WaterSMART: Development of Feasibility Studies under the
Title XVI Water Reclamation and Reuse Program for Fiscal Year 2017
Funding Opportunity Announcement No. BOR-DO-17-F003

OKLAHOMA WATER RESOURCES BOARD

Feasibility Study of Potential Impacts of Select Alternative Produced Water Management and Reuse Scenarios

Applicant
Oklahoma Water Resources Board
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Technical Proposal

Executive Summary

Date:	January 9, 2017
Applicant Name:	Oklahoma Water Resources Board
City:	Oklahoma City
County:	Oklahoma
State:	Oklahoma

Anticipated length of the study: 18 months upon issuance of notice to proceed

Federal Assistance Requested: $150,000.00 (>$300,000.00 total Project cost)

The proposed feasibility study, slated for completion not later than fall of 2018, responds to both of Governor Fallin's recent mandates to the Oklahoma Water Resources Board (OWRB): (1) to search for ways to use produced water (PW) as a *benefit* to the state as a part of the Water for 2060 initiative, and (2) to find solutions that reduce deep-well injection volumes and thereby reduce the threat of seismicity within the state. This study will investigate the feasibility and potential impacts of select alternative PW management and reuse scenarios identified in the state's Produced Water Working Group (PWWG)[1] report expected to be completed in late 2017. The OWRB proposes to build on the conclusions of the PWWG initial scoping study and fully evaluate the most encouraging leads at this juncture: 1) investigation of technical, economic, and environmental feasibility of current PW evaporation technologies on a wide scale as a PW management option, and 2) investigation of the technical, economic, and environmental feasibility of the transfer of excess PW from the state's Mississippi Lime play to the central Oklahoma plays (STACK and SCOOP) for reuse in oil and gas operations. Consideration of widespread implementation of practices envisioned in these scenarios requires further and more detailed assessment. Federal Funds are anticipated to pay for consulting contract expenses and any lab fees that may be incurred. Contract expertise may include but not be limited to producer group facilitation, engineering and cost estimates for a wide range of variables, and combining data and results into a final report. As stated in the WaterSMART Funding Opportunity Description: "Water reclamation and reuse is an essential tool in stretching the limited water supplies in the Western United States." This proposed WaterSMART Feasibility Study endeavors to meet that goal; either of the proposed scenarios could result in a reduced demand of the state's fresh water resources by the oil and gas industry and/or create, through evaporation, new *additional* volumes of usable water as part of the current water cycle in Oklahoma and throughout the region.

[1] More information on the PWWG can be found at: https://www.owrb.ok.gov/2060/pwwg.php.

Description: Project Background

The OWRB has been charged with establishing a Produced Water Working Group (PWWG) to investigate promotion of reuse and recycling of produced water related to oil and gas production. In addition to providing a new source of water that may be suitable for multiple purposes, the reduction of the disposal of produced water, primarily into the Arbuckle formation, may also provide a means for addressing issues pertaining to increased seismicity across the state. The PWWG is searching for sustainable alternatives to reduce the industry's reliance on deep-well disposal while still balancing costs to industry, public interest, and continued beneficial development of the state's valuable oil and gas resources. Ongoing PWWG investigations include the evaluation of potential costs to treat and deliver PW for alternative uses compared to deep-well injection and alternate disposal methods. The PWWG study report is expected to be fully drafted in the first quarter of 2017.

The non-Federal project partners are the Oklahoma Water Resources Board (Applicant), Environmental Defense Fund (EDF), Ground Water Protection Council (GWPC), and University of Texas Bureau of Economic Geology (UTBEG).

The proposal study area will include assessment of potential scenarios across the State of Oklahoma. Specific to proposed tasks described below, work related to evaporation will have state-wide influence through incorporation of input, data, and expertise from state experts, stakeholders and industries from across the state. This project will also include visitation at one, if not more, active evaporation sites in the state (to be determined). Work related to PW transfer will focus on the regions and plays shown in Figure 1.

Reclaimed and reused water within the scope of this project is needed and will be developed for the State of Oklahoma broadly, and potentially for neighboring states through the process of evaporation, where reclaimed water would be dispersed as vapor to the local atmosphere.

