17. Insurance;
18. Workers Compensation;
20. Equal Opportunity; and
26. Governing Law.

b. Subcontractor Awareness: Contractor shall inform and provide any and all retained Subcontractor(s) with copies of all Exhibits to this Agreement, as well as disclose to the Subcontractor(s) the binding application and nature of the following Paragraphs of Article III of this Agreement between the Contractor and the Foundation prior to the Subcontractor being retained and performing services or work on the Agreement and Project:

3. Time of Performance;
6. Compensation;
7. Payments;
13. Termination;
19. Breach/Damages;
21. Relationship of the Parties;
22. Modification in Writing;
23. Transferability; and
24. Exhibits.

IN WITNESS WHEREOF, the parties have caused this Agreement to be duly executed as of the day and year as indicated below.

WATER ENVIRONMENT & REUSE FOUNDATION	SAN FRANCISCO PUBLIC UTILITIES COMMISSION
By: Melissa L. Meeker	By:
Title: Chief Executive Officer	Title:
Federal I.D. #:	Federal I.D. #:
Date:_____	Date:_____

Exhibit A
Project Deliverables
Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02)

For purposes of this Agreement, the following items detailed below will be completed and delivered by the Contractor to the Project Manager pursuant to the schedule in Exhibit B. All Deliverables shall follow the Foundation's *Style Guide for Research Reports* as edited and updated unless specifically exempted. Upon submission, any Deliverable and all drafts shall become the Foundation's sole and exclusive Copyright.

A. Progress Reports. A "**Progress Report**" shall be defined as a report that is a written summary submitted **quarterly** throughout the Project by the Contractor to the Foundation pursuant to the schedule detailed in Exhibit B and including details pursuant to Exhibit A. All Progress Reports shall include status, budget, and outreach information. Progress Reports shall provide sufficient information to allow the PAC and Foundation staff to evaluate, at their reasonable discretion, the progress and quality of the work completed. The Contractor shall submit all Progress Reports to the Foundation's Project Manager on or before the due date specified in Exhibit B. If the PAC and/or Foundation staff determine that a Progress Report lacks sufficient detail and information to allow the PAC and Foundation staff to, at their sole discretion, properly evaluates the progress and quality of the work completed, a new Progress Report shall be required as per Article III, Paragraph 5.

(i) Progress Report Format A Progress Report template is available for download on the Foundation website. If this template is not used, the Progress Report shall follow the format:

1. Title Page: Shall include: Project Title and number; Contractor, Principal Investigator(s) and affiliations if different from Contractor; participating utilities and other organizations; Progress Report number (1, 2, ...etc.); and date.

2. Quarterly Brief: 250-500 word summary (maximum one (1) page) of the Progress Report status and findings, suitable for posting on Foundation website/distribution. When possible, include applicability of results to the water reuse or desalination industry.

3. Response to Foundation's comments on previous progress report

4. Status Summary: The purpose of the status summary in the Progress Report is to record the work completed and document the execution of the tasks and activities described in this Agreement. The report must be sufficiently detailed to allow the Foundation to monitor the Contractor's performance on the Project. The status summary shall include: tabular or graphic summary of progress; summary of tasks completed; list of accomplishments to date; problems encountered in this reporting period; rationale of proposed change (if any) to the scope of work; and proposed tasks to be completed in next quarter.

5. Technical Review: The technical review shall include a description of all work performed during the reporting period, including: methods and materials, data and analysis, and significant findings and relevance (use appendices for extensive data or supporting information).

6. Budget Summary: The budget summary is not an invoice. This section shall report all expenses cash or in-kind services including: an updated Exhibit C from this Agreement; summary of expenditures versus Tasks for the reporting period and for the project to date; and a reporting of in-kind services for the reporting period and the project to date (this must also be reported in invoices).

7. Outreach Summary: This shall include a summary this period's outreach (publication, presentation, article, etc) as well as a running list of citations in the format specified by the *American Chemical Society* of the outreach from previous Progress Reports. When practical, a copy of the outreach material for the period should be included. Any outreach conducted by the project team should be included with a full citation.

B. Project Profile. The "**Project Profile**" shall be defined as a profile that may be edited and formatted for inclusion in the Foundation's outreach and publicity material, or for public release by the Foundation. The profile will be used to create a two page Project Synopsis, which the PI will be expected to review. The profile shall include a clearly identified section explaining the practical benefits and applicability of the Project results to the water reuse/desalination industry. The Contractor shall submit the Project Profile to the Project Manager on or before the due date specified in Exhibit B in the format as detailed by Exhibit A.

(i). Project Profile Format. A Project Profile template is available for download on the Foundation website. If this template is not used, the Project Profile shall follow the format:

Section 1. Basic Project Information: Project number and title, Principal Investigator(s) and affiliations, participating agencies, and keywords for this project.

Section 2. Plain Language Summary: **Project Objectives** (75 word max), **Project Introduction/Rationale** (75 word max, Provide background information on the project and explain why the topic of the project is important.), **Research Approach** (100 word max, Describe the research approach for this project.), **Key findings, Conclusions, and Benefits to Subscribers/industry** (250 word max, Describe the results/ findings of the research. Include how the finding impact Subscribers and advance the reuse/desalination industry.

Section 3. Project Closeout Information: Future Recommendations (Provide recommendations for topics of future study or descriptions of future research projects suggested by the results of this study.), **Project Outreach** (List all outreach activities that have been produced due to the funding of this project; please use full ACS style citations for all outreach items or activities.), and a **Final accounting of all in-kind cash and services provided over the course or the project and a full list of all funding partners.**

C. Draft Report. The term "**Draft Report**" shall be defined as a written report detailing the conduct and outcome of the entire Project submitted by the Contractor to the Foundation pursuant to the schedule detailed in Exhibit B. The Draft Report shall be a polished document ready for publication if the reviewers have no comments. The Draft Report shall follow the Foundation's *Style Guide for Research Reports* as edited and updated. Additional drafts of this report shall be required by the Foundation in order to address the Foundation's comments and questions, as per Article III, Paragraph 5. The Contractor shall submit an electronic copy of the entire Draft Report to the Project Manager in a single Microsoft

Word file pursuant to the schedule detailed in Exhibit B. Included with the Draft Report must be all the necessary licenses for items whose copyright is not owned by the Water Environment & Reuse Foundation, including permission to reprint any figures or tables copied from other publications. In the event the reviewers provide feedback, the Contractor shall promptly consider such feedback and either incorporate the feedback into any Revised Draft Report, or the Contractor must respond directly in writing detailing the reasons why the feedback was not or could not be incorporated. A part of this Deliverable shall be a fully executed copy of Exhibit E, Assignment of Copyright to the Water Environment & Reuse Foundation, filled out for the Deliverable.

D. Revised Draft Report. The term **Revised Draft Report** shall be defined as a revision of the Draft Report. The Contractor shall submit an electronic copy of the entire Revised Draft Report to the Project Manager in a single Microsoft Word file pursuant to the schedule detailed in Exhibit B. The Contractor shall include any and all the explanations and revisions requested or required by the Foundation pursuant to Article III, Paragraph 5 of this Agreement. In the event the reviewers provide feedback, the Contractor shall promptly consider such feedback and either incorporate the feedback into any additional Revised Draft Report, or the Contractor must respond directly in writing detailing the reasons why the feedback was not or could not be incorporated. The Foundation Reserves the right to require more than one Revised Draft Report if the reviewers and the Foundation do not deem the first Revised Draft Report acceptable and suitable for publication. If more than two Revised Draft Reports are required, a schedule extension will be considered and will need to be approved in writing by both parties. A part of this Deliverable shall be a fully executed copy of Exhibit E, Assignment of Copyright to the Water Environment & Reuse Foundation, filled out for the Deliverable.

E. Final Report. The "**Final Report**" shall be defined as the Revised Draft Report that the reviewers and the Foundation deem acceptable and suitable for publication. The Contractor shall provide an electronic copy of the Final Report to the Project Manager in Microsoft Word, pursuant to the schedule detailed in Exhibit B. A part of this Deliverable shall be a fully executed copy of Exhibit E, Assignment of Copyright to the Water Environment & Reuse Foundation, filled out for the Deliverable.

F. Published Report. The "**Published Report**" shall be defined as the Final Report submitted to a technical editor and reviewed by the staff. The Contractor will submit to all editorial queries and requested changes as per Article III, Paragraph 5.C. of this Agreement. The Foundation reserves the right to determine which process, including digital publication, hardcopy publication, or methods currently unknown, shall be used to publish the Final Report.

G. Response to Copyeditor Queries. The **"Response to Copyeditor Queries"** shall be defined to be a response prepared by the Contractor for the Foundation prior to the "Published Report" but after the "Final Report". The Contractor will respond to any and all requests by staff, copyeditor, or other interested partied to make grammatical or stylistic fixes, or to fill in missing information.

H. Post-Project Update Report.

1. **Accomplishments and Applicability**
    a. What has been accomplished since the submittal of the Final Report? How have the Project findings/results of the Final Report been applied/implemented (e.g., regional application of results, pilot study results used for full-scale implementation, additional research performed, impacts on regulations/legislation, technical advances, etc.)?
    b. Discuss new information obtained during this reporting period, and how this knowledge will further future efforts.
    c. If applicable, provide additional data obtained since the submittal of the Final Report (e.g., pilot project water quality data, etc.).
2. **Next Steps**

a. Describe specific plans, if any, for continuing work on this Project or related projects.

Optional Deliverables (upon Request by the Foundation):

I. Proof of Submission to World Water. Upon request, the Contractor shall prepare document or other suitable submission based on work completed under this Agreement for consideration to be included in the publication "World Water: Water Reuse & Desalination". The Contractor should review the policies of "World Water: Water Reuse & Desalination" and create an item based on the Project in the proper format that would be of interest to the readership of "World Water: Water Reuse & Desalination". The Contractor shall send the Project Manager some proof that the item was submitted to the publication by the due date detailed in Exhibit B. This item is specifically removed from the Foundation's Copyright and does not need to follow *Style Guide for Research Reports*.

J. Webcast. The Contractor may be invited to present a webcast on project findings and relevance for the industry for the Foundation's webcast program. Webcasts are online, real time presentations (2-4 presenters) lasting 60-90 minutes including 15 minutes for questions from the audience.

Exhibit B
Project Schedule[KC3]
Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02)

The Start Date for this Project is the Date of Execution (DOE) of the Project Funding Agreement. The due dates will be calculated based on third column below if the DOE is after July 1, 2016.

Deliverable or Action	Due Dates based on 7-1-2016 Project start	Time Due After DOE
Begin Project	DOE	DOE
Contractor presents Proof of Insurance(s) or Certificate of Self Insurance (III.17)	7/1/2016	30 Days
Contractor presents Proof of Worker's Compensation Insurance (III.18)	7/1/2016	30 Days
Foundation receipt of all Subcontractors Agreement Certifications (III.27)	7/1/2016	30 Days
Progress Report Number 1(Exhibit A)	10/15/2016	3.5 Months
Progress Report Number 2	1/15/2017	6.5 Months
Progress Report Number 3	4/15/2017	9.5 Months
Progress Report Number 4	7/15/2017	12.5 Months
Draft Report (Exhibit A)	**10/1/2017**	**15 Months**
Revised Draft Report (Exhibit A)	1/1/2018	18 Months
Proof of Submission to a Selected World Water (Exhibit A, upon request)	1/1/2018	18 Months
Project Synopsis and Profile (Exhibit A)	1/1/2018	18 Months
Final Report (Exhibit A) and Execution of Assignment Documents for Foundation Intellectual Property (III.9.d)	4/1/2018	21 Months
Webcast Presentation (Exhibit A, upon request)	5/1/2018	22 Months
Response to Copyeditor Queries (Exhibit A)	8/1/2018	25 Months
Post-Project Update Report	10/1/2018	27 Months
Completion Date (III.13) and Published Report (Exhibit A)	**10/1/2018**	**27 Months**

Exhibit C
Project Budget
Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02)

[EXAMPLE, an Excel template will be provided upon request]

Any changes in budget line item(s) as described in Exhibit C of whichever is greater, ten percent (10%) of the line item or one thousand dollars ($1,000), must be approved in writing by the Foundation.

					In-Kind		WateReuse	Total
Personnel (Prime Contractor)					**Services**	**Cash**	**Cost**	**Cost**
Name	**Project Role**	**Hours**	**Rate ($/hour)**	**Fringe Benefits**				
John Doe	PI	0	$0.00	$0.00	$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Other Direct Costs								
Equipment								
					$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**		**$0.00**	**$0.00**
Supplies								
					$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Subcontracts								
					$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Disadvantaged Business								
					$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Travel								
					$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Other Costs								
					$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**
				Total Direct Cost	**$0.00**	**$0.00**	**$0.00**	**$0.00**
				Total Indirect Cost	$0.00	$0.00	$0.00	$0.00
				Fee (if applicable)	$0.00	$0.00	$0.00	$0.00
				TOTAL	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Third Party Contributions								
					$0.00	$0.00	$0.00	**$0.00**
				Subtotal	**$0.00**	**$0.00**	**$0.00**	**$0.00**
				Grand Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Exhibit D
Subcontractor Agreement Certification
Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02)

The Subcontractor **[Insert name of Subcontractor here]** to **San Francisco Public Utilies Commission** on this Project has a signed agreement with the San Francisco Public Utilities Commission in which it agrees to comply with and be bound by the following Paragraphs of Article III of the Project Funding Agreement between **San Francisco Public Utilities Commission** and the Water Environment & Reuse Foundation prior to working on the Project in any manner:

8. Accounting;
9. Intellectual Property;
10. Publicity, Press Releases, and Surveys.
11. Accuracy of Testing;
12. Originality;
16. Indemnification and Liability;
17. Insurance;
18. Workers Compensation;
20. Equal Opportunity; and
26. Governing Law.

The Subcontractor **[Insert name of Subcontractor here]** has signed an agreement in which it confirms that it has been provided with and reviewed copies of all Exhibits to the Agreement as well as the following Paragraphs of Article III of the Project Funding Agreement prior to working on the Project in any manner:

3. Time of Performance;
6. Compensation;
7. Payments;
13. Termination;
19. Breach/Damages;
21. Relationship of the Parties;
22. Modification in Writing;
23. Transferability; and
24. Exhibits.

CONTRACTOR will return copies of this form signed and dated for each Subcontract.

Subcontractor Name:

Subcontractor Address:

Contractor's Designated Representatives Signature:

_____

Name [Print]:
Title:
Date:

Exhibit E
Assignment of Copyright to the Water Environment & Reuse Foundation
Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02)

In consideration of money paid by the Water Environment & Reuse Foundation towards the Project Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02), an individual/entity whose principal place of business is _____(hereinafter "Assignor"), the Assignor hereby assigns and forever transfers title to the Water Environment & Reuse Foundation (hereinafter "Assignee"), a 501(c)(3) non-profit corporation having its principal business office at 1199 North Fairfax Street, Suite 410, Alexandria, Virginia 22314, all right, title and interest, including the copyright, in the work titled _____ (hereinafter "the Work"). Assignor understands and agrees that Assignee WRRF may make any use of the Work that it deems appropriate, including publishing the Work in print, on a CD-ROM, on the Internet, or in any other media or format.

The term "Work" as used in this Assignment of Copyright, includes all of the Assignor's notes, drafts, memoranda, final drafts and proofs, work sheets, graphic designs and charts and any and all relevant documents related to the Work.

This assignment by the Assignor of all right, title and interest in the Work to the Assignee WRRF is a transfer to the Assignee of the full ownership in and to the Work, including all rights of reproduction, distribution, performance, display and the right to create derivative works.

Assignor warrants that he/it is the sole owner of all such rights in and to the Work; that the Work is original with the Assignor and not in the public domain; that the Work does not violate or infringe any existing copyright; and that the Assignor has full power and authority to enter into this Assignment. The Assignor further warrants that he/it shall defend, indemnify and hold harmless the Assignee, it's officers, directors, employees and volunteers from and against any and all third party claims, actions, causes of action, judgments, liabilities, damages or injuries to persons or property, costs and expenses, including reasonable attorneys' fees, arising out of or resulting from the Assignor's breach of this assignment of copyright, a violation or infringement of copyright, defamation, libel or slander in connection with the Work.

_____ Date: _____
Assignor, by its authorized signatory

_____ Date: _____
Assignee Water Environment & Reuse Foundation
By its authorized signatory

Exhibit F
Project Scope
Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02)

The following materials are incorporated by reference and made a part of this Agreement:

The Request for Proposals, January 5, 2016

Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring Proposal, April 11, 2016

Water Environment & Reuse Foundation Award Memorandum, May 12, 2016

Response Memo to Water Environment & Reuse Foundation Award Memorandum, May 12, 2016

All related subsequent correspondence

Exhibit G
Scope of Work Document as prepared by San Francisco Public Utilities Commission
Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring (WRRF-16-02)

Attached here will be the Scope of Work Document as prepared by the Contractor. The "**Scope of Work Document**" shall be defined as a one page written document that clearly describes the Project scope and the duties and responsibilities of the Contractor. The Scope of Work Document may be an abbreviated derivative work of the Project Proposal with any updates made since. Please include:

- Title
- Team
- Introduction
- Research approach/tasks
- Schedule by task

WATER ENVIRONMENT & REUSE FOUNDATION

WE&RF

MEMORANDUM

Date: May 12, 2016

To: Paula Kehoe, SFPUC

From: Julie Minton, Director of Research Programs

Subject: Acceptance of WateReuse Research Foundation TC Proposal titled *Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring*

Introduction

The WateReuse Research Foundation's Tailored Collaboration (TC) Committee and Board of Directors have recommended that the Foundation accept SFPUC's proposal submitted in April for the above mentioned project. Award of a project is dependent on our negotiation of a contractual agreement acceptable to both parties. The Funding agreement will incorporate the proposal, this memorandum, your response, and subsequent correspondence relating to the project award. The Foundation reserves the right to withdraw this award if we cannot come to agreement within 90 days of your acceptance. The project's Scope of Work document will also be due at the date of execution of the agreement.

Instructions

The Foundation requests that you respond to this memorandum in writing (email is sufficient) stating acceptance of the award. Please address the below recommendations within the scope of work submitted upon agreement execution. If you have any questions please feel free to call me, Julie Minton, at 571-445-5508.

WATEREUSE

WateReuse Research Foundation
Proposal Cover Sheet

RFP # Tailored Collaboration

Title: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Submitting Member: Paula Kehoe

Personnel:

Principal Investigator: Paula Kehoe

Affiliation: San Francisco Public Utilities Commission

Address: 525 Golden Gate Ave., 10th Floor, San Francisco, CA 94102

Phone #: 415-554-0792

E-mail: pkehoe@sfwater.org

Principal Investigator: Manisha Kothari

Affiliation: San Francisco Public Utilities Commission

Address: 525 Golden Gate Ave., 10th Floor, San Francisco, CA 94102

Phone #: 415-554-3256

E-mail: mkothari@sfwater.org

Co-Principal Investigator: Andrew Salveson

Affiliation: Carollo Engineers, Inc.

Address: 2700 Ygnacio Valley Rd., Suite 300, Walnut Creek, CA 94598

Phone #: 925-977-3060

E-mail: asalveson@carollo.com

Total WRRF Funds Requested: $ 100,000

Total SFPUC Cash Contribution: $ 324,670

Other Funding: $100,000

In-Kind Total: $101,830

Total Project Budget: $626,500

ABSTRACT

This proposed research project is intended as a collaborative effort between the SFPUC and WRRF, and potentially other organizations, such as Water Research Foundation (WRF) and the US Bureau of Reclamation (USBR). The SFPUC is seeking equal contribution from WRRF and WRF ($100,000 each), and the budget detailed in this proposal reflects the funding requests. The SFPUC has previously submitted a funding proposal to USBR for $200,000; however, we have not received a response at the time of this submittal. Therefore, the proposed budget assumes that USBR funding is not forthcoming. If USBR funding is made available at a future date, those funds would be used to extend the duration of our demonstration and conduct a power analysis and increase sampling, beyond the current scope. If WRF funds are not available, the project is still viable and the SFPUC remains committed to its implementation. We expect all funding sources to be known in May 2016, before we enter into funding agreements. As a research project intended to provide valuable information to the industry regarding the efficacy and reliability of treatment processes for Direct Potable Reuse (DPR), we value a partnership with WRRF for the credibility it lends to this research, and hope that you will support this project.

Overview and Objectives. DPR starts with raw wastewater and ends with purified water that is protective of public health. This project will use innovative building-scale treatment, proven purification processes, real time online monitoring, and advanced analytical tools to demonstrate water quality and public health protection in real time. The proposed project will help fill an important research gap, providing data on the technical viability of building-scale treatment. We recognize that economic and operational feasibility will also need to be addressed in the future. The advanced purification system for DPR will be sited at the San Francisco Public Utilities Commission Headquarters Building, where an existing Living Machine® System treats the building's wastewater to non-potable reuse standards. After performance data is collected, effluent from the purification treatment train will blended with the living machine effluent for toilet flushing in the building.

Technical Approach and Anticipated Results. The treatment train will use the existing tertiary treatment system, followed by ultrafiltration (UF), reverse osmosis (RO), and ultraviolet light with an advanced oxidation process (UV AOP) to produce purified water. State-of-the-art advanced analytics, including bioassays and non-target analyses, will be used in conjunction with Critical Control Point (CCP) monitoring to prove the safety of the purification facility. Finally, the viability of DPR will be demonstrated while educating the public on the importance and safety of potable water reuse through online and print materials, tours, and presentations proposed as part of this project.

Submitting Organization and Budget. The San Francisco Public Utilities Commission (SFPUC) is submitting this proposal in collaboration with Carollo Engineers. The research effort is being led by Principal Investigators Paula Kehoe and Manisha Kothari at the SFPUC and Co-Principal Investigator Andrew Salveson, PE at Carollo Engineers. A contribution of $100,000 is requested from WateReuse Research Foundation and $100,000 is requested from the Water Research Foundation. The total project budget is $626,500, composed of $324,670 cash contribution from SFPUC, and in-kind contributions totaling $101,830.

UNDERSTANDING OF THE PROBLEM

Advanced treatment of wastewater for direct potable reuse (DPR) is operational at one facility in the United States, the Colorado River Municipal Water District's Raw Water Production Facility in Big Spring Texas. Ongoing research of that facility is demonstrating the production of a high quality water that is protective of public health (Steinle-Darling *et al.*, 2015). These results demonstrated the effective use of multiple barriers for reduction of trace pollutants and pathogens. While providing high quality water, the "Big Spring" facility relies upon monitoring systems designed for indirect potable reuse (IPR) applications. Nationally, the National Water Research Institute (NWRI) recently published a 173-page "how to" document on DPR, titled *Framework for Direct Potable Reuse* (NWRI, 2015). ***Central to this document was the use of precise and accurate monitoring technologies for public health protection in DPR applications.*** Within California, an extensive research program (>$6M), the California DPR Initiative, has been undertaken to define the necessary level of treatment for a DPR project in California, and inform the discussion of DPR nationally. The Division of Drinking Water (DDW) is part of this Initiative, providing third party review of all research as they consider the possibility of regulating DPR in California. Even with the success of "Big Spring," with the development of clear guidelines for safe DPR implementation, and with extensive funding for research, the public and regulatory concern over "unknown unknowns" remains. What is that next pollutant? How do we find it? Are trace levels of pollutants harmful? The State Water Resources Control Board recently conducted an expert workshop to lay the groundwork for tracking down these questions (SWRCB, 2015). ***The expert workshop team recommended the use of non-target analysis (NTA) and bioassays to better grasp the significance of the "unknown unknowns."***

These key research needs, the ability to document real time precise and accurate monitoring technologies and the use of advanced analytics to understand the impact of the "unknown unknowns," are the primary objectives of this proposed research project. There is a secondary value of this project, which is the integration of DPR methodologies into building-scale treatment. Although building-scale treatment would require much more research and evaluation, this project would contribute data to the industry and to regulators that would help inform that future discussion. The proposed project would use the existing constructed wetlands with tertiary treatment that harvests wastewater from the building and treats it to non-potable water reuse standards, and then purify the water to potable standards. The treated water would be tested and then blended with the tertiary treated water for onsite toilet flushing.

In total, the goals of the demonstration are:

- Demonstrate innovative building-scale treatment of wastewater for DPR.
- Procure purification processes that produce potable water in accordance with health criteria established in National documents (NWRI, 2015).
- Use leading edge online analytical techniques to demonstrate the performance of each treatment process.
- Use advanced analytical monitoring to understand the potential impact of unknown trace level pollutants.
- Clearly document the costs of a potential future DPR system for utilities in California.
- Educate regulators and community members about the safety of properly engineered potable water reuse treatment systems.

This ambitious project will span one year, and includes a substantial work effort which is supported by funding from the San Francisco Public Utilities Commission (SFPUC) and Carollo Engineers.

TECHNICAL APPROACH

1.0 Building-Scale Treatment for Non-Potable Water Reuse

This project starts with raw wastewater, harvested from the 13-story, 900 employee SFPUC headquarters building. The advanced, ecologically based tertiary treatment system currently collects and treats wastewater for non-potable reuse inside the structure. The tertiary treatment system can treat a maximum flow of 5,000 gallons per day. As shown in Figure 1, the system consists of primary treatment and flow equalization followed by a wetland system, denitrification, polishing and disinfection and a reclaimed water reservoir. The system has proven capable of treating raw wastewater with a small physical footprint, appropriate to an urban setting.

The value of de-centralized wastewater treatment cannot be overstated. Water can be treated and used within one watershed, eliminating the need for sewers, pump stations, and wasted conveyance energy. Demonstrating advanced purification of the reclaimed water to potable water standards is possible and safe may lead to a radical revolution in the water industry.

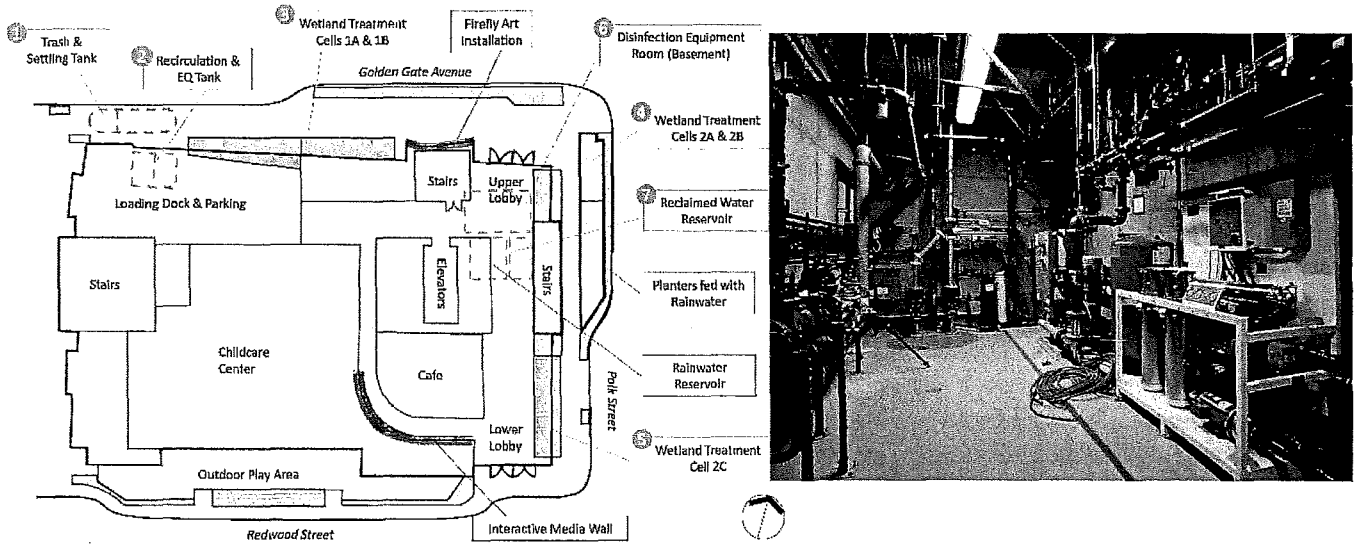


Figure 1. Wetland Treatment Schematic and Photo of Disinfection Room at SFPUC

2.0 Purification Processes for Potable Water Reuse

There are numerous treatment trains that could be used for potable water reuse. Within California, the particular processes that could be employed for this type of project are more limited (CDPH, 2014). In particular, IPR projects in California that include 100 percent purified water (no dilution) and do not benefit from surface spreading (soil aquifer treatment), must have reverse osmosis (RO) and advanced oxidation processes (AOP) within the treatment train. Using these two processes as a starting point, and relying upon the NWRI Framework for Direct Potable Reuse (NWRI, 2015), the purification process proposed for this treatment train are ultrafiltration (UF), RO, ultraviolet light (UV) AOP, and an engineered storage buffer (ESB) with free chlorine during storage (Figure 2, shown on the next page). These processes will provide multiple barriers to both pollutants and pathogens, as shown in Table 1 on

the next page. When coupled together, the proposed processes meet all pathogen and pollutant requirements for potable water reuse as defined by CDPH (2014).

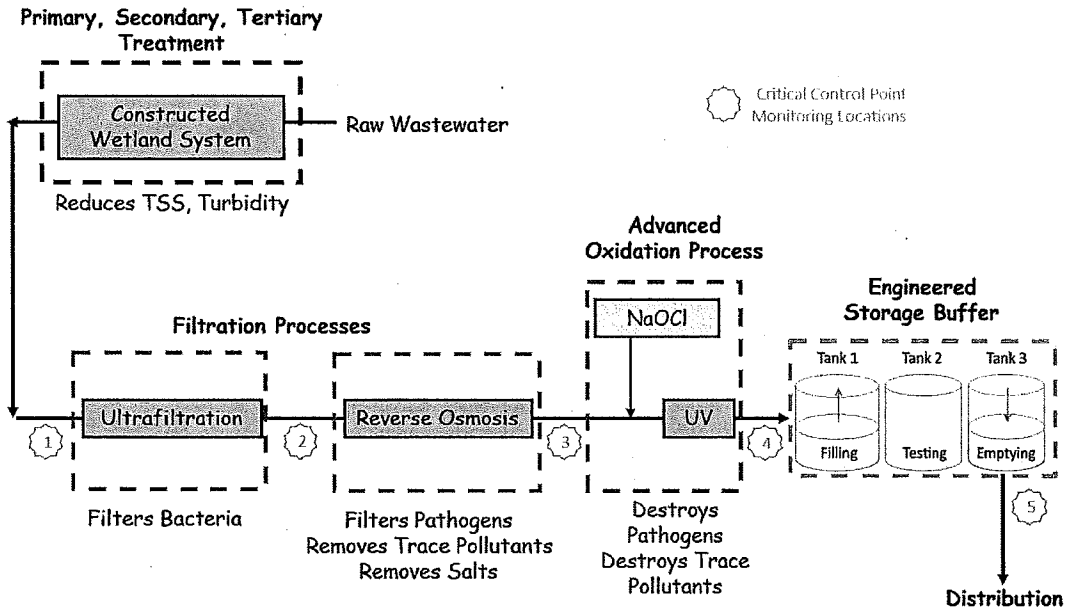


Figure 2. Proposed Advanced Treatment Train for Direct Potable Reuse

Table 1. Use of Multiple Barriers for Purification

	Bulk Organic Removal	Trace Organic Removal	Virus Removal	Protozoa Removal	Bacteria Removal
Primary, Secondary, and Tertiary Treatment	•	•	•	•	•
UF	•	–	–	•	•
RO	–	•	•	•	•
UV AOP	–	•	•	•	•
ESB with free chlorine	–	Partial	•	Partial	•

This proposed treatment train will have online monitoring at critical control points (CCPs), as detailed further on below.

Ultrafiltration

Recent work with Clean Water Services (CWS) (Oregon), as part of DPR demonstration testing, indicates that a well-functioning UF (0.01 µm nominal pore size) can attain 4.7-log reduction of seeded virus (CWS, 2014) without chemical use (such as alum or polymer) ahead of the membrane. Equivalent or greater reduction of protozoa can be assumed based upon this data, and is directly supported by NSF (2012). Furthermore, MF or UF membrane integrity testing (MIT), confirms system performance and

demonstrates how MIT data can be used to track and ensure continued membrane performance (CWS, 2014). Therefore, both MF and UF membranes can be relied upon for 4+ log reduction of protozoa.

Reverse Osmosis

The RO is the primary treatment process that addresses the removal of total dissolved solids (TDS), hardness, and trace levels of organic and inorganic contaminants. The RO trains also help to remove trace organic compounds, total organic carbon (TOC), and pathogens from the tertiary effluent.

Studies have found virus removal by RO to be from 3 to >6-log (Reardon *et al.*, 2005, NRMMC/EPHC/NHMRC 2008, CWS 2014). Equal or greater removal is expected for protozoa. Unfortunately, RO process performance for pathogen rejection is not governed by the ability of an intact membrane to reject pathogens; it is governed by the ability to monitor process integrity (Reardon et al., 2005 and Schäfer et al., 2005). The monitors currently used, electrical conductivity (EC) meters and total organic carbon (TOC) meters, can measure 99 percent or less removal of both parameters through the RO process. Recently, the DDW granted 1.5 log reduction credit for all pathogens for RO (WRD, 2013), based upon a requirement to continuously monitor TOC reduction across RO. Alternative technologies, such as online fluorescent dye monitoring, have been shown to have higher accuracy in assessing membrane efficiency (3+ log based upon new research as part of Water Research Foundation project 4536), with other research showing similar results (Kitis et al., 2003; Henderson et al., 2009; Pype et al., 2013). Using traditional monitoring technology, we recommend using the 1.5-log reduction value for all pathogens for RO at this time.

UV AOP

In the event of pathogens passing through RO, the UV process provides for a high level of disinfection. NDMA, with a DDW notification level (NL) of 10 ng/L, can pass through RO at low concentrations (typically 20 to 100 ng/L), requiring destruction by UV photolysis (Sharpless and Linden, 2003). Therefore, it is common to set the UV dose at 800+ millijoule per square centimeter (mJ/cm^2). This high UV dose photolyzes NDMA as well as many other smaller chemicals that may have passed through the RO train. Adding H_2O_2 before the high dose UV, typically in the range of 3 to 5 mg/L, results in the generation of hydroxyl radicals throughout the UV process. This turns the treatment into an AOP. Hydroxyl radicals are nonselective and break down most chemicals with which they come in contact, destroying a range of trace level pollutants.

At a dose of 800+ mJ/cm^2, as would be applied for this project, the high UV dose will result in 6+ log reductions of all target pathogens (USEPA, 2006; Hijnen et al., 2006; Rochelle et al., 2005), including *Cryptosporidium, Giardia*, and adenovirus. Higher reductions are theoretically possible, but the DDW allows only a maximum of 6-log reduction credits per any one treatment technology (CDPH, 2014).

ESB with Free Chlorine

DPR forgoes the environmental buffer in lieu of an Engineered Storage Buffer (ESB, Tchobanoglous *et al.*, 2011). The ESB would be applied for any DPR application in California.

Eliminating the environmental buffer leads to the loss of several benefits, including contaminant reduction, dilution, and, perhaps most importantly, time to detect and respond to a treatment failure. Recent potable reuse reports suggest that these are limitations that can be overcome. These studies include the WateReuse Research Foundation's 2011 report entitled "Direct Potable Reuse: A Path Forward" (Tchobanoglous et al., 2011), the National Research Council's 2012 report entitled "Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater" (NRC, 2012), the Australian Academy of Technological Sciences and Engineering's 2013 report entitled "Drinking Water through Recycling: The benefits and costs of supplying direct to the distribution system"

(ATSE, 2013), and the WateReuse Research Foundation Project 11-10, Application of Risk Reduction Principles to Direct Potable Reuse (Salveson et al., 2014). They suggest that a higher level of treatment at the Advanced Water Treatment (AWT) facility can compensate for the treatment and dilution provided by the groundwater aquifer or surface water reservoir. The ESB can be designed to provide time to hold and test the treated water to ensure its safety before distribution. No further treatment is added in the ESB (except, perhaps further contact time), and therefore no log-removal credits for pathogens should be expected from this treatment process.

The ESB provides several key benefits over the environmental buffer. For communities without available environmental buffers such as rivers or aquifers (which are often in the most dire need), water reuse is still a possibility with ESBs. Second, ESBs eliminate the need for costly pumps and pipes to and from environmental buffers. Much of the treated water is also lost in the environmental buffer, either washed downstream or dispersed through an aquifer. Finally, advanced treated water is typically higher in quality than groundwater or surface water. Environmental sources can be easily contaminated with runoff and other influences. Keeping the treated water separate from these sources can lower contamination and decrease further treatment costs.

For this project, the ESB would follow the recommendations in Salveson et al. (*in press*) for ESB application. For each unit process and its associated monitoring method, a failure and response time (FRT) is defined. The process FRT is the maximum possible time between when a failure occurs and when the system has reacted such that the final product water quality is no longer affected. The FRT is a sum of the sampling interval, the sample turnaround time (TAT), and the system reaction time, as shown in Figure 3 on the next page. For a unit process monitored by a traditional sampling technique, the sampling interval may range from continuous online monitoring to periodic sampling. In this pilot project, key process monitoring will be done online determine the minimum acceptable FRT for this type of advanced treatment system.

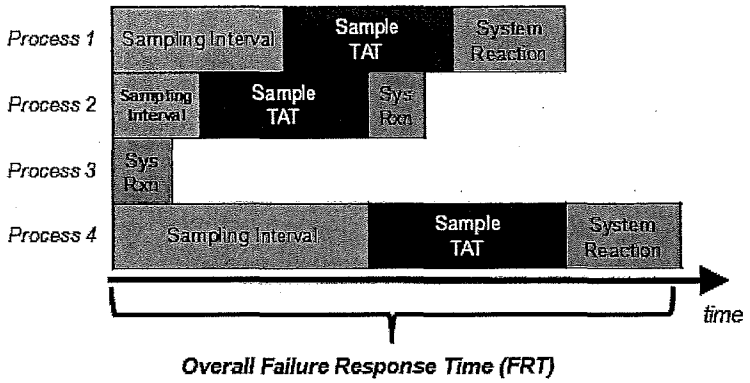


Figure 3. Determination of Failure and Response Time for ESB

In addition to the FRT value of the ESB, the ESB provides for substantial disinfection treatment by free chlorine. A future ESB would have free chlorine dosing and be controlled to maintain a target free chlorine *Ct* sufficient to attain 3-log for *Giardia* and 4-log for viruses, based upon a 4 hour contact time with a 1 mg/L free chlorine residual, with an RO permeate pH of 6. The pathogen credits are based upon the 1990 SWTR Guidance Manual (USEPA, 1990).

3.0 Monitoring Technologies

Conventional potable reuse trains have repeatedly met EPA drinking water standards, as documented by long term compliance with California regulations by the Orange County Water District, among many others. Demonstration testing of similar advanced treatment trains has shown similar performance (CWS, 2014; Trussell, 2013). Emerging pollutants will be evaluated for this project, focusing on the following trace level pollutants:

- A suite of pharmaceuticals and personal care products (PPCPs)
- A suite of perfluorinated compounds (PFCs)
- NDMA
- NDMA formation potential
- THM and HAA formation potential
- Fluorescence

Pathogens will also be evaluated for this project, documenting with grab sampling the pathogen levels after secondary treatment and thus allowing an analysis of sufficient reduction of such pathogens through the purification processes. Pathogens (and surrogate organisms) to be evaluated include: male specific and somatic coliphage, *enterococci, E. coli,* total coliform, *Giardia*, *Cryptosporidium*, enterovirus, and norovirus.

The ability for these processes to produce high quality water in accordance with regulations is not in question. What this project looks to define is the ability to continuously monitor the performance of the advanced treatment systems in real time. This will be done through the use of precise and accurate metering of the critical control points in the purification process. To that end, we have secured the use of two ZAPs LiquID stations to perform such monitoring, as shown in Table 2, on the next page. These parameters will be used to demonstrate process by process performance; as follows:

- **UF** - UF filtrate turbidity and *E. coli* concentrations will closely track UF performance. These continuous measurements will be paired with daily pressure decay test (PDT) results to provide real-time confidence in protozoa and bacteria removal performance.
- **RO** - TOC values collected pre and post RO allow for clear determination of a conservative surrogate for pathogen removal by RO as well as consistent reduction in TOC. TOC values will be paired with online electrical conductivity (EC) to verify TOC performance values.
- **UV AOP** - Destruction of total chlorine across UV systems has now been shown to correlate directly with UV dose, which then correlates directly to pathogen removal and destruction of pollutants such as NDMA (work in press). Free chlorine measurements and UV absorbance (UVA) can be used to develop a "chlorine weighted UV dose," which has recently been shown to correlate directly with destruction of trace pollutants by UV AOP (work in press).
- **ESB** - Free chlorine residual after the ESB will be used to calculate a Ct and show disinfection credit in accordance with EPA standards.

Table 2. Online Real Time Monitoring for Demonstration Project

Measurement	Post UF	Post RO	Pre UV	Post UV
Chloramines	•		•	•
Free Chlorine	•		•	•
E. coli	•			
TOC	•	•		
UVA			•	•
Turbidity	•			

The information from the ZAPs systems will be logged for the duration of the 6-month demonstration and used to evaluate overall reliability in system performance. These values will also be used to monitor system performance remotely, available 24/7/365.

The research will take one further step, the investigation of the "unknown unknowns." While hundreds of chemicals have been detected in water, thousands more likely occur at very low concentrations but have not yet been detected. Chemical surrogates and indicators are often used to gauge the efficacy and efficiency of a particular treatment process and/or multibarrier train (Yu et al., 2015; Merel et al., 2015; Anumol et al., 2015; Gerrity et al., 2012). However, these measures do not provide any reference to biological effects and thus do not account for the potential additive or synergistic effects of chemical mixtures. Bioassay-based monitoring complements chemical analysis by providing a comprehensive assessment of the mixture of substances present in a particular water sample (Escher et al., 2014). A limitation of bioassays is the ability to determine what substance, or substances, were responsible for the bioactivity observed. Therefore, non-targeted analysis (NTA) will also be performed using high-resolution mass spectrometry (HRMS) with both gas chromatography (GC) and liquid chromatography (LC) interfaces for volatile and non-volatile organic compounds, respectively. National experts convened in California recently to examine two promising techniques for such investigation (SWRCB, 2015). In that two-day workshop, the expert group concluded that these two methods, non-target analysis (NTA) and bioassays, should be paired.

In order to accomplish both the bioassays and NTA methods proposed below, we will use 4L of water (approximately one gallon) for each sample. Technically, two liters of water is required; however, we recommend providing additional water for replicates (3) to improve statistical accuracy of the NTA work, and allows for repeat analyses if necessary. Two one-liter samples will be extracted using a comprehensive two-SPE system previously shown to capture the majority of organic contaminants occurring in water systems (Escher et al. 2014; Jia et al., 2015). Positive controls for bioassays will be used for matrix spikes to ensure acceptable recovery (greater than 70 percent) of bioactive substances.

Assays selected were those recently demonstrated to address relevant endpoints, displayed significant activity using water samples, and were reliable in multiple laboratories (Escher et al., 2015).

1) Non-specific Toxicity: Cytotoxicity. Cytotoxicity will be assessed using the MTS assay. The MTS reagent will be purchased from Promega (CellTiter 96® AQueous One Solution Cell Proliferation Assay, #G3580). MTS (tetrazolium) is bioreduced by cells in culture into a colored formazan product that is soluble in tissue culture medium, and this conversion is presumably accomplished by NADPH or NADH produced by dehydrogenase enzymes in metabolically active cells. Assays are performed by adding a

small amount of the MTS Reagent directly into culture wells, incubating for 2 hours, and then recording the absorbance at 490 nm with a 96-well plate reader.

2) Specific (Receptor-mediated) Toxicity: Glucocorticoid Receptor (GR) and Estrogen Receptor (ER). Estrogens and glucocorticoids have been reported to occur widely in WWTP effluents (Escher et al., 2014; Snyder et al. 2001; Stavreva et al., 2012). Based on previous testing of multiple ER and GR assays, our team has elected to use the Invitrogen platform as it also was selected by the State of California funded project on which Snyder is a Co-PI. The ER/GR assay uses GeneBLAzer® HEK 293T cells which contain an estrogen receptor/glucocorticoid receptor (ER/GR) ligand-binding domain/Gal4 DNA binding domain chimera stably integrated into the GeneBLAzer® UAS-*bla* HEK 293T cell line. GeneBLAzer® UAS-*bla* HEK 293T contains a beta-lactamase reporter gene under control of a UAS response element stably integrated into HEK 293T cells. Fluorescence Resonance Energy Transfer (FRET) substrate that generates a ratiometric reporter response and dual-color (blue/green) reading is used to minimize experimental noise. The ER and GR assay will help to identify potential for endocrine disruption effects caused by estrogenic and glucocorticoid hormones, respectively, as well as contaminants that mimic these hormones.

3) Xenobiotic Metabolism: Aryl Hydrocarbon Receptor (AhR). A well-known example of a xenobiotic receptor is the arylhydrocarbon receptor (AhR), which responds to exposure to dioxin-like chemicals. The AhR assay has been used to gauge remediation of PCB and dioxin in environmental spill scenarios (Giesy et al., 2002). For the proposed research, rat hepato-carcinoma cells (H4IIE-luc) which have been stably transfected with the luciferase gene under control of the AhR will be used (Giesy et al., 2002; Sanderson et al., 1996; Jarosov et al., 2012).

4) p53 reporter gene. The p53 protein is known for its major role in the prevention of cancer. It acts as a tumor suppressant, recognizing damaged DNA and triggering DNA repair. This pathway also plays a role in cell cycle arrest and apoptosis. Our team has chosen to use the CellSensor *p53RE-bla HCT-116* cell line, which operates very similarly to GeneBLAzer® HEK 293T cells, to represent stress response. The CellSensor *p53RE-bla HCT-116* cell line contains a p53 receptor ligand-binding domain/Gal4 binding domain, as well as a beta-lactamase reporter gene under control of a UAS response element. CCF4-AM substrate will be used to measure fluorescence, as it emits a green in the absence of betalactamase and blue in the presence. The primary difference between the CellSensor *p53RE-bla HCT-116* cell line and to GeneBLAzer® HEK 293T cells is that the p53 cell line uses human colorectal carcinomacells, where the ER/GR cell lines use human embryonic kidney cells. The p53 assay will help determine the quality of the water since the ability of a cell to repair itself may be more sensitive than actual damage done.

NTA of unknown compounds will be performed using the latest generation quadrupole-time-of-flight (QTOF) mass spectrometers. The LC-QTOF will use an aliquot of methanol extracts prepared for bioassay and analyzed using both positive and negative electrospray ionization (ESI). These extracts will also be analyzed by GC-QTOF by injection of the methanol extracts and analyzed with electron impact ionization. Samples will be analyzed in auto-MS/MS mode in both instruments, where instruments record all the mass to charge ratios (m/z). Between acquisitions of MS spectra, the instrument is programmed to isolate the most abundant ions and fragment them to acquire their corresponding MS/MS spectra. These analyses generate large amounts of data, which will be processed using software specifically designed for this purpose.

Using the QTOF data, our team is able to statistically "fingerprint" different water qualities based on their mass profile. In previous preliminary studies, our team has demonstrated that HRMS could discriminate water exposed to different treatments or different doses of the same oxidant. Resulting HRMS data is evaluated initially through heatmaps, revealing multiple classes of compounds such as recalcitrant, those

removed, and transformation products (including intermediates). Each sample profile will be paired both with water treatment variable and with bioassay results. Therefore, while bioassays indicate if a treatment leads to an increase or decrease in toxicity, QTOF data will provide information on which compounds or group of compounds correlate statistically to the biological observation.

The second value of this approach consists in being able to identify compounds of interest among the list of molecular features. For example, if sample toxicity increases after a specific treatment, the transformation products formed by such treatment will be isolated from the molecular features enclosed in the sample profile for further identification. Based on their high resolution mass spectra, transformation products will be searched against libraries of compounds available in Dr. Snyder's laboratory. While some of these products may not be registered in the library, a first identification of chemical formula can be proposed based on the accurate mass. Such molecular formula would then be further evaluated based on MS/MS spectra. In addition, these data produce a lasting electronic record of what substances were present, thus if a new contaminant is identified, these spectra can be retroactively mined to determine if the substance was present and its relative abundance.

For this initial research, the NTA and bioassay analysis will be taken across the treatment train as detailed in the Scope of Work. These two tools, when used in combination, will present a powerful picture of water quality through different levels of treatment over the duration of the study. These tools will supplement the previously detailed analysis for regulated and unregulated pollutants and pathogens and begin to answer the questions about the "unknown unknowns" frequently raised by opponents to water reuse projects.

4.0 Data Analysis

Three distinct sets of data will be collected. What those data are, and how they will be utilized, is defined below:

- **Online Data** - online data will be logged and performance probability distribution functions (PDFs) will be created, which document the statistical reliability of each process to provide the desired results (for pathogen and pollutant reduction)
- **Grab Sample Data** - trace pollutant data will be collected and compared against industry standards, and then used to compare pollutant levels with the results from the advanced analytics. Pathogen data will be used to set a baseline of pathogen levels in the purification feed water, and then document the levels of reduction of those pathogens to the new potable water supply, clearly documenting compliance (or lack thereof) with published health standards (CDPH, 2014; NWRI, 2015).
- **Advanced Analytics** - NTAs and bioassays will be paired together and compared/contrasted with the trace pollutant data.

Scope of Work

Task 1: Project Management

As Principal Investigator (PI) for this project, Manisha Kothari, will serve as the contact PI on this project and work closely with PI Paula Kehoe. As such, Ms. Kothari and Ms. Kehoe will be responsible for overall project management, including oversight of Carollo as the contractor, communication with WRF and WRRF, and review of the technical progress of the research and ensure that results are applicable to the water community. Ms. Kothari and Ms. Kehoe, in conjunction with Carollo, will monitor the progress of the research through review of progress reports, participation in project calls and face-to-face meetings, and review of all project final deliverables.

The Co-PI for this project, Andrew Salveson, will manage the day-to-day and long-term objectives of this project. That includes the review and guidance of Carollo staff in the performance of their duties and the coordination of subconsultant team members. The project management responsibilities extend to the management of the project budget and the billings. Finally, project management includes quality assurance/quality control, which is a period review of project progress from outside the core project team by experts in the relevant field(s).

Schedule: N/A.

Deliverables: The management team will be available for weekly check-in calls for the duration of the project. Any issues that arise during the management of this project will be documented in progress reports. Further details of communication with WRF and WRRF and of the dissemination of this work are outlined in the Communication Plan.

Task 2: Site Preparation

Small modifications will be made to the existing tertiary treatment system. These changes will require coordination efforts with the building staff, minor equipment adjustments, and piping modifications.

Task 3: Purification Facility Design and Construction

For potable water reuse, the project team will select and install a series of advanced processes to purify the Tertiary treatment system effluent and to monitor the water quality online. The proposed technologies to be applied are ultrafiltration (UF), reverse osmosis (RO), ultraviolet light disinfection (UV) with sodium hypochlorite addition to result in an advanced oxidation process (AOP), with a final treatment/storage step using an engineered storage buffer (ESB). Online monitoring includes turbidity, *E. coli*, total organic carbon (TOC), electrical conductivity (EC), total and free chlorine, and ultraviolet transmittance (UVT). These online monitoring parameters will be done by the ZAPs LiquiD, as shown in Table 3 below.

Table 3. Online Monitoring Parameters

Measurement	Post UF	Post RO	Pre UV	Post UV
Chloramines	•		•	•
Free Chlorine	•		•	•
E. coli	•			
TOC	•	•		
UVA			•	•
Turbidity	•			

For this Task, the project team will do the following:

- Select and rent (or purchase) small-scale advanced treatment processes (as listed above), with capacities in the range of 1 to 3 gpm[1].
- Select and purchase online monitoring processes (as listed above).
- Start up the purification and monitoring systems

[1] The current plan is to rent UF and RO systems and purchase small UV and ESB treatment systems. For monitoring systems, the project team will need to purchase online monitoring equipment.

- Collect and store all online data in a centralized control system, allowing for later analysis.
- Summarize all process, monitoring, and startup procedures in a TM.

Schedule: Selection of equipment, installation of equipment, and startup of equipment would be expected to start within 30 days of the receipt of grant funding and will be completed within 4 months of the notice to proceed.

Deliverables: A TM will be completed in draft form that details the treatment and monitoring processes as well as any details related to operation and startup. The TM will document the purification treatment train meets all pathogen and pollutant requirements for potable water reuse as required by CDPH. The TM will also document the costs of equipment procurement, installation, and expected analytics to understand the costs of DPR treatment at the building scale.

Task 4: Direct Potable Water Reuse Performance Demonstration

To date, no potable water reuse system (indirect or direct), provides a comprehensive real-time monitoring of overall performance. For potable water reuse, the treatment targets include virus, protozoa, bacteria, total organic carbon, salts, and trace level pollutants. This project will build a treatment system that tracks and records performance of each system, and most importantly of the entire system for the removal of pathogens and pollutants. This will be the first real-time "smart" potable water reuse treatment system, operating for 6 consecutive months, which will be used to demonstrate the long term reliability of advanced water purification processes.

To that end, we have broken up the 6-month demonstration into the following work efforts.

Operation. The facility will be run continuously for 6 months. The system will be run automatically, with twice-weekly inspections and calibration of online devices.

Conventional Parameters, PPCPs, Pathogens, and Advanced Analytics. Over the 6-month timeframe, the system will be continuously monitored using the online technologies discussed previously. This online monitoring will be supplemented by three different analytical chemistry approaches, as shown in the bullets and Table 4 on the next page.

- **Conventional Parameters:** TOC (twice monthly), ATP (weekly), turbidity, UVA, total and free chlorine (twice weekly).
- **CECs[2]:** pharmaceuticals and personal care products (PPCPs), perfluorinated compounds (PFCs), NDMA, NDMA FP, THM/HAA FP, and fluorescence EEM, all monthly. This work will be done by (monthly) work will be done by the Dr. Eric Dickenson at the Southern Nevada Water Authority.
- **Pathogens:** male specific and somatic coliphage, enterococci, *E. coli*, total coliform, *Giardia*, *Cryptosporidium*, enterovirus, and norovirus. Biological analysis will be done (monthly) by Dr. Rick Danielson at BioVir.
- **Advanced Analytics:** non-target analysis and bioassays. Advanced analytics will be done (monthly) by Dr. Shane Snyder at the University of Arizona.

[2] The CEC list and pathogen list are identical to WaterRF 4536 and WateReuse Research Foundation 14-16, which are both run by this current project team.

Table 4. Online Monitoring - Analytical Chemistry Approaches

Measurement	Tertiary Effluent	Post UF	Post RO	Post UV
Conventional Parameters		•	•	•
CECs		•	•	•
Pathogens	•			
Advanced Analytics		•	•	•

Schedule: Testing will be done periodically over a 6 month time period.

Deliverables: Prior to the start of testing, a test protocol will be developed which includes detailed sampling methods, lab testing methods, and quality control. Conventional parameters will be compared against similar DPR demonstrations (CWS, Big Springs, TX), while CECs and pathogens will be compared to established health criteria standards (NWRI 2015). The Advanced Analytic testing will demonstrate the feasibility of monitoring the unknown toxicity of DPR treatment trains. These novel results will evaluated for the first time to demonstrate the safety of DPR. All results will be compiled in the draft report as described below and may be published via research journals to share the state of the art with academics, regulators, and the public.

Task 5: Public Communication and Outreach

Multiple outreach efforts, provided by Data Instincts, will be developed as part of the demonstration project.

Development of Online Materials

Data Instincts and RMC will develop dedicated web pages to describe the demonstration project and engage the public about this research effort, as well as Direct Potable Reuse more broadly. The web interface will include updates on the demonstration project as it is proceeding.

Development of Print Materials

This task will include the development of various forms of print media to supplement online material on the demonstration project. It will include a pocket brochure describing the demonstration project, as well as fact sheets for various audiences, information on Frequently Asked Questions, and the preparation of pre- and post- tour surveys to help measure the effectiveness of the demonstration project.

Virtual Tour

A video production that provides a virtual tour of the pilot demonstration, the virtual tour will be showcased online and will provide information on the objectives and processes associated with the demonstration project.

Digital Wall

The SFPUC Headquarter building includes a large public space / café at its entry level. A large digital wall provides a venue for information to be displayed in a large and very visible format to people working in and visiting the building. The wall is also visible from public streets outside. In this task, we will prepare and display key messages and images to convey about the demonstration project and Direct Potable Reuse.

Develop/Distribute Educational Materials

The objective of this task is to create specific educational materials and disseminate them to targeted audiences including schoolchildren, media, public officials, and special groups.

Schedule: The outreach work would begin prior to the start of testing and run through the completion of the project.

Deliverables: Final report, survey results, and any other outreach materials will be shared with the funding agencies. The final report will document the outreach campaign efforts, survey results, and will provide documentation of public acceptance. Project results will be submitted for peer-review publications and conference proceedings.

Task 6: Project Communication and Reporting

The project team will prepare quarterly reports for the duration of this project, one draft report, and one final report. At a minimum, the project team will meet with the Project Advisory Committee (PAC) and Research Advisory Committee (RAC), the WRF and WRRF research managers in person. Additional meetings can be conducted remotely on a monthly basis as needed.

Schedule: Reporting will be done throughout the duration of the project, with quarterly reports done after the first three months of work and done every three months thereafter. An on-site project meeting will occur at the start of the 6 month DPR testing period. One draft report and one final report will be completed after the end of the 6 month demonstration period. Near the completion of the project, one member of the project team will travel to Denver to present the results to Reclamation staff.

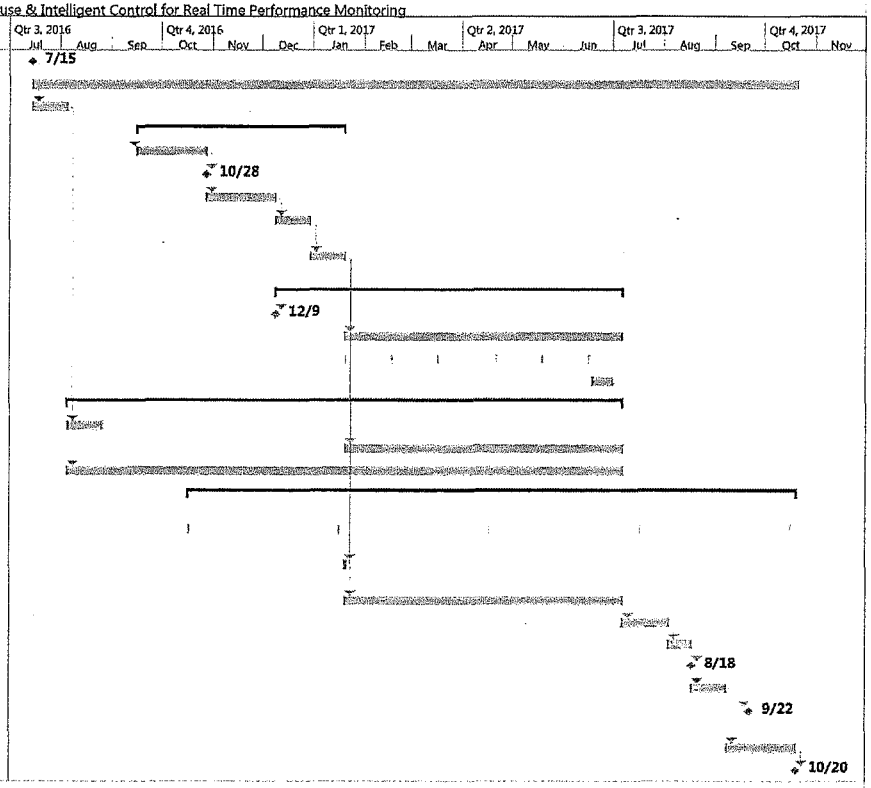
Deliverables: Quarterly reports, one draft report, and one final report, and one on-site project meeting with the advisory committees and WRF/WRRF research managers. The report will compile the results of all tasks, including operational startup, detailed analytic sampling methods, conventional and analytic results, and work through the public outreach campaign.

RESEARCH WORK PLAN AND SCHEDULE

The work to be carried out in the demonstration study is described in task descriptions of the Scope of Work Section. The project schedule, including all major tasks and subtasks, is shown below. The schedule details the elapsed time for the entire pilot testing project. Estimates of equipment delivery dates, pilot construction and commissioning, and dates of all deliverables are included. The total project duration is expected to be 15 months.

Building Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

ID	Task Name	Duration	Start	Finish	Predecessors
1	DPR Demonstration	0 days	Fri 7/15/16	Fri 7/15/16	
2	**Task 1: Project Management**	331 days	Fri 7/15/16	Fri 10/20/17	
3	**Task 2: Site Preparation**	15 days	Fri 7/15/16	Thu 8/4/16	1
4	**Task 3: Purification Facility Design and Construction**	90 days	Fri 9/16/16	Thu 1/19/17	
5	Purchase UF/RO/UV AOP from Suppliers	30 days	Fri 9/16/16	Thu 10/27/16	3FS+30 days
6	Submit Treatment and Monitoring TM	0 days	Fri 10/28/16	Fri 10/28/16	5
7	Deliver UF/RO/UV AOP to Site	30 days	Fri 10/28/16	Thu 12/8/16	5
8	Advanced Purification Pilot Installation, Testing, and Commissioning	15 days	Fri 12/9/16	Thu 12/29/16	7
9	Advanced Monitoring/Intelligent Control Installation, Testing, and Commissioning	15 days	Fri 12/30/16	Thu 1/19/17	8
10	**Task 4: DPR Performance Demonstration**	150 days	Fri 12/9/16	Thu 7/6/17	
11	Submit Test Protocol	0 days	Fri 12/9/16	Fri 12/9/16	7
12	DPR Pilot Operation	6 mons	Fri 1/20/17	Thu 7/6/17	9
13	**Advanced Analytics**	106 days	Fri 1/20/17	Fri 6/16/17	
20	Decommission and Site Clean-Up	10 days	Mon 6/19/17	Fri 6/30/17	13
21	**Task 5: Public Outreach**	240 days	Fri 8/5/16	Thu 7/6/17	
22	Install Banners	15 days	Fri 8/5/16	Thu 8/25/16	3
23	Provide Educational Tours	6 mons	Fri 1/20/17	Thu 7/6/17	9
24	Create/Maintain Demonstration Website	12 mons	Fri 8/5/16	Thu 7/6/17	3
25	**Task 6: Project Communication and Reporting**	264 days	Mon 10/17/16	Fri 10/20/17	
26	**Prepare and Submit Progress Reports**	261 days	Mon 10/17/16	Mon 10/16/17	
32	Onsite Project Meeting with Advisory Committees/Research Managers	1 day	Fri 1/20/17	Fri 1/20/17	9
33	Compile Pilot Plant Data	6 mons	Fri 1/20/17	Thu 7/6/17	9
34	Prepare Draft Report	20 days	Fri 7/7/17	Thu 8/3/17	33
35	Internal Review of Draft Report	10 days	Fri 8/4/17	Thu 8/17/17	34
36	Submit Draft Report to WRF/WRRF for Review	0 days	Fri 8/18/17	Fri 8/18/17	35
37	WRF/WRRF Review of Report	15 days	Fri 8/18/17	Thu 9/7/17	36
38	Presentation to Advisory Committess/Research Managers	0 days	Fri 9/22/17	Fri 9/22/17	37FS+10 days
39	Prepare Final Report	30 days	Fri 9/8/17	Thu 10/19/17	37
40	Submit Final Report to WRF/WRRF	0 days	Fri 10/20/17	Fri 10/20/17	39

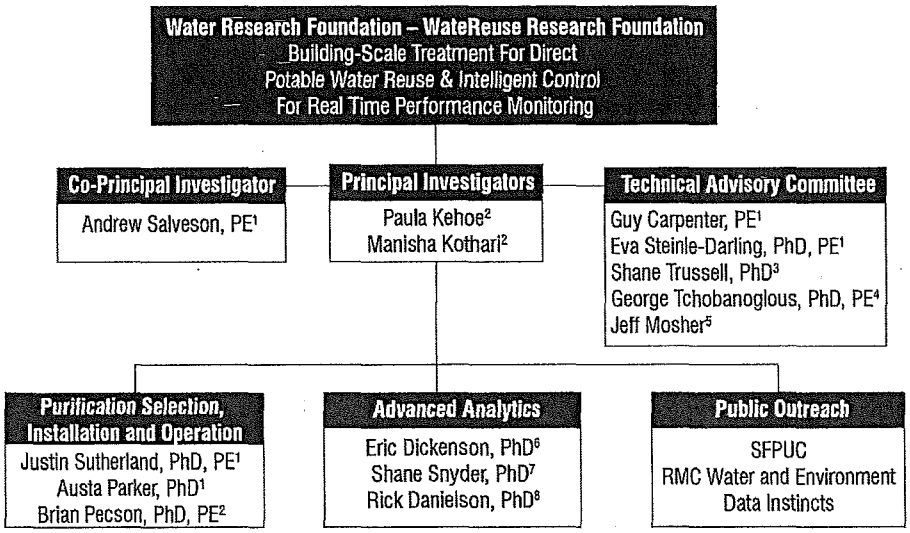


Project: DPR Demonstration
Date: Thu 4/7/16

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

MANAGEMENT PLAN

The proposed project is intended as a collaboration between SFPUC, WRRF, and WRF. Both WRRF and WRF are being asked to participate as equal partners. Should WRRF or WRF wish to have specific deliverables tied to their cash contributions, the team can provide such a breakout.



1. Carollo Engineers, Inc.
2. San Francisco Public Utilities Commission (SFPUC)
3. Trussell Technologies
4. University of California Davis
5. National Water Research Institute
6. Southern Nevada Water Authority
7. University of Arizona
8. IEH-BioVir Laboratories

SFPUC will be responsible for overall project management, coordination, and communications with WRRF and WRF, and facilitation with the research team. Carollo will be the technical leader for this project. We have assembled a team of professionals experienced in municipal reuse and leading-edge water technology.

Key Team Members

Paula Kehoe – Principal Investigator

Paula Kehoe is the Director of Water Resources for the San Francisco Public Utilities Commission (SFPUC). She is responsible for diversifying San Francisco's local water supply portfolio through the development and implementation of conservation, groundwater, and recycled water programs. Paula spearheaded the landmark legislation allowing for the collection, treatment, and use of alternate water sources for non-potable end uses in buildings and districts within San Francisco.

Manisha Kothari – Principal Investigator

Manisha Kothari is a Project Manager with the Water Resources Division of the San Francisco Public Utilities Commission. Manisha represents the SFPUC in the planning of water reuse projects that the SFPUC is developing through regional partnerships in order to diversify its water supply portfolio and meet future demands. She works with water agencies throughout the Bay Area to evaluate and develop recycled water and desalination opportunities for San Francisco's customers. Manisha has over 10 years of experience managing infrastructure projects from concept to implementation.

Andrew Salveson, PE – Co-Principal Investigator

Andy Salveson has 22 years of environmental consulting experience serving public and private-sector clients in the research and design of water and wastewater treatment systems. He is a nationally recognized expert in water reuse, including IPR and DPR. Mr. Salveson provides guidance and expertise on state-of-the-art technologies on the latest industry issues regarding reuse, including extensive projects for the Water Research Foundation and WateReuse Research Foundation related to Potable Reuse. Andy was named to a national panel of 7 experts to develop national guidance on Direct Potable Reuse (NWRI Framework for

Direct Potable Reuse) and was named to a panel of experts to develop potable water reuse for the World Health Organization.

Justin Sutherland, PhD, PE – Purification Selection, Installation, and Operation

Dr. Justin Sutherland is a member of Carollo's Research Group with 16 years of experience in applied research, bench- and pilot-scale process design and testing. He has extensive experience in water reuse. He served as Project engineer for the Texas Water Development Board-funded project, "Testing Water Quality in a Municipal Wastewater Effluent Treated to Drinking Water Standards." He was responsible for the review of historical RO performance data and sampling water quality (EDC, pharmaceuticals, etc.) around the MF, RO, and AOP processes at the Direct Potable Reuse Plant and led a pilot scale evaluation of a direct integrity monitor (Nalco's Trasar technology) for potable reuse RO systems.

Eric Dickenson, PhD – Advanced Analytics

Dr. Dickenson serves as R&D project manager for the Southern Nevada Water Authority. His experience includes the fate of emerging contaminants (e.g., EDCs and pharmaceuticals) in natural systems (e.g., aquifer recharge, riverbank filtration) and conventional and advanced engineered systems (e.g., RO, nanofiltration, GAC, ozone, AOP, MBR). Additionally he is experienced in the utilization of state-of-the-art characterization methods for natural and effluent organic matter for water quality characterization and optimization of disinfection processes.

Shane Snyder, PhD – Advanced Analytics

Dr. Snyder is a Professor of Chemical and Environmental Engineering at the University of Arizona. He holds a PhD in Environmental Toxicology and Zoology and a BA in Chemistry. He is a microconstituents expert who participated in the "Blue Ribbon Panel" for the California Water Resources Control Board to consider Constituents/Contaminants of Emerging Concern in Recycled Water. He is also Co-director of the Arizona Laboratory for Emerging Contaminants, a state-of-the-art analytical facility that identifies and quantifies emerging contaminants, such as pharmaceutical compounds, endocrine disrupting compounds, and nanoparticles.

Rick Danielson, PhD – Advanced Analytics

Dr. Danielson has a broad background in environmental health microbiology including: the development and application of bio-technology (PCR, ELISA, monoclonal antibodies, plasmid analysis, etc.); microbiological risk assessment; environmental virology and parasitology (certified USEPA Principal Analyst for protozoans and viruses); providing information and consultation on agents of bioterrorism; expert testimony in environmental microbial contamination cases; and, the establishment of certified environmental microbiological testing laboratories. He is a lecturer of microbiology at the U.C. Berkeley School of Public Health (1993 to present) and has served on several national public health (US FDA & NMFS, ASTM) and research review committees (WERF, AWWA, Sea Grant, USDA).

COMMUNICATION PLAN

The proposed research will benefit the drinking water, wastewater, and reuse industries through demonstration of safe DPR treatment processes. Regulators, utilities, and the public will have access to both the physical demonstration facility and the analytic results and key outcomes that show the process performance throughout the treatment train. The proposed outreach options to communicate the results of the research include the following:

Periodic Technical Progress Reports

Periodic technical progress reports and a Draft Final Report will be prepared and submitted for ongoing review by the WRRF and WRF, and their respective Advisory Committees. It is estimated that up to six progress reports, occurring every 3 months, will be submitted during the duration of the pilot testing. The reports will be letter-style and will include a Technical Summary, summary of the completed activities, activities in progress, and a calculation of the estimated percent of completed work. The Technical Summary will include descriptions of the materials and methods, results, and discussion of the results.

Conference Presentations

Conference presentations will be used as an interim outreach activity prior to submission of the final report to WRRF and WRF. Several conferences are planned as a forum to disseminate research results to utilities and technical audiences within the reuse industry. The selected conferences for presentation include those targeted to the water reuse industry, such as the annual WQTC and WRRF conferences as well as ACE and the WRF annual conference.

Final Report

This report will be submitted to the WRF and WRRF upon completion of the project. The report will include a description of the research project including research materials and methods, results, discussion, conclusions, and recommendations to meet the objectives for each task outlined in the technical section.

Webcast

Upon completion of the project, the Principal and Co-Principal Investigators will develop and deliver a webcast disseminating the project findings to participants within the water industry, particularly public and private utilities. Recommendations and implementation strategies will also be discussed. The webcast will be scheduled within 6 months of the publication of the project report. This webcast will be targeted to both WRRF and WRF subscribers and other stakeholders.

Project Meetings

SFPUC and Carollo will participate in one intermediate project meeting with the Advisory Committees and the WRRF/WRF research managers. Team members may attend via webinar. This meeting will be held at SFPUC's Headquarters and include a visit to the pilot plant site.

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance and Quality Control (QA/QC) are necessary aspects of any research project, and particularly so for this project as it pertains to the protection of public health. The test plan proposed for this effort includes duplicate sampling of advanced analytics (CECs, fluorescence, non-target analysis, and bioassays) in six different sampling events. The project team will work closely with certified laboratories running accepted standard methods to ensure data precision and accuracy (defined below). Method Detection limits (MDLs) will be used to determine the statistical significance of any detectable response.

Three certified laboratories will be performing the analysis in this project and will be responsible for internal QA/QC for each sampling parameter.

- Southern Nevada Water Authority (SNWA) will be providing analysis for: Contaminants of Emerging Concern (CECs), Total Organic Carbon (TOC), and Fluorescence (EEM).

- BioVir Laboratories will provide all pathogen analysis, including Phage, Enteroccoci, E. coli , Total Coliform, Giardia, Cryptosporidium, Enterovirus, and Norovirus.
- University of Arizona will perform advanced analytics using bioassays, Gas Chromatography Non-Target Analysis (GC-NTA), and Liquid Chromatography Non-Target Analysis LGC-NTA).

Precision

The precision of duplicate samples is assessed by calculating the relative percent difference (RPD) according to:

$$RPD = \frac{|S - D|}{\frac{(S + D)}{2}} \times 100\%$$

where,

S = Sample concentration and

D = Duplicate sample concentration.

If calculated from three or more replicates, the precision is determined using the relative standard deviation (RSD):

$$RSD = \frac{SD}{Average} \times 100\%$$

where,

SD = Standard deviation for the replicate samples.

Sample Replicates

The demonstration facility will run for a minimum of 6 months, with online monitoring of a range of parameters, daily inspection of online equipment, and with monthly or more frequent sampling for a wide range of offline laboratory analysis (see Table 5 on the next page). Routine sampling is expected with Turbidity, UVA, total and free chlorine being tested bi-weekly. ATP and TOC will be tested more frequently, once per week and twice per week, respectively. Online monitoring tools (Turbidity, UVA, Total and Free Chlorine, TOC, *E. coli*) will verify performance conditions and provide additional confidence in the laboratory analysis.

Table 5. Replicates and Associated Number of Sampling Events

Sample Location	Parameter to Analyze	Frequency of Sampling Events	Number of Sampling Events
Tertiary Influent	Pathogens[1]	Monthly	6
UF Effluent (RO Influent)	Turbidity, UVA, Total Chlorine, Free Chlorine	Bi-weekly (online)	48
	ATP	Weekly	24
	TOC	Bi-monthly	12
	Pathogens[1], CECs[2], EEMs[3], Bioassays[4], NT Analysis[5]	Monthly	8 (includes 2 duplicates)
		Monthly	4
RO Effluent (UV AOP Influent)	Turbidity, UVA, Total Chlorine, Free Chlorine	Bi-weekly (online)	48
	ATP	Weekly	24
	TOC	Bi-monthly	12
	Pathogens[1], CECs[2], EEMs[3], Bioassays[4], NT Analysis[5]	Monthly	8 (includes 2 duplicates)
UV AOP Effluent (Finished Water)	Turbidity, UVA, Total Chlorine, Free Chlorine	Bi-weekly (online)	48
	ATP	Weekly	24
	TOC	Bi-monthly	12
	Pathogens[1], CECs[2], EEMs[3], Bioassays[4], NT Analysis[5]	Monthly	8 (includes 2 duplicates)

NOTES:

1) Pathogens include Coliphage, Enterococci, E. *coli* , Total Coliform, Giardia, Cryptosporidium, Enterovirus, and Norovirus. Samples will be analyzed at the BioVir laboratory.
2) CECs include Gemfibrozil, Naproxen, Triclosan, Ibuprofen, Acetaminophen, Sucralose, Triclocarban, Sulfamethoxazole, Atenolol, Trimethoprim, Caffeine, Fluoxetine, Meprobamate, Carbamazepine, Primidone, DEET, TCEP, PFBA, PFHxS, PFHxA, PFOA, PFOS, PFNA, PFDA, PFUdA, PFDoA, PFPnA, PFHpA, NDMA, Nitrosomethylethylamine, Nitrosodiethylamine, Nitrosodipropylamine, Nitrosomorpholine, Nitrosopyrrolidine, Nitrosopiperidine, Nitrosodibutylamine, Nitrosodiphenylamine, Estrone, Estradiol, Ethynylestradiol, Testosterone, Progesterone, NDMA FP, and THM/HAA FP. Samples will be analyzed at the Southern Nevada Water Authority.
3) Fluorescence (EEMs) grab samples will be analyzed at the Southern Nevada Water Authority in parallel with all other sampling events.
4) Select and TBD bioassays will be run by the University of Arizona.
5) Non-Target (NT) analysis will be performed in parallel with bioassay analysis when sampled on the same date.

Accuracy

For measurements where matrix spikes (constituent seeding) are used, accuracy is evaluated by calculating the percent recovery (R):

$$R(\%) = \frac{S - U}{C_{SA}} \times 100\%$$

where,

S = Measured concentration in spiked sample,

U = Measured concentration in unspiked sample, and

C_{SA} = Calculated concentration of spike in sample.

When a standard reference material (SRM) is used, the percent recovery is determined by:

$$R(\%) = \frac{C_m}{C_{SRM}} \times 100\%$$

where,

C_m = Measured concentration of SRM and

CSRM: = Actual concentration of SRM.

Matrix spiking will only occur when necessary for analytical recovery or in the event of additional benchtop testing.

Method Detection Limit (MDL)

To determine the MDL, at least seven replicates of a laboratory fortified blank at a concentration of three to five times the estimated instrument detection limit is analyzed through the entire analytical method. The MDL for each constituent tested will be determined by the laboratory in accordance with the standard method listed for each constituent. It is important to show that the detection limit for each chemical parameter is sensitive enough such that it can measure below the regulatory limit, and show appropriate removal of each compound in question. The MDL is calculated using the following equation:

$$MDL = (t) \times (SD)$$

where,

t = Student's *t* value for 99 percent (*t* for 7 replicates= 3.14) and

SD = Standard deviation for the replicates samples.

Comparability

Much of the critical data will be analyzed by on-site online monitors and field kits, and outside laboratory analysis will take place at SNWA, Biovir and the University of Arizona. It is therefore important to prove consistency between laboratories and have a common practice to ensure quality control across various laboratories. Comparability is the degree of consistency between a data set obtained at one laboratory and data sets from another. It is achieved by use of consistent methods and materials (i.e., standards). Comparability of data will be promoted by adherence to the standard and certified analytical methods decided by each outside laboratory.

BUDGET DETAILS

This proposal is requesting $100,000 in cash funds from the WateReuse Research Foundation (WRRF). Cash matching will come from The San Francisco Public Utilities Commission (SFPUC), and will exceed the 50% cash match requirement with a $324,670 cash contribution. Additionally, this proposal is simultaneously being submitted as a tailored collaboration with the Water Research Foundation (WRF) with a requested cash matching of $100,000. This total cash contribution from SFPUC, WRRF, and WRF would amount to $524,670 for project funding. Cash funding would be spent for equipment, operation and maintenance, outreach, and wages for Carollo Engineers (Carollo) and RMC and Data Instincts. The SFPUC and subcontractors (Carollo and RMC and Data Instincts) will provide in-kind contributions amounting to $101,830. If all funding is secured, the total project value will amount to $626,500. The following is a summarized detailed budget for the project:

Total WRRF Funds Requested:	**$100,000**
Total Cash Contribution from SFPUC:	**$324,670**
Additional Funding from WRF:	**$100,000**
Total In-Kind Contribution:	**$101,830**
SFPUC In-Kind	$71,613
Carollo In-Kind	$25,216
RMC and Data Instincts:	$5,000
Total Project Value:	**$626,500**

Detailed Budget:

The SFPUC team is proposing to complete this project in under 2 years (15 months). The WRRF cash contribution of $100,000 will be directly applied to Task 4 of the project for analytical analysis and pilot equipment rental. Cash funds of $100,000 from the Water Research Foundation will be paid directly to either WRRF, SFPUC, or managed by WRF (TBD). SFPUC cash funds of $324,670 will be spent throughout the 15 month duration, with the highest cost in the 6-14 month window. In-kind work will be delivered throughout the project as needed.

Primary Contractor Budget Justification – SFPUC

Salaries and Wages

Salary and wages for SFPUC employees participating in this project will be covered by SFPUC as part of their lump-sum in-kind budget of $71,613.

Equipment Purchase and Rental

All equipment needed for this project will be procured by Carollo, as a subcontractor.

Materials and Supplies

No materials are expected as part of this proposal for SFPUCs portion of the work. Materials for analytical analysis and pilot testing are included in the lump sum proposal budget. Carollo Engineers will be responsible for the division of funds under SFPUC, WRF, and WRRF direction.

Travels

Travel costs, if necessary, will be donated in-kind to the project from all team members.

Subcontract

SFPUC will enter into a subcontract with two entities. The subcontracts include Carollo Engineers (Carollo) for $430,232 and RMC/Data Instincts for $115,968. Equipment will be rented and purchased by Carollo with cash allocation from SFPUC.

See below (Subcontractor Budget Justification) for a detailed description of these costs.

Other Direct Costs

All direct costs will be covered by RMC and Data Instincts and Carollo Engineers with funding allocated by SFPUC, WRF, and WRRF.

Indirect Costs

No indirect costs from SFPUC are expected for this project.

Subcontractor Budget Justification

Carollo Engineers

Salaries and Wages (Total: $111,578)

Salary rates for the nonfederal employees (Andrew Salveson, Julian Inoue, Dr. Austa Parker with clerical staff [word processing/graphics]) are established in conjunction with their employer, Carollo Engineers, Inc. (Carollo). Indirect costs of 126% are included in the hourly rates budget for each of these researchers. A 0% wage increase has been incorporated for each staff person for each year of the project. Overall, 10% of all Carollo salaries are being contributed as an in-kind contribution to this project.

Fringe Benefits

For Carollo personnel, fringe benefits are 50% of direct labor.

Equipment Purchase and Rental ($125,250)

SFPUC will require the rental and purchase of advanced treatment equipment, totaling $125,250. Carollo will be renting all equipment for this project with cash funds covered by $52,000 of WRRF funding. The remaining cost of $73,250 of purchased equipment and operation and maintenance needs will be covered by cash funds from SFPUC. A breakdown of pilot equipment costs are as follows:

- **MF/UF (GE) total: $26,000**, skid rental $12,500 ($2500/month for 5 moths), commissioning and decommissioning ($13,500), replacement membranes ($1000)
- **RO (GE) total: $26,000**, skid rental $12,500 ($2500/month for 5 moths), commissioning and decommissioning ($13,500), replacement membranes ($1000)
- **UV (Trojan Reactor) total: $7,500**, purchase of 1 gpm unit ($3000) and O&M ($4500)
- **Flow Meters, piping and storage total: $10,750**
- **Analyzers total: $55,000**, purchase of online analyzers from ZAPs

Materials and Supplies ($15,750)

Additional pilot maintenance supplies such as fittings, tape, and small needs that will come about during pilot operation are accounted for with a $10,000 budget accompanied by $5,750 for additional pilot support as needed from outside parties. A flexible budget is being provided for contingency purposes during the design, construction, and operation of the pilot system over a 6 month period of time.

Travel

Any necessary travel costs for Carollo will be covered internally by Carollo.

Other Direct Costs ($91,894)

Analytical Analysis (detailed in QA/QC) for all pilot testing is estimated to cost $91,894, covered by $48,000 cash match funds from WRRF and $39,894 from WRF. Southern Nevada Water Authority (SNWA) will be paid $44,760 for analyzing conventional parameters and CECs, BioVir Laboratories (BioVir) will be paid $17,920 for Pathogen analysis, and University of Arizona (UofA) will be paid $29,214 for advanced analytics. Carollo will be responsible for managing these funds as a subcontractor to SFPUC.

Indirect Costs

As noted earlier, 126% indirect costs for non-federal researcher salaries have been included in the Salaries and Wages budget estimate, as these costs are more accurately described for this project as Direct Costs incurred by Carollo.