Reclaimed water within the specific context of PW transfer will address needs within the oil and gas industry for fresh water replacement alternatives, in this case, produced water from the Mississippi Lime of a quality appropriate for reuse in the SCOOP and STACK plays as shown in Figure 1. Fresh water replacement will benefit counties surrounding those plays as well.

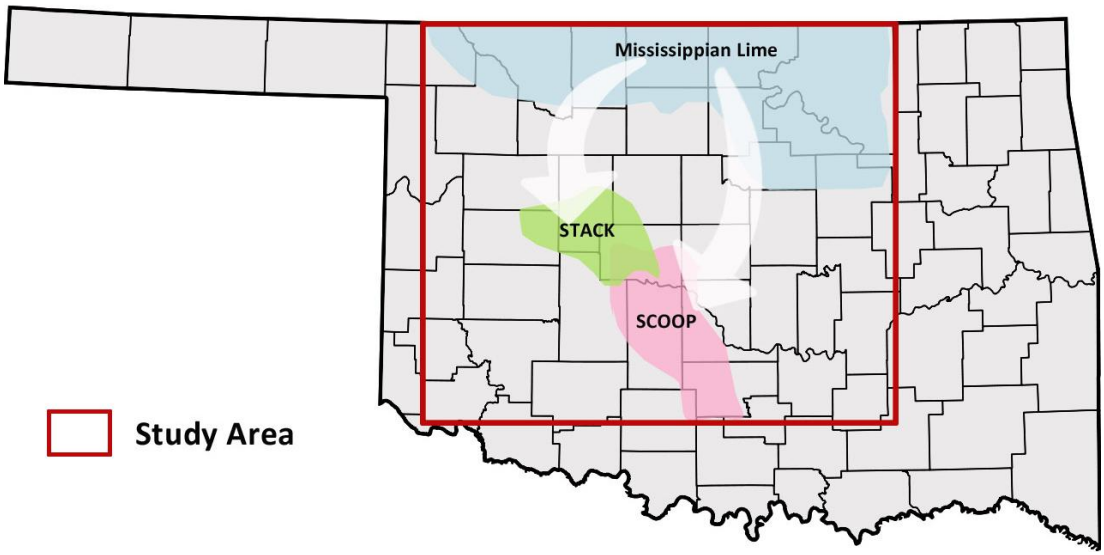

Figure 1 Map depicting proposed feasibility study area.

Description: Project Purpose and Scope

As noted above, the State of Oklahoma and its oil and gas industry faces a challenge with respect to the use of valuable fresh water in the state and the management of PW volumes in a manner that minimizes risk (e.g., of induced seismicity through underground injection). Initial work of the PWWG has aimed to explore scenarios for reclamation, reuse, and alternative management strategies for produced water to address this need.

The purpose of this proposal is to supplement existing efforts of the PWWG with more detailed research and investigation into the feasibility and potential impacts of select alternative wastewater management and reuse scenarios identified in the forthcoming PWWG report. The OWRB proposes to build on the conclusions of the PWWG initial study to fully evaluate the most encouraging leads. The PWWG study is not yet in complete draft form and therefore the specific conclusions are yet to be fully developed. However, while this Title XVI WaterSMART application is purposefully broad in scope to allow flexibility based on the final report of the PWWG scoping evaluation, early assessments indicate that two scenarios, identified below, are most appropriate for further investigation.

The following scenarios are being prioritized in this application because of their potential for feasibility in the short-term based on PWWG analysis and other environmental, regulatory, and technical considerations (e.g., supply and demand estimates for the areas of study; limited human and environmental exposure pathways than other potential scenarios considered by PWWG; availability of existing technologies; and availability of data and information necessary for further assessment). To consider the opportunity for widespread implementation or adoption of these scenarios as produced water management and reuse techniques, further and more detailed assessment is required.