RMC/Data Instincts

Direct Costs (Total: $114,968)

RMC/Data Instincts will be responsible for the majority of the public communication and outreach portion of the project. The $119,968 project value will be covered by $50,000 of WRF cash funding, $5,000 of additional in-kind work from RMC/Data Instincts, with the remaining $64,968 funded by SFPUC cash contributions. RMC and Data Instincts will be responsible for developing online materials, hard copies of materials, creating a virtual tour of the pilot, a digital wall, and developing and distributing educational materials. All time, travel expenses, materials and supplies will be covered by this lump sum fee, listed as a direct cost to the project. This work will be supported by in-kind time from both Carollo and SFPUC.

Indirect Costs

No indirect costs for the project.

Equipment Rental and Purchase

No equipment is required for this subcontractor.

Materials and Supplies

All materials and supplies will be covered in the lump sum direct cost, at the discretion of Direct Insights.

Travel

All necessary travel will be covered by RMC/Data Instincts lump sum fees.

Additional Funding

Water Research Foundation

Cash Contribution ($100,000)

As part of this tailored collaboration and extensive project, this research proposal is also being submitted to the Water Research Foundation for a cash match of $100,000 for SFPUC. The cash funding (if provided and approved by the Water Research Foundation), would assist with analytical expenses and outreach efforts. The breakdown of this funding is expected to be $50,000 for analytical analysis for the duration of the pilot and $50,000 for outreach efforts to supplement RMC/Data Instincts costs. If this funding is not granted by the Water Research Foundation, this proposal for WRRF funding remains unchanged. The SFPUC would either increase its contribution or, in concert with WRRF, determine if any aspects of the scope may be scaled down while meeting all of the research objectives of the project.

Personnel	Hours	Rate	Total Costs (Direct)	Direct + Fringe (50%)	Task(s)		WRRF Cost		In-Kind Contribution		Total
Andrew Salveson (Co-PI)	191	95.00	$ 18,145.00	$ 27,217.50	1,2,3,4,5,6	$	-	$	2,721.75	$	27,217.50
Austa Parker	314	60.00	$ 18,840.00	$ 28,260.00	1,2,3,4,5,6	$	-	$	2,826.00	$	28,260.00
Julian Inoue	720	50.00	$ 36,000.00	$ 54,000.00	2,3,4	$	-	$	5,400.00	$	54,000.00
Clerical	56	25.00	$ 1,400.00	$ 2,100.00	6	$	-	$	210.00	$	2,100.00
Sub-Total	1281					$	-	$	11,157.75	$	111,577.50
Equipment Rental											
GE MF/UF Skid (5 months)			$ 26,000.00		4	$	26,000.00	$	-	$	26,000.00
GE RO Skid (5 months)			$ 26,000.00		4	$	26,000.00	$	-	$	26,000.00
Sub-Total						$	52,000.00	$	-	$	52,000.00
Equipment Purchase											
UV (Trojan) Reactor			$ 7,500.00		4	$	-	$	-	$	7,500.00
Flow Meters, Piping and Storage			$ 10,750.00		4	$	-	$	-	$	10,750.00
Online Analyzers (ZAPs)			$ 55,000.00		4	$	-	$	-	$	55,000.00
						$	-	$	-	$	73,250.00
Supplies											
Pilot Operation Parts			$ 10,000.00		4	$	-	$	-	$	10,000.00
Pilot Operation and Maintenance Support			$ 5,750.00		4	$	-	$	-	$	5,750.00
						$	-	$	-	$	15,750.00
Subcontractors (Contact Person)											
RMC and Data Instincts (Mark Millan)			$ 114,968.00		5,6	$	-	$	-	$	114,968.00
Sub-Total						$	-	$	-	$	114,968.00
Travel											
Travel							Nil		Nil		Nil
Sub-Total						$	-	$	-	$	-
Other											
Analytical Analysis (UofA, SNWA, BioVir)			$ 91,894.00		4	$	48,000.00	$	-	$	91,894.00
Sub-Total						$	48,000.00	$	-	$	91,894.00
			Total Direct Cost			$	100,000.00	$	11,157.75	$	459,439.50
			Total Indirect Cost (1.26 multiplier on Direct+Fringe Costs) - as it pertains to Carollo			$	-	$	14,058.77	$	140,587.65
			TOTAL			$	100,000.00	$	25,216.52	$	600,027.15

Third Party Contributions Not Included Above		Cash Contribution		In-Kind Contribution		Total Contribution
SFPUC		$ 324,670.00		$ 71,613.00	$	396,283.00
RMC and Data Instincts				$ 5,000.00	$	5,000.00
Water Research Foundation		$ 100,000.00				
	Subtotal	$ 25,905,294,670.00		$ 4,673,469,613.00	$	24,478,664,283.00

	Cash Contribution	WRRF Cost	Total In-Kind Contribution	Total Project Budget
TOTAL PROJECT COST	$ 25,905,294,670.00	$ 100,000.00	$ 4,673,494,830.00	$ 30,578,889,500.00

Approximate Breakdown of WRRF Cash by Task		
	Task 1	$ -
	Task 2	$ -
	Task 3	$ -
	Task 4	$ 100,000.00
	Task 5	$ -
	Task 6	$ -
	Total	$ 100,000.00

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102
T 415.554.3155
F 415.554.3161
TTY 415.554.3488

April 11, 2016

Julie Minton
WateReuse Research Foundation
1199 North Fairfax Street, Ste. 410
Alexandria, VA 22314

Dear Ms. Minton:

I am pleased to submit this proposal for funding consideration for the 2016 WRRF TC Program. As the Sponsoring Utility, the SFPUC is committed to exploring new opportunities in Direct Potable Reuse (DPR) application and we see a potential partnership with WRRF for this research project as an important step forward to that end. The proposed project is a building-scale treatment demonstration for DPR (proposed project) that we are very pleased to be able to host in our own headquarters building in San Francisco. The proposed project will 1) demonstrate the technical viability of building-scale DPR treatment; 2) provide comprehensive real-time monitoring of the system, including its efficacy in removing pathogens and pollutants; 3) use emerging analytical tools to better understand the relevance of trace level pollutants; and 4) help communicate the results of this research and possible applications of DPR broadly.

The SFPUC has been successfully using an innovative constructed wetland treatment system to treat wastewater to Title 22 tertiary standards for toilet flushing in our building since 2012. The proposed project will add reverse osmosis (RO) and advanced oxidation processes (AOP) for a complete advanced, decentralized wastewater treatment system to achieve potable water standards. We propose to continuously monitor the performance of the advanced treatment system in real time to provide meaningful data regarding water quality. In addition, the proposed project will include advanced analytics to evaluate pathogens and emerging pollutants, and important outreach to engage regulators, other utilities and the public. Although the treated water will continue to be used for non-potable purposes (toilet flushing) in our building, we believe that this effort will provide invaluable data and fill a research gap as we collectively think about future possibilities for DPR application.

In addition to hosting the demonstration project, the SFPUC is prepared to provide both cash and in-kind contributions totaling over $400,000 to support this project. We believe your support and the potential support of the Water Research Foundation will demonstrate a strong partnership across utilities and research organizations to advance DPR. We look forward to working with you and WRF to develop a Multi-Funded Research Agreement that aligns our collective interests, including the streamlining of PACs and disbursement of funds.

We have a strong team and thorough plan in place to carry out this important project. We hope you will support this effort.

Sincerely,

Steven R. Ritchie
Assistant General Manager, Water

Carollo
Engineers...Working Wonders With Water®

WATER
OUR FOCUS
OUR BUSINESS
OUR PASSION

April 6, 2016

Ms. Paula Kehoe
San Francisco Public Utilities Commission
525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102

Subject: WRF and WRRF TC Study: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Dear Ms. Kehoe:

Carollo Engineers, Inc. is pleased to provide this Letter of Commitment to confirm our support to the City of San Francisco, acting through the Public Utilities Commission, for our services (both paid and in-kind) related to the proposed project to pilot test building scale direct potable reuse with intelligent control systems and advanced performance monitoring. Carollo is committed to providing the following services for this project:

- Provide 10 percent of contractual hours as an in-kind service (an in-kind contribution of $20,530).
- Vehicular travel to and from the pilot site and to one trip to Denver to present findings to the WRF as an in-kind service, not quantified here.

Carollo commits to providing identified staff and resources for the duration of the project. The services include approximately 1,300 hours of time, equipment, chemicals and consumable supplies, and analytical services. Carollo commits to providing $20,530 as in-kind contributions and, should the proposal be successful, will contract with SFPUC for $430,232 to perform other services.

If you have any questions regarding our participation, please contact me at 925-788-9857.

Sincerely,

CAROLLO ENGINEERS, INC.

Andrew Salveson

Andrew Salveson, P.E.
Vice-President

AS:MS

2700 Ygnacio Valley Road, Suite 300, Walnut Creek, California 94598
P. 925.932.1710 F. 925.930.0208
carollo.com

Data instincts
Public Outreach Consultants
239 Windsor River Road, Windsor, CA 95492
Tel: 707.836.0300 Fax: 707.836.0842

April 6, 2016

Paula Kehoe
San Francisco Public Utilities Commission
525 Golden Gate Ave
San Francisco, CA 12345

Subject: **In-kind Commitment for Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring**

Dear Paula,

We are in full support of San Francisco Public Utilities Commission's (SFPUC) proposed study regarding the use of Direct Potable Reuse (DPR). Potable reuse as a water supply alternative is receiving greater interest as an approach to augment potable water supplies and maximizing recycled water use. We believe this study is critical to both expanding effective treatment knowledge and educating people about this vital resource and to ultimately bolster acceptance of DPR.

We are pleased to participate in this research effort in support of *Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring* and are pledging to provide in-kind services totaling $5,000. Specifically, the in-kind services will be in the form of labor (approximately 25 labor hours at an average rate of $185 per hour distributed over the project period not exceeding one year in duration). We anticipate the contributed labor will include, but not be limited to, the following:

- Including previous findings for effective communication regarding DPR
- Coordination of developing outreach materials

We are committed and supportive of this priority research project proposed by the SFPUC and believe it will foster further public acceptance and a better understanding of DPR.

Very truly yours,

Mark Millan
Principal, Data Instincts

QUALIFICATIONS - PAST PERFORMANCE

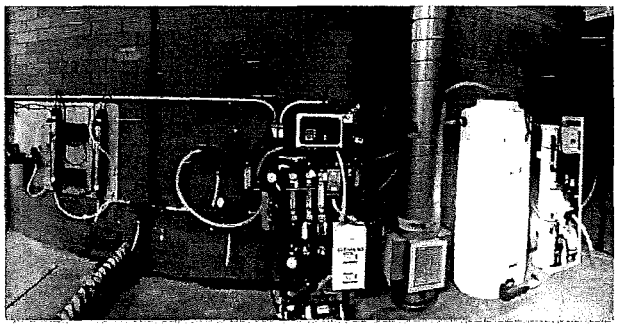
Clean Water Services, Oregon – 2550 SW Hillsboro Highway, Hillsboro, OR 97123

High Purity Water Project – Direct Potable Reuse Demonstration Facility

Client Reference

Mr. Rick Shanley, PE
Engineering Division Manager
Ph: 503-547-8178

Completion Date: April 2015



Clean Water Services (CWS) produces a high quality wastewater effluent that can be recycled. Advanced water treatment technologies make it feasible to treat water to any level. To demonstrate this potential, CWS conducted a demonstration project to purify municipal secondary effluent to various levels sufficient for use in a variety of purposes, including semiconductor processing, agriculture and food crops, product manufacturing, and human consumption. CWS is interested in demonstrating to the public that advanced treatment of wastewater can be a viable source of water supply. Regulatory challenges had to be overcome, as the Oregon regulations (from the Oregon Department of Environmental Quality (ODEQ)) specifically did not allow potable water reuse.

Carollo worked closely with CWS staff in the process design, installing ultrafiltration, reverse osmosis, ultraviolet light advanced oxidation process, and granular activated carbon as the purification steps. These technologies provided robust pathogen and pollutant treatment through multiple barriers. These processes were used in series to purify disinfected secondary effluent from CWS's Forest Grove Facility (FGF). The testing demonstrated that the FGF effluent, when treated with UF, RO, and UV AOP, provides a very high quality water that is absent of trace pollutants and pathogens. As a result, a purified water suitable for potable use and public consumption was confirmed, and a single use DPR permit was obtained from ODEQ.

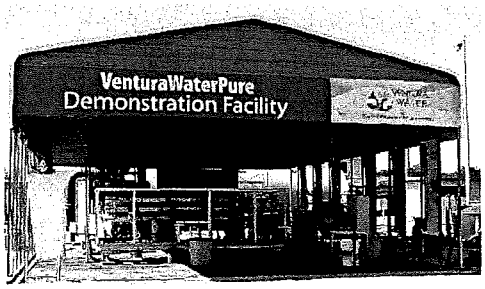
City of Ventura, California – 501 Poli Street, Ventura, CA 93001

Direct Potable Reuse Demonstration Study

Client Reference

Ms. Shana Epstein
General Manager
Ph: 805-652-4518

Completion Date: April 2016



The primary purpose of the demonstration facility is to document the high quality of purified reclaimed water through extensive water quality testing and to understand the impact of blending this purified water with the conventional finished potable water. A secondary purpose of the demonstration facility is to provide an educational opportunity for the community, including Ventura Water and City of Ventura staff, the general public, and for local regulators.

The VenturaWaterPure demonstration facility was designed to have multiple barriers for both pathogens and trace pollutants in excess of the treatment required for indirect potable reuse (IPR) via groundwater

injection. The ~20 gallon-gpm process train takes undisinfected filtered secondary effluent from the Ventura Water Reclamation Facility and provides treatment through pasteurization, ultrafiltration, reverse osmosis, and an ultraviolet light advanced oxidation process. For a future DPR facility, granular activated carbon (GAC) may be added after RO for an additional barrier to trace pollutants and an engineered storage buffer (ESB) would be added to the treatment train after the UV AOP to allow for appropriate system monitoring and water quality assurance.

The VenturaWaterPure direct potable reuse (DPR) demonstration facility represents the combined efforts of Ventura Water, the City of Ventura, Carollo Engineers, and members of the Water Research Foundation Project 4536 team.

Colorado River Municipal Water District in Big Spring, Texas – PO Box 13231, Austin, TX 78711

High Purity Water Project – Direct Potable Reuse Demonstration Facility Evaluation

Client Reference

Ms. Erika Mancha, Team Lead
Innovative Water Technologies
Texas Water Development Board
Ph: 512-463-7932

Completion Date: May 2016

A team led by Carollo was selected by the Texas Water Development Board to perform a comprehensive evaluation and monitoring study of the Raw Water Production Facility in Big Spring, TX, the country's first direct potable reuse facility

A team led by Carollo was selected by the Texas Water Development Board to perform a comprehensive evaluation and monitoring study of the Raw Water Production Facility in Big Spring, TX, the country's first direct potable reuse facility. An overarching goal of the study was to determine the efficacy and reliability of DPR treatment for implementation across the State of Texas, and ultimately support the development of DPR projects across the nation. Our study includes:

- A comprehensive and independent evaluation of the Big Spring DPR process (MF, RO, UV AOP), including analysis of each treatment barrier, determination of pathogen and pollutant removal and the use of surrogate parameters for performance demonstration.
- Development and implementation of a detailed testing protocol that included direct measurement of pathogens (virus, protozoa, and bacteria) and trace chemicals (pharmaceuticals and personal care products, hormones, flame retardants, and others) as well as a number of indicator and surrogate measurements that could be used to monitor treatment performance.
- A guidance document that recommends monitoring approaches for DPR.

Additional research was funded by the WateReuse Research Foundation to extend the depth and breadth of the analysis. Leading edge research was completed, including the use of fluorescent dyes to provide greater accuracy and precision for pathogen removal by RO.

To support development of a robust monitoring approach that is practicable for utilities of various sizes and financial means, our testing protocol included measurement of less costly surrogates wherever possible to complement the testing for primary parameters, and defined correlations between primary parameters and surrogates.

The results shown an extremely high quality water produced from this facility and serves to support broad acceptance of DPR in Texas.

Paula A. Kehoe
525 Golden Gate Ave, 10th Floor San Francisco, CA 94102
(415) 554-0792/pkehoe@sfwater.org

EMPLOYMENT

City and County of San Francisco, Public Utilities Commission — *San Francisco, CA*
Director of Water Resources — **May 2004- Present**

- Manage the development of new local water supplies, including groundwater, recycled water, desalinated water and alternate water sources.
- Develop and implement water shortage allocation plans, drought polices, and water shortage measures.
- Prepare ordinances to streamline regulatory pathways to develop new non-potable water supplies to offset potable supplies.
- Lead innovative water strategies, including installing composting toilets in urban areas and treating blackwater to flush toilets in new commercial and multi-family buildings.
- Identify water conservation measures, prepare ordinances and implement tools to reduce and track consumption among residential, commercial and industrial sectors.
- Identify partnerships and negotiate agreements with external governmental and non-governmental agencies to develop and implement new water supply projects.
- Direct long-range water demand studies, integrated water resource plans, groundwater management plans, recycled water plans, desalinated water plans and water efficiency plans.
- Conduct research on public perceptions and acceptance of new water supplies, such as groundwater, recycled water and desalinated water.
- Prepare operations plans to document water system facilities, operating strategies, water quality and permitting requirements.
- Participate in U.S. Department of State, Bureau of International Information Programs, to share technical assistance on Water Management in Brazil, including Sao Paulo, Brasilia, and Rio de Janeiro.
- Prepare water resources management Memorandum of Understanding between San Francisco and Bangalore, India.
- Develop and track performance measures for SFPUC Sustainability Plan.
- Manage staff, produce publications and technical reports, administer contracts and manage $9 million annual budget.

City and County of San Francisco, Public Utilities Commission — *San Francisco, CA*
Chief of Staff and Public Affairs Manager — **Oct 1999- May 2004**

- Developed educational programs and served as a liaison with commissioners, elected officials, media and stakeholders to increase awareness of the SFPUC's water system improvements and water resource issues.
- Assisted with the development and public outreach for the SFPUC $3.6 billion capital improvement program designed to rebuild and repair the third largest water delivery system in California.

- Managed the bottling and distribution of Hetch Hetchy Mountain Water™ to promote high quality municipal drinking water.
- Coordinated a strategic management system (Balanced Scorecard) to identify organization goals, objectives, and performance measures specific to water, wastewater, and power operations.
- Directed multifaceted communications and government affairs programs and staff, created coalitions and resolved disputes.
- Produced publications, administered contracts, prepared annual work plans and managed a $400,000 annual budget.

City and County of San Francisco, Public Utilities Commission ***San Francisco, CA***
Pollution Prevention Public Education Director **Dec 1991-Oct 1999**

- Developed and managed water resource programs for the Water Pollution Prevention Program to reduce pollutant loadings to the San Francisco Bay and Pacific Ocean from point and non-point sources.
- Prepared technical reports, including source identification studies, waste minimization plans and influent and effluent mass loading studies.
- Conducted market research, developed marketing strategies and implemented innovative public education campaigns for targeted audiences.
- Developed publications and programs shown to change behaviors among targeted populations.
- Designed and implemented educational outreach programs through public-private partnerships.
- Awarded six state and national awards for excellence in water pollution prevention public education.
- Received grant funding to develop an integrated pest management and green gardening program.
- Obtained significant media coverage on pollution prevention and water conservation issues.
- Assisted with the development of an *Effluent Management Training Course* for the Water Environment Federation and U.S. AID in Cairo and Alexandria, Egypt, March-April 1998

EDUCATION

University of San Francisco, San Francisco, CA
Master of Science, Environmental Management
September 1990-December 1993

University of Colorado, Boulder, CO
Bachelor of Arts Degree, Geography
September 1983-May 1987

PUBLICATIONS

Kehoe, P. *Drought, San Francisco, and Innovation Though Local Water and Alternative Water Projects*, Green Technology Magazine, August 2015.
Kehoe, P., Rhodes, S., Scarpulla, J. *Blueprint for Onsite Water Systems Shifts Traditional Views on Water Use*. Trim Tab The Magazine for Transformative People + Design. February 2015.
Kehoe, P., Rhodes, S., Scarpulla, J. *Moving from Building-scale to District-scale – San Francisco 's Non-potable Water Program.*
Alternative Water Supply Systems. London. IWA Publishing. 2015.
Elmer, V., Kehoe, P. *The Tricky Business of Onsite Water Treatment and Reuse.* Planning Magazine. American Planning Association. December 2014.
Kehoe, P., Rhodes, S., Scarpulla, J. *San Francisco Takes the Lead in Setting Standards for Onsite Reuse*. Source Magazine. AWWA. Vol 28, No 4. Fall 2014.
Kehoe, P., Rhodes, S. *Innovations for Water in Urban Areas Require Rethinking and Reuse*. ECOHOME Magazine. Winter 2013. Beck, S., Goel, N., Kehoe, P., Linden, K., Rhodes, S., Rodriguez, R., Salveson, A. *Disinfection Methods for Treating Low TOC, Light Graywater to California Title 22 Water Reuse Standard.* Journal of Environmental Engineering. Volume 139, Issue 9. September 2013.
Kehoe, P., Rhodes, S. *Pushing the Conservation Envelope Through the Use of Alternate Water Sources*. Journal of the American Water Works Association. Vol. 105:2. February 2013.
Kehoe, P., Rhodes, S. *Regulatory Pathway Streamlined for Onsite Non-potable Reuse in San Francisco.* Water Reuse and Desalination. Vol. 3:3. Autumn 2012.
Kehoe, P., O'Rorke, M. *An Educated Approach to Educating the Public.* Wastewater Technology Showcase, Water Environment Federation. 2000.
Kehoe, P., O'Rorke, M. *Targeted Research and Marketing Put Muscle into Pollution Prevention Education Campaigns.*
Utility Executive, Water Environment Federation. 2000.
Kehoe, P., O'Rorke, M. *Targeted Research and Marketing Put Muscle into Pollution Prevention Education Campaigns.*
Watershed & Wet Weather, Water Environment Federation. 2000.
Mass Loadings of Used Motor Oil and Latex Paints to the Sewerage System. City and County of San Francisco, Department of Public Works, Bureau of Environmental Regulation and Management, Water Pollution Prevention Program, San Francisco, California. 1993. *A Community of Land.* Gildea Review. 1988.

PROFESSIONAL ORGANIZATIONS

Alliance for Water Efficiency, Project Advisory Committee Member: *Net Blue Development*, 2015-Present
WaterReuse Research Foundation, Project Subcommittee Member: *A Framework for the Successful Implementation of Onsite Industrial Water Reuse*, 2014- Present
Water Research Foundation, Project Subcommittee Member: *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities*, 2014-Present
One Water Council, U.S. Water Alliance, Committee Member, 2013-Present **California Urban Water Agencies**, Water Reuse Committee Member, 2013-Present **Vision 2020, ECOHOME, Hanley Wood,** Water Efficiency Chair, 2013
Water Research Foundation, Project Subcommittee Member: *Institutional Issues for Green-Grey Infrastructure based on integrated "OneWater" Management and Resource Recovery,* 2013- 2015

WateReuse Foundation, Project Advisory Committee Member: *Evaluating Long and Short Term Planning Under Climate Change Scenarios to Better Assess the Role of Water Reuse,* 2009-2012
Water Environment Federation, member, Public Education Committee 2006- 2012
WateReuse Foundation, Project Advisory Committee Member: *Talking About Water: Vocabulary and Images that Support Informed Decisions about Water Recycling and Desalination,* 2008-2011
WateReuse Foundation, Project Advisory Committee Member: *Feasibility Study of Offshore Desalination Plants,* 2007-2010
Bay Area Clean Water Agencies, Chair, Water Recycling Committee, 2005-2009
American Water Works Association, Vice Chair, Water Resources Planning & Management Committee, 2006-2007
Water Environment Research Foundation, Member, Peer Review Committee for WERF Project: *Communicating Risks with Your Local Government and Community,* 2004-2006

MANISHA KOTHARI
525 Golden Gate Avenue, 10th Floor, San Francisco, CA, 94102
Tel: (415) 554-3256 (direct); E-mail: mkothari@sfwater.org

PROFESSIONAL EXPERIENCE

Project Manager
San Francisco, CA

5602 Utility Specialist
2007-Present

5620 Regulatory Specialist
2006-2007

San Francisco Public Utilities Commission (www.sfwater.org), *a department of the City and County of San Francisco that provides water and wastewater services in San Francisco; wholesale water to three Bay Area counties; and green hydroelectric and solar power to San Francisco's municipal departments*

Key responsibilities and achievements include:

- Manage project planning, environmental review, design, and implementation activities for complex capital improvement projects in the areas of recycled water, desalination and potable reuse.
- Manage water supply planning effort for the evaluation of key decisions affecting the SFPUC's post-2018 supply obligations (WaterMAP).
- Deliver project milestones on-time and within budget, including the successful implementation of the SFPUC's first two recycled water projects.
- Initiate, build, and manage long-term regional partnerships with other water and wastewater service providers in the Bay Area to develop strategic, collaborative, cost-effective water supplies.
- Lead public outreach efforts working with environmental groups, schools, local communities and regulatory agencies on behalf of multiple agencies to evaluate the potential for regional desalination and recycled water projects.
- Prepare and manage project reporting of the alternative local water supply portfolio
- Secured over $6 million in grant funds to support water supply projects.
- Successfully advanced projects that faced significant challenges from various groups through effective education and public outreach campaigns.

Sr Environmental Planner
2002-2006

URS Corporation (now part of AECOM www.aecom.com), *a global environmental and engineering consulting firm with expertise in the planning, assessment, design, and implementation of projects in over 65 countries worldwide.*

Key responsibilities and achievements include:

- Managed the environmental review, including stakeholder engagement and public outreach activities, for California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) compliance for various public and private capital projects in water, wetland restoration, natural resource development and transportation.
- Assisted with the development of corporate policies and initiatives for U.S. companies working in developing countries to address environmental justice and labor concerns.
- Prepared and won several competitive project and grant proposals.
- Contributed to the development of strategic business plans, identifying key growth areas and opportunities with the U.S. federal government and in Asia.

Program Manager, Asia
Arlington, VA

U.S. Trade and Development Agency (USTDA) (www.ustda.gov), *a foreign assistance agency of the U.S. federal government that grants seed capital for priority infrastructure projects in low and middle-income countries, while promoting job creation in the United States*

Key responsibilities and achievements included:

- Managed grant program for South and Southeast Asian countries, supporting the development of infrastructure in sectors including, banking, technology, transportation, environment, telecommunications, energy, and security
- Worked with the U.S. Departments of State and Commerce to re-engage political discourse on the subjects of human rights and nuclear non-proliferation through new trade initiatives in China, India and Pakistan
- Reviewed, assessed, and successfully recommended over 100 projects for federal grant assistance
- Worked with U.S. companies to ensure compliance with U.S. laws and policies, and the promotion of U.S. goods and services while working overseas
- Partnered with U.S. government agencies (including the Department of Commerce, OPIC, Ex-Im Bank, the FAA, DOE, and USAID), multilateral development banks (Asian Development Bank and World Bank) and other regional players to structure and implement projects
- Monitored performance of past investments and the associated impact on U.S. jobs and exports for annual Congressional and agency reports and to develop regional strategic priorities for the future
- Planned and executed roundtable discussions, conferences and study tours for Asian project sponsors
- Drafted marketing materials, public information briefs, presidential and congressional briefs, and press releases

EDUCATION

Georgetown University — Washington, DC

- Master of Science in Foreign Service (International/Public Policy) — 1998
  Landeggar Program in International Business-Government Relations

University of California, Berkeley — Berkeley, CA

- Bachelor of Arts, cum laude, in Political Science — 1996
- Bachelor of Arts in Mass Communications — 1996
- Semester-long internship with the United Nations High Commissioner for Refugees (UNHCR)
- (Political Communications position at headquarters in Geneva, Switzerland) — 1995

LANGUAGE SKILLS

Languages: Native speaker of ***English***, ***Hindi***; fluent in ***Thai***; working knowledge of ***French***

Andrew T. Salveson

Education

MS Water and Wastewater Engineering, University of California, Davis, 1994

BS Civil Engineering, San Jose State University, San Jose, California, 1993

Licenses

Civil Engineer, California

Professional Engineer, Texas, New Mexico

Professional Affiliations

International UV Association

Water Environment Foundation

Expert Services

Contributing Author, MOP 8, Design of Municipal Wastewater Treatment Plants

Editor of Reuse Treatment, EPA's 2012 Guidelines for Water Reuse

Contributing Author, National Water Research Institute, 2012 UV Guidelines

Contributing Author, National Water Research Institute DPR Framework

Contributing Author, World Health Institute Potable Water Reuse Guidelines

Mr. Salveson has 21 years of environmental consulting experience serving public and private-sector clients in the research and design of water and wastewater treatment systems. He is a nationally recognized expert in water reuse and disinfection. Mr. Salveson provides guidance and expertise on state-of-the-art technologies on the latest industry issues regarding reuse, as has led numerous planning, design, and research projects for various organizations, utilities, and corporations. In recognition of his contributions to the industry, Mr. Salveson was honored with the 2007 WateReuse Person of the Year Award for bringing innovative technologies to market.

Predesign/Design/Planning/ Permitting

- Project manager for the analysis of indirect and direct potable reuse feasibility for the Encina Wastewater Authority.
- Project manager for the analysis of indirect potable reuse treatment technologies for the Water Replenishment District, with Carollo as a subconsultant to CH2M HILL.
- Process engineer for the 30% design of MBR, UF, Ozone, UV, and chlorination membrane and UV disinfection for water reuse for the Barwon Water of Victoria Australia (Carollo teamed with SKM).
- Project manager for the potable reuse feasibility analysis for the Santa Clara Valley Water District, San Jose, California. Work includes expert services related to regulations, treatment, and the creation of a feasibility report for potable reuse.
- Project manager for the preliminary design of a microfiltration (MF)/reverse osmosis (RO)/advanced oxidization process (AOP) for streamflow augmentation with reclaimed water for the Southwest Florida Water Management District, Florida.
- Process advisor for the research and design of advanced membrane and carbon treatment technologies for the Synderville Basin Water Reclamation District, Utah.
- Technical assistance for the Santa Clara Valley Water District, California, Potable Reuse Grant Funding Program.
- Project manager for the City of Los Angeles Bureau of Sanitation for the analysis of alternative advanced oxidation technologies for potable reuse and subsequent permitting with the DDW for those technologies.
- Project engineer for the permitting of IPR for the City of Oxnard, California.
- Technical specialist for the IPR Design/Build for the City of Los Angeles Terminal Island Water Purification Facility.

Testing and Research

- Co-principal Investigator for the 2013 Texas Water Development Board Priority Research Topic Study, "Testing Water Quality in a Municipal Wastewater Effluent Treated to Drinking Water Standards." This study will develop and implement a detailed testing protocol at the Colorado River Municipal Water District's Raw Water Production Facility (RWPF) at Big Spring. This advanced treatment facility constitutes the nation's first instance of direct potable reuse (DPR). The project will also develop monitoring guidelines, based on in-depth parallel study of pathogens, chemicals, and appropriate surrogates, for use at DPR facilities like RWPF and others across the nation. The WateReuse Research Foundation
- Principal investigator for the WateReuse Research Foundation WERF Project 12-06, "Guidelines for Engineered Storage for Direct Potable Reuse" Work includes an evaluation of how to integrate Engineered Storage treatment and monitoring into Direct Potable Reuse Treatment trains.

- Principal investigator for the WateReuse Research Foundation Project 10-06, "Challenge Projects on Low Energy Treatment Schemes for Water Reuse" Work includes an evaluation of emerging treatment technologies for low energy treatment for water reuse.

- Co-principal investigator for the WERF project ENER4R12 – Low Energy Alternatives for Activated Sludge, Advancing AnMBR Research, Work includes the design and construction of three AnMBR treatment trains utilizing flat sheet, hollow fiber, and ceramic membranes.

- Co-principal investigator for the WateReuse Foundation's 11-02 "Equivalency of Advanced Treatment Trains for Potable Reuse). Work includes the search for lower energy and lower cost treatment technologies has increased the depth and breadth of this work through their tailored collaboration process.

- Principal investigator for Water Research Foundation Project 4536, Blending Requirements for Water from Direct Potable Reuse Treatment Facilities. This project examines the pathogens, pollutants, and subsequent water quality impacts to drinking water quality due to blending reclaimed water with other raw water supplies.

- Principal investigator for the WERF project CEC4R08, examining the most cost efficient method to reduce microconstituents. The project includes investigations of the secondary treatment process and comparisons with various tertiary methods to destroy microconstituents.

that meet the public health objectives for potable water reuse.

- Project manager for the treatment and analysis of Clean Water Services (Oregon) Direct Potable Reuse Demonstration Facility.

- Principal investigator for the WateReuse Foundation Project 10-10, "Filtration and Disinfection Compliance through Soil Aquifer Treatment." Work included detailed water quality monitoring pre and post SAT to prove treatment to Title 22 Standards.

- Principal investigator for the WateReuse Foundation Project 11-10, "Evaluation of Risk Reduction Principles for Direct Potable Reuse." This important project is examining the methods to modify our current approach to IPR design and operation for direct potable reuse systems.

- Project manager for the WateReuse Foundation's 06-019 "Monitoring for Microcontaminants in an Advanced Wastewater Treatment (AWT) Facility and Modeling Discharge of Reclaimed Water to Surface Canals for Indirect Potable Use " study. Work includes detailed trace organic

(EDC, etc.) analysis and in-vivo and in-vitro bioassays to determine hormonal impact, as well as surface water modeling to track fate and transport of trace organics.

- Co-principle investigator for the Australian Water Quality Center of Excellence Pasteurization Demonstration in Melbourne, Australia.

- Co-principal investigator for the WateReuse Foundation's 02-009 "Innovative Treatments for Reclaimed Water" study. Work includes detailed pathogen and micropollutant analysis and the investigation of innovative, but market ready, advanced oxidation technologies.

- Lead investigator for the performance evaluation of pasteurization for reclaimed water disinfection, a sustainable approach to harnessing waste energy for reclaimed water disinfection. Work resulted in the approval of pasteurization by the State of California for wastewater reuse. Demonstration testing has been completed at Santa Rosa, Ventura, and Graton, California.

- Project manager for the research and analysis of a microfiltration, reverse osmosis, and UV disinfection use for the potable reuse of wastewater at Dublin San Ramon Services District, California. The analysis addressed NDMA, standard DBPs, and endocrine disrupting compounds. This project received the 1999 California Water Environment Association Research Achievement Award.

- Technical advisor for the SFWMD to evaluate secondary and tertiary processes for microcontaminant removal and disinfection for 100+ mgd of wastewater to be potentially supplied to the Biscayne Bay as part of the Comprehensive Everglades Restoration Project (CERP). The investigation addresses advanced oxidation for microcontaminant destruction and examines standard compounds with drinking water MCLs, as well as numerous research-level compounds.

- Co-principal investigator for the WateReuse Foundation's 03-001 "Pathogen Removal and Inactivation in Reclamation Plants" study, which investigated the ability of various disinfectants to reduce pathogens of concern.

Shane A. Snyder Ph.D. snyders2@email.arizona.edu
Professor of Chemical and Environmental Engineering *(520) 621-2573*

Education

1994-2000	**Michigan State University, East Lansing, Michigan** – Ph.D. Environ. Toxicology/Zoology
1990-1994	**Thiel College, Greenville, Pennsylvania** – B.A. Chemistry (*Magna Cum Laude*)

Employment

2010-Present	**University of Arizona – Professor of Chemical and Environmental Engineering.**
2010-Present	**Arizona Laboratory for Emerging Contaminants (ALEC) – Co-Director.**
2013-Present	**Water & Energy Sustainable Technology Center (WEST) – Co-Director.**
2000-2010	**Research and Development – Project Manager.** Southern Nevada Water Authority, Las Vegas, Nevada. Develop and manage diversity of drinking and wastewater projects related to emerging
1998–Present	**Owner/Consultant.** Total Environmental Solutions Inc., Boulder City, Nevada.

Relevant Research Projects

2015	**CoPI - WateReuse Research Foundation:** "Advancing the Potential for Direct Potable Reuse through Novel Sensor Systems and Effective Decision Tools" Project 14-01
2014	**CoPI - Water Research Foundation**: "Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities"
2014	**CoPI – WateReuse Research Foundation:** "Integrating Sensor Data for Real-Time Decision Management" (Project# 14-01)
2013	**PI – CARD Technologies**: "Chemical Contaminant Attenuation with Catalytic Activated Carbon"
2012	**PI – Suez Environment:** "Advanced Treatment Technologies for RO/NF Brine Streams"
2012	**PI – PWN Technologies:** "Mutagenic Nitrogenous Compounds from UV and Nitrate Treatment"
2010	**PI - WateReuse Research Foundation:** "Use of UV and Fluorescence Spectra as Surrogate Measures for Contaminant Oxidation and Disinfection in the Ozone/H2O2 Advanced Oxidation Process"
2010	**Principal Investigator – Water Sustainability Program (University of Arizona):** "Parallel Evaluation of Ozone and UV Advanced Oxidation for Reducing Toxicity in Reclaimed Water"
2009	**PI - WateReuse Research Foundation:** "Use of Ozone in Water Reclamation for Contaminant Oxidation"

Recent Synergistic Efforts

2011-2016	**Visiting Professor.** National University of Singapore.
2014-Present	**World Health Organization.** Drinking water advisory panel.
2014-Present	**Co-Editor in Chief.** *Chemosphere* (Impact Factor 3.6)
2012-Present	**US EPA Science Advisory Board** Drinking Water Committee member.
2008-2011	**National Research Council**: Member of Water Reuse expert panel
2008-2013	**WateReuse Research Foundation:** Research Advisory Council (RAC) member

Recent Publications (from Google Scholar November 2014: h-index = 48; times cited = 9752)

2015	Anumol T and **Snyder SA.** *Rapid Analysis of Trace Organic Compounds in Water by Automated Online Solid-Phase Extraction Coupled to Liquid Chromatography-Tandem Mass Spectrometry.* Talanta. **132**:77-86.
2014	Sgroi M, Roccaro P, Oelker GL, **Snyder SA.** *N-Nitrosodimethylamine Formation upon Ozonation and Identification of Precursors Source in a Municipal Wastewater Treatment Plant.* Environmental Science & Technology 48(17):10308-10315.
2013	Drewes JE, Anderson P, Denslow N, Olivieri A, Schlenk D, **Snyder SA**, and K.A. Maruya. *Designing monitoring programs for chemicals of emerging concern in potable reuse - what to include and what not to include?* Water Science and Technology. **67**(2): 433-439.
2014	**Snyder SA.** *Emerging Chemical Contaminants: Looking for Better Harmony.* Journal of the American Water Works Association. **106**(8):38-52.
2014	Escher BI, et al. *Benchmarking Organic Micropollutants in Wastewater, Recycled Water and Drinking Water with In Vitro Bioassays.* Environ. Sci. Technol. **48**(3):1940-1956.
2013	Merel S, Walker D, Chicana R, **Snyder SA**, Baurès E, Thomas O. *State of knowledge and concerns on cyanobacterial blooms and cyanotoxins.* Environment International **59**:303-327.
2012	Bull RJ, Kolisetty N, Zhang XL, Muralidhara S, Quinones, Lim KY, Guo ZX, Cotruvo JA, Fisher JW, Yang XX, Delker D, **Snyder SA**, Cummings BS. *Absorption and disposition of bromate in F344 rats.* Toxicology. **300** (1-2):83-91.
2012	Pisarenko AN, Stanford BD, Yan DX, Gerrity D, **Snyder SA.** *Effects of ozone and ozone/peroxide on trace organic contaminants and NDMA in drinking water and water reuse applications.* Water Research. **46**(2):316-326.
2012	Mawhinney DB, Vanderford BJ, **Snyder SA.** Transformation of 1H-Benzotriazole by Ozone in Aqueous Solution. Environmental Science & Technology. 46(13):7102-7111.

2012	Pisarenko AN, Stanford BD, Yan DX, Gerrity D, **Snyder SA**. Effects of ozone and ozone/peroxide on trace organic contaminants and NDMA in drinking water and water reuse applications. Water Research. 46(2):316-326.
2011	Stanford BD, Pisarenko AN, Holbrook RD, **Snyder SA**. Preozonation Effects on the Reduction of Reverse Osmosis Membrane Fouling in Water Reuse. Ozone: Science & Engineering. 33(5):379-388.
2011	Gerrity D and **Snyder SA**. Review of Ozone for Water Reuse Applications: Toxicity, Regulations, and Trace Organic Contaminant Oxidation. Ozone Science and Engineering. 33:253-266.
2011	Sarp S, Stanford B, **Snyder SA**, Cho J. Ozone oxidation of desalinated seawater, with respect to optimized control of boron and bromate. Desalination and Water Treatment. 27:308-312.
2011	Dickenson ERV, **Snyder SA**, Sedlak DL, Drewes JE. Indicator Compounds for Assessment of Wastewater Effluent Contributions to Flow and Water Quality. Water Research 45:1199-1212.
2009	Dickenson ERV, Drewes JE, Sedlak DL, Wert EC, **Snyder SA**. Applying Surrogates and Indicators to Assess Removal Efficiency of Trace Organic Chemicals during Chemical Oxidation of Wastewaters. Environmental Science & Technology 43(16):6242-6247.
2009	Wert EC, Rosario FL, **Snyder SA**. Effect of Ozone Exposure on the Oxidation of Trace Organic Contaminants in Water. Water Research. 43:1005-1014.
2009	Wert EC, Rosario FL, **Snyder SA**. Using UV Absorbance and Color to Assess Pharmaceutical Oxidation during Ozonation of Wastewater. Environmental Science & Technology. 43(13):4858-4863.
2008	Ikehata K, El-Din MG, **Snyder SA**. Ozonation and Advanced Oxidation Treatment of Emerging Organic Pollutants in Water and Wastewater. Ozone Science & Engineering. 30(1):21-26.
2008	Rosario-Ortiz FL, Mezyk SP, Doud DFR, Wert EC, **Snyder SA**. Effect of Ozone Oxidation on the Molecular and Kinetic Properties of Effluent Organic Matter. Journal of Applied Oxidation Technologies. 11(3):529-535
2007	Lei H and **Snyder SA**. 3D QSPR models for the removal of trace organic contaminants by ozone and free chlorine. Water Research 41:3271-3280
2007	Wert EC, Rosario-Ortiz FL, Drury DD, **Snyder SA**. Formation of Oxidation Byproducts from Ozonation of Wastewater. Water Research. 41:1481-1490
2006	**Snyder SA**, Wert EC, Rexing DJ, Zegers RE, Drury DD. Ozone Oxidation of Endocrine Disruptors and Pharmaceuticals in Surface Water and Wastewater. Ozone Science & Engineering. 28:445-460

REFERENCES

Anumol, T., Sgroi, M., Park, M., Roccaro, P., Snyder, S.A. 2015. Predicting Trace Organic Compound Breakthrough in Granular Activated Carbon using Fluorescence and UV Absorbance as Surrogates. *Water Research*, 76:76-87.

Australian Academy of Technological Sciences and Engineering (ATSE), 2013. Drinking Water through Recycling: The Benefits and Costs of Supplying Direct to the Distribution System." Australian Water Recycling Centre of Excellence. Melbourne, Australia.

CDPH 2014. Groundwater Replenishment Using Recycled Water (Water Recycling Criteria. Title 22, Division 4, Chapter 3, California Code of Regulations). California State Water Resources Control Board Division of Drinking Water.

Clean Water Services 2014. Direct Potable Reuse Water Reuse Demonstration. Carollo Engineers for Clean Water Services, Oregon.

Escher, B.I. , Allinson, M. Altenburger, R., Bain, P.A., Balaguer, P., Busch, W., Crago, J., Denslow, N.D., Dopp, E., Hilscherova, K. *et al* 2014. Benchmarking Organic Micropollutants in Wastewater, Recycled Water and Drinking Water with In Vitro Bioassays. *Environmental Science and Technology*, 48(3):1940-1956.

Gerrity, D., Gamage, S., Jones, D., Korshin, G.V., Lee, Y., Pisarenko, A., Trenholm, R.A., von Gunten, U., Wert, E.C., Snyder, S.A. 2012. Development of Surrogate Correlation Models to Predict Trace Organic Contaminant Oxidation and Microbial Inactivation during Ozonation. *Water Research*, 46(19):6257-6272.

Giesy, J.P., Hilscherova, K., Jones, P.D., Kannan, K., Machala, M. 2002. Cell Bioassays for Detection of Aryl Hydrocarbon (AhR) and Estrogen Receptor (ER) Mediated Activity in Environmental Samples. *Marine Pollution Bulletin*, 45(1-12):3-16.

Henderson, R. K., Baker, A., Murphy, K. R., Hambly, A., Stuetz, R. M., and Khan, S. J. 2009. Fluorescence as a Potential Monitoring Tool for Recycled Water Systems: A Review. *Water Research*, *43*(4), 863–881. http://doi.org/10.1016/j.watres.2008.11.027.

Hijnen, W., Beerendonk, E. and Medema, G. 2006. Inactivation Credit of UV Radiation for Viruses, Bacteria and Protozoan (oo) Cysts in Water: A Review. *Water Research*, 40, 1, 3-22.

Jarosova, B., Blaha, L., Vrana, B., Randak, T., Grabic, R., Giesy, J.P., Hilscherova, K. 2012. Changes in Concentrations of Hydrophilic Organic Contaminants and of Endocrine-Disrupting Potential Downstream of Small Communities Located Adjacent to Headwaters. *Environment International*, 45:22-31.

Jia, A., Escher, B.I., Leusch, F.D.L., Tang, J.Y.M., Prochazka, E., Dong, B., Snyder, E.M., Snyder, S.A. 2015 In Vitro Bioassays to Evaluate Complex Chemical Mixtures in Recycled Water. *Water Research*, 80(0):1-11.

Kitis, M., Lozier, J.C., Kim, J.H., Mi, B., and Marinas, B.J, 2003. Microbial Removal and Integrity Monitoring of RO and NF Membranes." *AWWA*, 95, 12, 105-119.

Merel, S., Anumol, T., Park, M., Snyder, S.A. 2015. Application of Surrogates, Indicators, and High-Resolution Mass Spectrometry to Evaluate the Efficacy of UV Processes for Attenuation of Emerging Contaminants in Water. *Journal of Hazardous Materials*, 282:75-85. 2 NRMMC/EPHC/NHMRC 2008. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Augmentation of Drinking Water Supplies, Australia.

NRMMC/EPHC/NHMRC 2008. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Augmentation of Drinking Water Supplies, Australia.

NRC 2012. Water Reuse: Potential for Expanding the Nation's Water Supply through Reuse of Municipal Wastewater. National Academies Press, Washington, D.C.

NSF 2012. Siemens Industry, Inc. L10N and L20N Ultrafiltration Modules, Product-Specific Challenge Tests for Cryptosporidium and Virus Removal Credits under LT2ESWTR. NSF Certification for Public Drinking Water Equipment Performance. Ann Arbor, Michigan. September 2012.

NWRI 2015. Report of an NWRI Expert Panel for Developing a Direct Potable Reuse Framework." Alexandria, VA. Co-sponsored by American Water Works Association and the Water Environment Foundation.

Pype, M. L., Patureau, D., Wery, N., Poussade, Y., and Gernjak, W. 2013. Monitoring Reverse Osmosis Performance: Conductivity vs Fluorescence Excitation–Emission Matrix (EEM). *Journal of Membrane Science*, *428*, 205–211.

Reardon, R., DiGiano, F., Aitken, M., Paranjape, S., Kim, J., and Chang, S. 2005. "Membrane Treatment of Secondary Effluent for Subsequent Use." Water Environmental Research Foundation Project 01-CTS-6 Final Report, Washington, DC.

Rochelle, P., Upton S., Montelone, B., and Woods, K. 2005. The Response of Cryptosporidium Parvum to UV Light: Trends in Parasitology. 21, 2, 81-87.

Salveson, A., Mackey, E., Salveson, M., Flynn, M. 2014. Application of Risk Reduction Principles to Direct Potable Reuse, Final Report for WateReuse Research Foundation Project No. 11-10, Alexandria, VA.

Sanderson J.T., Aarts J, Brouwer A, Froese K.L., Denison M.S., and Giesy J.P. 1996. Comparison of Ah Receptor-Mediated Luciferase and Ethoxyresorufin-O-Deethylase Induction in H4IIE Cells: Implications for Their Use as Bioanalytical Tools for the Detection of Polyhalogenated Aromatic Hydrocarbons. *Toxicology and Applied Pharmacology*, 137(2):316- 325

Schäfer, A.I., Fane, A.G. and Waite, T.D. 2005. Nanofiltration, Principles and Applications. Elsevier.

Sharpless, C. and Linden, K. 2003. Experimental and Model Comparisons of Low- and Medium- Pressure Hg Lamps for the Direct and H2O2 Assisted UV Photodegradation of N-Nitrosodimethylamine in Simulated Drinking Water. *Environmental Science and Technology*, *37*, 1933-1940.

Snyder, S.A, Villeneuve, D.L., Snyder, E.M., Giesy, J.P. 2012. Identification and Quantification of Estrogen Receptor Agonists in Wastewater Effluents. *Environmental Science and Technology* 2001, 35(18):3620-3625.

Stavreva, D.A., George A.A., Klausmeyer, P., Varticovski, L., Sack, D., Voss, T.C., Schiltz, R.L., Blazer, V.S., Iwanowicz, L.R., Hager, G.L. 2012. Prevalent Glucocorticoid and Androgen Activity in US Water Sources. *Scientific Reports*, 2:937. 3 SWRCB 2015. California Water Boards: Recycled Water Research Workshop." Costa Mesa CA,

Steinle-Darling, E., Juby, G.; Salveson, A. 2015. "Direct Potable Reuse - Full-Scale Demonstrations Testing Results from Big Spring, Texas. Proceedings from California Water Environment Association Conference.

SWRCB 2015. California Water Boards: Recycled Water Research Workshop." Costa Mesa CA,

Tchobanoglous, G., Leverenz, H.L., Nellor, M.H. and Crook, J. 2011. Direct Potable Reuse: A Path Forward. WateReuse Research Foundation and WateReuse California, Alexandria, VA.

Trussell, R. R.; Salveson, A.; Snyder, S. A.; Trussell, R. S.; Gerrity, D.; Pecson, B. M. 2013. Potable Reuse: State of the Science Report and Equivalency Criteria for Treatment Trains. WateReuse Research Foundation, Alexandria, VA.

USEPA 1990. Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public water Systems Using Surface Water Sources, Office of Drinking Water, prepared by Malcolm Pirnie, Inc. and HDR Engineering, Inc. under EPA Contract no. 68-01- 6989, Washington, DC.

USEPA 2006. Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule, EPA Office of Water (4601), EPA 815-R-06-007, Washington, DC.

Water Replenishment District. 2013. Amended Title 22 Engineering Report for the Leo. J. Vander Lans Water Treatment Facility Expansion: Alamitos Barrier Recycled Water Project.

Yu, H-W., Anumol, T., Park, M., Pepper, I., Scheideler, J., Snyder, S.A. 2015. On-line Sensor Monitoring for Chemical Contaminant Attenuation During UV/H_2O_2 Advanced Oxidation Process. *Water Research*, 81(0):250-260.

7-2279 (02-2016)
Bureau of Reclamation

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ASSISTANCE AGREEMENT

1A. AGREEMENT NUMBER	1B. MOD NUMBER	2. TYPE OF AGREEMENT	3. CLASS OF RECIPIENT
File Number		☐ GRANT ☒ COOPERATIVE AGREEMENT	Entity Type

4. ISSUING OFFICE	5. RECIPIENT
Bureau of Reclamation Financial Assistance Services 84-27850 P.O. Box 25007 Denver Colorado 80225	Entity Address Address

EIN #:		County:	
DUNS #:		Congress. Dist:	ST- ###

6. GRANTS MANAGEMENT SPECIALIST	7. RECIPIENT PROJECT MANAGER
Janeen Koza Bureau of Reclamation Financial Assistance Operations 84-27852 P.O. Box 25007 Denver Colorado 80225 303-445-3446 jkoza@usbr.gov	Name, Title Entity Address Address phone email

8. GRANTS OFFICER TECHNICAL REPRESENTATIVE	9A. INITIAL AGREEMENT EFFECTIVE DATE:	9B. MODIFICATION EFFECTIVE DATE:
Name, Title Bureau of Reclamation, Name of Office Address Address phone email	See block 17.a below	
	10. COMPLETION DATE Date	

11A. PROGRAM STATUTORY AUTHORITY	11B. CFDA Number
Omnibus Public Land Management Act of 2009, Public Law 111-11, Section 9509	15.506

12. FUNDING INFORMATION	RECIPIENT/OTHER	RECLAMATION
Total Estimated Amount of Agreement		
This Obligation		
Previous Obligation		
Total Obligation		
Cost-Share %		

13. REQUISITION NUMBER
002XXXXXXX

14A. ACCOUNTING AND APPROPRIATION DATA
Fund:
WBS:

14B. TREASURY ACCOUNT FUNDING SYMBOL
14X0680

15. PROJECT TITLE

16a. Acceptance of this Assistance Agreement in accordance with the terms and conditions contained herein is hereby made on behalf of the above-named recipient	17a. Award of this Assistance Agreement in accordance with the terms and conditions contained herein is hereby made on behalf of the United States of America, Department of the Interior, Bureau of Reclamation
BY: _____	BY: _____
DATE: _____	DATE: _____
16b. NAME, TITLE, AND TELEPHONE NUMBER OF SIGNER ☐ Additional signatures are attached	17b. NAME OF GRANTS OFFICER Wilson Orvis 303-445-2444

TABLE OF CONTENTS[IHM1]

I. OVERVIEW AND SCHEDULE

II. RECLAMATION STANDARD TERMS AND CONDITIONS

Grant / Cooperative Agreement
Between
Bureau of Reclamation
And
Recipient
For
Project

I. OVERVIEW AND SCHEDULE

1. AUTHORITY

This Grant/Cooperative Agreement (Agreement) is entered into between the United States of America, acting through the Department of the Interior, Bureau of Reclamation, hereinafter referred to as "Reclamation," and **RECIPIENT**, hereinafter referred to as the "Recipient" or "Grantee," pursuant to the **OMNIBUS PUBLIC LAND MANAGEMENT ACT OF 2009, Public Law 111-11, Section 9509** (the "Act"). The following section, provided in full text, authorizes Reclamation to award this financial assistance agreement:

> **Public Law 111-11, Section 9509, Research Agreement Authority**
>
> *The Secretary may enter into contracts, grants, and cooperative agreements, for periods not to exceed 5 years, to carry out research within the Bureau of Reclamation.*

2. PUBLIC PURPOSE OF SUPPORT OR STIMULATION

Through the Desalination and Water Purification Research and Development (DWPR) Program, Reclamation funds research where the benefits are widespread as well as research where the issues are of large-scale concern and the benefits accrue to a large sector of the public.

The proposed Project Name project (Project) describe project benefits here

3. BACKGROUND AND OBJECTIVES

Reclamation is forming partnerships with private industry, universities, water utilities, and others to address a broad range of desalting and water purification needs. Reclamation is interested in research where the benefits are widespread but where private-sector entities are not able to make the full investment and assume all the risks. Reclamation is also interested in research that has a national significance— where the issues are of large-scale concern and the benefits accrue to a large sector of the public.

The goal of the DWPR Program is to reduce the costs and environmental impacts of treating impaired and unusable waters. The program has aligned its objectives with the strategic desalination research agenda from National Research Council's *Desalination: A National Perspective.* Washington, D.C.: National Research Council of the National Academies, 2008 and *Water Reuse* Washington, D.C.: National Research Council of the National Academies, 2012. These objectives include:

- Assessment of environmental impacts of desalination intake and concentrate management approaches
- Development of improved intake methods at coastal facilities to minimize impingement of larger organisms and entrainment of smaller ones
- Assessment of the quantity and distribution of brackish water resources nationwide
- Improvement of pretreatment for membrane desalination
- Improvement of membrane system performance
- Improvement of existing desalination approaches to reduce primary energy use
- Development of novel approaches or processes to desalinate water in a way that reduces primary energy use

Insert Project Description from AID

4. PERIOD OF PERFORMANCE AND FUNDS AVAILABILITY

This Agreement becomes effective on the date shown in Block 17a of Form 7-2279, United States of America, Department of the Interior, Bureau of Reclamation, Assistance Agreement. The Agreement shall remain in effect until the date shown in Block 10 of Form 7-2279, United States of America, Department of the Interior, Bureau of Reclamation, Assistance Agreement. The period of performance for this Agreement may only be modified through written modification of the Agreement by a Reclamation Grants Officer (GO).

No legal liability on the part of the Government for any payment may arise until funds are made available, in writing, to the Recipient by the Grants Officer. The total estimated amount of federal funding for this agreement is **$XXXXXXX** of which the initial amount of federal funds available is limited to **$XXXXXXX** as indicated by "this obligation" within Block 12 of Form 7-2279, United States of America, Department of the Interior, Bureau of Reclamation, Assistance Agreement. Subject to the availability of Congressional appropriations, subsequent funds will be made available for payment through written modifications to this agreement by a Reclamation Grants Officer.

5. SCOPE OF WORK AND MILESTONES

Include the Detailed Project Plan here (Scope of Work). The project plan must describe, in detail, the activities to be undertaken, including the proposed work, reporting, major tasks, and project milestones including the identification of the anticipated start and ending dates of all major stages/tasks of the project proposal. It is highly recommended that the milestones within the SOW are constructed around the reporting frequency. For example, if the reporting frequency is semi-annual, then there would be milestones for each semi-annual period.

The full proposal, *Proposal Title,* submitted in response to Funding Opportunity Announcement R16-FOA-DO-009/010, Fiscal Year 2016 Desalination and Water Purification Research Program, is incorporated herein via reference. It includes the detailed technical approach, assumptions, key personnel, and other details regarding the Project.

Milestone / Task / Activity	Planned Start Date	Planned Completion Date

6. RESPONSIBILITY OF THE PARTIES

6.1 Recipient Responsibilities

6.1.1 The Recipient shall carry out the Scope of Work (SOW) in accordance with the terms and conditions stated herein. The Recipient shall adhere to Federal, state, and local laws, regulations, and codes, as applicable, and shall obtain all required approvals and permits. If the SOW contains construction activities, the Recipient is responsible for construction inspection, oversight, and acceptance. If applicable, the Recipient shall also coordinate and obtain approvals from site owners and operators.

6.1.2 Reporting. Recipient will prepare and submit to Reclamation interim Project performance reports (Interim Reports) and a final Project performance report (Final Report) as required by Section I.9 of this Agreement.

Each Interim Report will include (but is not limited to) the information identified in paragraph I.9.3 and the following:

- For each project or activity within a task, identify the start date and anticipated completion date as well as the work conducted within the reporting period.
- Describe any significant accomplishments as well as any unanticipated delays encountered during the reporting period.
- Discuss whether the activities comprising the agreement are on schedule to meet expected completion date. If not, discuss the actions being taken bring the activities back on schedule.
- State the progress of spending within each task.
- Compare spending in each task relative to the planned expenditures and provide an explanation for any discrepancies.
- Sufficient information to allow for tracking of project expenditures for each task.
- Copies of any presentations (in pdf format) given at conferences and any journal publications that have resulted from this study during the reporting period.
- A minimum of 2 powerpoint slides at the end of 2nd and 4th quarter that summarize the project and any findings up to that date. Do not include any intellectual property or confidential information.

The Final Report will include the information identified in paragraph I.9.3 in the format specified by Reclamation. Recipient shall submit a draft of the Final Report for GOTR review and input prior to the end of the period of performance. Recipient must incorporate any GOTR input received as part of the finalization of the Final Report. Recipient understands that the Final Report is a public document and will be made available on Reclamation's website.

6.1.3. Presentation. In accordance with the Funding Opportunity Announcement, at the time of delivery of the draft final report, the Principle Investigator / Project Manager shall make a presentation to Reclamation in Denver on the achievements of the project. This presentation shall inform Reclamation on the project accomplishments, the final results of each task item, and suggestions for future work.

6.1.4. Publications. Recipient shall submit a draft of any proposed publications for GOTR review and input prior to publication. Recipient must incorporate any GOTR input received as part of the finalization of the publication. Recipient understands that Reclamation may make publicly available any publications made as a result of this cooperative agreement. Recipient will follow publication guidelines at www.usbr.gov/research/AWT/DWPR/appendix16-4.pdf.

6.1.X. Identify any activities/responsibilities specific to this agreement to be performed by the Recipient in support of this agreement

6.1.X Identify any special terms and conditions identified as mitigation actions in the BE&RD

Additional as needed terms and conditions can be found at H:\Acquisition Share\84-27850-FA\84-27852 FAOS\DO FA FORMS

6.2 Reclamation Responsibilities

6.2.1 Reclamation will monitor and provide Federal oversight of activities performed under this Agreement. Monitoring and oversight includes review and approval of financial status and performance reports, payment requests, and any other deliverables identified as part of the SOW. Additional monitoring activities may include site visits, conference calls, and other on-site and off-site monitoring activities. At the Recipient's request, Reclamation may also provide technical assistance to the Recipient in support of the SOW and objectives of this Agreement.

6.2.2 Substantial involvement by Reclamation is anticipated during the performance of activities funded under this cooperative agreement. In support of this Agreement, Reclamation will be responsible for the following:

- Coordination of contributions made by team members from the different partners and evaluating successes as each task is undertaken as well as suggesting changes to tasks to accomplish project goals.

- Review, input, and approval of draft and final research outcomes including the final research report.

6.2.X Identify any activities/responsibilities specific to this agreement to be performed by Reclamation in support of this agreement. Reclamation may have additional responsibilities that do not constitute substantial involvement – thus grant agreements may list additional responsibilities, not just cooperative agreements.

7. BUDGET

7.1 Budget Estimate. The following is the estimated budget for this Agreement. As Federal financial assistance agreements are cost-reimbursable, the budget provided is for estimation purposes only. Final costs incurred under the budget categories listed may be either higher or lower than the estimated costs. All costs incurred by the Recipient under this agreement must be in accordance with any pre-award clarifications conducted between the Recipient and Reclamation, as well as with the terms and conditions of this agreement. Final determination of the allowability, allocability, or reasonableness of costs incurred under this agreement is the responsibility of the Grants Officer. Recipients are encouraged to direct any questions regarding allowability, allocability or reasonableness of costs to the Grants Officer for review prior to incurrence of the costs in question.

INSERT BUDGET TABLE HERE

FUNDING SOURCES	PERCENT TOTAL PROJECT COST	TOTAL COST BY SOURCE
RECIPIENT FUNDING		$
OTHER NON-FEDERAL FUNDING (SPECIFY SOURCE)		$
RECLAMATION FUNDING		$
OTHER FEDERAL FUNDING (SPECIFY SOURCE)		$
TOTALS		**$**

7.2 Cost Sharing Requirement

Non-Federal cost-share is not required for this Agreement.

OR

At least ____% non-Federal cost-share is required for costs incurred under this Agreement. If pre-award costs are authorized, reimbursement of these costs is limited to federal cost share percentage identified in this agreement.

The Federal share of allowable costs shall not be expended in advance of the Recipient's non-Federal share. It is expected that expenditure of Federal and non-Federal funds shall occur concurrently based upon the cost share percentages reflected in Block 12 of Form 7-2279 United States of America, Department of the Interior, Bureau of Reclamation, Assistance Agreement. At the end of the period of performance, if the final costs are lower than the original estimate and the _____% nonfederal cost share is met, the final payment and financial report can reflect a lower Recipient cost share than the original budget estimate.[IHM2]

If a bona fide need arises which requires the expenditure of Federal funds in advance of the Recipient share, then the Recipient must request written approval from the Grants Officer prior to the expenditure. Recipient's may expend their agreed upon share of costs in advance of the expenditure of Federal funds without prior written approval.

OR

Use this when there is no required cost-share but Recipient is providing cost-share voluntarily

Non-Federal cost-share for this Agreement is not required by the Act; however, Recipient agrees to provide non-Federal cost share necessary to complete the SOW. As of the effective date of this Agreement, approximately ____% non-Federal cost-share ($_____) is estimated for costs incurred under this Agreement. Recipient will report on this non-Federal cost-share in the Financial Status Reports required under Section I.9.2 of this Agreement.

The Federal share of allowable costs shall not be expended in advance of the Recipient's non-Federal share. It is expected that expenditure of Federal and non-Federal funds shall occur concurrently based upon the cost share percentages reflected in Block 12 of Form 7-2279 United States of America, Department of the Interior, Bureau of Reclamation, Assistance Agreement. At the end of the period of performance, if the final costs are lower than the original estimate, the final payment and financial report can reflect a lower Recipient cost share than the original budget estimate.

If a bona fide need arises which requires the expenditure of Federal funds in advance of the Recipient share, then the Recipient must request written approval from the Grants Officer prior to the expenditure. Recipient's may expend their agreed upon share of costs in advance of the expenditure of Federal funds without prior written approval.

7.3 Pre-Award Incurrence of Costs

The Recipient shall be entitled to reimbursement for costs incurred on or after [(date)_____, [IHM3]which if had been incurred after this Agreement was entered into, would have been allowable, allocable, and reasonable under the terms and conditions of this Agreement.

OR

The Recipient is not authorized to incur costs prior to the award of this Agreement. Costs incurred prior to the award of this agreement are not allowable.

7.4 Allowable Costs (2 CFR Subpart E §200.400 through §200.475)

Costs incurred for the performance of this Agreement must be allowable, allocable to the project, and reasonable. The following regulations, codified within the Code of Federal Regulations (CFR), governs the allowability of costs for Federal financial assistance:

2 CFR Subpart E, "Cost Principles"

Expenditures for the performance of this Agreement must conform to the requirements within this CFR. The Recipient must maintain sufficient documentation to support these expenditures. Questions on the allowability of costs should be directed to the GO responsible for this Agreement.

The Recipient shall not incur costs or obligate funds for any purpose pertaining to operation of the program or activities beyond the expiration date stated in the Agreement. The only costs which are authorized for a period of up to 90 days following the project performance period are those strictly associated with closeout activities for preparation of the final reports. However, in accordance with 2 CFR §200.461(3), Recipient may charge this award before closeout for the costs of publication of research results if the costs are not incurred during the period of performance of the Agreement.

7.5 Revision of Budget and Program Plans (2 CFR §200.308)

Use this section for non-construction awards

In accordance with 2 CFR §200.308(c)-(e) the recipient must request prior written approval for any of the following changes:

a) A change in the approved scope of work or associated tasks, even if there is no associated budget revisions.

b) Change in key personnel specified in section 8 "Key Personnel" of this agreement.

c) Changes in the approved cost-sharing or matching outlined within this agreement in section 7.2 "Cost Share requirements"

d) Inclusion of pre-award costs or reimbursement for pre-award costs which are not included in the initially approved budget and included in section 7.3 "Pre-Award Incurrence of Costs" of this agreement.

e) Extensions to the Completion Date outlined in block 10 of the coversheet (form 7-2279) of this agreement.

f) The transfer of funds between direct cost categories, functions, and activities for which the expected transfer amount is to exceed 10 percent of the total approved budget.

7.6 Modifications

Any changes to this Agreement shall be made by means of a written modification. Reclamation may make changes to the Agreement by means of a unilateral modification to address administrative matters, such as changes in address, no-cost time extensions, changes to Reclamation Key Personnel, or the addition of previously agreed upon funding. Additionally, a unilateral modification may be utilized by Reclamation if it should become necessary to suspend or terminate the Agreement in accordance with 2 CFR §200.338.

All other changes shall be made by means of a bilateral modification to the Agreement. No oral statement made by any person, or written statement by any person other than the GO, shall be allowed in any manner or degree to modify or otherwise effect the terms of the Agreement.

All requests for modification of the Agreement shall be made in writing, provide a full description of the reason for the request, and be sent to the attention of the GO. Any request for project extension shall be made at least 45 days prior to the expiration date of the Agreement or the expiration date of any extension period that may have been previously granted. Any determination to extend the period of performance or to provide follow-on funding for continuation of a project is solely at the discretion of Reclamation.

8. KEY PERSONNEL

8.1 Recipient's Key Personnel

The Recipient's Project Manager for this Agreement shall be:

From coversheet[IHM4]

Additional key personnel for this Agreement are identified as follows:

Fill this in (If applicable) If not, remove this section.

8.2 Reclamation's Key Personnel

8.2.1 Grants Officer (GO):

Wilson Orvis
Bureau of Reclamation
Financial Assistance Operations 84-27852
P.O. Box 25007
Denver Colorado 80225
303-445-3446
worvis@usbr.gov

(a) The GO is the only official with legal delegated authority to represent Reclamation. The GO's responsibilities include, but are not limited to, the following:

(1) Formally obligate Reclamation to expend funds or change the funding level of the Agreement;

(2) Approve through formal modification changes in the scope of work and/or budget;

(3) Approve through formal modification any increase or decrease in the period of performance of the Agreement;

(4) Approve through formal modification changes in any of the expressed terms, conditions, or specifications of the Agreement;

(5) Be responsible for the overall administration, management, and other non-programmatic aspects of the Agreement including, but not limited to, interpretation of financial assistance statutes, regulations, circulars, policies, and terms of the Agreement;

(6) Where applicable, ensures that Reclamation complies with the administrative requirements required by statutes, regulations, circulars, policies, and terms of the Agreement.

8.2.2 Grants Officer Technical Representative (GOTR):

From coversheet

(a) The GOTR's authority is limited to technical and programmatic aspects of the Agreement. The GOTR's responsibilities include, but are not limited to, the following:

(1) Assist the Recipient, as necessary, in interpreting and carrying out the scope of work in the Agreement;

(2) Review, and where required, approve Recipient reports and submittals as required by the Agreement;

(3) Where applicable, monitor the Recipient to ensure compliance with the technical requirements of the Agreement;

(4) Where applicable, ensure that Reclamation complies with the technical requirements of the Agreement;

(b) The GOTR does not have the authority to and may not issue any technical assistance which:

(1) Constitutes an assignment of additional work outside the scope of work of the Agreement;

(2) In any manner causes an increase or decrease in the total estimated cost or the time required for performance; or

(3) Changes any of the expressed terms, conditions, or specifications of the Agreement.

8.2.3 Grants Management Specialist. The Grants Management Specialist is the primary administrative point of contact for this agreement and should be contacted regarding issues related to the day-to-day management of the agreement. Requests for approval regarding the terms and conditions of the agreement, including but not limited to modifications and prior approval, may only be granted, in writing, by a Reclamation Grants Officer. Please note that for some agreements, the Grants Officer and the Grants Management Specialist may be the same individual.

Janeen Koza
Bureau of Reclamation
Financial Assistance Operations 84-27852
P.O. Box 25007
Denver Colorado 80225
303-445-3446
jkoza@usbr.gov

9. REPORTING REQUIREMENTS AND DISTRIBUTION

9.1 Noncompliance. Failure to comply with the reporting requirements contained in this Agreement may be considered a material noncompliance with the terms and conditions of the award. Noncompliance may result in withholding of payments pending receipt of required reports, denying both the use of funds and matching credit for all or part of the cost of the activity or action not in compliance, whole or partial suspension or termination of the Agreement, recovery of funds paid under the Agreement, withholding of future awards, or other legal remedies in accordance with 2 CFR §200.338.

9.2 Financial Reports. Financial Status Reports shall be submitted by means of the SF-425 and shall be submitted according to the Report Frequency and Distribution schedule below. All financial reports shall be signed by an Authorized Certifying Official for the Recipient's organization.

9.3 Monitoring and reporting program performance (2 CFR §200.328)

(a) Monitoring by the non-Federal entity. The non-Federal entity is responsible for oversight of the operations of the Federal award supported activities. The non-Federal entity must monitor its activities under Federal awards to assure compliance with applicable Federal requirements and performance expectations are being achieved. Monitoring by the non-Federal entity must cover each program, function or activity. See also §200.331 Requirements for pass-through entities.

(b) Non-construction performance reports. The Federal awarding agency must use standard, OMB-approved data elements for collection of performance information (including performance progress reports, Research Performance Progress Report, or such future collections as may be approved by OMB and listed on the OMB Web site).

(1) The non-Federal entity must submit performance reports at the interval required by the Federal awarding agency or pass-through entity to best inform improvements in program outcomes and productivity. Intervals must be no less frequent than annually nor more frequent than quarterly except in unusual circumstances, for example where more frequent reporting is necessary for the effective monitoring of the Federal award or could significantly affect program outcomes. Annual reports must be due 90 calendar days after the reporting period; quarterly or semiannual reports must be due 30 calendar days after the reporting period. Alternatively, the Federal awarding agency or pass-through entity may require annual reports before the anniversary dates of multiple year Federal awards. The final performance report will be due 90 calendar days after the period of performance end date. If a justified request is submitted by a non-Federal entity, the Federal agency may extend the due date for any performance report.

(2) The non-Federal entity must submit performance reports using OMB-approved governmentwide standard information collections when providing performance information. As appropriate in accordance with above mentioned information collections, these reports will contain, for each Federal award, brief information on the following unless other collections are approved by OMB:

(i) A comparison of actual accomplishments to the objectives of the Federal award established for the period. Where the accomplishments of the Federal award can be quantified, a computation of the cost (for example, related to units of accomplishment) may be required if that information will be useful. Where performance trend data and analysis would be informative to the Federal awarding agency program, the Federal awarding agency should include this as a performance reporting requirement.

(ii) The reasons why established goals were not met, if appropriate.

(iii) Additional pertinent information including, when appropriate, analysis and explanation of cost overruns or high unit costs.

(c) Construction performance reports. For the most part, onsite technical inspections and certified percentage of completion data are relied on heavily by Federal awarding agencies and pass-through entities to monitor progress under Federal awards and subawards for construction. The Federal awarding agency may require additional performance reports only when considered necessary.

(d) Significant developments. Events may occur between the scheduled performance reporting dates that have significant impact upon the supported activity. In such cases, the non-Federal entity must inform the Federal awarding agency or pass-through entity as soon as the following types of conditions become known:

(1) Problems, delays, or adverse conditions which will materially impair the ability to meet the objective of the Federal award. This disclosure must include a statement of the action taken, or contemplated, and any assistance needed to resolve the situation.

(2) Favorable developments which enable meeting time schedules and objectives sooner or at less cost than anticipated or producing more or different beneficial results than originally planned.

Reclamation requires Performance reporting for all financial assistance awards, both Construction and non-Construction. Performance reports for Construction agreements shall meet the same minimum requirements outlined in 2 CFR §200.328(b)(2) above.

9.4 Report Frequency and Distribution. The following table sets forth the reporting requirements for this Agreement. Please note the first report due date listed for each type of report.

Required Reports	Interim Reports	Final Report
Performance Report		

Required Reports	Interim Reports	Final Report
Format	No specific format required. See content requirements within Section 9.3 (2 CFR §200.328) and Section 6.1.2 above.	Summary of activities completed during the entire period of performance is required. See content requirements within Section 9.3 (2 CFR §200.328) above.
Reporting Frequency	Quarterly	Final Report due after completion of Agreement's period of performance
Reporting Period	Federal fiscal quarters ending: December 31, March 31, June 30 September 30	Entire period of performance
Due Date*	Within 30 days after the end of the Reporting Period.	Within 90 days after the completion date of the Agreement
First Report Due Date	The first performance report is due for reporting period ending December 31/ March 31/ June 30/ September 30, 20XX	N/A
Submit to:	**sha-dro-faoperations@usbr.gov**	**sha-dro-faoperations@usbr.gov**
Federal Financial Report		
Format	SF-425 (all sections must be completed)	SF-425(all sections must be completed)
Reporting Frequency	Quarterly	Final Report due after completion of Agreement's period of performance
Reporting Period	Federal fiscal quarters ending: December 31, March 31, June 30 September 30	Entire period of performance
Due Date*	Within 30 days after the end of the Reporting Period.	Within 90 days after the completion date of the Agreement
First Report Due Date	The first Federal financial report is due for reporting period ending December 31/ March 31/ June 30/ September 30, 20XX	N/A
Submit to:	**sha-dro-faoperations@usbr.gov**	**sha-dro-faoperations@usbr.gov**

* If the completion date is prior to the end of the next reporting period, then no interim report is due for that period. Instead, the Recipient is required only to submit the final financial and performance reports, which will cover the entire period of performance including the last abbreviated reporting period.

10. REGULATORY COMPLIANCE

The Recipient agrees to comply or assist Reclamation with all regulatory compliance requirements and all applicable state, Federal, and local environmental and cultural and paleontological resource protection laws and regulations as applicable to this project. These may include, but are not limited to, the National Environmental Policy Act (NEPA), including the

Council on Environmental Quality and Department of the Interior regulations implementing NEPA, the Clean Water Act, the Endangered Species Act, consultation with potentially affected Tribes, and consultation with the State Historic Preservation Office.

Certain environmental and other associated compliance are Federal responsibilities, and will occur as appropriate. Reclamation will identify the need for and will complete any appropriate environmental compliance requirements, as identified above, pertinent to Reclamation pursuant to activities specific to this assisted activity. Environmental and other associated compliance shall be completed prior to the start of this project. As such, notwithstanding any other provision of this Agreement, Reclamation shall not provide any funds to the Recipient for Agreement purposes, and the Recipient shall not begin implementation of the assisted activity described in this Agreement, until Reclamation provides written notice to the Recipient that all applicable environmental and regulatory compliance analyses and clearances have been completed and that the Recipient may begin implementation of the assisted activity. If the Recipient begins project activities that require environmental and other regulatory compliance approval, such as construction activities, prior to receipt of written notice from Reclamation that all such clearances have been obtained, then Reclamation reserves the right to unilaterally terminate this agreement for cause.

11. INTANGIBLE PROPERTY (2 CFR 200.315)

(a) Title to intangible property (see §200.59 Intangible property) acquired under a Federal award vests upon acquisition in the non-Federal entity. The non-Federal entity must use that property for the originally-authorized purpose, and must not encumber the property without approval of the Federal awarding agency. When no longer needed for the originally authorized purpose, disposition of the intangible property must occur in accordance with the provisions in §200.313 Equipment paragraph (e).

(b) The non-Federal entity may copyright any work that is subject to copyright and was developed, or for which ownership was acquired, under a Federal award. The Federal awarding agency reserves a royalty-free, nonexclusive and irrevocable right to reproduce, publish, or otherwise use the work for Federal purposes, and to authorize others to do so.

(c) The non-Federal entity is subject to applicable regulations governing patents and inventions, including governmentwide regulations issued by the Department of Commerce at 37 CFR Part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Awards, Contracts and Cooperative Agreements."

(d) The Federal Government has the right to:

(1) Obtain, reproduce, publish, or otherwise use the data produced under a Federal award; and

(2) Authorize others to receive, reproduce, publish, or otherwise use such data for Federal purposes.

(e) Freedom of Information Act (FOIA).

(1) In response to a Freedom of Information Act (FOIA) request for research data relating to published research findings produced under a Federal award that were used by the Federal Government in developing an agency action that has the force and effect of law, the Federal awarding agency must request, and the non-Federal entity must provide, within a reasonable time, the research data so that they can be made available to the public through the procedures established under the FOIA. If the Federal awarding agency obtains the research data solely in response to a FOIA request, the Federal awarding agency may charge the requester a reasonable fee equaling the full incremental cost of obtaining the research data. This fee should reflect costs incurred by the Federal agency and the non-Federal entity. This fee is in addition to any fees the Federal awarding agency may assess under the FOIA (5 U.S.C. 552(a)(4)(A)).

(2) Published research findings means when:

(i) Research findings are published in a peer-reviewed scientific or technical journal; or

(ii) A Federal agency publicly and officially cites the research findings in support of an agency action that has the force and effect of law. "Used by the Federal Government in developing an agency action that has the force and effect of law" is defined as when an agency publicly and officially cites the research findings in support of an agency action that has the force and effect of law.

(3) Research data means the recorded factual material commonly accepted in the scientific community as necessary to validate research findings, but not any of the following: preliminary analyses, drafts of scientific papers, plans for future research, peer reviews, or communications with colleagues. This "recorded" material excludes physical objects (e.g., laboratory samples). Research data also do not include:

(i) Trade secrets, commercial information, materials necessary to be held confidential by a researcher until they are published, or similar information which is protected under law; and

(ii) Personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study.

If BE&RD reflects that Agency Review is required, insert Agency Review Special Term and Condition here

II. RECLAMATION STANDARD TERMS AND CONDITIONS

1. REGULATIONS

The regulations at 2 CFR Subtitle A, Chapter II, Part 200 "Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards", are hereby incorporated by reference as though set forth in full text. Failure of a Recipient to comply with any applicable regulation or circular may be the basis for withholding payments for proper charges made by the Recipient and/or for termination of support.

2. PAYMENT

2.1 Payment. (2 CFR §200.305)

(a) For states, payments are governed by Treasury-State CMIA agreements and default procedures codified at 31 CFR Part 205 "Rules and Procedures for Efficient Federal-State Funds Transfers" and TFM 4A-2000 Overall Disbursing Rules for All Federal Agencies.

(b) For non-Federal entities other than states, payments methods must minimize the time elapsing between the transfer of funds from the United States Treasury or the pass-through entity and the disbursement by the non-Federal entity whether the payment is made by electronic funds transfer, or issuance or redemption of checks, warrants, or payment by other means. See also §200.302 Financial management paragraph (b)(6). Except as noted elsewhere in this part, Federal agencies must require recipients to use only OMB-approved standard government-wide information collection requests to request payment.

> (1) The non-Federal entity must be paid in advance, provided it maintains or demonstrates the willingness to maintain both written procedures that minimize the time elapsing between the transfer of funds and disbursement by the non-Federal entity, and financial management systems that meet the standards for fund control and accountability as established in this part. Advance payments to a non-Federal entity must be limited to the minimum amounts needed and be timed to be in accordance with the actual, immediate cash requirements of the non-Federal entity in carrying out the purpose of the approved program or project. The timing and amount of advance payments must be as close as is administratively feasible to the actual disbursements by the non-Federal entity for direct program or project costs and the proportionate share of any allowable indirect costs. The non-Federal entity must make timely payment to contractors in accordance with the contract provisions.

(2) Whenever possible, advance payments must be consolidated to cover anticipated cash needs for all Federal awards made by the Federal awarding agency to the recipient.

(i) Advance payment mechanisms include, but are not limited to, Treasury check and electronic funds transfer and must comply with applicable guidance in 31 CFR part 208.

(ii) Non-Federal entities must be authorized to submit requests for advance payments and reimbursements at least monthly when electronic fund transfers are not used, and as often as they like when electronic transfers are used, in accordance with the provisions of the Electronic Fund Transfer Act (15 U.S.C. 1693-1693r).

(3) Reimbursement is the preferred method when the requirements in paragraph (b) cannot be met, when the Federal awarding agency sets a specific condition per §200.207 Specific conditions, or when the non-Federal entity requests payment by reimbursement. This method may be used on any Federal award for construction, or if the major portion of the construction project is accomplished through private market financing or Federal loans, and the Federal award constitutes a minor portion of the project. When the reimbursement method is used, the Federal awarding agency or pass-through entity must make payment within 30 calendar days after receipt of the billing, unless the Federal awarding agency or pass-through entity reasonably believes the request to be improper.

(4) If the non-Federal entity cannot meet the criteria for advance payments and the Federal awarding agency or pass-through entity has determined that reimbursement is not feasible because the non-Federal entity lacks sufficient working capital, the Federal awarding agency or pass-through entity may provide cash on a working capital advance basis. Under this procedure, the Federal awarding agency or pass-through entity must advance cash payments to the non-Federal entity to cover its estimated disbursement needs for an initial period generally geared to the non-Federal entity's disbursing cycle. Thereafter, the Federal awarding agency or pass-through entity must reimburse the non-Federal entity for its actual cash disbursements. Use of the working capital advance method of payment requires that the pass-through entity provide timely advance payments to any subrecipients in order to meet the subrecipient's actual cash disbursements. The working capital advance method of payment must not be used by the pass-through entity if the reason for using this method is the unwillingness or inability of the pass-through entity to provide timely advance payments to the subrecipient to meet the subrecipient's actual cash disbursements.