The scope of this initial effort aims to expand the PWWG feasibility assessment for two potentially near-term scenarios through the following investigations:

1. **Evaporation Technologies: Investigation of technical, economic, and environmental feasibility on a wide scale as a produced water management option.**

   Evaporation technologies potentially provide an alternative water management strategy for limiting volumes of underground disposal while simultaneously contributing to water reclamation and reuse efforts through evaporation. There are many variations of evaporation technology that could be applied to PW. Currently, companies offering evaporation solutions have not assessed reclamation and reuse potential. Based on initial analyses from the ongoing PWWG study, evaporation costs may be one third to one half less than desalination costs, which would be required for other reclamation or reuse scenarios that return treated PW to the environment (i.e., surface discharge). However, there are unique environmental and operational considerations for evaporation in addition to cost. Therefore, this part of the proposed WaterSMART Feasibility Study would aim to (1) assess the efficacy of various evaporation treatment technologies; (2) identify leading practices for design, construction, maintenance and operation of ponds or other evaporation vessels; (3) identify potential environmental impacts (i.e., air emissions, groundwater contamination, residual solid management, spill and leak risks from storage and transportation, etc.) and available mitigation measures; and (4) assess other legal, regulatory, and commercial considerations such as costs, impacts to land use, wastes generated, fuel needs, and infrastructure requirements. The efforts would be coordinated through the PWWG and contributed to by project partners. The study includes a desktop study, interviews with treatment companies and oil and gas operators, and visiting at least one permitted evaporation site in Oklahoma.

2. **Water Transfer: Investigation of the technical, economic, and environmental feasibility of the transfer of excess produced water from the Mississippi Lime play to the central Oklahoma plays (STACK and SCOOP) for Reuse in Oil and Gas Operations.**

   It is generally recognized that the Mississippi Lime play has excess water that cannot be reused in operations and that the central Oklahoma plays need source water for hydraulic fracturing – therefore, one identified and potentially viable scenario is to transfer water from high water cut to low water cut plays in Oklahoma. While the ongoing PWWG study will have a cursory commercial evaluation of this scenario, additional technical, environmental, and commercial assessment will be required to evaluate the feasibility of this scenario and investigate leading practices for storage, transportation, and oil-field reuse of produced water. This proposed WaterSMART Feasibility Study will dive deeper into assessment of play-to-play reuse alternatives, including detailed steps potentially including but not limited to the following: (1) evaluate the mixing of the two identified potential water sources to determine how much, if any, treatment may be needed to

prevent scaling, including understanding the quality and chemical character of the produced water volumes in question; (2) facilitate discussions with and among central Oklahoma producers to better clarify any limitations on using the Mississippi Lime water for hydraulic fracturing in the central plays, and evaluate the needs of both the Mississippi Lime and central Oklahoma producers in a potentially complex arrangement; (3) conduct a more detailed cost estimate of pipeline cost, pump stations, and required PW storage; (4) identify any unique legal or regulatory considerations; and (5) evaluate potential impacts of such a transfer on land, ecosystems, water, wildlife, and/or human communities, including an assessment of spill and leak risks due to PW storage and transportation infrastructure required to facilitate transfer and identification of leading design, construction, operation, and maintenance practices that minimize such risks.

Having a two-part evaluation of produced water reuse and recycling will allow flexibility to evaluate possibilities as they develop. The ongoing PWWG study is the first of its kind study based on pressing needs at the state level. This proposed WaterSMART Study would allow the best opportunities identified from the initial PWWG study to be evaluated by the OWRB in greater detail.

Evaluation Criteria

Criterion 1. Statement of Problems and Needs (10 points)

The proposed project, if funded, would be an important step towards addressing one of Oklahoma's highest priorities today. Finding alternatives to deep-well injection and reducing fresh water demand could provide a new *source* of water, and if feasible, may one day have great implications for Oklahoma producers and even the overall economy of the state.

Produced water issues lead to complex political, economic, and environmental challenges that must be addressed. The feasibility of these conceptual alternatives could lead to widespread and considerable ramifications.