(5) Use of resources before requesting cash advance payments. To the extent available, the non-Federal entity must disburse funds available from program income (including repayments to a revolving fund), rebates, refunds, contract settlements, audit recoveries, and interest earned on such funds before requesting additional cash payments.

(6) Unless otherwise required by Federal statutes, payments for allowable costs by non-Federal entities must not be withheld at any time during the period of performance unless

the conditions of §§200.207 Specific conditions, Subpart D—Post Federal Award Requirements of this part, 200.338 Remedies for Noncompliance, or one or more of the following applies:

(i) The non-Federal entity has failed to comply with the project objectives, Federal statutes, regulations, or the terms and conditions of the Federal award.

(ii) The non-Federal entity is delinquent in a debt to the United States as defined in OMB Guidance A-129, "Policies for Federal Credit Programs and Non-Tax Receivables." Under such conditions, the Federal awarding agency or pass-through entity may, upon reasonable notice, inform the non-Federal entity that payments must not be made for obligations incurred after a specified date until the conditions are corrected or the indebtedness to the Federal Government is liquidated.

(iii) A payment withheld for failure to comply with Federal award conditions, but without suspension of the Federal award, must be released to the non-Federal entity upon subsequent compliance. When a Federal award is suspended, payment adjustments will be made in accordance with §200.342 Effects of suspension and termination.

(iv) A payment must not be made to a non-Federal entity for amounts that are withheld by the non-Federal entity from payment to contractors to assure satisfactory completion of work. A payment must be made when the non-Federal entity actually disburses the withheld funds to the contractors or to escrow accounts established to assure satisfactory completion of work.

(7) Standards governing the use of banks and other institutions as depositories of advance payments under Federal awards are as follows.

(i) The Federal awarding agency and pass-through entity must not require separate depository accounts for funds provided to a non-Federal entity or establish any eligibility requirements for depositories for funds provided to the non-Federal entity. However, the non-Federal entity must be able to account for the receipt, obligation and expenditure of funds.

(ii) Advance payments of Federal funds must be deposited and maintained in insured accounts whenever possible.

(8) The non-Federal entity must maintain advance payments of Federal awards in interest-bearing accounts, unless the following apply.

(i) The non-Federal entity receives less than $120,000 in Federal awards per year.

(ii) The best reasonably available interest-bearing account would not be expected to earn interest in excess of $500 per year on Federal cash balances.

(iii) The depository would require an average or minimum balance so high that it would not be feasible within the expected Federal and non-Federal cash resources.

(iv) A foreign government or banking system prohibits or precludes interest bearing accounts.

(9) Interest earned amounts up to $500 per year may be retained by the non-Federal entity for administrative expense. Any additional interest earned on Federal advance payments deposited in interest-bearing accounts must be remitted annually to the Department of Health and Human Services Payment Management System (PMS) through an electronic medium using either Automated Clearing House (ACH) network or a Fedwire Funds Service payment. Remittances must include pertinent information of the payee and nature of payment in the memo area (often referred to as "addenda records" by Financial Institutions) as that will assist in the timely posting of interested earned on federal funds. Pertinent details include the Payee Account Number (PAN) if the payment originated from PMS, or Agency information if the payment originated from ASAP, NSF or another federal agency payment system. The remittance must be submitted as follows:

(i) For ACH Returns:
Routing Number: 051036706
Account number: 303000
Bank Name and Location: Credit Gateway—ACH Receiver St. Paul, MN

(ii) For Fedwire Returns*:
Routing Number: 021030004
Account number: 75010501
Bank Name and Location: Federal Reserve Bank Treas NYC/Funds Transfer Division New York, NY
(* Please note organization initiating payment is likely to incur a charge from your Financial Institution for this type of payment)

(iii) For International ACH Returns:
Beneficiary Account: Federal Reserve Bank of New York/ITS (FRBNY/ITS)
Bank: Citibank N.A. (New York)
Swift Code: CITIUS33
Account Number: 36838868
Bank Address: 388 Greenwich Street, New York, NY 10013 USA
Payment Details (Line 70): Agency
Name (abbreviated when possible) and ALC Agency POC: Michelle Haney, (301) 492-5065

(iv) For recipients that do not have electronic remittance capability, please make check** payable to: "The Department of Health and Human Services."
Mail Check to Treasury approved lockbox:
HHS Program Support Center, P.O. Box 530231, Atlanta, GA 30353-0231
(** Please allow 4-6 weeks for processing of a payment by check to be applied to the appropriate PMS account)

(v) Any additional information/instructions may be found on the PMS Web site at http://www.dpm.psc.gov/.

2.2 Payment Method

Recipients must utilize the Department of Treasury Automated Standard Application for Payments (ASAP) payment system to request advance or reimbursement payments. ASAP is a Recipient-initiated payment and information system designed to provide a single point of contact for the request and delivery of Federal funds. ASAP is the only allowable method for request and receipt of payment. Recipient procedures must minimize the time elapsing between the drawdown of Federal funds and the disbursement for agreement purposes.

Recipients must complete enrollment in ASAP for all active financial assistance agreements with Reclamation. ASAP enrollment is specific to each Agency and Bureau; meaning, if a Recipient organization has an existing ASAP account with another Federal agency or Department of the Interior bureau, but not with Reclamation, then the Recipient must initiate and complete enrollment in ASAP under Reclamation's Agency Location Code (1425) through submission of an enrollment form found at www.usbr.gov/mso/aamd/asap.html. For information regarding ASAP enrollment, please visit www.usbr.gov/mso/aamd/asap.html, or contact the Reclamation ASAP Help Desk BOR_ASAP_Enroll@usbr.gov. Further information regarding ASAP may be obtained from the ASAP website at http://www.fms.treas.gov/asap.

In accordance with 2 CFR 25.200(b)(2) the Recipient shall "Maintain an active SAM registration with current information at all times during which it has an active Federal award or an application or plan under consideration by an agency". If the Recipient allows their SAM registration to lapse, the Recipient's accounts within ASAP will be automatically suspended by Reclamation until such time as the Recipient renews their SAM registration.

3. PROCUREMENT STANDARDS (2 CFR§200.317 through §200.326)

§200.317 Procurements by states.

When procuring property and services under a Federal award, a state must follow the same policies and procedures it uses for procurements from its non-Federal funds. The state will comply with §200.322 Procurement of recovered materials and ensure that every purchase order or other contract includes any clauses required by section §200.326 Contract provisions. All other non-Federal entities, including subrecipients of a state, will follow §§200.318 General procurement standards through 200.326 Contract provisions.

§200.318 General procurement standards.

(a) The non-Federal entity must use its own documented procurement procedures which reflect applicable State, local, and tribal laws and regulations, provided that the procurements conform to applicable Federal law and the standards identified in this part.

(b) Non-Federal entities must maintain oversight to ensure that contractors perform in accordance with the terms, conditions, and specifications of their contracts or purchase orders.

(c)

(1) The non-Federal entity must maintain written standards of conduct covering conflicts of interest and governing the actions of its employees engaged in the selection, award and administration of contracts. No employee, officer, or agent may participate in the selection, award, or administration of a contract supported by a Federal award if he or she has a real or apparent conflict of interest. Such a conflict of interest would arise when the employee, officer, or agent, any member of his or her immediate family, his or her partner, or an organization which employs or is about to employ any of the parties indicated herein, has a financial or other interest in or a tangible personal benefit from a firm considered for a contract. The officers, employees, and agents of the non-Federal entity may neither solicit nor accept gratuities, favors, or anything of monetary value from contractors or parties to subcontracts. However, non-Federal entities may set standards for situations in which the financial interest is not substantial or the gift is an unsolicited item of nominal value. The standards of conduct must provide for disciplinary actions to be applied for violations of such standards by officers, employees, or agents of the non-Federal entity.

(2) If the non-Federal entity has a parent, affiliate, or subsidiary organization that is not a state, local government, or Indian tribe, the non-Federal entity must also maintain written standards of conduct covering organizational conflicts of interest. Organizational conflicts of interest means that because of relationships with a parent company, affiliate, or subsidiary organization, the non-Federal entity is unable or appears to be unable to be impartial in conducting a procurement action involving a related organization.

(d) The non-Federal entity's procedures must avoid acquisition of unnecessary or duplicative items. Consideration should be given to consolidating or breaking out procurements to obtain a

more economical purchase. Where appropriate, an analysis will be made of lease versus purchase alternatives, and any other appropriate analysis to determine the most economical approach.

(e) To foster greater economy and efficiency, and in accordance with efforts to promote cost-effective use of shared services across the Federal Government, the non-Federal entity is encouraged to enter into state and local intergovernmental agreements or inter-entity agreements where appropriate for procurement or use of common or shared goods and services.

(f) The non-Federal entity is encouraged to use Federal excess and surplus property in lieu of purchasing new equipment and property whenever such use is feasible and reduces project costs.

(g) The non-Federal entity is encouraged to use value engineering clauses in contracts for construction projects of sufficient size to offer reasonable opportunities for cost reductions. Value engineering is a systematic and creative analysis of each contract item or task to ensure that its essential function is provided at the overall lower cost.

(h) The non-Federal entity must award contracts only to responsible contractors possessing the ability to perform successfully under the terms and conditions of a proposed procurement. Consideration will be given to such matters as contractor integrity, compliance with public policy, record of past performance, and financial and technical resources. See also §200.212 Suspension and debarment.

(i) The non-Federal entity must maintain records sufficient to detail the history of procurement. These records will include, but are not necessarily limited to the following: rationale for the method of procurement, selection of contract type, contractor selection or rejection, and the basis for the contract price.

(j)

(1) The non-Federal entity may use a time and materials type contract only after a determination that no other contract is suitable and if the contract includes a ceiling price that the contractor exceeds at its own risk. Time and materials type contract means a contract whose cost to a non-Federal entity is the sum of:

(i) The actual cost of materials; and

(ii) Direct labor hours charged at fixed hourly rates that reflect wages, general and administrative expenses, and profit.

(2) Since this formula generates an open-ended contract price, a time-and-materials contract provides no positive profit incentive to the contractor for cost control or labor efficiency. Therefore, each contract must set a ceiling price that the contractor exceeds at its own risk. Further, the non-Federal entity awarding such a contract must assert a high degree of oversight in order to obtain reasonable assurance that the contractor is using efficient methods and effective cost controls.

(k) The non-Federal entity alone must be responsible, in accordance with good administrative practice and sound business judgment, for the settlement of all contractual and administrative issues arising out of procurements. These issues include, but are not limited to, source evaluation, protests, disputes, and claims. These standards do not relieve the non-Federal entity of any contractual responsibilities under its contracts. The Federal awarding agency will not substitute its judgment for that of the non-Federal entity unless the matter is primarily a Federal concern. Violations of law will be referred to the local, state, or Federal authority having proper jurisdiction.

§200.319 Competition.

(a) All procurement transactions must be conducted in a manner providing full and open competition consistent with the standards of this section. In order to ensure objective contractor performance and eliminate unfair competitive advantage, contractors that develop or draft specifications, requirements, statements of work, or invitations for bids or requests for proposals must be excluded from competing for such procurements. Some of the situations considered to be restrictive of competition include but are not limited to:

(1) Placing unreasonable requirements on firms in order for them to qualify to do business;

(2) Requiring unnecessary experience and excessive bonding;

(3) Noncompetitive pricing practices between firms or between affiliated companies;

(4) Noncompetitive contracts to consultants that are on retainer contracts;

(5) Organizational conflicts of interest;

(6) Specifying only a "brand name" product instead of allowing "an equal" product to be offered and describing the performance or other relevant requirements of the procurement; and

(7) Any arbitrary action in the procurement process.

(b) The non-Federal entity must conduct procurements in a manner that prohibits the use of statutorily or administratively imposed state, local, or tribal geographical preferences in the evaluation of bids or proposals, except in those cases where applicable Federal statutes expressly mandate or encourage geographic preference. Nothing in this section preempts state licensing laws. When contracting for architectural and engineering (A/E) services, geographic location may be a selection criterion provided its application leaves an appropriate number of qualified firms, given the nature and size of the project, to compete for the contract.

(c) The non-Federal entity must have written procedures for procurement transactions. These procedures must ensure that all solicitations:

(1) Incorporate a clear and accurate description of the technical requirements for the material, product, or service to be procured. Such description must not, in competitive procurements, contain features which unduly restrict competition. The description may include a statement of the qualitative nature of the material, product or service to be procured and, when necessary, must set forth those minimum essential characteristics and standards to which it must conform if it is to satisfy its intended use. Detailed product specifications should be avoided if at all possible. When it is impractical or uneconomical to make a clear and accurate description of the technical requirements, a "brand name or equivalent" description may be used as a means to define the performance or other salient requirements of procurement. The specific features of the named brand which must be met by offers must be clearly stated; and

(2) Identify all requirements which the offerors must fulfill and all other factors to be used in evaluating bids or proposals.

(d) The non-Federal entity must ensure that all prequalified lists of persons, firms, or products which are used in acquiring goods and services are current and include enough qualified sources to ensure maximum open and free competition. Also, the non-Federal entity must not preclude potential bidders from qualifying during the solicitation period.
[78 FR 78608, Dec. 26, 2013, as amended at 79 FR 75885, Dec. 19, 2014]

§200.320 Methods of procurement to be followed.

The non-Federal entity must use one of the following methods of procurement.

(a) Procurement by micro-purchases. Procurement by micro-purchase is the acquisition of supplies or services, the aggregate dollar amount of which does not exceed the micro-purchase threshold (§200.67 Micro-purchase). To the extent practicable, the non-Federal entity must distribute micro-purchases equitably among qualified suppliers. Micro-purchases may be awarded without soliciting competitive quotations if the non-Federal entity considers the price to be reasonable.

(b) Procurement by small purchase procedures. Small purchase procedures are those relatively simple and informal procurement methods for securing services, supplies, or other property that do not cost more than the Simplified Acquisition Threshold. If small purchase procedures are used, price or rate quotations must be obtained from an adequate number of qualified sources.

(c) Procurement by sealed bids (formal advertising). Bids are publicly solicited and a firm fixed price contract (lump sum or unit price) is awarded to the responsible bidder whose bid, conforming with all the material terms and conditions of the invitation for bids, is the lowest in price. The sealed bid method is the preferred method for procuring construction, if the conditions in paragraph (c)(1) of this section apply.

(1) In order for sealed bidding to be feasible, the following conditions should be present:

(i) A complete, adequate, and realistic specification or purchase description is available;

(ii) Two or more responsible bidders are willing and able to compete effectively for the business; and

(iii) The procurement lends itself to a firm fixed price contract and the selection of the successful bidder can be made principally on the basis of price.

(2) If sealed bids are used, the following requirements apply:

(i) Bids must be solicited from an adequate number of known suppliers, providing them sufficient response time prior to the date set for opening the bids, for state, local, and tribal governments, the invitation for bids must be publically advertised;

(ii) The invitation for bids, which will include any specifications and pertinent attachments, must define the items or services in order for the bidder to properly respond;

(iii) All bids will be opened at the time and place prescribed in the invitation for bids, and for local and tribal governments, the bids must be opened publicly;

(iv) A firm fixed price contract award will be made in writing to the lowest responsive and responsible bidder. Where specified in bidding documents, factors such as discounts, transportation cost, and life cycle costs must be considered in determining which bid is lowest. Payment discounts will only be used to determine the low bid when prior experience indicates that such discounts are usually taken advantage of; and

(v) Any or all bids may be rejected if there is a sound documented reason.

(d) Procurement by competitive proposals. The technique of competitive proposals is normally conducted with more than one source submitting an offer, and either a fixed price or cost-reimbursement type contract is awarded. It is generally used when conditions are not appropriate for the use of sealed bids. If this method is used, the following requirements apply:

(1) Requests for proposals must be publicized and identify all evaluation factors and their relative importance. Any response to publicized requests for proposals must be considered to the maximum extent practical;

(2) Proposals must be solicited from an adequate number of qualified sources;

(3) The non-Federal entity must have a written method for conducting technical evaluations of the proposals received and for selecting recipients;

(4) Contracts must be awarded to the responsible firm whose proposal is most advantageous to the program, with price and other factors considered; and

(5) The non-Federal entity may use competitive proposal procedures for qualifications-based procurement of architectural/engineering (A/E) professional services whereby competitors' qualifications are evaluated and the most qualified competitor is selected, subject to negotiation of fair and reasonable compensation. The method, where price is not used as a selection factor, can only be used in procurement of A/E professional services. It cannot be used to purchase other types of services though A/E firms are a potential source to perform the proposed effort.

(e) [Reserved]

(f) Procurement by noncompetitive proposals. Procurement by noncompetitive proposals is procurement through solicitation of a proposal from only one source and may be used only when one or more of the following circumstances apply:

(1) The item is available only from a single source;

(2) The public exigency or emergency for the requirement will not permit a delay resulting from competitive solicitation;

(3) The Federal awarding agency or pass-through entity expressly authorizes noncompetitive proposals in response to a written request from the non-Federal entity; or

(4) After solicitation of a number of sources, competition is determined inadequate.

[78 FR 78608, Dec. 26, 2013, as amended at 79 FR 75885, Dec. 19, 2014]

§200.321 Contracting with small and minority businesses, women's business enterprises, and labor surplus area firms.

(a) The non-Federal entity must take all necessary affirmative steps to assure that minority businesses, women's business enterprises, and labor surplus area firms are used when possible.

(b) Affirmative steps must include:

(1) Placing qualified small and minority businesses and women's business enterprises on solicitation lists;

(2) Assuring that small and minority businesses, and women's business enterprises are solicited whenever they are potential sources;

(3) Dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by small and minority businesses, and women's business enterprises;

(4) Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority businesses, and women's business enterprises;

(5) Using the services and assistance, as appropriate, of such organizations as the Small Business Administration and the Minority Business Development Agency of the Department of Commerce; and

(6) Requiring the prime contractor, if subcontracts are to be let, to take the affirmative steps listed in paragraphs (1) through (5) of this section.

§200.322 Procurement of recovered materials.

A non-Federal entity that is a state agency or agency of a political subdivision of a state and its contractors must comply with section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act. The requirements of Section 6002 include procuring only items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition, where the purchase price of the item exceeds $10,000 or the value of the quantity acquired during the preceding fiscal year exceeded $10,000; procuring solid waste management services in a manner that maximizes energy and resource recovery; and establishing an affirmative procurement program for procurement of recovered materials identified in the EPA guidelines.

[78 FR 78608, Dec. 26, 2013, as amended at 79 FR 75885, Dec. 19, 2014]

§200.323 Contract cost and price.

(a) The non-Federal entity must perform a cost or price analysis in connection with every procurement action in excess of the Simplified Acquisition Threshold including contract modifications. The method and degree of analysis is dependent on the facts surrounding the particular procurement situation, but as a starting point, the non-Federal entity must make independent estimates before receiving bids or proposals.

(b) The non-Federal entity must negotiate profit as a separate element of the price for each contract in which there is no price competition and in all cases where cost analysis is performed. To establish a fair and reasonable profit, consideration must be given to the complexity of the work to be performed, the risk borne by the contractor, the contractor's investment, the amount of subcontracting, the quality of its record of past performance, and industry profit rates in the surrounding geographical area for similar work.

(c) Costs or prices based on estimated costs for contracts under the Federal award are allowable only to the extent that costs incurred or cost estimates included in negotiated prices would be allowable for the non-Federal entity under Subpart E—Cost Principles of this part. The non-Federal entity may reference its own cost principles that comply with the Federal cost principles.

(d) The cost plus a percentage of cost and percentage of construction cost methods of contracting must not be used.

§200.324 Federal awarding agency or pass-through entity review.

(a) The non-Federal entity must make available, upon request of the Federal awarding agency or pass-through entity, technical specifications on proposed procurements where the Federal awarding agency or pass-through entity believes such review is needed to ensure that the item or service specified is the one being proposed for acquisition. This review generally will take place prior to the time the specification is incorporated into a solicitation document. However, if the non-Federal entity desires to have the review accomplished after a solicitation has been developed, the Federal awarding agency or pass-through entity may still review the specifications, with such review usually limited to the technical aspects of the proposed purchase.

(b) The non-Federal entity must make available upon request, for the Federal awarding agency or pass-through entity pre-procurement review, procurement documents, such as requests for proposals or invitations for bids, or independent cost estimates, when:

(1) The non-Federal entity's procurement procedures or operation fails to comply with the procurement standards in this part;

(2) The procurement is expected to exceed the Simplified Acquisition Threshold and is to be awarded without competition or only one bid or offer is received in response to a solicitation;

(3) The procurement, which is expected to exceed the Simplified Acquisition Threshold, specifies a "brand name" product;

(4) The proposed contract is more than the Simplified Acquisition Threshold and is to be awarded to other than the apparent low bidder under a sealed bid procurement; or

(5) A proposed contract modification changes the scope of a contract or increases the contract amount by more than the Simplified Acquisition Threshold.

(c) The non-Federal entity is exempt from the pre-procurement review in paragraph (b) of this section if the Federal awarding agency or pass-through entity determines that its procurement systems comply with the standards of this part.

(1) The non-Federal entity may request that its procurement system be reviewed by the Federal awarding agency or pass-through entity to determine whether its system meets these standards in order for its system to be certified. Generally, these reviews must occur where there is continuous high-dollar funding, and third party contracts are awarded on a regular basis;

(2) The non-Federal entity may self-certify its procurement system. Such self-certification must not limit the Federal awarding agency's right to survey the system. Under a self-certification procedure, the Federal awarding agency may rely on written assurances from the non-Federal entity that it is complying with these standards. The non-Federal entity must cite specific policies, procedures, regulations, or standards as being in compliance with these requirements and have its system available for review.

§200.325 Bonding requirements.

For construction or facility improvement contracts or subcontracts exceeding the Simplified Acquisition Threshold, the Federal awarding agency or pass-through entity may accept the bonding policy and requirements of the non-Federal entity provided that the Federal awarding agency or pass-through entity has made a determination that the Federal interest is adequately protected. If such a determination has not been made, the minimum requirements must be as follows:

(a) A bid guarantee from each bidder equivalent to five percent of the bid price. The "bid guarantee" must consist of a firm commitment such as a bid bond, certified check, or other negotiable instrument accompanying a bid as assurance that the bidder will, upon acceptance of the bid, execute such contractual documents as may be required within the time specified.

(b) A performance bond on the part of the contractor for 100 percent of the contract price. A "performance bond" is one executed in connection with a contract to secure fulfillment of all the contractor's obligations under such contract.

(c) A payment bond on the part of the contractor for 100 percent of the contract price. A "payment bond" is one executed in connection with a contract to assure payment as required by

law of all persons supplying labor and material in the execution of the work provided for in the contract.

§200.326 Contract provisions.

The non-Federal entity's contracts must contain the applicable provisions described in Appendix II to Part 200—Contract Provisions for non-Federal Entity Contracts Under Federal Awards.

4. EQUIPMENT (2 CFR §200.313)

See also §200.439 Equipment and other capital expenditures.

(a) Title. Subject to the obligations and conditions set forth in this section, title to equipment acquired under a Federal award will vest upon acquisition in the non-Federal entity. Unless a statute specifically authorizes the Federal agency to vest title in the non-Federal entity without further obligation to the Federal Government, and the Federal agency elects to do so, the title must be a conditional title. Title must vest in the non-Federal entity subject to the following conditions:

(1) Use the equipment for the authorized purposes of the project during the period of performance, or until the property is no longer needed for the purposes of the project.

(2) Not encumber the property without approval of the Federal awarding agency or pass-through entity.

(3) Use and dispose of the property in accordance with paragraphs (b), (c) and (e) of this section.

(b) A state must use, manage and dispose of equipment acquired under a Federal award by the state in accordance with state laws and procedures. Other non-Federal entities must follow paragraphs (c) through (e) of this section.

(c) Use.

(1) Equipment must be used by the non-Federal entity in the program or project for which it was acquired as long as needed, whether or not the project or program continues to be supported by the Federal award, and the non-Federal entity must not encumber the property without prior approval of the Federal awarding agency. When no longer needed for the original program or project, the equipment may be used in other activities supported by the Federal awarding agency, in the following order of priority:

(i) Activities under a Federal award from the Federal awarding agency which funded the original program or project, then

(ii) Activities under Federal awards from other Federal awarding agencies. This includes consolidated equipment for information technology systems.

(2) During the time that equipment is used on the project or program for which it was acquired, the non-Federal entity must also make equipment available for use on other projects or programs currently or previously supported by the Federal Government, provided that such use will not interfere with the work on the projects or program for which it was originally acquired. First preference for other use must be given to other programs or projects supported by Federal awarding agency that financed the equipment and second preference must be given to programs or projects under Federal awards from other Federal awarding agencies. Use for non-federally-funded programs or projects is also permissible. User fees should be considered if appropriate.

(3) Notwithstanding the encouragement in §200.307 Program income to earn program income, the non-Federal entity must not use equipment acquired with the Federal award to provide services for a fee that is less than private companies charge for equivalent services unless specifically authorized by Federal statute for as long as the Federal Government retains an interest in the equipment.

(4) When acquiring replacement equipment, the non-Federal entity may use the equipment to be replaced as a trade-in or sell the property and use the proceeds to offset the cost of the replacement property.

(d) Management requirements. Procedures for managing equipment (including replacement equipment), whether acquired in whole or in part under a Federal award, until disposition takes place will, as a minimum, meet the following requirements:

(1) Property records must be maintained that include a description of the property, a serial number or other identification number, the source of funding for the property (including the FAIN), who holds title, the acquisition date, and cost of the property, percentage of Federal participation in the project costs for the Federal award under which the property was acquired, the location, use and condition of the property, and any ultimate disposition data including the date of disposal and sale price of the property.

(2) A physical inventory of the property must be taken and the results reconciled with the property records at least once every two years.

(3) A control system must be developed to ensure adequate safeguards to prevent loss, damage, or theft of the property. Any loss, damage, or theft must be investigated.

(4) Adequate maintenance procedures must be developed to keep the property in good condition.

(5) If the non-Federal entity is authorized or required to sell the property, proper sales procedures must be established to ensure the highest possible return.

(e) Disposition. When original or replacement equipment acquired under a Federal award is no longer needed for the original project or program or for other activities currently or previously supported by a Federal awarding agency, except as otherwise provided in Federal statutes,

regulations, or Federal awarding agency disposition instructions, the non-Federal entity must request disposition instructions from the Federal awarding agency if required by the terms and conditions of the Federal award. Disposition of the equipment will be made as follows, in accordance with Federal awarding agency disposition instructions:

(1) Items of equipment with a current per unit fair market value of $5,000 or less may be retained, sold or otherwise disposed of with no further obligation to the Federal awarding agency.

(2) Except as provided in §200.312 Federally-owned and exempt property, paragraph (b), or if the Federal awarding agency fails to provide requested disposition instructions within 120 days, items of equipment with a current per-unit fair-market value in excess of $5,000 may be retained by the non-Federal entity or sold. The Federal awarding agency is entitled to an amount calculated by multiplying the current market value or proceeds from sale by the Federal awarding agency's percentage of participation in the cost of the original purchase. If the equipment is sold, the Federal awarding agency may permit the non-Federal entity to deduct and retain from the Federal share $500 or ten percent of the proceeds, whichever is less, for its selling and handling expenses.

(3) The non-Federal entity may transfer title to the property to the Federal Government or to an eligible third party provided that, in such cases, the non-Federal entity must be entitled to compensation for its attributable percentage of the current fair market value of the property.

(4) In cases where a non-Federal entity fails to take appropriate disposition actions, the Federal awarding agency may direct the non-Federal entity to take disposition actions.

[78 FR 78608, Dec. 26, 2013, as amended at 79 FR 75884, Dec. 19, 2014]

5. SUPPLIES (2 CFR §200.314)

See also §200.453 Materials and supplies costs, including costs of computing devices.

(a) Title to supplies will vest in the non-Federal entity upon acquisition. If there is a residual inventory of unused supplies exceeding $5,000 in total aggregate value upon termination or completion of the project or program and the supplies are not needed for any other Federal award, the non-Federal entity must retain the supplies for use on other activities or sell them, but must, in either case, compensate the Federal Government for its share. The amount of compensation must be computed in the same manner as for equipment. See §200.313 Equipment, paragraph (e)(2) for the calculation methodology.

(b) As long as the Federal Government retains an interest in the supplies, the non-Federal entity must not use supplies acquired under a Federal award to provide services to other organizations for a fee that is less than private companies charge for equivalent services, unless specifically authorized by Federal statute.

6. INSPECTION

Reclamation has the right to inspect and evaluate the work performed or being performed under this Agreement, and the premises where the work is being performed, at all reasonable times and in a manner that will not unduly delay the work. If Reclamation performs inspection or evaluation on the premises of the Recipient or a sub-Recipient, the Recipient shall furnish and shall require sub-recipients to furnish all reasonable facilities and assistance for the safe and convenient performance of these duties.

7. AUDIT REQUIREMENTS (2 CFR Subpart F §200.501)

(a) Audit required. A non-Federal entity that expends $750,000 or more during the non-Federal entity's fiscal year in Federal awards must have a single or program-specific audit conducted for that year in accordance with the provisions of this part.

(b) Single audit. A non-Federal entity that expends $750,000 or more during the non-Federal entity's fiscal year in Federal awards must have a single audit conducted in accordance with §200.514 Scope of audit except when it elects to have a program-specific audit conducted in accordance with paragraph (c) of this section.

(c) Program-specific audit election. When an auditee expends Federal awards under only one Federal program (excluding R&D) and the Federal program's statutes, regulations, or the terms and conditions of the Federal award do not require a financial statement audit of the auditee, the auditee may elect to have a program-specific audit conducted in accordance with §200.507 Program-specific audits. A program-specific audit may not be elected for R&D unless all of the Federal awards expended were received from the same Federal agency, or the same Federal agency and the same pass-through entity, and that Federal agency, or pass-through entity in the case of a subrecipient, approves in advance a program-specific audit.

(d) Exemption when Federal awards expended are less than $750,000. A non-Federal entity that expends less than $750,000 during the non-Federal entity's fiscal year in Federal awards is exempt from Federal audit requirements for that year, except as noted in §200.503 Relation to other audit requirements, but records must be available for review or audit by appropriate officials of the Federal agency, pass-through entity, and Government Accountability Office (GAO).

(e) Federally Funded Research and Development Centers (FFRDC). Management of an auditee that owns or operates a FFRDC may elect to treat the FFRDC as a separate entity for purposes of this part.

(f) Subrecipients and Contractors. An auditee may simultaneously be a recipient, a subrecipient, and a contractor. Federal awards expended as a recipient or a subrecipient are subject to audit under this part. The payments received for goods or services provided as a contractor are not Federal awards. Section §200.330 Subrecipient and contractor determinations sets forth the considerations in determining whether payments constitute a Federal award or a payment for goods or services provided as a contractor.

(g) Compliance responsibility for contractors. In most cases, the auditee's compliance responsibility for contractors is only to ensure that the procurement, receipt, and payment for goods and services comply with Federal statutes, regulations, and the terms and conditions of Federal awards. Federal award compliance requirements normally do not pass through to contractors. However, the auditee is responsible for ensuring compliance for procurement transactions which are structured such that the contractor is responsible for program compliance or the contractor's records must be reviewed to determine program compliance. Also, when these procurement transactions relate to a major program, the scope of the audit must include determining whether these transactions are in compliance with Federal statutes, regulations, and the terms and conditions of Federal awards.

(h) For-profit subrecipient. Since this part does not apply to for-profit subrecipients, the pass-through entity is responsible for establishing requirements, as necessary, to ensure compliance by for-profit subrecipients. The agreement with the for-profit subrecipient must describe applicable compliance requirements and the for-profit subrecipient's compliance responsibility. Methods to ensure compliance for Federal awards made to for-profit subrecipients may include pre-award audits, monitoring during the agreement, and post-award audits. See also §200.331 Requirements for pass-through entities.

[78 FR 78608, Dec. 26, 2013, as amended at 79 FR 75887, Dec. 19, 2014]

8. REMEDIES FOR NONCOMPLIANCE (2 CFR §200.338)

§200.338 Remedies for noncompliance.

If a non-Federal entity fails to comply with Federal statutes, regulations or the terms and conditions of a Federal award, the Federal awarding agency or pass-through entity may impose additional conditions, as described in §200.207 Specific conditions. If the Federal awarding agency or pass-through entity determines that noncompliance cannot be remedied by imposing additional conditions, the Federal awarding agency or pass-through entity may take one or more of the following actions, as appropriate in the circumstances:

(a) Temporarily withhold cash payments pending correction of the deficiency by the non-Federal entity or more severe enforcement action by the Federal awarding agency or pass-through entity.

(b) Disallow (that is, deny both use of funds and any applicable matching credit for) all or part of the cost of the activity or action not in compliance.

(c) Wholly or partly suspend or terminate the Federal award.

(d) Initiate suspension or debarment proceedings as authorized under 2 CFR part 180 and Federal awarding agency regulations (or in the case of a pass-through entity, recommend such a proceeding be initiated by a Federal awarding agency).

(e) Withhold further Federal awards for the project or program.

(f) Take other remedies that may be legally available.

9. TERMINATION (2 CFR §200.339)

(a) The Federal award may be terminated in whole or in part as follows:

(1) By the Federal awarding agency or pass-through entity, if a non-Federal entity fails to comply with the terms and conditions of a Federal award;

(2) By the Federal awarding agency or pass-through entity for cause;

(3) By the Federal awarding agency or pass-through entity with the consent of the non-Federal entity, in which case the two parties must agree upon the termination conditions, including the effective date and, in the case of partial termination, the portion to be terminated; or

(4) By the non-Federal entity upon sending to the Federal awarding agency or pass-through entity written notification setting forth the reasons for such termination, the effective date, and, in the case of partial termination, the portion to be terminated. However, if the Federal awarding agency or pass-through entity determines in the case of partial termination that the reduced or modified portion of the Federal award or subaward

will not accomplish the purposes for which the Federal award was made, the Federal awarding agency or pass-through entity may terminate the Federal award in its entirety.

(b) When a Federal award is terminated or partially terminated, both the Federal awarding agency or pass-through entity and the non-Federal entity remain responsible for compliance with the requirements in §§200.343 Closeout and 200.344 Post-closeout adjustments and continuing responsibilities.

10. DEBARMENT AND SUSPENSION (2 CFR §1400)

The Department of the Interior regulations at 2 CFR 1400—Governmentwide Debarment and Suspension (Nonprocurement), which adopt the common rule for the governmentwide system of debarment and suspension for nonprocurement activities, are hereby incorporated by reference and made a part of this Agreement. By entering into this grant or cooperative Agreement with the Bureau of Reclamation, the Recipient agrees to comply with 2 CFR 1400, Subpart C, and agrees to include a similar term or condition in all lower-tier covered transactions. These regulations are available at http://www.gpoaccess.gov/ecfr/.

11. DRUG-FREE WORKPLACE (2 CFR §182 and §1401)

The Department of the Interior regulations at 2 CFR 1401—Governmentwide Requirements for Drug-Free Workplace (Financial Assistance), which adopt the portion of the Drug-Free Workplace Act of 1988 (41 U.S.C. 701 et seq, as amended) applicable to grants and cooperative agreements, are hereby incorporated by reference and made a part of this agreement. By entering into this grant or cooperative agreement with the Bureau of Reclamation, the Recipient agrees to comply with 2 CFR 182.

12. ASSURANCES AND CERTIFICATIONS INCORPORATED BY REFERENCE

The provisions of the Assurances, SF 424B or SF 424D as applicable, executed by the Recipient in connection with this Agreement shall apply with full force and effect to this Agreement. All anti-discrimination and equal opportunity statutes, regulations, and Executive Orders that apply to the expenditure of funds under Federal contracts, grants, and cooperative Agreements, loans, and other forms of Federal assistance. The Recipient shall comply with Title VI or the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Section 504 of the Rehabilitation Act of 1973, the Age Discrimination Act of 1975, and any program-specific statutes with anti-discrimination requirements. The Recipient shall comply with civil rights laws including, but not limited to, the Fair Housing Act, the Fair Credit Reporting Act, the Americans with Disabilities Act, Title VII of the Civil Rights Act of 1964, the Equal Educational Opportunities Act, the Age Discrimination in Employment Act, and the Uniform Relocation Act.

Such Assurances also include, but are not limited to, the promise to comply with all applicable Federal statutes and orders relating to nondiscrimination in employment, assistance, and housing; the Hatch Act; Federal wage and hour laws and regulations and work place safety standards; Federal environmental laws and regulations and the Endangered Species Act; and Federal protection of rivers and waterways and historic and archeological preservation.

13. COVENANT AGAINST CONTINGENT FEES

The Recipient warrants that no person or agency has been employed or retained to solicit or secure this Agreement upon an Agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide offices established and maintained by the Recipient for the purpose of securing Agreements or business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability or, in its discretion, to deduct from the Agreement amount, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

14. TRAFFICKING VICTIMS PROTECTION ACT OF 2000 (2 CFR §175.15)

Trafficking in persons.

(a) *Provisions applicable to a recipient that is a private entity.*

(1) You as the recipient, your employees, subrecipients under this award, and subrecipients' employees may not

(i) Engage in severe forms of trafficking in persons during the period of time that the award is in effect;

(ii) Procure a commercial sex act during the period of time that the award is in effect; or

(iii) Use forced labor in the performance of the award or subawards under the award.

(2) We as the Federal awarding agency may unilaterally terminate this award, without penalty, if you or a subrecipient that is a private entity —

(i) Is determined to have violated a prohibition in paragraph a.1 of this award term; or

(ii) Has an employee who is determined by the agency official authorized to terminate the award to have violated a prohibition in paragraph a.1 of this award term through conduct that is either:

(A) Associated with performance under this award; or

(B) Imputed to you or the subrecipient using the standards and due process for imputing the conduct of an individual to an organization that are provided in 2 CFR part 180, "OMB Guidelines to Agencies on Governmentwide Debarment and Suspension (Nonprocurement)," as implemented by our agency at *2 CFR part 1400.*

(b) *Provision applicable to a recipient other than a private entity.* We as the Federal awarding agency may unilaterally terminate this award, without penalty, if a subrecipient that is a private entity—

(1) Is determined to have violated an applicable prohibition in paragraph a.1 of this award term; or

(2) Has an employee who is determined by the agency official authorized to terminate the award to have violated an applicable prohibition in paragraph a.1 of this award term through conduct that is either:

(i) Associated with performance under this award; or

(ii) Imputed to the subrecipient using the standards and due process for imputing the conduct of an individual to an organization that are provided in 2 CFR part 180, "OMB Guidelines to Agencies on Governmentwide Debarment and Suspension (Nonprocurement)," as implemented by our agency at *2 CFR part 1400.*

(c) *Provisions applicable to any recipient.*

(1) You must inform us immediately of any information you receive from any source alleging a violation of a prohibition in paragraph a.1 of this award term.

(2) Our right to terminate unilaterally that is described in paragraph a.2 or b of this section:

(i) Implements section 106(g) of the Trafficking Victims Protection Act of 2000 (TVPA), as amended (22 U.S.C. 7104(g)), and

(ii) Is in addition to all other remedies for noncompliance that are available to us under this award.

(3) You must include the requirements of paragraph a.1 of this award term in any subaward you make to a private entity.

(d) *Definitions*. For purposes of this award term:

(1) "Employee" means either:

(i) An individual employed by you or a subrecipient who is engaged in the performance of the project or program under this award; or

(ii) Another person engaged in the performance of the project or program under this award and not compensated by you including, but not limited to, a volunteer or individual whose services are contributed by a third party as an in-kind contribution toward cost sharing or matching requirements.

(2) "Forced labor" means labor obtained by any of the following methods: the recruitment, harboring, transportation, provision, or obtaining of a person for labor or services, through

the use of force, fraud, or coercion for the purpose of subjection to involuntary servitude, peonage, debt bondage, or slavery.

(3) "Private entity":

(i) Means any entity other than a state, local government, Indian tribe, or foreign public entity, as those terms are defined in 2 CFR 175.25.

(ii) Includes:

(A) A nonprofit organization, including any nonprofit institution of higher education, hospital, or tribal organization other than one included in the definition of Indian tribe at 2 CFR 175.25(b).

(B) A for-profit organization.

(4) "Severe forms of trafficking in persons," "commercial sex act," and "coercion" have the meanings given at section 103 of the TVPA, as amended (22 U.S.C. 7102).

15. NEW RESTRICTIONS ON LOBBYING (43 CFR §18)

The Recipient agrees to comply with 43 CFR 18, New Restrictions on Lobbying, including the following certification:

(a) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Recipient, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying" in accordance with its instructions.

(c) The Recipient shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify accordingly. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S. Code. Any person who

fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

16. UNIFORM RELOCATION ASSISTANCE AND REAL PROPERTY ACQUISITION POLICIES ACT OF 1970 (URA) (42 USC § 4601 *et seq.)*

(a) The Uniform Relocation Assistance Act (URA), 42 U.S.C. § 4601 *et seq.*, as amended, requires certain assurances for Reclamation funded land acquisition projects conducted by a Recipient that cause the displacement of persons, businesses, or farm operations. Because Reclamation funds only support acquisition of property or interests in property from willing sellers, it is not anticipated that Reclamation funds will result in any "displaced persons," as defined under the URA.

(b) However, if Reclamation funds are used for the acquisition of real property that results in displacement, the URA requires Recipients to ensure that reasonable relocation payments and other remedies will be provided to any displaced person. Further, when acquiring real property, Recipients must be guided, to the greatest extent practicable, by the land acquisition policies in 42 U.S.C. § 4651.

(c) Exemptions to the URA and 49 CFR Part 24

(1) The URA provides for an exemption to the appraisal, review and certification rules for those land acquisitions classified as "voluntary transactions." Such "voluntary transactions" are classified as those that do not involve an exercise of eminent domain authority on behalf of a Recipient, and must meet the conditions specified at 49 CFR § 24.101(b)(1)(i)-(iv).

(2) For any land acquisition undertaken by a Recipient that receives Reclamation funds, but does not have authority to acquire the real property by eminent domain, to be exempt from the requirements of 49 CFR Part 24 the Recipient must:

(i) provide written notification to the owner that it will not acquire the property in the event negotiations fail to result in an amicable agreement, and;

(ii) inform the owner in writing of what it believes to be the market value of the property

(d) Review of Land Acquisition Appraisals. Reclamation reserves the right to review any land appraisal whether or not such review is required under the URA or 49 CFR § 24.104. Such reviews may be conducted by the Department of the Interior's Appraisal Services Directorate or a Reclamation authorized designee. When Reclamation determines that a review of the original appraisal is necessary, Reclamation will notify the Recipient and provide an estimated completion date of the initial appraisal review.

17. CENTRAL CONTRACTOR REGISTRATION AND UNIVERSAL IDENTIFIER REQUIREMENTS (2 CFR 25, APPENDIX A)

The Central Contractor Registration (CCR) has been migrated to the System for Award Management (SAM). Recipients must continue to comply with the CCR requirements below by maintaining current registration within www.SAM.gov.

A. Requirement for Central Contractor Registration (CCR)
Unless you are exempted from this requirement under 2 CFR 25.110, you as the recipient must maintain the currency of your information in the CCR until you submit the final financial report required under this award or receive the final payment, whichever is later. This requires that you review and update the information at least annually after the initial registration, and more frequently if required by changes in your information or another award term.

B. Requirement for Data Universal Numbering System (DUNS) Numbers
If you are authorized to make subawards under this award, you:

1. Must notify potential subrecipients that no entity (*see* definition in paragraph C of this award term) may receive a subaward from you unless the entity has provided its DUNS number to you.

2. May not make a subaward to an entity unless the entity has provided its DUNS number to you.

C. Definitions
For purposes of this award term:

1. *Central Contractor Registration (CCR)* means the Federal repository into which an entity must provide information required for the conduct of business as a recipient. Additional information about registration procedures may be found at the CCR Internet site (currently at *http://www.ccr.gov*).

2. *Data Universal Numbering System (DUNS) number* means the nine-digit number established and assigned by Dun and Bradstreet, Inc. (D&B) to uniquely identify business entities. A DUNS number may be obtained from D&B by telephone (currently 866–705–5711) or the Internet (currently at *http://fedgov.dnb.com/webform*).

3. *Entity,* as it is used in this award term, means all of the following, as defined at 2 CFR part 25, subpart C:
   a. A Governmental organization, which is a state, local government, or Indian Tribe;
   b. A foreign public entity;
   c. A domestic or foreign nonprofit organization;
   d. A domestic or foreign for-profit organization; and
   e. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

4. *Subaward:*

   a. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.

   b. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, *see* Sec. ll.210 of the attachment to OMB Circular A–133, ''Audits of States, Local Governments, and Non-Profit Organizations'').

   c. A subaward may be provided through any legal agreement, including an agreement that you consider a contract.

5. *Subrecipient* means an entity that:

   a. Receives a subaward from you under this award; and
   b. Is accountable to you for the use of the Federal funds provided by the subaward.

18. PROHIBITION ON TEXT MESSAGING AND USING ELECTRONIC EQUIPMENT SUPPLIED BY THE GOVERNMENT WHILE DRIVING

Executive Order 13513, *Federal Leadership On Reducing Text Messaging While Driving*, was signed by President Barack Obama on October 1, 2009 (ref: http://edocket.access.gpo.gov/2009/pdf/E9-24203.pdf). This Executive Order introduces a Federal Government-wide prohibition on the use of text messaging while driving on official business or while using Government-supplied equipment. Additional guidance enforcing the ban will be issued at a later date. In the meantime, please adopt and enforce policies that immediately ban text messaging while driving company-owned or rented vehicles, government-owned or leased vehicles, or while driving privately owned vehicles when on official government business or when performing any work for or on behalf of the government.

19. REPORTING SUBAWARDS AND EXECUTIVE COMPENSATION (2 CFR 170 APPENDIX A)

I. Reporting Subawards and Executive Compensation.

a. *Reporting of first-tier subawards.*

1. *Applicability.* Unless you are exempt as provided in paragraph d. of this award term, you must report each action that obligates $25,000 or more in Federal funds that does not include Recovery funds (as defined in section 1512(a)(2) of the American Recovery and Reinvestment Act of 2009, Pub. L. 111-5) for a subaward to an entity (see definitions in paragraph e. of this award term).

2. *Where and when to report.*

i. You must report each obligating action described in paragraph a.1. of this award term to *http://www.fsrs.gov*.

ii. For subaward information, report no later than the end of the month following the month in which the obligation was made. (For example, if the obligation was made on November 7, 2010, the obligation must be reported by no later than December 31, 2010.)

3. *What to report.* You must report the information about each obligating action that the submission instructions posted at *http://www.fsrs.gov specify.*

b. *Reporting Total Compensation of Recipient Executives.*

1. *Applicability and what to report.* You must report total compensation for each of your five most highly compensated executives for the preceding completed fiscal year, if—

i. the total Federal funding authorized to date under this award is $25,000 or more;

ii. in the preceding fiscal year, you received—

(A) 80 percent or more of your annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

iii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at *http://www.sec.gov/answers/execomp.htm.*)

2. *Where and when to report.* You must report executive total compensation described in paragraph b.1. of this award term:

i. As part of your registration profile at *http://www.ccr.gov.*

ii. By the end of the month following the month in which this award is made, and annually thereafter.

c. *Reporting of Total Compensation of Subrecipient Executives.*

1. *Applicability and what to report.* Unless you are exempt as provided in paragraph d. of this award term, for each first-tier subrecipient under this award, you shall report the names and total compensation of each of the subrecipient's five most highly compensated executives for the subrecipient's preceding completed fiscal year, if—

i. in the subrecipient's preceding fiscal year, the subrecipient received—

(A) 80 percent or more of its annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts), and Federal financial assistance subject to the Transparency Act (and subawards); and

ii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at *http://www.sec.gov/answers/execomp.htm.*)

2. *Where and when to report.* You must report subrecipient executive total compensation described in paragraph c.1. of this award term:

i. To the recipient.

ii. By the end of the month following the month during which you make the subaward. For example, if a subaward is obligated on any date during the month of October of a given year (*i.e.,* between October 1 and 31), you must report any required compensation information of the subrecipient by November 30 of that year.

d. *Exemptions*

If, in the previous tax year, you had gross income, from all sources, under $300,000, you are exempt from the requirements to report:

i. Subawards,

and

ii. The total compensation of the five most highly compensated executives of any subrecipient.

e. *Definitions.* For purposes of this award term:

1. *Entity* means all of the following, as defined in 2 CFR part 25:

i. A Governmental organization, which is a State, local government, or Indian tribe;

ii. A foreign public entity;

iii. A domestic or foreign nonprofit organization;

iv. A domestic or foreign for-profit organization;

v. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

2. *Executive* means officers, managing partners, or any other employees in management positions.

3. *Subaward:*

i. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.

ii. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. __ .210 of the attachment to OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations").

iii. A subaward may be provided through any legal agreement, including an agreement that you or a subrecipient considers a contract.

4. *Subrecipient* means an entity that:

i. Receives a subaward from you (the recipient) under this award; and

ii. Is accountable to you for the use of the Federal funds provided by the subaward.

5. *Total compensation* means the cash and noncash dollar value earned by the executive during the recipient's or subrecipient's preceding fiscal year and includes the following (for more information see 17 CFR 229.402(c)(2)):

i. *Salary and bonus.*

ii. *Awards of stock, stock options, and stock appreciation rights.* Use the dollar amount recognized for financial statement reporting purposes with respect to the fiscal year in accordance with the Statement of Financial Accounting Standards No. 123 (Revised 2004) (FAS 123R), Shared Based Payments.

iii. *Earnings for services under non-equity incentive plans.* This does not include group life, health, hospitalization or medical reimbursement plans that do not discriminate in favor of executives, and are available generally to all salaried employees.

iv. *Change in pension value.* This is the change in present value of defined benefit and actuarial pension plans.

v. *Above-market earnings on deferred compensation which is not tax-qualified.*

vi. Other compensation, if the aggregate value of all such other compensation (e.g. severance, termination payments, value of life insurance paid on behalf of the employee, perquisites or property) for the executive exceeds $10,000.

20. RECIPIENT EMPLOYEE WHISTLEBLOWER RIGHTS AND REQUIREMENT TO INFORM EMPLOYEES OF WHISTLEBLOWER RIGHTS (SEP 2013)

(a) This award and employees working on this financial assistance agreement will be subject to the whistleblower rights and remedies in the pilot program on Award Recipient employee whistleblower protections established at 41 U.S.C. 4712 by section 828 of the National Defense Authorization Act for Fiscal Year 2013 (Pub.L. 112-239).

(b) The Award Recipient shall inform its employees in writing, in the predominant language of the workforce, of employee whistleblower rights and protections under 41 U.S.C 4712.

(c) The Award Recipient shall insert the substance of this clause, including this paragraph (c), in all subawards or subcontracts over the simplified acquisition threshold. 48 CFR § 52.203-17 (as referenced in 48 CFR § 3.908-9).

21. RECIPIENT INTEGRITY AND PERFORMANCE MATTERS (APPENDIX XII to 2 CFR Part 200)

A. Reporting of Matters Related to Recipient Integrity and Performance

1. General Reporting Requirement

If the total value of your currently active grants, cooperative agreements, and procurement contracts from all Federal awarding agencies exceeds $10,000,000 for any period of time during the period of performance of this Federal award, then you as the recipient during that period of time must maintain the currency of information reported to the System for Award Management (SAM) that is made available in the designated integrity and performance system (currently the Federal Awardee Performance and Integrity Information System (FAPIIS)) about civil, criminal, or administrative proceedings described in paragraph 2 of this award term and condition. This is a statutory requirement under section 872 of Public Law 110-417, as amended (41 U.S.C. 2313). As required by section 3010 of Public Law 111-212, all information posted in the designated integrity and performance system on or after April 15, 2011, except past performance reviews required for Federal procurement contracts, will be publicly available.

2. Proceedings About Which You Must Report

Submit the information required about each proceeding that:

a. Is in connection with the award or performance of a grant, cooperative agreement, or procurement contract from the Federal Government;

b. Reached its final disposition during the most recent five year period; and

c. Is one of the following:

(1) A criminal proceeding that resulted in a conviction, as defined in paragraph 5 of this award term and condition;

(2) A civil proceeding that resulted in a finding of fault and liability and payment of a monetary fine, penalty, reimbursement, restitution, or damages of $5,000 or more;

(3) An administrative proceeding, as defined in paragraph 5. of this award term and condition, that resulted in a finding of fault and liability and your payment of either a monetary fine or penalty of $5,000 or more or reimbursement, restitution, or damages in excess of $100,000; or

(4) Any other criminal, civil, or administrative proceeding if:

(i) It could have led to an outcome described in paragraph 2.c.(1), (2), or (3) of this award term and condition;

(ii) It had a different disposition arrived at by consent or compromise with an acknowledgment of fault on your part; and

(iii) The requirement in this award term and condition to disclose information about the proceeding does not conflict with applicable laws and regulations.

3. Reporting Procedures

Enter in the SAM Entity Management area the information that SAM requires about each proceeding described in paragraph 2 of this award term and condition. You do not need to submit the information a second time under assistance awards that you received if you already provided the information through SAM because you were required to do so under Federal procurement contracts that you were awarded.

4. Reporting Frequency

During any period of time when you are subject to the requirement in paragraph 1 of this award term and condition, you must report proceedings information through SAM for the most recent five year period, either to report new information about any proceeding(s) that you have not reported previously or affirm that there is no new information to report. Recipients that have Federal contract, grant, and cooperative agreement awards with a cumulative total value greater than $10,000,000 must disclose semiannually any information about the criminal, civil, and administrative proceedings.

5. Definitions

For purposes of this award term and condition:

a. Administrative proceeding means a non-judicial process that is adjudicatory in nature in order to make a determination of fault or liability (e.g., Securities and Exchange Commission Administrative proceedings, Civilian Board of Contract Appeals proceedings, and Armed Services Board of Contract Appeals proceedings). This includes proceedings at the Federal and State level but only in connection with performance of a Federal contract or grant. It does not include audits, site visits, corrective plans, or inspection of deliverables.

b. Conviction, for purposes of this award term and condition, means a judgment or conviction of a criminal offense by any court of competent jurisdiction, whether entered upon a verdict or a plea, and includes a conviction entered upon a plea of nolo contendere.

c. Total value of currently active grants, cooperative agreements, and procurement contracts includes—

(1) Only the Federal share of the funding under any Federal award with a recipient cost share or match; and

(2) The value of all expected funding increments under a Federal award and options, even if not yet exercised.

United States Department of the Interior

BUREAU OF RECLAMATION
PO Box 25007
Denver, Colorado 80225-0007

IN REPLY REFER TO:
84-27852
1.3.11

June 30, 2016

VIA ELECTRONIC MAIL

City and County of San Francisco
Attn: Manisha Kothari,
525 Golden State Avenue, 10th Floor
San Francisco, CA 94102

Subject: Funding Opportunity Announcement No. R16-FOA-DO-010 – Desalination and Water Purification Research Program for Fiscal Year 2016 Pilot Projects – DWPR-019P - "Building Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring"

Dear Ms. Kothari,

Thank you for submitting a Desalination and Water Purification Research Program Grant application. The Bureau of Reclamation is pleased to inform you that your application was among those receiving the highest ratings and is now being considered for award of a financial assistance agreement at the requested amount of $200,000 to complete your proposal titled, "Building Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring".

Please note that this letter is not a final commitment of funding. A financial assistance agreement will not be executed and funds will not be awarded until further information about your project is developed and all statutory and regulatory requirements have been met as described in Section V.C of the FOA. In addition, Reclamation must have sufficient evidence prior to award that non-Federal cost share will be available by the start of the project. The final funding amount may be adjusted if necessary.

Please refer back to Section VI.C. of the FOA for the terms and details on reporting requirements and deliverables. In addition, please note that you are required to present your findings at the end of your agreement in Denver, CO.

Thank you for your interest and participation in the DWPR program. If you have any questions about the program, please contact Yuliana Porras-Mendoza, Advanced Water Treatment Coordinator, at 303-445-2265 or yporrasmendoza@usbr.gov. The Grants Specialist that will be responsible for awarding and administering your agreement will contact you to finalize your award. If you have questions concerning the next steps in awarding this agreement, please contact me at worvis@usbr.gov.

Sincerely,

Wilson Orvis
Grants Officer

U.S. Department of the Interior
Bureau of Reclamation

PROPOSAL

DESALINATION AND WATER PURIFICATION RESEARCH AND DEVELOPMENT (DWPR)

FISCAL YEAR 2016 PILOT PROJECTS:

Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

R16-FOA-DO-010

San Francisco Water Power Sewer

carollo
Engineers...Working Wonders With Water®

FEBRUARY 2016

OMB Number: 4040-0004
Expiration Date: 8/31/2016

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 2/8/16

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: City and County of San Francisco

* b. Employer/Taxpayer Identification Number (EIN/TIN): 94-6000417

* c. Organizational DUNS: 0276590640000

d. Address:

* Street1: 525 Golden Gate Avenue, 10th Floor
Street2:
* City: San Francisco
County/Parish:
* State: CA: California
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 94102-3220

e. Organizational Unit:

Department Name: Public Utilities Commission

Division Name: Water Treatment

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Ms.
* First Name: Manisha
Middle Name:
* Last Name: Kothari
Suffix: P.E.

Title: Project Manager

Organizational Affiliation: San Francisco Public Utilities Commission

* Telephone Number: 415-554-3256
Fax Number:

* Email: mkothari@sfwater.org

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

C: City or Township Government

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Bureau of Reclamation

11. Catalog of Federal Domestic Assistance Number:

CFDA Title:

*** 12. Funding Opportunity Number:**

No. R16-FOA-DO-010

* Title:

Desalination and Water Purification Research And Development (DWPR) - Fiscal Year 2016 - Pilot Projects

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: CA-012 * b. Program/Project: CA-012

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 07/15/2016 * b. End Date: 07/17/2017

18. Estimated Funding ($):

* a. Federal	200,000.00
* b. Applicant	262,000.00
* c. State	0.00
* d. Local	0.00
* e. Other	20,530.00
* f. Program Income	0.00
* g. TOTAL	482,530.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☒ a. This application was made available to the State under the Executive Order 12372 Process for review on 02/08/2016.

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☐ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix:	Mr.
* First Name:	Steven
Middle Name:	R.
* Last Name:	Ritchie
Suffix:	
* Title:	Assistant General Manager, Water
* Telephone Number:	415-934-5736
Fax Number:	
* Email:	sritchie@sfwater.org
* Signature of Authorized Representative:	
* Date Signed:	2/4/16

OMB Number: 4040-0007
Expiration Date: 01/31/2019

ASSURANCES - NON-CONSTRUCTION PROGRAMS

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0040), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C.§§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U. S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee- 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
	Assistant General Manager, Water
APPLICANT ORGANIZATION	DATE SUBMITTED
San Francisco Public Utilities Commission	02/05/2016

Standard Form 424B (Rev. 7-97) Back

San Francisco Water Power Sewer

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Desalination and Water Purification Research and Development Program (DWPR)

Funding Opportunity Announcement No. R16-FOA-DO-010

San Francisco Public Utilities Commission

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CONTENTS

BUILDING-SCALE TREATMENT FOR DIRECT POTABLE WATER REUSE & INTELLIGENT CONTROL FOR REAL TIME PERFORMANCE MONITORING

EXECUTIVE SUMMARY

Direct potable water reuse (DPR) starts with raw wastewater and ends with purified water that is protective of public health. This project will use innovative building-scale treatment, proven purification processes, real time online monitoring, and advanced analytical tools to demonstrate the first operational and safe facility in the country. This project examines two innovative concepts: DPR at the building-scale coupled with advanced analytical monitoring and a "smart" control system that verifies the performance of each process and the collective water quality online in real time, which would be a first for potable reuse systems anywhere. The advanced purification system for DPR will be sited at the San Francisco Public Utilities Commission Headquarters Building, where an existing Living Machine® System (a constructed wetlands with tertiary treatment) treats the building's wastewater to non-potable reuse standards.

The treatment train will use the existing tertiary treatment system, followed by ultrafiltration (UF), reverse osmosis (RO), and ultra violet light with an advanced oxidation process (UV AOP) to produce purified water. A final engineered storage buffer (ESB) is included to provide a time barrier to safely monitor all processes before distribution. State-of-the-art advanced analytics, including bioassays and non-target analyses, will be used during the DPR demonstration to prove the safety of the purification facility. These analytics allow researchers to understand the impact of the "unknown unknowns," chemicals of unknown type at trace levels that may have some degree of toxicity.

This project brings together international experts in treatment, analytical chemistry, and biological monitoring. This project also brings substantial financial support; including $262,000 from the San Francisco Public Utilities Commission and $20,530 from Carollo Engineers. This outside funding will be used to best leverage funding from the Bureau of Reclamation - $200,000 for one year.

BACKGROUND AND INTRODUCTION

Advanced treatment of wastewater for direct potable reuse (DPR) is operational at one facility in the United States, the Colorado River Municipal Water District's Raw Water Production Facility in Big Spring Texas. Ongoing research of that facility is demonstrating the production of a high quality water that is protective of public health (Steinle-Darling *et al.,* 2015). These results demonstrated the effective use of multiple barriers for reduction of trace pollutants and pathogens. While providing high quality water, the "Big Spring" facility relies upon monitoring systems designed for indirect potable reuse (IPR) applications. Nationally, the National Water Research Institute (NWRI) recently published a 173-page "how to" document on DPR, titled *Framework for Direct Potable Reuse* (NWRI, 2015). ***Central to this document was the use of precise and accurate monitoring technologies for public health protection in DPR applications***. Within California, an extensive research program (>$6M), the California DPR Initiative, has been undertaken to define the necessary level of treatment for a DPR project in California, and inform the discussion of DPR nationally. The Division of Drinking Water (DDW) is part of this Initiative, providing third party review of all research as they consider the possibility of regulating DPR in California. Even with the success of "Big Spring," with the development of clear guidelines for safe DPR implementation, and with extensive funding for research, the public and regulatory concern over

"unknown unknowns" remains. What is that next pollutant? How do we find it? Are trace levels of pollutants harmful? The State Water Resources Control Board recently conducted an expert workshop to lay the groundwork for tracking down these questions (SWRCB, 2015). ***The expert workshop team recommended the use of non-target analysis (NTA) and bioassays to better grasp the significance of the "unknown unknowns."***

These key research needs, the ability to document real time precise and accurate monitoring technologies and the use of advanced analytics to understand the impact of the "unknown unknowns," are the primary objectives of this proposed research project. There is a secondary value of this project, which is the integration of DPR methodologies into building-scale treatment. The proposed project would use the existing constructed wetlands with tertiary treatment that harvests wastewater from the building and treats it to non-potable water reuse standards, and then purify the water to potable standards.

In total, the goals of the demonstration are:

- Demonstrate innovative building-scale treatment of wastewater for DPR.
- Procure purification processes that produce potable water in accordance with health criteria established in National documents (NWRI, 2015).
- Use leading edge online analytical techniques to demonstrate the performance of each treatment process.
- Use advanced analytical monitoring to understand the potential impact of unknown trace level pollutants.
- Clearly document the costs of a potential future DPR system for utilities in California.
- Educate regulators and community members about the safety of properly engineered potable water reuse treatment systems.

This ambitious project will span one year, and includes a substantial work effort which is supported by funding from the San Francisco Public Utilities Commission (SFPUC) and Carollo Engineers.

TECHNICAL APPROACH

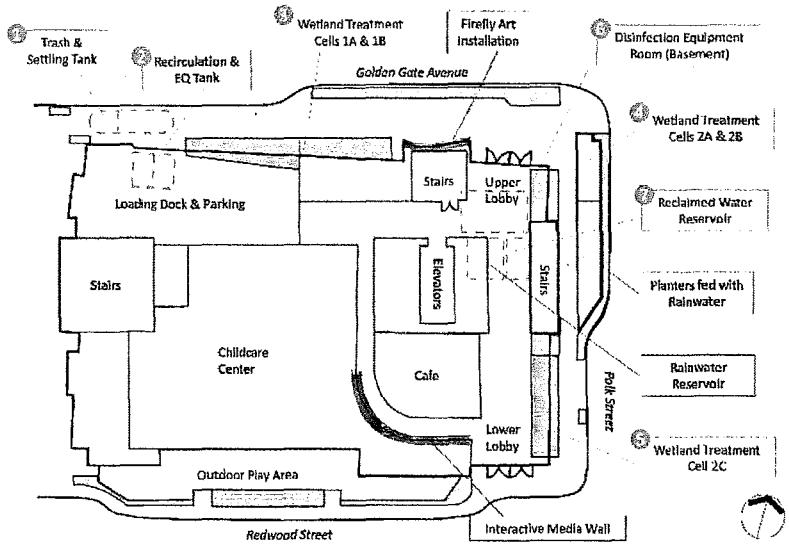
1.0 Building-Scale Treatment for Non-Potable Water Reuse

This project starts with raw wastewater, harvested from the 13-story, 900 employee SFPUC headquarters building. The advanced, ecologically based Tertiary treatment system currently collects and treats wastewater for non-potable reuse inside the structure. The Tertiary treatment system consists of a two-stage, recirculating, engineered wetland system with subsequent filtration and disinfection units (collectively called a tertiary treatment system henceforth in this proposal) and is housed in landscaped planters on the interior and exterior of the structure.

The tertiary treatment system can treat a maximum flow of 5,000 gallons per day and consists of primary treatment and flow equalization followed by (2) the Recirculating Tidal Wetland System, (3) the Recirculating Vertical Flow Polishing Wetland System (4) denitrification and (5) polishing and disinfection and (6) a reclaimed water reservoir. The system has proven capable of treating raw wastewater with a small physical footprint, appropriate to an urban setting.

The value of de-centralized wastewater treatment cannot be overstated. Water can be treated and used within one watershed, eliminating the need for sewers, pump stations, and wasted conveyance energy. Demonstrating

advanced purification of the reclaimed water to potable water standards is possible and safe may lead to a radical revolution in the water industry.



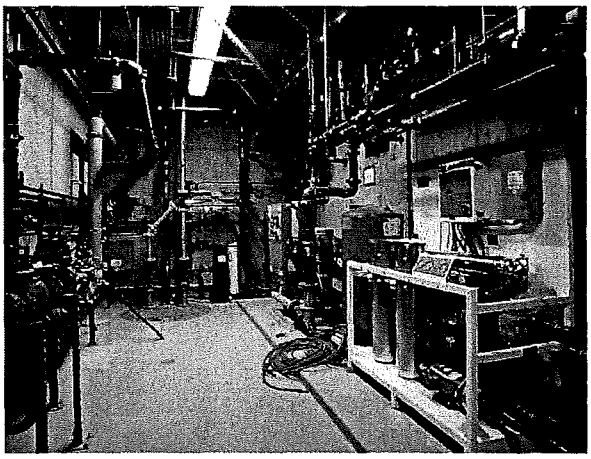


Figure 1. Wetland Treatment Schematic and Photo of Disinfection Room at SFPUC

2.0 Purification Processes for Potable Water Reuse

There are numerous treatment trains that could be used for potable water reuse. Within California, the particular processes that could be employed for this type of project are more limited (CDPH, 2014). In particular, IPR projects in California that include 100 percent purified water (no dilution) and do not benefit from surface spreading (soil aquifer treatment), must have reverse osmosis (RO) and advanced oxidation processes (AOP) within the treatment train. Using these two processes as a starting point, and relying upon the NWRI Framework for Direct Potable Reuse (NWRI, 2015), the purification process proposed for this treatment train are ultrafiltration (UF), RO, ultraviolet light (UV) AOP, and an engineered storage buffer (ESB) with free chlorine during storage (Figure 2, shown on the next page). These processes will provide multiple barriers to both pollutants and pathogens, as shown in Table 1 on the next page. When coupled together, the proposed processes meet all pathogen and pollutant requirements for potable water reuse as defined by CDPH (2014).

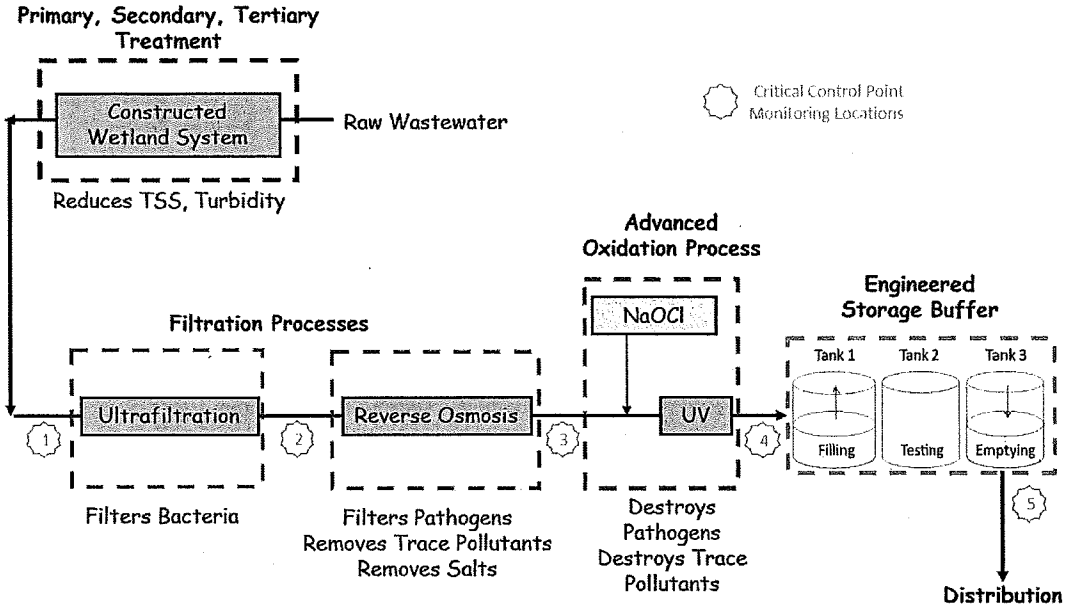


Figure 2. Proposed Advanced Treatment Train for Direct Potable Reuse

Table 1. Use of Multiple Barriers for Purification

	Bulk Organic Removal	Trace Organic Removal	Virus Removal	Protozoa Removal	Bacteria Removal
Primary, Secondary, and Tertiary Treatment	•	•	•	•	•
UF	•	–	–	•	•
RO	–	•	•	•	•
UV AOP	–	•	•	•	•
ESB with free chlorine	–	Partial	•	Partial	•

This proposed treatment train will have online monitoring at critical control points (CCPs), as detailed further on below.

Ultrafiltration

Recent work with Clean Water Services (CWS) (Oregon), as part of DPR demonstration testing, indicates that a well-functioning UF (0.01 μm nominal pore size) can attain 4.7-log reduction of seeded virus (CWS, 2014) without chemical use (such as alum or polymer) ahead of the membrane. Equivalent or greater reduction of protozoa can be assumed based upon this data, and is directly supported by NSF (2012). Furthermore, MF or UF membrane integrity testing (MIT), confirms system performance and demonstrates how MIT data can be

used to track and ensure continued membrane performance (CWS, 2014). Therefore, both MF and UF membranes can be relied upon for 4+ log reduction of protozoa.

Reverse Osmosis

The RO is the primary treatment process that addresses the removal of total dissolved solids (TDS), hardness, and trace levels of organic and inorganic contaminants. The RO trains also help to remove trace organic compounds, total organic carbon (TOC), and pathogens from the tertiary effluent.

Studies have found virus removal by RO to be from 3 to >6-log (Reardon *et al.*, 2005, NRMMC/EPHC/NHMRC 2008, CWS 2014). Equal or greater removal is expected for protozoa. Unfortunately, RO process performance for pathogen rejection is not governed by the ability of an intact membrane to reject pathogens; it is governed by the ability to monitor process integrity (Reardon et al., 2005 and Schäfer et al., 2005). The monitors currently used, electrical conductivity (EC) meters and total organic carbon (TOC) meters, can measure 99 percent or less removal of both parameters through the RO process. Recently, the DDW granted 1.5 log reduction credit for all pathogens for RO (WRD, 2013), based upon a requirement to continuously monitor TOC reduction across RO. Alternative technologies, such as online fluorescent dye monitoring, have been shown to have higher accuracy in assessing membrane efficiency (3+ log based upon new research as part of Water Research Foundation project 4536), with other research showing similar results (Kitis et al., 2003; Henderson et al., 2009; Pype et al., 2013). Using traditional monitoring technology, we recommend using the 1.5-log reduction value for all pathogens for RO at this time.

UV AOP

In the event of pathogens passing through RO, the UV process provides for a high level of disinfection. NDMA, with a DDW notification level (NL) of 10 ng/L, can pass through RO at low concentrations (typically 20 to 100 ng/L), requiring destruction by UV photolysis (Sharpless and Linden, 2003). Therefore, it is common to set the UV dose at 800+ millijoule per square centimeter (mJ/cm^2). This high UV dose photolyzes NDMA as well as many other smaller chemicals that may have passed through the RO train. Adding H_2O_2 before the high dose UV, typically in the range of 3 to 5 mg/L, results in the generation of hydroxyl radicals throughout the UV process. This turns the treatment into an AOP. Hydroxyl radicals are nonselective and break down most chemicals with which they come in contact, destroying a range of trace level pollutants.

At a dose of 800+ mJ/cm^2, as would be applied for this project, the high UV dose will result in 6+ log reductions of all target pathogens (USEPA, 2006; Hijnen et al., 2006; Rochelle et al., 2005), including *Cryptosporidium, Giardia*, and adenovirus. Higher reductions are theoretically possible, but the DDW allows only a maximum of 6-log reduction credits per any one treatment technology (CDPH, 2014).

ESB with Free Chlorine

DPR forgoes the environmental buffer in lieu of an Engineered Storage Buffer (ESB, Tchobanoglous *et al.*, 2011). The ESB would be applied for any DPR application in California.

Eliminating the environmental buffer leads to the loss of several benefits, including contaminant reduction, dilution, and, perhaps most importantly, time to detect and respond to a treatment failure. Recent potable reuse reports suggest that these are limitations that can be overcome. These studies include the WateReuse Research Foundation's 2011 report entitled "Direct Potable Reuse: A Path Forward" (Tchobanoglous et al., 2011), the National Research Council's 2012 report entitled "Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater" (NRC, 2012), the Australian Academy of Technological Sciences and Engineering's 2013 report entitled "Drinking Water through Recycling: The benefits and costs of supplying direct to the distribution system" (ATSE, 2013), and the WateReuse Research Foundation Project 11-

10, Application of Risk Reduction Principles to Direct Potable Reuse (Salveson et al., 2014). They suggest that a higher level of treatment at the Advanced Water Treatment (AWT) facility can compensate for the treatment and dilution provided by the groundwater aquifer or surface water reservoir. The ESB can be designed to provide time to hold and test the treated water to ensure its safety before distribution. No further treatment is added in the ESB (except, perhaps further contact time), and therefore no log-removal credits for pathogens should be expected from this treatment process.

The ESB provides several key benefits over the environmental buffer. For communities without available environmental buffers such as rivers or aquifers (which are often in the most dire need), water reuse is still a possibility with ESBs. Second, ESBs eliminate the need for costly pumps and pipes to and from environmental buffers. Much of the treated water is also lost in the environmental buffer, either washed downstream or dispersed through an aquifer. Finally, advanced treated water is typically higher in quality than groundwater or surface water. Environmental sources can be easily contaminated with runoff and other influences. Keeping the treated water separate from these sources can lower contamination and decrease further treatment costs.

For this project, the ESB would follow the recommendations in Salveson et al. (*in press*) for ESB application. The ESB would be designed to hold at least 4 hours of water, allowing for all key processes to be monitored for quality prior to release of water. The time value becomes critical, as the subsequent processes must perform at a high level during such upstream process upsets. For each unit process and its associated monitoring method, a failure and response time (FRT) is defined. The process FRT is the maximum possible time between when a failure occurs and when the system has reacted such that the final product water quality is no longer affected. The FRT is a sum of the sampling interval, the sample turnaround time (TAT), and the system reaction time, as shown in Figure 3 below. For a unit process monitored by a traditional sampling technique, the sampling interval may range from continuous online monitoring to periodic sampling. In this pilot project, key process monitoring will be done online to minimize the FRT of the system.

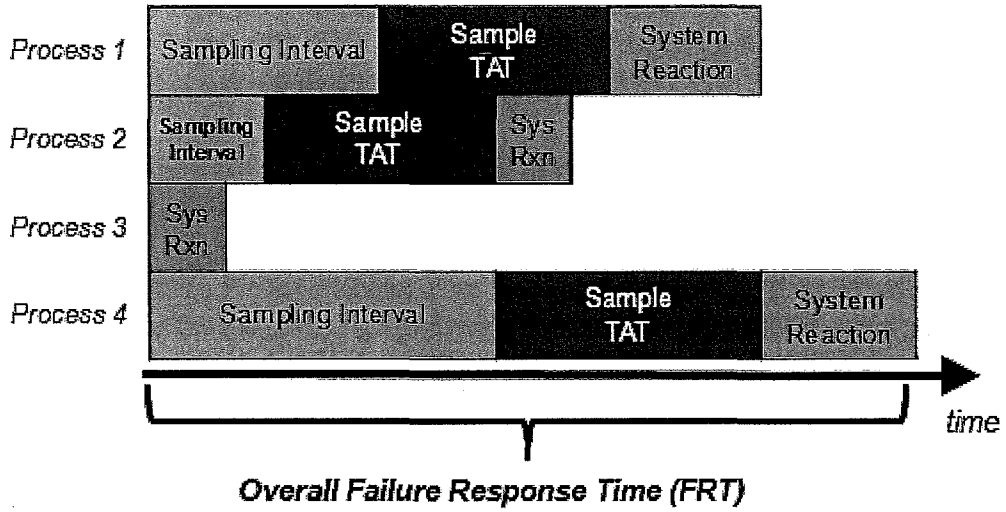


Figure 3. Determination of Failure and Response Time for ESB

In addition to the FRT value of the ESB, the ESB provides for substantial disinfection treatment by free chlorine. The ESB would have free chlorine dosing and be controlled to maintain a target free chlorine *Ct* sufficient to attain 3-log for *Giardia* and 4-log for viruses, based upon a 4 hour contact time with a 1 mg/L free chlorine

residual, with an RO permeate pH of 6. The pathogen credits are based upon the 1990 SWTR Guidance Manual (USEPA, 1990).

3.0 Monitoring Technologies

Conventional potable reuse trains have repeatedly met EPA drinking water standards, as documented by long term compliance with California regulations by the Orange County Water District, among many others. Demonstration testing of similar advanced treatment trains has shown similar performance (CWS, 2015; Trussell, 2013). Emerging pollutants will be evaluated for this project, focusing on the following trace level pollutants:

- A suite of pharmaceuticals and personal care products (PPCPs)
- A suite of perfluorinated compounds (PFCs)
- NDMA
- NDMA formation potential
- THM and HAA formation potential
- Fluorescence

Pathogens will also be evaluated for this project, documenting with grab sampling the pathogen levels after secondary treatment and thus allowing an analysis of sufficient reduction of such pathogens through the purification processes. Pathogens (and surrogate organisms) to be evaluated include: male specific and somatic coliphage, *enterococci, E. coli,* total coliform, *Giardia*, *Cryptosporidium*, enterovirus, and norovirus.

The ability for these processes to produce high quality water in accordance with regulations is not in question. What this project looks to define is the ability to continuously monitor the performance of the advanced treatment systems in real time. This will be done through the use of precise and accurate metering of the critical control points in the purification process. To that end, we have secured the use of two ZAPs LiquID stations to perform such monitoring, as shown in Table 2, on the next page. These parameters will be used to demonstrate process by process performance; as follows:

- **UF -** UF filtrate turbidity and *E. coli* concentrations will closely track UF performance. These continuous measurements will be paired with daily pressure decay test (PDT) results to provide real-time confidence in protozoa and bacteria removal performance.
- **RO -** TOC values collected pre and post RO allow for clear determination of a conservative surrogate for pathogen removal by RO as well as consistent reduction in TOC. TOC values will be paired with online electrical conductivity (EC) to verify TOC performance values.
- **UV AOP -** Destruction of total chlorine across UV systems has now been shown to correlate directly with UV dose, which then correlates directly to pathogen removal and destruction of pollutants such as NDMA (work in press). Free chlorine measurements and UV absorbance (UVA) can be used to develop a "chlorine weighted UV dose," which has recently been shown to correlate directly with destruction of trace pollutants by UV AOP (work in press).
- **ESB -** Free chlorine residual after the ESB will be used to calculate a Ct and show disinfection credit in accordance with EPA standards.

Table 2. Online Real Time Monitoring for Demonstration Project

Measurement	Post UF	Post RO	Pre UV	Post UV
Chloramines	•		•	•
Free Chlorine	•		•	•
E. coli	•			
TOC	•	•		
UVA			•	•
Turbidity	•			

The information from the ZAPs systems will be logged for the duration of the 6-month demonstration and used to evaluate overall reliability in system performance. These values will also be used to monitor system performance remotely, available 24/7/365.

The research will take one further step, the investigation of the "unknown unknowns." While hundreds of chemicals have been detected in water, thousands more likely occur at very low concentrations but have not yet been detected. Chemical surrogates and indicators are often used to gauge the efficacy and efficiency of a particular treatment process and/or multibarrier train (Yu et al., 2015; Merel et al., 2015; Anumol et al., 2015; Gerrity et al., 2012). However, these measures do not provide any reference to biological effects and thus do not account for the potential additive or synergistic effects of chemical mixtures. Bioassay-based monitoring complements chemical analysis by providing a comprehensive assessment of the mixture of substances present in a particular water sample (Escher et al., 2014). A limitation of bioassays is the ability to determine what substance, or substances, were responsible for the bioactivity observed. Therefore, non-targeted analysis (NTA) will also be performed using high-resolution mass spectrometry (HRMS) with both gas chromatography (GC) and liquid chromatography (LC) interfaces for volatile and non-volatile organic compounds, respectively. National experts convened in California recently to examine two promising techniques for such investigation (SWRCB, 2015). In that two-day workshop, the expert group concluded that these two methods, non-target analysis (NTA) and bioassays, should be paired.

In order to accomplish both the bioassays and NTA methods proposed below, we will use 4L of water (approximately one gallon) for each sample. Technically, two liters of water is required; however, we recommend providing additional water for replicates (3) to improve statistical accuracy of the NTA work, and allows for repeat analyses if necessary. Two one-liter samples will be extracted using a comprehensive two-SPE system previously shown to capture the majority of organic contaminants occurring in water systems (Escher et al. 2014; Jia et al., 2015). Positive controls for bioassays will be used for matrix spikes to ensure acceptable recovery (greater than 70 percent) of bioactive substances.

Assays selected were those recently demonstrated to address relevant endpoints, displayed significant activity using water samples, and were reliable in multiple laboratories (Escher et al., 2015).

1) Non-specific Toxicity: Cytotoxicity. Cytotoxicity will be assessed using the MTS assay. The MTS reagent will be purchased from Promega (CellTiter 96® AQueous One Solution Cell Proliferation Assay, #G3580). MTS (tetrazolium) is bioreduced by cells in culture into a colored formazan product that is soluble in tissue culture medium, and this conversion is presumably accomplished by NADPH or NADH produced by dehydrogenase enzymes in metabolically active cells. Assays are performed by adding a small amount of the MTS Reagent

directly into culture wells, incubating for 2 hours, and then recording the absorbance at 490 nm with a 96-well plate reader.

2) Specific (Receptor-mediated) Toxicity: Glucocorticoid Receptor (GR) and Estrogen Receptor (ER). Estrogens and glucocorticoids have been reported to occur widely in WWTP effluents (Escher et al., 2014; Snyder et al. 2001; Stavreva et al., 2012). Based on previous testing of multiple ER and GR assays, our team has elected to use the Invitrogen platform as it also was selected by the State of California funded project on which Snyder is a Co-PI. The ER/GR assay uses GeneBLAzer® HEK 293T cells which contain an estrogen receptor/glucocorticoid receptor (ER/GR) ligand-binding domain/Gal4 DNA binding domain chimera stably integrated into the GeneBLAzer® UAS-*bla* HEK 293T cell line. GeneBLAzer® UAS-*bla* HEK 293T contains a beta-lactamase reporter gene under control of a UAS response element stably integrated into HEK 293T cells. Fluorescence Resonance Energy Transfer (FRET) substrate that generates a ratiometric reporter response and dual-color (blue/green) reading is used to minimize experimental noise. The ER and GR assay will help to identify potential for endocrine disruption effects caused by estrogenic and glucocorticoid hormones, respectively, as well as contaminants that mimic these hormones.