The proposed project will focus on PW from oil and gas wells. The oil and gas industry in the state of Oklahoma produces over two billion barrels[2] of PW that require management each year. The injection of PW into deep underground formations has been linked to seismicity in Oklahoma. The average number of earthquakes for a 20 year period before 2009 above a magnitude 3.0 in Oklahoma was about 2 or 3 per year. In 2015, there were over 900 earthquakes above 3.0 in the state. Regulators in Oklahoma have limited disposal of PW in an attempt to reduce seismicity. The PWWG is working to identify alternatives to disposal as well as options to limit fresh water use in the face of drought, i.e., reuse and reclamation alternatives, moving forward to meet the state's "Water for 2060" goal to use no more fresh water in 2060 than was used statewide in 2010.

[2] John Veil, U.S. Produced Water Volumes and Management Practices in 2012 (April 2015) (Prepared for the Ground Water Protection Council), *available at* http://www.gwpc.org/sites/default/files/Produced%20Water%20Report%202014-GWPC_0.pdf.

The project will be focused on two areas. First, the evaluation of evaporation as a solution to water disposal is one practical approach to addressing the needs listed above. Various technologies exist to accelerate evaporation to eliminate at least a portion of the PW, but there have been limited commercial projects nationwide demonstrating the viability of this practice. The evaporated water becomes part of the water cycle and will fall as rain and is thus, is also a potential reclamation and reuse opportunity for the management of the large volumes of PW in the state. The technology offers hope to allow additional oil and gas development without risking the seismicity that is associated with water injection in some areas of the state.

The second potential solution to the needs listed above is addressed in part two of the proposed project, the technical and commercial assessment of PW transfer, specifically an inter-basinal pipeline. Transferring usable PW volumes would reduce underground water injection volumes while also increasing opportunities for PW reclamation and reuse by moving the water from an area where there is excess water to an area where ongoing industry activity could reuse it. Therefore, if a transfer pipeline system becomes operational, it could potentially reduce water injection across the state and also reduce the need for other sources of fresh water in the receiving oil and gas operation areas. Through the lens of the Water for 2060 initiative, PW can be part of the solution by bringing more water into a region in need and/or reducing the amount of fresh water consumed.

There is a need in both instances, however, for further evaluation of cost, practicality, environmental, regulatory, and other considerations that must be understood to effectively balance the potential risks of alternative strategies against the gains listed above. This feasibility study will allow for such further evaluation.

Criterion 2. Water Reclamation and Reuse Opportunities (15 points)

Identifying alternatives to underground injection not only provides an opportunity to assist operators and the state of Oklahoma in addressing induced seismicity concerns, but also contributes to drought and conservation efforts aimed at minimizing the volume of fresh water used by oil and gas operations in the state. The projects addressed in this study investigate multiple reclamation and reuse opportunities. For example, there are areas of the state where excess water requires underground disposal because nearby operations cannot reuse the high volumes – yet this PW presents a potential reclamation and reuse opportunity for other areas of the state that produce little PW for their own reuse and need larger volumes of fresh water to operate. To more fully understand this opportunity, however, the design, construction, operation and other mechanics and detail of a water transfer option, such as a pipeline, must be investigated. Similarly, existing and emerging technologies that dispose of PW by evaporation provide a potential opportunity to reclaim produced water volumes by returning them to the water cycle, but further assessment of the efficacy of these practices is required.

In further detail, this feasibility study will evaluate the following potential water reclamation and reuse opportunities:

1. In the evaporation evaluation, the evaporated PW will be an addition to the water cycle. In this way, it will contribute to all uses for water: fish, wildlife, groundwater recharge, municipal, industrial, and recreation. The evaluation of a pipeline system to transfer produced water from northern to central Oklahoma would have the specific objective of water reuse for oil and gas operations. Such a transfer system would reduce demand for fresh water in central Oklahoma from hydraulic fracturing operations, and provide a reclamation/reuse alternative to disposal for producers further north.

2. A pipeline to transfer PW would meet water market needs for oil and gas hydraulic fracturing in central Oklahoma. The plays in central Oklahoma do not produce enough water to sustain ongoing hydraulic fracturing operations, meaning that operators must utilize water resources from surrounding counties. Demand for PW will be stimulated by having a pipeline system to deliver water to new well sites in a low cost manner.