3) Xenobiotic Metabolism: Aryl Hydrocarbon Receptor (AhR). A well-known example of a xenobiotic receptor is the arylhydrocarbon receptor (AhR), which responds to exposure to dioxin-like chemicals. The AhR assay has been used to gauge remediation of PCB and dioxin in environmental spill scenarios (Giesy et al., 2002). For the proposed research, rat hepato-carcinoma cells (H4IIE-luc) which have been stably transfected with the luciferase gene under control of the AhR will be used (Giesy et al., 2002; Sanderson et al., 1996; Jarosov et al., 2012).

4) p53 reporter gene. The p53 protein is known for its major role in the prevention of cancer. It acts as a tumor suppressant, recognizing damaged DNA and triggering DNA repair. This pathway also plays a role in cell cycle arrest and apoptosis. Our team has chosen to use the CellSensor *p53RE-bla HCT-116* cell line, which operates very similarly to GeneBLAzer® HEK 293T cells, to represent stress response. The CellSensor *p53RE-bla HCT-116* cell line contains a p53 receptor ligand-binding domain/Gal4 binding domain, as well as a beta-lactamase reporter gene under control of a UAS response element. CCF4-AM substrate will be used to measure fluorescence, as it emits a green in the absence of betalactamase and blue in the presence. The primary difference between the CellSensor *p53RE-bla HCT-116* cell line and to GeneBLAzer® HEK 293T cells is that the p53 cell line uses human colorectal carcinomacells, where the ER/GR cell lines use human embryonic kidney cells. The p53 assay will help determine the quality of the water since the ability of a cell to repair itself may be more sensitive than actual damage done.

NTA of unknown compounds will be performed using the latest generation quadrupole-time-of-flight (QTOF) mass spectrometers. The LC-QTOF will use an aliquot of methanol extracts prepared for bioassay and analyzed using both positive and negative electrospray ionization (ESI). These extracts will also be analyzed by GC-QTOF by injection of the methanol extracts and analyzed with electron impact ionization. Samples will be analyzed in auto-MS/MS mode in both instruments, where instruments record all the mass to charge ratios (m/z). Between acquisitions of MS spectra, the instrument is programmed to isolate the most abundant ions and fragment them to acquire their corresponding MS/MS spectra. These analyses generate large amounts of data, which will be processed using software specifically designed for this purpose.

Using the QTOF data, our team is able to statistically "fingerprint" different water qualities based on their mass profile. In previous preliminary studies, our team has demonstrated that HRMS could discriminate water exposed to different treatments or different doses of the same oxidant. Resulting HRMS data is evaluated initially through heatmaps, revealing multiple classes of compounds such as recalcitrant, those removed, and

transformation products (including intermediates). Each sample profile will be paired both with water treatment variable and with bioassay results. Therefore, while bioassays indicate if a treatment leads to an increase or decrease in toxicity, QTOF data will provide information on which compounds or group of compounds correlate statistically to the biological observation.

The second value of this approach consists in being able to identify compounds of interest among the list of molecular features. For example, if sample toxicity increases after a specific treatment, the transformation products formed by such treatment will be isolated from the molecular features enclosed in the sample profile for further identification. Based on their high resolution mass spectra, transformation products will be searched against libraries of compounds available in Dr. Snyder's laboratory. While some of these products may not be registered in the library, a first identification of chemical formula can be proposed based on the accurate mass. Such molecular formula would then be further evaluated based on MS/MS spectra. In addition, these data produce a lasting electronic record of what substances were present, thus if a new contaminant is identified, these spectra can be retroactively mined to determine if the substance was present and its relative abundance.

For this initial research, the NTA and bioassay analysis will be taken across the treatment train as detailed in the Scope of Work. These two tools, when used in combination, will present a powerful picture of water quality through different levels of treatment over the duration of the study. These tools will supplement the previously detailed analysis for regulated and unregulated pollutants and pathogens and begin to answer the questions about the "unknown unknowns" frequently raised by opponents to water reuse projects.

4.0 Data Analysis

Three distinct sets of data will be collected. What those data are, and how they will be utilized, is defined below:

- **Online Data -** online data will be logged and performance probability distribution functions (PDFs) will be created, which document the statistical reliability of each process to provide the desired results (for pathogen and pollutant reduction)
- **Grab Sample Data** - trace pollutant data will be collected and compared against industry standards, and then used to compare pollutant levels with the results from the advanced analytics. Pathogen data will be used to set a baseline of pathogen levels in the purification feed water, and then document the levels of reduction of those pathogens to the new potable water supply, clearly documenting compliance (or lack thereof) with published health standards (CDPH, 2014; NWRI, 2015).
- **Advanced Analytics** - NTAs and bioassays will be paired together and compared/contrasted with the trace pollutant data.

SCOPE OF WORK

Project Management

As Principal Investigator (PI) for this project, Manisha Kothari, will serve as the contact PI on this project and work closely with PI Paula Kehoe. As such, Ms. Kothari and Ms. Kehoe will be responsible for overall project management, including oversight of Carollo as the contractor, communication with USBR, and review of the technical progress of the research and ensure that results are applicable to the water community. Ms. Kothari and Ms. Kehoe, in conjunction with Carollo, will monitor the progress of the research through review of semi-annual reports, participation in project calls and face-to-face meetings, and review of all project final deliverables.

The Co-PI for this project, Andrew Salveson, will manage the day-to-day and long-term objectives of this project. That includes the review and guidance of Carollo staff in the performance of their duties and the coordination of

subconsultant team members. The project management responsibilities extend to the management of the project budget and the billings. Additionally, Andrew Salveson will meet with the funding parties and the project team during the project. Finally, project management includes quality assurance/quality control, which is a period review of project progress from outside the core project team by experts in the relevant field(s).

Schedule: N/A.

Deliverables: The management team will be available for weekly check-in calls for the duration of the project. Any issues that arise during the management of this project will be documented in quarterly reports.

Purification Facility Design and Construction

For potable water reuse, the project team will select and install a series of advanced processes to purify the Tertiary treatment system effluent and to monitor the water quality online. The proposed technologies to be applied are ultrafiltration (UF), reverse osmosis (RO), ultraviolet light disinfection (UV) with sodium hypochlorite addition to result in an advanced oxidation process (AOP), with a final treatment/storage step using an engineered storage buffer (ESB). Online monitoring includes turbidity, *E. coli*, total organic carbon (TOC), electrical conductivity (EC), total and free chlorine, and ultraviolet transmittance (UVT). These online monitoring parameters will be done by the ZAPs LiquiD, as shown in Table 3 below.

Table 3. Online Monitoring Parameters

Measurement	Post UF	Post RO	Pre UV	Post UV
Chloramines	•		•	•
Free Chlorine	•		•	•
E. coli	•			
TOC	•	•		
UVA			•	•
Turbidity	•			

For this Task, the project team will do the following:

- Select and rent (or purchase) small-scale advanced treatment processes (as listed above), with capacities in the range of 1 to 3 gpm[1].
- Select and purchase online monitoring processes (as listed above).
- Start up the purification and monitoring systems
- Collect and store all online data in a centralized control system, allowing for later analysis.
- Summarize all process, monitoring, and startup procedures in a TM.

Schedule: Selection of equipment, installation of equipment, and startup of equipment would be expected to start within 30 days of the receipt of grant funding and will be completed within 4 months of the notice to proceed.

Deliverables: A TM will be completed in draft form that details the treatment and monitoring processes as well as any details related to operation and startup.

[1] The current plan is to rent UF and RO systems and purchase small UV and ESB treatment systems. For monitoring systems, the project team will need to purchase online monitoring equipment.

Direct Potable Water Reuse Performance Demonstration

To date, no potable water reuse system (indirect or direct), provides a comprehensive real-time monitoring of overall performance. For potable water reuse, the treatment targets include virus, protozoa, bacteria, total organic carbon, salts, and trace level pollutants. This project will build a treatment system that tracks and records performance of each system, and most importantly of the entire system for the removal of pathogens and pollutants. This will be the first real-time "smart" potable water reuse treatment system, operating for 6 consecutive months, which will be used to demonstrate the long term reliability of advanced water purification processes.

To that end, we have broken up the 6-month demonstration into the following work efforts.

Operation. The facility will be run continuously for 6 months. The system will be run automatically, with twice-weekly inspections and calibration of online devices.

Conventional Parameters, PPCPs, Pathogens, and Advanced Analytics. Over the 6-month timeframe, the system will be continuously monitored using the online technologies discussed previously. This online monitoring will be supplemented by three different analytical chemistry approaches, as shown in the bullets and Table 4 below.

- **Conventional Parameters:** TOC (twice monthly), ATP (weekly), turbidity, UVA, total and free chlorine (twice weekly).
- **CECs[2]:** pharmaceuticals and personal care products (PPCPs), perfluorinated compounds (PFCs), NDMA, NDMA FP, THM/HAA FP, and fluorescence EEM, all monthly. This work will be done by (monthly) work will be done by the Dr. Eric Dickenson at the Southern Nevada Water Authority.
- **Pathogens:** male specific and somatic coliphage, enterococci, *E. coli*, total coliform, *Giardia*, *Cryptosporidium*, enterovirus and norovirus. Biological analysis will be done (monthly) by Dr. Rick Danielson at BioVir.
- **Advanced Analytics:** non-target analysis and bioassays. Advanced analytics will be done (monthly) by Dr. Shane Snyder at the University of Arizona.

Table 4. Online Monitoring - Analytical Chemistry Approaches

Measurement	Secondary Effluent	Post UF	Post RO	Post UV	Post ESB
Conventional Parameters		•	•	•	•
CECs	•	•	•	•	•
Pathogens	•				
Advanced Analytics	•	•	•	•	•

Schedule: Testing will be done periodically over a 6 month time period.

Deliverables: Prior to the start of testing, a test protocol will be developed which includes detailed sampling methods, lab testing methods, and quality control. Test results will compiled in the draft report as detailed below.

[2] The CEC list and pathogen list are identical to WaterRF 4536 and WateReuse Research Foundation 14-16, which are both run by this current project team.

Public Communication and Outreach

Outreach efforts will be provided by SFPUC and as an in-kind contribution. SFPUC outreach materials will include web-site information, educational banners at the demonstration facility, handouts, and tour materials. SFPUC will schedule guided tours with the community on a regular basis. In addition, the utility may prepare a web-based education and survey campaign in accordance with the Ways of Water analysis in WateReuse Research Foundation Project 12-06. Project results will be submitted for peer-review publications and conference proceedings.

Schedule: The outreach work would begin prior to the start of testing and run through the completion of the project.

Deliverables: Webcast and final report, survey results, and any other outreach materials will be shared with the funding agencies.

Project Communication and Reporting

The project team will prepare quarterly reports for the duration of this project (one year), one draft report, and one final report. The project team will meet with the funding agencies in person twice and can meet by phone on a monthly basis as needed.

Schedule: Reporting will be done throughout the duration of the project, with quarterly reports done after the first three months of work and done every three months thereafter. An on-site project meeting will occur at the start of the 6 month DPR testing period. One draft report and one final report will be completed after the end of the 6 month demonstration period. Near the completion of the project, one member of the project team will travel to Denver to present the results to Reclamation staff.

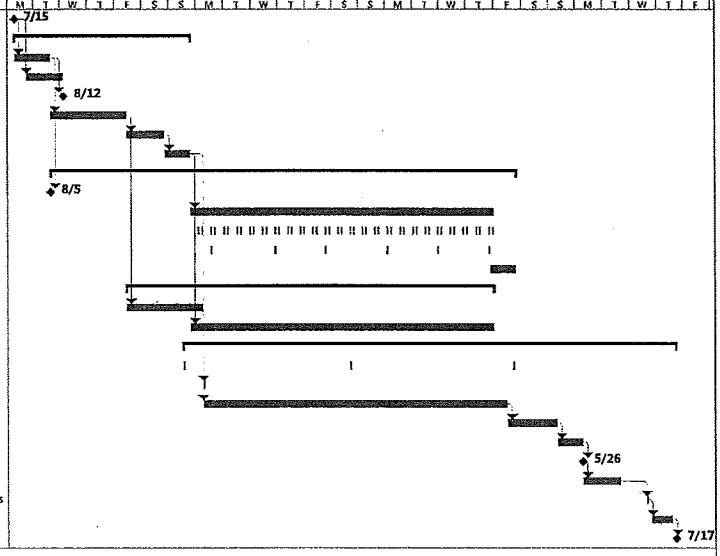
Deliverables: 3 quarterly reports, one draft report, and one final report, one on-site project meeting, and one USBR presentation delivered in Denver.

RESEARCH WORK PLAN AND SCHEDULE

The work to be carried out in the demonstration study is described in task descriptions of the Scope of Work Section. The project schedule, including all major tasks and subtasks, is shown below. The schedule details the elapsed time for the entire pilot testing project. Estimates of equipment delivery dates, pilot construction and commissioning, and dates of all deliverables are included.

US Bureau of Reclamation

ID	Task Name	Duration	Start	Finish	Predecessors
1	USBR Award	0 days	Fri 7/15/16	Fri 7/15/16	
2	**Task 1: Pilot Facility Design and Construction**	**70 days**	**Fri 7/15/16**	**Thu 10/20/16**	
3	Purchase/Rent UF/RO/UVAOP Units	15 days	Fri 7/15/16	Thu 8/4/16	1
4	Site Preparation	15 days	Fri 7/22/16	Thu 8/11/16	1FS+5 days
5	Submit Treatment and Monitoring TM	0 days	Fri 8/12/16	Fri 8/12/16	3
6	Deliver UF/RO/UVAOP to site	30 days	Fri 8/5/16	Thu 9/15/16	3
7	Pilot Installation, Testing, and Commissioning	15 days	Fri 9/16/16	Thu 10/6/16	6
8	Pilot Monitoring/Control Installation, Testing, Commissioning	10 days	Fri 10/7/16	Thu 10/20/16	7
9	**Task 2: Direct Potable Water Reuse Demonstration**	**183 days**	**Fri 8/5/16**	**Tue 4/18/17**	
10	Submit DPR Test Protocol	0 days	Fri 8/5/16	Fri 8/5/16	3
11	DPR Pilot Operation	6 mons	Fri 10/21/16	Thu 4/6/17	8
12	Pilot Inspection and Calibration	118 days	Tue 10/25/16	Thu 4/6/17	
61	Advanced Analytics	111 days	Tue 11/1/16	Tue 4/4/17	
68	Pilot Decomissioning and Site Clean-up	10 days	Wed 4/5/17	Tue 4/18/17	61
69	**Task 3: Public Outreach**	**145 days**	**Fri 9/16/16**	**Thu 4/6/17**	
70	Install Banners/Distribute Educational Material	30 days	Fri 9/16/16	Thu 10/27/16	6
71	Provide Educational Tours	6 mons	Fri 10/21/16	Thu 4/6/17	8
72	**Task 4: Project Communication and Reporting**	**195 days**	**Mon 10/17/16**	**Mon 7/17/17**	
73	Prepare and Submit Quarterly Progress Reports	131 days	Mon 10/17/16	Mon 4/17/17	
77	Onsite Project Meeting	1 day	Fri 10/28/16	Fri 10/28/16	8FS+5 days
78	Compile Pilot Data	6 mons	Fri 10/28/16	Thu 4/13/17	8FS+5 days
79	Prepare Draft Report	20 days	Fri 4/14/17	Thu 5/11/17	78
80	Internal Review of Draft Report	10 days	Fri 5/12/17	Thu 5/25/17	79
81	Submit Draft Report to USBR for Review	0 days	Fri 5/26/17	Fri 5/26/17	80
82	USBR Review of Report	15 days	Fri 5/26/17	Thu 6/15/17	81
83	Presentation to USBR Staff	1 day	Fri 6/30/17	Fri 6/30/17	82FS+10 days
84	Prepare Final Report to USBR	10 days	Mon 7/3/17	Fri 7/14/17	83
85	Submit Final Report to USBR	0 days	Mon 7/17/17	Mon 7/17/17	84



Project: USBR
Date: Tue 2/2/16

Task	Project Summary	Manual Task	Start-only	Deadline			
Split	Inactive Task	Duration-only	Finish-only	Progress			
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress			
Summary	Inactive Summary	Manual Summary	External Milestone				

PROJECT MANAGEMENT

SFPUC will be responsible for overall project management, coordination, and communications with USBR, and facilitation with the research team. Carollo will be the technical leader for this project and will manage it as it manages all of its research projects. Hourly expenditures will be monitored and compared to the percent completion of the tasks.

Quarterly Technical Progress Reports

In accordance with Reclamation requirements, quarterly technical progress reports will be prepared and submitted. It is estimated that up to seven progress reports will be required during the duration of the pilot testing. The reports will be letter-style and will include a summary of the completed activities, activities in progress, and a calculation of the estimated percent of completed work. The quarterly reports will also identify areas where delays have occurred and the reason for the delay, planned activities during the next reporting period, and recommendations to get the project back on schedule and/or budget, if necessary.

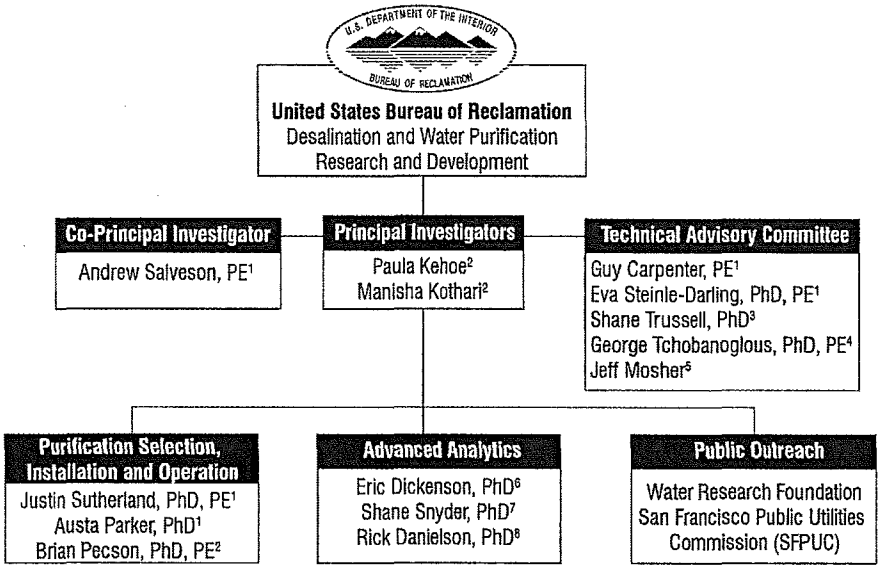
Project Meetings

In accordance with Reclamation requirements, Carollo will participate in one intermediate project meeting. Other team members will attend via webinar. This meeting is anticipated in October 2016 and will be held in Carollo's Walnut Creek, California, office and include a visit to the pilot plant site.

PERSONNEL QUALIFICATIONS

We have assembled a team of professionals experienced in municipal reuse and leading-edge water technology. They offer strength in their core technical specialties and have a proven track-record of delivering projects on time and within budget. Your project will benefit from the diversity of experience and perspective that our team members bring to this effort.

The core project team and its lines of communication are depicted in the organizational chart below. Biographies of key personnel are provided on the next page. Customized resumes are included at the end of this section.



1. Carollo Engineers, Inc.
2. San Francisco Public Utilities Commission
3. Trussell Technologies
4. University of California Davis
5. National Water Research Institute
6. Southern Nevada Water Authority
7. University of Arizona
8. IEH-BioVir Laboratories

Key Team Members

Paula Kehoe – Principal Investigator

Paula Kehoe is the Director of Water Resources for the San Francisco Public Utilities Commission (SFPUC). She is responsible for diversifying San Francisco's local water supply portfolio through the development and implementation of conservation, groundwater, and recycled water programs. Paula spearheaded the landmark legislation allowing for the collection, treatment, and use of alternate water sources for non-potable end uses in buildings and districts within San Francisco.

Manisha Kothari – Principal Investigator

Manisha Kothari is a Project Manager with the Water Resources Division of the San Francisco Public Utilities Commission. Manisha represents the SFPUC in the planning of water reuse projects that the SFPUC is developing through regional partnerships in order to diversify its water supply portfolio and meet future demands. She works with water agencies throughout the Bay Area to evaluate and develop recycled water and desalination opportunities for San Francisco's customers. Manisha has over 10 years of experience managing infrastructure projects from concept to implementation. Manisha has a BA in Political Science and Economics from the University of California, Berkeley and an M.S. from Georgetown University.

Andrew Salveson, PE – Co-Principal Investigator

Andy Salveson has 22 years of environmental consulting experience serving public and private-sector clients in the research and design of water and wastewater treatment systems. He is a nationally recognized expert in water reuse, including IPR and DPR. Mr. Salveson provides guidance and expertise on state-of-the-art technologies on the latest industry issues regarding reuse, as has led numerous planning, design, and research projects, including extensive projects for the WateReuse Research Foundation and Water Research Foundation related to Potable Reuse. Andy was named to a national panel of 7 experts to develop national guidance on Direct Potable Reuse (NWRI Framework for Direct Potable Reuse) and was named to a panel of experts to develop potable water reuse for the World Health Organization. In recognition of his contributions to the industry, Mr. Salveson was honored with the 2007 WateReuse Person of the Year Award for bringing innovative technologies to market.

Justin Sutherland, PhD, PE – Purification Selection, Installation, and Operation

Dr. Justin Sutherland is a member of Carollo's Research Group with 16 years of experience in applied research, bench- and pilot-scale process design and testing. He has extensive experience in water reuse. He served as project manager for Water Research Foundation Project #4536, titled "Blending Requirements for Water from Direct Potable Reuse Treatment Facilities." He also served as Project engineer for the Texas Water Development Board-funded project, "Testing Water Quality in a Municipal Wastewater Effluent Treated to Drinking Water Standards." He was responsible for the review of historical RO performance data and sampling water quality (EDC, pharmaceuticals, etc.) around the MF, RO, and AOP processes at the Direct Potable Reuse Plant and led a pilot scale evaluation of a direct integrity monitor (Nalco's Trasar technology) for potable reuse RO systems.

Austa Parker – Purification Selection, Installation, and Operation

Ms. Parker joined Carollo in early 2014, gaining experience in potable reuse permitting and planning studies, and also providing expertise in advanced oxidation processes. She serves as the Northern California Lead for the Carollo Research Group. Austa is currently serving as staff engineer for WRRF Project #14-16, Operational, Monitoring & Response Data from Unit Processes in Full-Scale Water Treatment, IPR, and DPR.

Eric Dickenson, PhD – Advanced Analytics

Dr. Dickenson serves as R&D project manager for the Southern Nevada Water Authority. His experience includes the fate of emerging contaminants (e.g., EDCs and pharmaceuticals) in natural systems (e.g., aquifer recharge, riverbank filtration) and conventional and advanced engineered systems (e.g., RO, nanofiltration, GAC, ozone, AOP, MBR). Additionally he is experienced in the utilization of state-of-the-art characterization methods for natural and effluent organic matter for water quality characterization and optimization of disinfection processes.

Shane Snyder, PhD – Advanced Analytics

Dr. Snyder is a Professor of Chemical and Environmental Engineering at the University of Arizona. He holds a PhD in Environmental Toxicology and Zoology and a BA in Chemistry. Dr. Snyder is a microconstituents expert who participated in the "Blue Ribbon Panel" for the California Water Resources Control Board to consider Constituents/Contaminants of Emerging Concern in Recycled Water. He is also Co-director of the Arizona Laboratory for Emerging Contaminants, a state-of-the-art analytical facility that identifies and quantifies emerging contaminants, such as pharmaceutical compounds, endocrine disrupting compounds, and nanoparticles.

Rick Danielson, PhD – Advanced Analytics

Dr. Danielson has a broad background in environmental health microbiology including: the development and application of bio-technology (PCR, ELISA, monoclonal antibodies, plasmid analysis, etc.); microbiological risk assessment; environmental virology and parasitology (certified USEPA Principal Analyst for protozoans and viruses); providing information and consultation on agents of bioterrorism; expert testimony in environmental microbial contamination cases; and, the establishment of certified environmental microbiological testing laboratories. He is a lecturer of microbiology at the U.C. Berkeley School of Public Health (1993 to present) and has served on several national public health (US FDA & NMFS, ASTM) and research review committees (WERF, AWWA, Sea Grant, USDA).

Resumes

Resumes of key personnel are shown starting on the next page.

Paula A. Kehoe

525 Golden Gate Ave, 10th Floor San Francisco, CA 94102
(415) 554-0792/pkehoe@sfwater.org

EMPLOYMENT

City and County of San Francisco, Public Utilities Commission — ***San Francisco, CA***
Director of Water Resources — **May 2004- Present**

- Manage the development of new local water supplies, including groundwater, recycled water, desalinated water and alternate water sources.
- Develop and implement water shortage allocation plans, drought polices, and water shortage measures.
- Prepare ordinances to streamline regulatory pathways to develop new non-potable water supplies to offset potable supplies.
- Lead innovative water strategies, including installing composting toilets in urban areas and treating blackwater to flush toilets in new commercial and multi-family buildings.
- Identify water conservation measures, prepare ordinances and implement tools to reduce and track consumption among residential, commercial and industrial sectors.
- Identify partnerships and negotiate agreements with external governmental and non-governmental agencies to develop and implement new water supply projects.
- Direct long-range water demand studies, integrated water resource plans, groundwater management plans, recycled water plans, desalinated water plans and water efficiency plans.
- Conduct research on public perceptions and acceptance of new water supplies, such as groundwater, recycled water and desalinated water.
- Prepare operations plans to document water system facilities, operating strategies, water quality and permitting requirements.
- Participate in U.S. Department of State, Bureau of International Information Programs, to share technical assistance on Water Management in Brazil, including Sao Paulo, Brasilia, and Rio de Janeiro.
- Prepare water resources management Memorandum of Understanding between San Francisco and Bangalore, India.
- Develop and track performance measures for SFPUC Sustainability Plan.
- Manage staff, produce publications and technical reports, administer contracts and manage $9 million annual budget.

City and County of San Francisco, Public Utilities Commission — ***San Francisco, CA***
Chief of Staff and Public Affairs Manager — **Oct 1999- May 2004**

- Developed educational programs and served as a liaison with commissioners, elected officials, media and stakeholders to increase awareness of the SFPUC's water system improvements and water resource issues.
- Assisted with the development and public outreach for the SFPUC $3.6 billion capital improvement program designed to rebuild and repair the third largest water delivery system in California.
- Managed the bottling and distribution of Hetch Hetchy Mountain Water™ to promote high quality municipal drinking water.
- Coordinated a strategic management system (Balanced Scorecard) to identify organization goals, objectives, and performance measures specific to water, wastewater, and power operations.
- Directed multifaceted communications and government affairs programs and staff, created coalitions and resolved disputes.
- Produced publications, administered contracts, prepared annual work plans and managed a $400,000 annual budget.

City and County of San Francisco, Public Utilities Commission — ***San Francisco, CA***
Pollution Prevention Public Education Director — **Dec 1991-Oct 1999**

- Developed and managed water resource programs for the Water Pollution Prevention Program to reduce pollutant loadings to the San Francisco Bay and Pacific Ocean from point and non-point sources.
- Prepared technical reports, including source identification studies, waste minimization plans and influent and effluent mass loading studies.
- Conducted market research, developed marketing strategies and implemented innovative public education campaigns for targeted audiences.
- Developed publications and programs shown to change behaviors among targeted populations.
- Designed and implemented educational outreach programs through public-private partnerships.
- Awarded six state and national awards for excellence in water pollution prevention public education.
- Received grant funding to develop an integrated pest management and green gardening program.
- Obtained significant media coverage on pollution prevention and water conservation issues.
- Assisted with the development of an *Effluent Management Training Course* for the Water Environment Federation and U.S. AID in Cairo and Alexandria, Egypt, March-April 1998

EDUCATION

University of San Francisco, San Francisco, CA
Master of Science, Environmental Management
September 1990-December 1993

University of Colorado, Boulder, CO
Bachelor of Arts Degree, Geography
September 1983-May 1987

PUBLICATIONS

Kehoe, P. *Drought, San Francisco, and Innovation Though Local Water and Alternative Water Projects*, Green Technology Magazine, August 2015.
Kehoe, P., Rhodes, S., Scarpulla, J. *Blueprint for Onsite Water Systems Shifts Traditional Views on Water Use*. Trim Tab The Magazine for Transformative People + Design. February 2015.
Kehoe, P., Rhodes, S., Scarpulla, J. *Moving from Building-scale to District-scale – San Francisco's Non-potable Water Program.* Alternative Water Supply Systems. London. IWA Publishing. 2015.
Elmer, V., Kehoe, P. *The Tricky Business of Onsite Water Treatment and Reuse.* Planning Magazine. American Planning Association. December 2014.
Kehoe, P., Rhodes, S., Scarpulla, J. *San Francisco Takes the Lead in Setting Standards for Onsite Reuse*. Source Magazine. AWWA. Vol 28, No 4. Fall 2014.
Kehoe, P., Rhodes, S. *Innovations for Water in Urban Areas Require Rethinking and Reuse*. ECOHOME Magazine. Winter 2013.
Beck, S., Goel, N., Kehoe, P., Linden, K., Rhodes, S., Rodriguez, R., Salveson, A. *Disinfection Methods for Treating Low TOC, Light Graywater to California Title 22 Water Reuse Standard.* Journal of Environmental Engineering. Volume 139, Issue 9. September 2013.
Kehoe, P., Rhodes, S. *Pushing the Conservation Envelope Through the Use of Alternate Water Sources*. Journal of the American Water Works Association. Vol. 105:2. February 2013.
Kehoe, P., Rhodes, S. *Regulatory Pathway Streamlined for Onsite Non-potable Reuse in San Francisco.* Water Reuse and Desalination. Vol. 3:3. Autumn 2012.
Kehoe, P., O'Rorke, M. *An Educated Approach to Educating the Public.* Wastewater Technology Showcase, Water Environment Federation. 2000.
Kehoe, P., O'Rorke, M. *Targeted Research and Marketing Put Muscle into Pollution Prevention Education Campaigns.* Utility Executive, Water Environment Federation. 2000.
Kehoe, P., O'Rorke, M. *Targeted Research and Marketing Put Muscle into Pollution Prevention Education Campaigns.* Watershed & Wet Weather, Water Environment Federation. 2000.
Mass Loadings of Used Motor Oil and Latex Paints to the Sewerage System. City and County of San Francisco, Department of Public Works, Bureau of Environmental Regulation and Management, Water Pollution Prevention Program, San Francisco, California. 1993.
A Community of Land. Gildea Review. 1988.

PROFESSIONAL ORGANIZATIONS

Alliance for Water Efficiency, Project Advisory Committee Member: *Net Blue Development*, 2015-Present
WaterReuse Research Foundation, Project Subcommittee Member: *A Framework for the Successful Implementation of Onsite Industrial Water Reuse*, 2014- Present
Water Research Foundation, Project Subcommittee Member: *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities*, 2014-Present
One Water Council, U.S. Water Alliance, Committee Member, 2013-Present **California Urban Water Agencies**, Water Reuse Committee Member, 2013-Present **Vision 2020, ECOHOME, Hanley Wood,** Water Efficiency Chair, 2013
Water Research Foundation, Project Subcommittee Member: *Institutional Issues for Green-Grey Infrastructure based on integrated "OneWater" Management and Resource Recovery,* 2013- 2015
WateReuse Foundation, Project Advisory Committee Member: *Evaluating Long and Short Term Planning Under Climate Change Scenarios to Better Assess the Role of Water Reuse,* 2009-2012
Water Environment Federation, member, Public Education Committee 2006- 2012
WateReuse Foundation, Project Advisory Committee Member: *Talking About Water: Vocabulary and Images that Support Informed Decisions about Water Recycling and Desalination,* 2008-2011
WateReuse Foundation, Project Advisory Committee Member: *Feasibility Study of Offshore Desalination Plants*, 2007-2010
Bay Area Clean Water Agencies, Chair, Water Recycling Committee, 2005-2009
American Water Works Association, Vice Chair, Water Resources Planning & Management Committee, 2006-2007
Water Environment Research Foundation, Member, Peer Review Committee for WERF Project: *Communicating Risks with Your Local Government and Community,* 2004-2006

MANISHA KOTHARI
525 Golden Gate Avenue, 10th Floor, San Francisco, CA, 94102
Tel: (415) 554-3256 (direct); E-mail: mkothari@sfwater.org

PROFESSIONAL EXPERIENCE

Project Manager
San Francisco, CA

5602 Utility Specialist
2007-Present

San Francisco Public Utilities Commission (www.sfwater.org), *a department of the City and County of San Francisco that provides water and wastewater services in San Francisco; wholesale water to three Bay Area counties; and green hydroelectric and solar power to San Francisco's municipal departments*

5620 Regulatory Specialist
2006-2007

Key responsibilities and achievements include:

- Manage project planning, environmental review, design and implementation activities for complex capital improvement projects in the areas of recycled water, desalination and potable reuse
- Manage water supply planning effort for the evaluation of key decisions affecting the SFPUC's post-2018 supply obligations (WaterMAP)
- Deliver project milestones on-time and within budget, including the successful implementation of the SFPUC's first two recycled water projects
- Initiate, build and manage long-term regional partnerships with other water and wastewater service providers in the Bay Area to develop strategic, collaborative, cost-effective water supplies
- Lead public outreach efforts working with environmental groups, schools, local communities and regulatory agencies on behalf of multiple agencies to evaluate the potential for regional desalination and recycled water projects
- Prepare and manage project reporting of the alternative local water supply portfolio
- Secured over $6 million in grant funds to support water supply projects
- Successfully advanced projects that faced significant challenges from various groups through effective education and public outreach campaigns

Sr Environmental Planner
2002-2006

URS Corporation (now part of AECOM www.aecom.com), *a global environmental and engineering consulting firm with expertise in the planning, assessment, design, and implementation of projects in over 65 countries worldwide*

Key responsibilities and achievements include:

- Managed the environmental review, including stakeholder engagement and public outreach activities, for California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) compliance for various public and private capital projects in water, wetland restoration, natural resource development and transportation
- Assisted with the development of corporate policies and initiatives for U.S. companies working in developing countries to address environmental justice and labor concerns

- Prepared and won several competitive project and grant proposals
- Contributed to the development of strategic business plans, identifying key growth areas and opportunities with the U.S. federal government and in Asia

Program Manager, Asia **U.S. Trade and Development Agency (USTDA)** (www.ustda.gov), *a foreign assistance agency of the U.S. federal government that grants seed capital for priority infrastructure projects in low and middle-income countries, while promoting job creation in the United States*

Key responsibilities and achievements included:

- Managed grant program for South and Southeast Asian countries, supporting the development of infrastructure in sectors including, banking, technology, transportation, environment, telecommunications, energy, and security
- Worked with the U.S. Departments of State and Commerce to re-engage political discourse on the subjects of human rights and nuclear non-proliferation through new trade initiatives in China, India and Pakistan
- Reviewed, assessed, and successfully recommended over 100 projects for federal grant assistance
- Worked with U.S. companies to ensure compliance with U.S. laws and policies, and the promotion of U.S. goods and services while working overseas
- Partnered with U.S. government agencies (including the Department of Commerce, OPIC, Ex-Im Bank, the FAA, DOE, and USAID), multilateral development banks (Asian Development Bank and World Bank) and other regional players to structure and implement projects
- Monitored performance of past investments and the associated impact on U.S. jobs and exports for annual Congressional and agency reports and to develop regional strategic priorities for the future
- Planned and executed roundtable discussions, conferences and study tours for Asian project sponsors
- Drafted marketing materials, public information briefs, presidential and congressional briefs, and press releases

EDUCATION

Georgetown University ***Washington, DC***
Master of Science in Foreign Service (International/Public Policy) **1998**
Landeggar Program in International Business-Government Relations

University of California, Berkeley ***Berkeley, CA***
Bachelor of Arts, *cum laude*, in Political Science **1996**
Bachelor of Arts in Mass Communications **1996**
Semester-long internship with the ***United Nations High Commissioner for Refugees (UNHCR)***
(Political Communications position at headquarters in Geneva, Switzerland) 1995

LANGUAGE SKILLS

Languages: Native speaker of ***English, Hindi***; fluent in ***Thai***; working knowledge of ***French***

Andrew T. Salveson

Education

MS Water and Wastewater Engineering, University of California, Davis, 1994

BS Civil Engineering, San Jose State University, San Jose, California, 1993

Licenses

Civil Engineer, California

Professional Engineer, Texas

Professional Affiliations

International UV Association

Water Environment Foundation

Expert Services

Contributing Author, MOP 8, Design of Municipal Wastewater Treatment Plants

Editor of Reuse Treatment, EPA's 2012 Guidelines for Water Reuse

Contributing Author, National Water Research Institute, 2012 UV Guidelines

Contributing Author, National Water Research Institute DPR Framework

Contributing Author, World Health Institute Potable Water Reuse Guidelines

Mr. Salveson has 21 years of environmental consulting experience serving public and private-sector clients in the research and design of water and wastewater treatment systems. He is a nationally recognized expert in water reuse and disinfection. Mr. Salveson provides guidance and expertise on state-of-the-art technologies on the latest industry issues regarding reuse, as has led numerous planning, design, and research projects for various organizations, utilities, and corporations. In recognition of his contributions to the industry, Mr. Salveson was honored with the 2007 WateReuse Person of the Year Award for bringing innovative technologies to market.

Predesign/Design/Planning/ Permitting

- Project manager for the analysis of indirect and direct potable reuse feasibility for the Encina Wastewater Authority.
- Project manager for the analysis of indirect potable reuse treatment technologies for the Water Replenishment District, with Carollo as a subconsultant to CH2M HILL.
- Process engineer for the 30% design of MBR, UF, Ozone, UV, and chlorination membrane and UV disinfection for water reuse for the Barwon Water of Victoria Australia (Carollo teamed with SKM).
- Project manager for the potable reuse feasibility analysis for the Santa Clara Valley Water District, San Jose, California. Work includes expert services related to regulations, treatment, and the creation of a feasibility report for potable reuse.
- Project manager for the preliminary design of a microfiltration (MF)/reverse osmosis (RO)/advanced oxidization process (AOP) for streamflow augmentation with reclaimed water for the Southwest Florida Water Management District, Florida.
- Process advisor for the research and design of advanced membrane and carbon treatment technologies for the Synderville Basin Water Reclamation District, Utah.
- Technical assistance for the Santa Clara Valley Water District, California, Potable Reuse Grant Funding Program.
- Project manager for the City of Los Angeles Bureau of Sanitation for the analysis of alternative advanced oxidation technologies for potable reuse and subsequent permitting with the DDW for those technologies.
- Project engineer for the permitting of IPR for the City of Oxnard, California.
- Technical specialist for the IPR Design/Build for the City of Los Angeles Terminal Island Water Purification Facility.

Testing and Research

- Co-principal Investigator for the 2013 Texas Water Development Board Priority Research Topic Study, "Testing Water Quality in a Municipal Wastewater Effluent Treated to Drinking Water Standards." This study will develop and implement a detailed testing protocol at the Colorado River Municipal Water District's Raw Water Production Facility (RWPF) at Big Spring. This advanced treatment facility constitutes the nation's first instance of direct potable reuse (DPR). The project will also develop monitoring guidelines, based on in-depth parallel study of pathogens, chemicals, and appropriate surrogates, for use at DPR facilities like RWPF and others across the nation. The WateReuse Research Foundation has increased the depth and breadth of this work through their tailored collaboration process.
- Principal investigator for Water Research Foundation Project 4536, Blending Requirements for Water from Direct Potable Reuse Treatment Facilities. This project examines the pathogens, pollutants, and subsequent water quality impacts to drinking water quality due to blending reclaimed water with other raw water supplies.
- Principal investigator for the WERF project CEC4R08, examining the most cost efficient method to reduce microconstituents. The project includes investigations of the secondary treatment process and comparisons with various tertiary methods to destroy microconstituents.

- Principal investigator for the WateReuse Research Foundation WERF Project 12-06, "Guidelines for Engineered Storage for Direct Potable Reuse" Work includes an evaluation of how to integrate Engineered Storage treatment and monitoring into Direct Potable Reuse Treatment trains.

- Principal investigator for the WateReuse Research Foundation Project 10-06, "Challenge Projects on Low Energy Treatment Schemes for Water Reuse" Work includes an evaluation of emerging treatment technologies for low energy treatment for water reuse.

- Co-principal investigator for the WERF project ENER4R12 – Low Energy Alternatives for Activated Sludge, Advancing AnMBR Research, Work includes the design and construction of three AnMBR treatment trains utilizing flat sheet, hollow fiber, and ceramic membranes.

- Co-principal investigator for the WateReuse Foundation's 11-02 "Equivalency of Advanced Treatment Trains for Potable Reuse). Work includes the search for lower energy and lower cost treatment technologies that meet the public health objectives for potable water reuse.

- Project manager for the treatment and analysis of Clean Water Services (Oregon) Direct Potable Reuse Demonstration Facility.

- Principal investigator for the WateReuse Foundation Project 10-10, "Filtration and Disinfection Compliance through Soil Aquifer Treatment." Work included detailed water quality monitoring pre and post SAT to prove treatment to Title 22 Standards.

- Principal investigator for the WateReuse Foundation Project 11-10, "Evaluation of Risk Reduction Principles for Direct Potable Reuse." This important project is examining the methods to modify our current approach to IPR design and operation for direct potable reuse systems.

- Project manager for the WateReuse Foundation's 06-019 "Monitoring for Microcontaminants in an Advanced Wastewater Treatment (AWT) Facility and Modeling Discharge of Reclaimed Water to Surface Canals for Indirect Potable Use " study. Work includes detailed trace organic (EDC, etc.) analysis and in-vivo and in-vitro bioassays to determine hormonal impact, as well as surface water modeling to track fate and transport of trace organics.

- Co-principle investigator for the Australian Water Quality Center of Excellence Pasteurization Demonstration in Melbourne, Australia.

- Co-principal investigator for the WateReuse Foundation's 02-009 "Innovative Treatments for Reclaimed Water" study. Work includes detailed pathogen and micropollutant analysis and the investigation of innovative, but market ready, advanced oxidation technologies.

- Lead investigator for the performance evaluation of pasteurization for reclaimed water disinfection, a sustainable approach to harnessing waste energy for reclaimed water disinfection. Work resulted in the approval of pasteurization by the State of California for wastewater reuse. Demonstration testing has been completed at Santa Rosa, Ventura, and Graton, California.

- Project manager for the research and analysis of a microfiltration, reverse osmosis, and UV disinfection use for the potable reuse of wastewater at Dublin San Ramon Services District, California. The analysis addressed NDMA, standard DBPs, and endocrine disrupting compounds. This project received the 1999 California Water Environment Association Research Achievement Award.

- Technical advisor for the SFWMD to evaluate secondary and tertiary processes for microcontaminant removal and disinfection for 100+ mgd of wastewater to be potentially supplied to the Biscayne Bay as part of the Comprehensive Everglades Restoration Project (CERP). The investigation addresses advanced oxidation for microcontaminant destruction and examines standard compounds with drinking water MCLs, as well as numerous research-level compounds.

- Co-principal investigator for the WateReuse Foundation's 03-001 "Pathogen Removal and Inactivation in Reclamation Plants" study, which investigated the ability of various disinfectants to reduce pathogens of concern.

Shane A. Snyder Ph.D.

Professor of Chemical and Environmental Engineering

snyders2@email.arizona.edu
(520) 621-2573

Education

1994-2000	**Michigan State University, East Lansing, Michigan** – Ph.D. Environ. Toxicology/Zoology
1990-1994	**Thiel College, Greenville, Pennsylvania** – B.A. Chemistry (*Magna Cum Laude*)

Employment

2010-Present	**University of Arizona – Professor of Chemical and Environmental Engineering.**
2010-Present	**Arizona Laboratory for Emerging Contaminants (ALEC) – Co-Director.**
2013-Present	**Water & Energy Sustainable Technology Center (WEST) – Co-Director.**
2000-2010	**Research and Development – Project Manager.** Southern Nevada Water Authority, Las Vegas, Nevada. Develop an
1998–Present	**Owner/Consultant.** Total Environmental Solutions Inc., Boulder City, Nevada.

Relevant Research Projects

2015	**CoPI - WateReuse Research Foundation:** "Advancing the Potential for Direct Potable Reuse through Novel Sensor Systems and Effective Decision Tools" Project 14-01
2014	**CoPI - Water Research Foundation**: "Assessment of Techniques to Evaluate and Demonstrate the Safety of Water from Direct Potable Reuse Treatment Facilities"
2014	**CoPI – WateReuse Research Foundation:** "Integrating Sensor Data for Real-Time Decision Management" (Project# 14-01)
2013	**PI – CARD Technologies**: "Chemical Contaminant Attenuation with Catalytic Activated Carbon"
2012	**PI – Suez Environment:** "Advanced Treatment Technologies for RO/NF Brine Streams"
2012	**PI – PWN Technologies:** "Mutagenic Nitrogenous Compounds from UV and Nitrate Treatment"
2010	**PI - WateReuse Research Foundation:** "Use of UV and Fluorescence Spectra as Surrogate Measures for Contaminant Oxidation and Disinfection in the Ozone/H2O2 Advanced Oxidation Process"
2010	**Principal Investigator – Water Sustainability Program (University of Arizona):** "Parallel Evaluation of Ozone and UV Advanced Oxidation for Reducing Toxicity in Reclaimed Water"
2009	**PI - WateReuse Research Foundation:** "Use of Ozone in Water Reclamation for Contaminant Oxidation"

Recent Synergistic Efforts

2011-2016	**Visiting Professor.** National University of Singapore.
2014-Present	**World Health Organization.** Drinking water advisory panel.
2014-Present	**Co-Editor in Chief.** *Chemosphere* (Impact Factor 3.6)
2012-Present	**US EPA Science Advisory Board** Drinking Water Committee member.
2008-2011	**National Research Council**: Member of Water Reuse expert panel
2008-2013	**WateReuse Research Foundation:** Research Advisory Council (RAC) member

Recent Publications (from Google Scholar November 2014: h-index = 48; times cited = 9752)

2015	Anumol T and **Snyder SA.** *Rapid Analysis of Trace Organic Compounds in Water by Automated Online Solid-Phase Extraction Coupled to Liquid Chromatography-Tandem Mass Spectrometry.* Talanta. **132**:77-86.
2014	Sgroi M, Roccaro P, Oelker GL, **Snyder SA.** *N-Nitrosodimethylamine Formation upon Ozonation and Identification of Precursors Source in a Municipal Wastewater Treatment Plant.* Environmental Science & Technology 48(17):10308-10315.
2013	Drewes JE, Anderson P, Denslow N, Olivieri A, Schlenk D, **Snyder SA**, and K.A. Maruya. *Designing monitoring programs for chemicals of emerging concern in potable reuse - what to include and what not to include?* Water Science and Technology. **67**(2): 433-439.
2014	**Snyder SA.** *Emerging Chemical Contaminants: Looking for Better Harmony.* Journal of the American Water Works Association. **106**(8):38-52.
2014	Escher BI, et al. *Benchmarking Organic Micropollutants in Wastewater, Recycled Water and Drinking Water with In Vitro Bioassays*. Environ. Sci. Technol. **48**(3):1940-1956.

2013 Merel S, Walker D, Chicana R, **Snyder SA**, Baurès E, Thomas O. *State of knowledge and concerns on cyanobacterial blooms and cyanotoxins*. Environment International **59**:303-327.

2012 Bull RJ, Kolisetty N, Zhang XL, Muralidhara S, Quinones, Lim KY, Guo ZX, Cotruvo JA, Fisher JW, Yang XX, Delker D, **Snyder SA**, Cummings BS. *Absorption and disposition of bromate in F344 rats*. Toxicology. **300** (1-2):83-91.

2012 Pisarenko AN, Stanford BD, Yan DX, Gerrity D, **Snyder SA**. *Effects of ozone and ozone/peroxide on trace organic contaminants and NDMA in drinking water and water reuse applications.* Water Research. **46**(2):316-326.

2012 Mawhinney DB, Vanderford BJ, **Snyder SA**. Transformation of 1H-Benzotriazole by Ozone in Aqueous Solution. Environmental Science & Technology. 46(13):7102-7111.

2012 Pisarenko AN, Stanford BD, Yan DX, Gerrity D, **Snyder SA**. Effects of ozone and ozone/peroxide on trace organic contaminants and NDMA in drinking water and water reuse applications. Water Research. 46(2):316-326.

2011 Stanford BD, Pisarenko AN, Holbrook RD, **Snyder SA**. Preozonation Effects on the Reduction of Reverse Osmosis Membrane Fouling in Water Reuse. Ozone: Science & Engineering. 33(5):379-388.

2011 Gerrity D and **Snyder SA**. Review of Ozone for Water Reuse Applications: Toxicity, Regulations, and Trace Organic Contaminant Oxidation. Ozone Science and Engineering. 33:253-266.

2011 Sarp S, Stanford B, **Snyder SA**, Cho J. Ozone oxidation of desalinated seawater, with respect to optimized control of boron and bromate. Desalination and Water Treatment. 27:308-312.

2011 Dickenson ERV, **Snyder SA**, Sedlak DL, Drewes JE. Indicator Compounds for Assessment of Wastewater Effluent Contributions to Flow and Water Quality. Water Research 45:1199-1212.

2009 Dickenson ERV, Drewes JE, Sedlak DL, Wert EC, **Snyder SA**. Applying Surrogates and Indicators to Assess Removal Efficiency of Trace Organic Chemicals during Chemical Oxidation of Wastewaters. Environmental Science & Technology 43(16):6242-6247.

2009 Wert EC, Rosario FL, **Snyder SA**. Effect of Ozone Exposure on the Oxidation of Trace Organic Contaminants in Water. Water Research. 43:1005-1014.

2009 Wert EC, Rosario FL, **Snyder SA**. Using UV Absorbance and Color to Assess Pharmaceutical Oxidation during Ozonation of Wastewater. Environmental Science & Technology. 43(13):4858-4863.

2008 Ikehata K, El-Din MG, **Snyder SA**. Ozonation and Advanced Oxidation Treatment of Emerging Organic Pollutants in Water and Wastewater. Ozone Science & Engineering. 30(1):21-26.

2008 Rosario-Ortiz FL, Mezyk SP, Doud DFR, Wert EC, **Snyder SA**. Effect of Ozone Oxidation on the Molecular and Kinetic Properties of Effluent Organic Matter. Journal of Applied Oxidation Technologies. 11(3):529-535

2007 Lei H and **Snyder SA**. 3D QSPR models for the removal of trace organic contaminants by ozone and free chlorine. Water Research 41:3271-3280

2007 Wert EC, Rosario-Ortiz FL, Drury DD, **Snyder SA**. Formation of Oxidation Byproducts from Ozonation of Wastewater. Water Research. 41:1481-1490

2006 **Snyder SA**, Wert EC, Rexing DJ, Zegers RE, Drury DD. Ozone Oxidation of Endocrine Disruptors and Pharmaceuticals in Surface Water and Wastewater. Ozone Science & Engineering. 28:445-460

FACILITIES AND EQUIPMENT INFORMATION

The treatment equipment, monitoring equipment, and facility information are documented throughout this proposal. The exact site of the advanced purification facilities within the SFPUC Headquarters Building has yet to be determined.

APPLICANT EXPERIENCE AND PAST PERFORMANCE

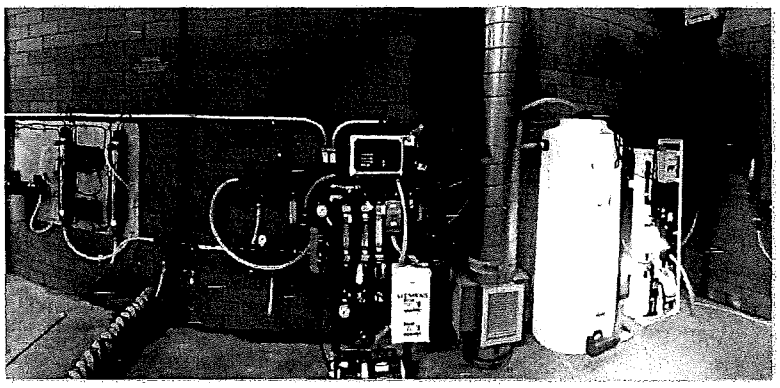
Clean Water Services, Oregon – 2550 SW Hillsboro Highway, Hillsboro, OR 97123

High Purity Water Project – Direct Potable Reuse Demonstration Facility

Client Reference

Mr. Rick Shanley, PE
Engineering Division Manager
Ph: 503-547-8178

Completion Date: April 2015

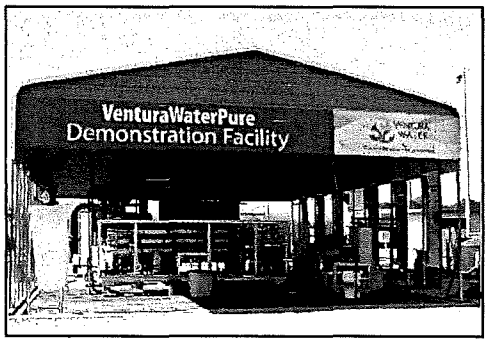


Clean Water Services (CWS) produces a high quality wastewater effluent that can be recycled. Advanced water treatment technologies make it feasible to treat water to any level. To demonstrate this potential, CWS conducted a demonstration project to purify municipal secondary effluent to various levels sufficient for use in a variety of purposes, including semiconductor processing, agriculture and food crops, product manufacturing, and human consumption. CWS is interested in demonstrating to the public that advanced treatment of wastewater can be a viable source of water supply. Regulatory challenges had to be overcome, as the Oregon regulations (from the Oregon Department of Environmental Quality (ODEQ) specifically did not allow potable water reuse.

Carollo worked closely with CWS staff in the process design, installing ultrafiltration, reverse osmosis, ultraviolet light advanced oxidation process, and granular activated carbon as the purification steps. These technologies provided robust pathogen and pollutant treatment through multiple barriers. These processes were used in series to purify disinfected secondary effluent from CWS's Forest Grove Facility (FGF). The testing demonstrated that the FGF effluent, when treated with UF, RO, and UV AOP, provides a very high quality water that is absent of trace pollutants and pathogens. As a result, a purified water suitable for potable use and public consumption was confirmed, and a single use DPR permit was obtained from ODEQ.

City of Ventura, California – 501 Poli Street, Ventura, CA 93001

Direct Potable Reuse Demonstration Study



Client Reference

Ms. Shana Epstein
General Manager
Ph: 805-652-4518

Completion Date: April 2016

The primary purpose of the demonstration facility is to document the high quality of purified reclaimed water through extensive water quality testing and to understand the impact of blending this purified water with the conventional finished potable water. A secondary purpose of the demonstration facility is to provide an educational opportunity for the community, including Ventura Water and City of Ventura staff, the general public, and for local regulators.

The VenturaWaterPure demonstration facility was designed to have multiple barriers for both pathogens and trace pollutants in excess of the treatment required for indirect potable reuse (IPR) via groundwater injection. The ~20 gallon-gpm process train takes undisinfected filtered secondary effluent from the Ventura Water Reclamation Facility and provides treatment through pasteurization, ultrafiltration, reverse osmosis, and an ultraviolet light advanced oxidation process. For a future DPR facility, granular activated carbon (GAC) may be added after RO for an additional barrier to trace pollutants and an engineered storage buffer (ESB) would be added to the treatment train after the UV AOP to allow for appropriate system monitoring and water quality assurance.

The VenturaWaterPure direct potable reuse (DPR) demonstration facility represents the combined efforts of Ventura Water, the City of Ventura, Carollo Engineers, and members of the Water Research Foundation Project 4536 team.

Colorado River Municipal Water District in Big Spring, Texas – PO Box 13231, Austin, TX 78711 - High Purity Water Project – Direct Potable Reuse Demonstration Facility Evaluation

Client Reference

Ms. Erika Mancha, Team Lead
Innovative Water Technologies
Texas Water Development Board
Ph: 512-463-7932

Completion Date: May 2016

A team led by Carollo was selected by the Texas Water Development Board to perform a comprehensive evaluation and monitoring study of the Raw Water Production Facility in Big Spring, TX, the country's first direct potable reuse facility. An overarching goal of the study was to determine the efficacy and reliability of DPR treatment for implementation across the State of Texas, and ultimately support the development of DPR projects across the nation. Our study includes:

A team led by Carollo was selected by the Texas Water Development Board to perform a comprehensive evaluation and monitoring study of the Raw Water Production Facility in Big Spring, TX, the country's first direct potable reuse facility

- A comprehensive and independent evaluation of the Big Spring DPR process (MF, RO, UV AOP), including analysis of each treatment barrier, determination of pathogen and pollutant removal and the use of surrogate parameters for performance demonstration.
- Development and implementation of a detailed testing protocol that included direct measurement of pathogens (virus, protozoa, and bacteria) and trace chemicals (pharmaceuticals and personal care products, hormones, flame retardants, and others) as well as a number of indicator and surrogate measurements that could be used to monitor treatment performance.
- A guidance document that recommends monitoring approaches for DPR.

Additional research was funded by the WateReuse Research Foundation to extend the depth and breadth of the analysis. Leading edge research was completed, including the use of fluorescent dyes to provide greater accuracy and precision for pathogen removal by RO.

To support development of a robust monitoring approach that is practicable for utilities of various sizes and financial means, our testing protocol included measurement of less costly surrogates wherever possible to complement the testing for primary parameters, and defined correlations between primary parameters and surrogates.

The results shown an extremely high quality water produced from this facility and serves to support broad acceptance of DPR in Texas.

WORK CURRENTLY SPONSORED BY OTHERS

This work has not been presented for funding elsewhere.

ENVIRONMENTAL IMPACT

The demonstration facility will be sited within the SFPUC Headquarters building, and therefore will not require an environmental impact documentation. The pilot system will be aesthetically contained and secured within the building. Public outreach banners and educational material will be posted around the system. Raw wastewater will be pumped from an existing sewer, treated, and returned to the same sewer along with all other waste streams generated from the pilot.

DISMANTLING PLANS

Upon completion of the pilot study, the dismantling of the pilot equipment will be undertaken by Carollo and SFPUC staff. The advanced purification process units will be decommissioned by the manufacturer's representative and removed from the site. All other miscellaneous equipment such as pumps, electrical equipment, etc. will be donated to Reclamation or other participating agencies. If these latter items are not desired by participating agencies, then Carollo may reuse or scrap the equipment.

OTHER INFORMATION

Technical References

Technical references will be provided upon request.

BUDGET NARRATIVE

The project team is proposing to complete this project in 1 year. We estimate that $200,000 of the Bureau share of the project will be expended in the first few months to rent and install the advanced purification facilities. Cash funds of **$200,000** from SFPUC will be distribution to the project team. Substantial in-kind funding totaling **$82,530** for this project is detailed in the Funding Plan and Letters of Commitment Section.

PRIMARY CONTRACTOR BUDGET JUSTIFICATION – CAROLLO ENGINEERS

Salaries and Wages (Total: $74,385)

Salary rates for the Carollo employees (Andrew Salveson and with support staff [word processing/graphics]) are established in conjunction with their employer, Carollo Engineers, Inc. (Carollo). Indirect costs of 126% are included in the hourly rates budget for each of Carollo employees. A 0% wage increase has been incorporated for each staff person for each year of the project.

Fringe Benefits (Total $37,193)

Fringe benefits at Carollo are provisional rates used for billing purposes, and include the following categories: Employer Taxes, Unemployment Insurance, Workers Compensation, Paid Time Off, Sick Time, Holiday Pay, Group Insurance, 401K Matching, incentive, and Allocated Group Insurance. For Carollo personnel, fringe benefits are 50% of direct labor.

Equipment Rental and Sample Shipping ($125,250)

SFPUC requires the rental of advanced treatment equipment, totaling $125,250. The funds for this equipment will be covered by USBR and SFPUC. The itemized list of pilot equipment costs are as follows:

Component	Vendor	Description	Rental/ Purchase	Unit	Unit Cost	Duration/ #Units	Subtotal
MF/UF	GE	3 gpm skid with membranes	R	$/ Month	$2,500.00	5	$26,000.00
		First Month, includes shipping and startup	P	$	$6,250.00	1	
		Last Month, includes de-mob and shipping	P	$/day	$6,250.00	1	
		Replacement Membranes	P	$	$1,000.00	1	
RO	GE	3 gpm skid with membranes	R	$/ Month	$2,500.00	5	$26,000.00
		First Month, includes shipping and startup	P	$	$6,250.00	1	
		Last Month, includes de-mob and shipping	P	$/day	$6,250.00	1	
		Replacement Membranes	P	$	$1,000.00	1	
ESB	TBD	Tankage and Valving	P	$	$750.00	3	$2,750.00
		Shipping	P	$	$500.00	1	

Component	Vendor	Description	Rental/ Purchase	Unit	Unit Cost	Duration/ #Units	Subtotal
UV	Trojan	1 gpm unit	P	$	$1,500.00	2	$7,500.00
		Shipping	P	$	$500.00	1	
		Oxidant Tankage and Pumping	P	$	$2,000.00	1	
		Sensors	P	$	$1,000.00	2	
Flow Meter	TBD		P	$	$3,000.00	2	$6,000.00
Piping	TBD		P	$	$ 2,000.00	1	$2,000.00
Analyzers	ZAPs	(turbidity, TOC, e. coli, UVA, total and free chlorine)	R-6 month	$			$51,000.00
EC	TBD		P	$	$ 2,000.00	2	$4,000.00
						Total	**$125,250.00**

Materials and Supplies ($62,000)

No materials, other than listed above, are expected as part of this proposal for Carollo portion of work. However, site preparation and dismantling, public outreach, miscellaneous supplies, and project management, is estimated to cost approximately $62,000. These funds, documented in their Letter of Commitment, will be contributed by SFPUC.

Travels ($0)

Travel for the proposed project will be limited to local vehicular travel to and from the test site, as well as one trip to Reclamation in Denver by the Project Manager to make a presentation of the final report. Travel will be covered as an in-kind contribution from Carollo.

Subcontract ($88,860)

Carollo will enter into a subcontract with three entities. The subcontracts include Southern Nevada Water Authority (SNWA) for $39,420, BioVir for $13,440, and University of Arizona for $36,000.

See below (Subcontractor Budget Justification) for a detailed description of these costs.

Other Direct Costs ($1,000)

Other direct costs include sample shipping during the demonstration. These costs are estimated at $1,000.

Indirect Costs ($93,725)

As noted earlier, 126% indirect costs for non-federal researcher salaries have been included in the Salaries and Wages budget estimate, as these costs are more accurately described for this project as Direct Costs incurred by Carollo.

CONTRACTUAL BUDGET JUSTIFICATION

Contractual work will include all advanced analytics. Southern Nevada Water Authority (SNWA) will perform all CEC analysis. BioVir will perform all pathogen analysis. The University of Arizona will perform all bioassays and non-target analysis testing. The itemized costs of each test and the contract subtotals are presented in the table below.

	Total Samples	$/Sample	Total $
SNWA Scope			
PPCPs	24	500	12,000
PFCs	24	500	12,000
NDMA	18	250	4,500
NDMA FP	18	350	6,300
THM/HAA FP	18	200	3,600
TOC	18	30	540
Fluorescence	24	20	480
		SNWA Subtotal	***39,420***
BioVir - Pathogen Analysis			
Male Specific Phage & Somatic Phage	6	125	750
Enterococci	6	60	360
E. coli	6	55	330
Total Coliform	6	Inc.	
Giardia/Cryptosporidium	6	350	2,100
Enterovirus and Norovirus	6	1,650	9,900
		BioVir Subtotal	***13,440***
University of Arizona Scope			
Bioassay Suite	24	500	12,000
GC-NTA	24	400	9,600
LC-NTA	24	600	14,400
		University of Arizona Subtotal	36,000
		Total Cost	**88,860**

TOTAL COSTS

The Total Project Cost is shown in the Table on the following page. Total Costs are **$482,413**.

FUNDING PLAN AND LETTERS OF COMMITMENT

This funding plan includes all anticipated project costs as $482,413. The Reclamation share of the cost will be $200,000 and the remaining funds ($282,413) will be provided by the project team members, in the form of both in-kind and monetary contributions. As shown, recipient funding accounts for 59 percent of the project total. Letters of commitment from SFPUC, and Carollo are provided on the following pages.

Funding Sources	Funding Amount	Cost Share (%)
Non-Federal Entities		
SFPUC, cash	$200,000	41
SFPUC, in-kind	$62,000	13
Carollo, in-kind	$20,530	4
Non-Federal Subtotal:	**$282,530**	**59**
Other Federal Entities - None		
Requested Reclamation Funding:	$200,000	41
Total Project Funding:	**$482,530**	**100**

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102
T 415.554.3155
F 415.554.3161
TTY 415.554.3488

February 5, 2016

Attn: Ms. Janeen Koza
Bureau of Reclamation
Mail Code: 84-27852
Denver Federal Center, Bldg. 67, Rm. 152
6th Avenue and Kipling Street
Denver, CO 80225

Electronic Submittal via www.grants.gov

Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Dear Ms. Koza:

The San Francisco Public Utilities Commission (SFPUC) is pleased to submit this application for a pilot demonstration for water purification research in response to the Bureau of Reclamation's Funding Opportunity Announcement No. R16-FOA-DO-010. As a wholesale and retail water provider serving over 2.6 million people, the SFPUC is committed to the responsible and sustainable use of water. We recognize that the development and application of technologies that improve the efficiency and quality of water reuse play a key role in meeting this commitment.

In an effort to continue to advance our water sustainability goals, we have put together a team of water treatment and public health experts to develop a building-scale direct potable water reuse (DPR) treatment facility. This new purification facility will take tertiary recycled water from an existing non-potable water system at our headquarters in San Francisco and treat it to potable water standards. This demonstration project will fulfill three critical values to the industry:

1. **Cost Effective Building-Scale Treatment** - The work will demonstrate the economic viability of building-scale treatment for potable water reuse using innovative technologies. The non-potable water system (Living Machine®), in place at the SFPUC Headquarters Building since 2012, treats the 13-story, 900+ employee building's wastewater to non-potable reuse standards. The tertiary effluent from the non-potable water system will then go through advanced membrane treatment and advanced oxidation treatment, producing a high quality potable water.

2. **Intelligent Control for DPR** - To date, no potable water reuse system (indirect or direct), provides a comprehensive real-time monitoring of overall performance. For potable water reuse, the treatment targets

include virus, protozoa, bacteria, total organic carbon, salts, and trace level pollutants. This project will build a treatment system that tracks and records performance of each system, and most importantly of the entire system for the removal of pathogens and pollutants. This will be the first real-time "smart" potable water reuse treatment system, operating for 6 consecutive months, which will be used to demonstrate the long term reliability of advanced water purification processes.

3. **Advanced Analytics** - No water is 100% pure, even after an RO system. Trace level chemicals can be found. This novel project will use emerging analytical tools such as a suite of bioassays and non-target analysis (NTA) to better understand the relevance of such trace level pollutants.

To that end, SFPUC is willing to support this effort by providing the following in-kind and direct funding support:

- a site for the advanced purification treatment at the SFPUC Headquarters Building that allows for public engagement;

- site work, which includes: purchase and installation of plumbing and electrical connections to the treatment facilities, as well as decomissioning (estimated at 120 hours over one year, at $150/hr, and $1,000 of materials and equipment, resulting in a cost of $19,000);

- educational and outreach materials for the treatment facilities (website, brochures, banners, tour materials, estimated at $25,000); and

- review and support of the work effort (estimated at 120 hours over one year, at $150/hr, resulting in a cost of $18,000).

In addition to the direct funding of the items above, SFPUC understands the high cost of analytical testing for this demonstration, which will span significant periods of the 1-year demonstration project. To that end, SFPUC is willing to provide $200,000 in cash in support of analytical testing.

The total costs for these contributions are estimated at **$262,000**. Please contact Manisha Kothari at (415) 554-3256 if you have any questions or comments. We look forward to working with your team on this important research topic.

Sincerely,

Steven R. Ritchie

Assistant General Manager, Water

Carollo
Engineers...Working Wonders With Water®

WATER
OUR FOCUS
OUR BUSINESS
OUR PASSION

February 4, 2016

Ms. Paula Kehoe
San Francisco Public Utilities Commission
525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102

Subject: Building-Scale Treatment for Direct Potable Water Reuse & Intelligent Control for Real Time Performance Monitoring

Dear Ms. Kehoe:

Carollo Engineers, Inc. is pleased to provide this Letter of Commitment to confirm our support to the City of San Francisco, acting through the Public Utilities Commission, for our services (both paid and in-kind) related to the proposed project to pilot test building scale direct potable reuse with intelligent control systems and advanced performance monitoring. Carollo is committed to providing the following services for this project:

- Provide 10 percent of contractual hours as an in-kind service (an in-kind contribution of $20,530).
- Vehicular travel to and from the pilot site and to one trip to Denver to present findings to the USBR as an in-kind service, not quantified here.

Carollo commits to providing identified staff and resources for the duration of the project. The value of the services is $420,412. The services include approximately 1,300 hours of time, equipment, chemicals and consumable supplies, and analytical services. Carollo commits to providing $20,530 as in-kind contributions and, should the proposal be successful, will contract with SFPUC for $399,882 to perform other services.
If you have any questions regarding our participation, please contact me at 925-788-9857.

Sincerely,

CAROLLO ENGINEERS, INC.

Andrew Salveson

Andrew Salveson, P.E.
Vice-President

AS:MS

2700 Ygnacio Valley Road, Suite 300, Walnut Creek, California 94598
P. 925.932.1710 F. 925.930.0208
carollo.com

LABOR AND BUDGET ESTIMATE 1/29/16

Task	Task Description	SP $95	AP $60	AP $50	WP $25	Carollo Hours	Carollo Labor Cost	Fringe 50%	Indirect 126%	Carollo In Kind Contribution 10%	Other Direct Costs (ODC)			Total Cost
											Equipment	Lab Analysis	ODC Total	
1.0	Project Management													
1.1	Prepare Project Work Plan	1	2		0	3	$215	$108	$271	$59	$0		$0	$534
1.2	Attend Meetings (2)	16	8	8	0	32	$2,400	$1,200	$3,024	$662	$0		$0	$5,962
1.3	Project Coordination, Tracking and Status	26	26	8	0	60	$4,430	$2,215	$5,582	$1,223	$0		$0	$11,004
1.4	QA/QC	16	0		0	16	$1,520	$760	$1,915	$420	$0		$0	$3,776
	Task 1.0 Totals =	**59**	**36**	**16**	**0**	**111**	**$8,565**	**$4,283**	**$10,792**	**$2,364**	**$0**		**$0**	**$21,275**
2.0	Building-Scale Treatment for Non-Potable Water Reuse													
	Living Machine® treatment facility currently in operation, performance data donated to the project	0	0			0	$0				$0		$0	$0
	Task 2.0 Totals =	**0**	**0**	**0**	**0**	**0**	**$0**				**$0**		**$0**	**$0**
3.0	Purification Facility Design and Construction													
3.1	Selection and Purchase/Rental of Treatment Processes	4	8	16		28	$1,660	$830	$2,092	$458	$70,250		$70,250	$74,373
3.2	Selection and Purchase/Rental of Online Monitoring Systems	4	8	16		28	$1,660	$830	$2,092	$458	$55,000		$55,000	$59,123
3.3	Installation and Startup of Treatment and Monitoring Systems	16	36	48		100	$6,080	$3,040	$7,661	$1,678	$0		$0	$15,103
3.4	Installation and Preliminary Collection of Online Monitoring System	16	36	48		100	$6,080	$3,040	$7,661	$1,678	$0		$0	$15,103
3.5	Summary TM	4	12	20	8	44	$2,300	$1,150	$2,898	$635	$0		$0	$5,713
	Task 3.0 Totals =	**44**	**100**	**148**	**8**	**300**	**$17,780**	**$8,890**	**$22,403**	**$4,907**	**$125,250**		**$125,250**	**$169,416**
4.0	Direct Potable Reuse Performance Demonstration													
4.1	6 months of O&M	40	104	312		456	$25,640	$12,820	$32,306	$7,077	$1,000		$1,000	$64,690
4.2	Conventional Parameters, PPCPs, Pathogens, and Advanced Analytics (additional hours for sampling only)	0	26	52		78	4160	$2,080	$5,242	$1,148		$88,860	$88,860	$99,193
	Task 4.0 Totals =	**40**	**130**	**364**	**0**	**534**	**$29,800**	**$14,900**	**$37,548**	**$8,224.80**	**$1,000**	**$88,860**	**$89,860**	**$163,883**
5.0	Public Communication and Outreach													
	Costs for public communication and outreach will be funded entirely by SFPUC	0	0			0	$0				$0		$0	$0
	Task 5.0 Totals =	**0**	**0**	**0**	**0**	**0**	**$0**				**$0**		**$0**	**$0**

LABOR AND BUDGET ESTIMATE 1/29/16 (CONT.)

Task	Task Description	SP $95	AP $60	AP $50	WP $25	Carollo Hours	Carollo Labor Cost	Fringe 50%	Indirect 126%	Carollo In Kind Contribution 10%	Other Direct Costs (ODC)			Total Cost
											Equipment	Lab Analysis	ODC Total	
6.0	Project Communication and Reporting													
	6.1 Quarterly Reporting	8	8	32	8	56	$3,040	$1,520	$3,830	$839	$0		$0	$7,551
	6.2 Final Report	40	40	160	40	280	$15,200	$7,600	$19,152	$4,195	$0		$0	$37,757
	Task 6.0 Totals =	**48**	**48**	**192**	**48**	**336**	**$18,240**	**$9,120**	**$22,982**	**$5,034.24**	**$0**		**$0**	**$45,308**
	Totals (Tasks 1-6)=	**191**	**314**	**720**	**56**	**1,281**	**$74,385**	**37,193**	**$93,725**	**$20,530**	**$126,250**	**$88,860**		**$399,882**

Legend:

SP	Senior Professional	AP	Assistant Professional
LPP	Lead Project Professional	CAD	CAD Technician/Graphics
PP	Project Professional	WP	Word Processor
P	Professional		

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 01/31/2019

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Desalination and Water Purification Research & Development	15.506	$	$	$ 200,000.00	$ 282,530.00	$ 482,530.00
2.						
3.						
4.						
5. Totals		$	$	$ 200,000.00	$ 282,530.00	$ 482,530.00

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1)	(2)	(3)	(4)	Total (5)
	Desalination and Water Purification Research & Development				
a. Personnel	$ 74,385.00	$	$	$	$ 74,385.00
b. Fringe Benefits	37,193.00				37,193.00
c. Travel					
d. Equipment	125,250.00				125,250.00
e. Supplies	62,000.00				62,000.00
f. Contractual	88,860.00				88,860.00
g. Construction					
h. Other	1,000.00				1,000.00
i. Total Direct Charges (sum of 6a-6h)	388,688.00				$ 388,688.00
j. Indirect Charges	93,725.00				$ 93,725.00
k. TOTALS (sum of 6i and 6j)	$ 482,413.00	$	$	$	$ 482,413.00
7. Program Income	$ 0.00	$	$	$	$

SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8. Desalination and Water Purification Research &	$ 262,000.00	$ 0.00	$ 20,530.00	$ 282,530.00
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$ 262,000.00	$	$ 20,530.00	$ 282,530.00

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 200,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00	$ 50,000.00
14. Non-Federal	$ 200,000.00	50,000.00	50,000.00	50,000.00	50,000.00
15. TOTAL (sum of lines 13 and 14)	$ 400,000.00	$ 100,000.00	$ 100,000.00	$ 100,000.00	$ 100,000.00

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. Desalination and Water Purification Research &	$ 200,000.00	$ 0.00	$ 0.00	$ 0.00
17.				
18.				
19.				
20. TOTAL (sum of lines 16 - 19)	$ 200,000.00	$	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:

22. Indirect Charges:

23. Remarks:

PUBLIC UTILITIES COMMISSION

City and County of San Francisco

RESOLUTION NO. **16-0191**

WHEREAS, The San Francisco Public Utilities Commission (SFPUC) remains committed to exploring alternative water supply options; and

WHEREAS, Purified water presents a potential water supply alternative that is drought proof and local; and

WHEREAS, The SFPUC has applied for and been awarded grants from 1) the Water Research Foundation (WRF) ($100,000) 2) Water Environment & Reuse Foundation (WE&RF) ($100,000) and 3) the U.S. Bureau of Reclamation (USBR) ($200,000); and

WHEREAS, Adoption of this Resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378 because there would be no physical change in the environment; and

WHEREAS, The grant match requirement is up to $300,000 in cash and $100,000 in in-kind service s from the SFPUC, a portion of which will be allocated to public outreach; and

WHEREAS, The estimated cost of contractor services is $600,000 and will be performed under a sole source pilot project feasibility contract with Carollo Engineers; and

WHEREAS, Services are anticipated to begin in September of 2016 and end in June of 2018 and the total duration of this agreement is 21 months; and

WHEREAS, Funds for this agreement will be available at the time of award of the agreement from Project No. CUW274 – Potable Reuse; now, therefore, be it

RESOLVED, That this Commission hereby authorizes the General Manager of the SFPUC to accept and expend grants awarded by the Water Research Foundation ($100,000), the Water Environment & Reuse Foundation ($100,000), and the U.S. Bureau of Reclamation ($200,000), subject to approval of the Board of Supervisors to accept and expend such grants; and to negotiate and execute an agreement with Carollo Engineers for a pilot research project not to exceed $600,000 in total value, and with a total duration of 21 months, in substantially the same form provided in the Commission's file and subject to approval as to form by the City Attorney.

I hereby certify that the foregoing resolution was adopted by the Public Utilities Commission at its meeting of September 13, 2016.

Alonna Hood

Secretary, Public Utilities Commission

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102
T 415.554.3155
F 415.554.3161
TTY 415.554.3488

October 17, 2016

The Honorable Ben Rosenfield
Controller
City and County of San Francisco
1 Dr. Carlton B. Goodlett Place, Room 316
San Francisco, CA 94102

Subject: Accept and Expend Grant – Implementation of a Decentralized Purified Water Pilot by the San Francisco Public Utilities Commission (SFPUC) in San Francisco - $400,000

Dear Controller Rosenfield:

Attached please find an original copy of a resolution that requires your signature. The resolution authorizes the San Francisco Public Utilities Commission's (SFPUC) General Manager to accept and expend grants in the amounts of $100,000 from the Water Research Foundation (WRF), $100,000 from the Water Environment & Reuse Foundation (WE&RF), and $200,000 from the U.S. Bureau of Reclamation (USBR) for a total of $400,000 toward the implementation of a decentralized purified water pilot project in San Francisco.

In this packet you will find:

- A copy of the BOS resolution requiring your signature
- Water Research Foundation Proposal
- Water Research Foundation Award Notice Memorandum
- Water Environment & Reuse Foundation Proposal
- Water Environment & Reuse Foundation Award Notice Memorandum
- U.S. Bureau of Reclamation Proposal
- U.S. Bureau of Reclamation Award Notice
- Grant Expenditures Budget by Task
- SFPUC Resolution No. 16-0191
- Grant Resolution Information Form

When you have signed this resolution, please forward the original copy to the Mayor's Budget Office, City Hall Room 288, for signature by the Mayor and submittal to the Clerk of the Board of Supervisors.

Sincerely,

Juliet Ellis ACTING GENERAL MGR

Harlan L. Kelly, Jr.
General Manager

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102
T 415.554.3155
F 415.554.3161
TTY 415.554.3488

TO: **Angela Calvillo, Clerk of the Board**

FROM: **John Scarpulla, Policy and Government Affairs**

DATE: **October 2016**

SUBJECT: **Accept and Expend Grant – Implementation of a Decentralized Purified Water Pilot by the San Francisco Public Utilities Commission (SFPUC) in San Francisco - $400,000**

Attached please find an original and one copy of a proposed resolution authorizing the San Francisco Public Utilities Commission (SFPUC) General Manager to accept and expend grants in the amounts of $100,000 from the Water Research Foundation (WRF), $100,000 from the Water Environment & Reuse Foundation (WE&RF), and $200,000 from the U.S. Bureau of Reclamation (USBR) for a total of $400,000 toward the implementation of a decentralized purified water pilot project in San Francisco.

The following is a list of accompanying documents (2 sets):

1. Board of Supervisors Resolution
2. Water Research Foundation Proposal
3. Water Research Foundation Award Notice Memorandum
4. Water Environment & Reuse Foundation
5. Water Environment & Reuse Foundation Award Notice Memorandum
6. U.S. Bureau of Reclamation Proposal
7. U.S. Bureau of Reclamation Award Notice
8. Grant Expenditures Budget by Task
9. SFPUC Resolution No. 16-0191
10. Grant Resolution Information Form

Please contact John Scarpulla at (415) 934-5782 if you need any additional information on these items.

OFFICE OF THE MAYOR
SAN FRANCISCO

DEPARTMENT HEAD
LEAVE FORM

Name	Harlan L. Kelly, Jr.
Department	San Francisco Public Utilities Commission
Work Phone	(415) 554-0740
Cell Phone	(415) 725-7267
Departure Date	10/11/2016
Return Date	10/14/2016

Purpose of Absence	Personal or Family Medical Leave Other Details: **Family Matter in Fresno** Name of Conference/Event

In the event of an emergency, how may we contact you?

Name of hotel/contact	Harlan L. Kelly, Jr.	Naomi Kelly
Address		
City, State, Zip		
Phone	(415) 725-7267	(415) 307-0611

Who will be acting on your behalf?

Acting General Manager	Michael Carlin (Acting:Oct.11)	Juliet Ellis (Acting:Oct.12-13)
Work Number	(415) 934-5787	(415) 554-1540
Cell Number	(415) 613-6150	(415) 385-8885
Email	MCarlin@sfwater.org	JEllis@sfwater.org

This form must be completed by all CCSF Department Heads and submitted to the Mayor's office **two weeks prior** to any vacation or leave.

If you are unable to request a leave in advance due to sickness or an emergency, please contact Úna Fannon at the first availability at 415-554-6910.

Please complete this form and email it to una.fannon@sfgov.org, sally.leung@sfgov.org and DEMdutyofficer@sfgov.org

Sick leave is granted under Civil Service Rule 22.02 and may be used only in the event of illness, injury, medical or dental appointment, bereavement, maternity leave or during care of a dependent relative.

1 DR. CARLTON B. GOODLETT PLACE, ROOM 200
SAN FRANCISCO, CALIFORNIA 94102-4681
TELEPHONE: (415) 554-6141

OFFICE OF THE MAYOR
SAN FRANCISCO

EDWIN M. LEE

TO: Angela Calvillo, Clerk of the Board of Supervisors

FROM: for Mayor Edwin M. Lee

RE: Accept and Expend Grant – Implementation of a Decentralized Purified Water Pilot by the San Francisco Public Utilities Commission (SFPUC) in San Francisco - $400,000

DATE: November 15, 2016

Attached for introduction to the Board of Supervisors is a resolution authorizing the San Francisco Public Utilities Commission (SFPUC) General Manager to accept and expend grants in the amounts of $100,000 from the Water Research Foundation (WRF), $100,000 from the Water Environment & Reuse Foundation (WE&RF), and $200,000 from the U.S. Bureau of Reclamation (USBR) for a total of $400,000 toward the implementation of a decentralized purified water pilot project in San Francisco.

I respectfully request that this item be calendared in Budget & Finance Committee on November 30, 2016.

Should you have any questions, please contact Nicole Elliott at (415) 554-7940.

1 DR. CARLTON B. GOODLETT PLACE, ROOM 200
SAN FRANCISCO, CALIFORNIA 94102-4681
TELEPHONE: (415) 554-6141