3. The sources of water being considered for evaporation would include PW across the state of Oklahoma. For a transfer pipeline system, the sources of water to be investigated would specifically include the Mississippi Lime formation water production from oil and gas wells in the area of Alfalfa, Woods, Grant and Major Counties.

Additional considerations for these projects beyond their mere potential for reuse and reclamation are numerous and will be addressed in this proposed study. In short, these opportunities will also necessitate a consideration of economics, laws and regulations, environmental and public health considerations such as spill and leak prevention, etc. in working to understand and eliminate and potential obstacles to implementation of the investigated projects.

Criterion 3. Description of Potential Alternatives (15 points)

The study alternatives in this proposal will be designed to meet objectives of the State of Oklahoma, specifically, efforts to address drought and minimize fresh water usage, as well as specific goals of investigating alternatives to the underground injection and disposal of produced water, which is tied to induced seismicity problems in the state. This project will investigate alternative water sources for hydraulic fracturing operations to replace fresh water resources, and will investigate the potential for alternative disposal strategies. The feasibility study proposed here is in itself an alternative to the current status quo option of continued water disposal that does not contribute to the state's efforts to alleviate drought and poses challenges for both operators and regulators with respect to induced seismicity.

Other supply alternatives have been considered over most of this last year by the PWWG, and during its assessment, meetings, and discussions, that group addressed the precise question being posed here with respect to viable alternatives. Some of the options evaluated include the following:

1. No action; potentially this would mean shutting in wells thereby stopping the generation of PW altogether.

2. Reuse by the oil and gas industry for drilling and production.

3. Reuse or release outside of the oil and gas industry (requiring advanced treatment technologies such as desalination) – including beneficial reuse for agriculture; electrical power generation; industrial plants; aquifer storage and recovery; and discharge to streams and rivers.

4. Evaporation of the PW; resulting in either generation of solid waste or greatly reduced volume of highly concentrated brine for deep-well disposal.

5. PW Transfer pipeline system from an oversupplied area to an undersupplied area of PW for oil and gas reuse.

Traditional reuse of PW within the oil and gas field, while a viable option for PW reclamation and reuse, is not prioritized for further assessment by the OWRB because details regarding effective implementation of this management strategy are already being evaluated directly by the producing companies themselves, and such assessment involves analysis of business plans often held confidential. It should also be noted that the current volumes of PW in Oklahoma far exceeds the needed volumes for drilling and production in the state. Hence, reuse within the industry, while an important part of the equation, cannot, by itself, solve the PW issue for Oklahoma.

Other alternatives that result in the reuse or release of PW outside of the oil field, while they may prove to be credible options for Oklahoma in the future, were nevertheless determined by the PWWG to require costly advanced water treatment technologies as well as PW storage and transportation costs. Also, beneficial reuse and other release or discharge scenarios involve complex environmental, regulatory, and risk-related considerations that must be addressed, making them less viable as near-term alternatives for this feasibility study.

The No-Action option of continued water disposal has challenges for companies and regulators, especially related to the complex issue of seismicity, and may ultimately lead to the widespread shut in of wells.

Thus, a deeper inquiry into the multitude of variables associated with both the evaporation option and water transfer option rise to the top for feasibility assessment. These alternatives hold hope for being economically viable and practical to implement near-term based on PWWG analysis and other environmental, regulatory, and technical considerations. These include factors such as supply and demand estimates for the areas of study; limited human and environmental exposure pathways than other potential scenarios considered by PWWG; availability of existing technologies; and availability of data and information necessary for further assessment.

For a general description of the proposed study subject and alternative measures that will be investigated see the above section on Project Purpose and Scope.

Criterion 4. Stretching Water Supplies (15 points)

Projects in this feasibility study would have potentially positive impacts on stretching water supplies by creating new or expanded supplies (such as through evaporation), making smarter use of existing supplies (such as transferring PW for reuse as opposed to disposal), and contribute to reducing demand on both state and federal water supplies. Oil and gas operations in Oklahoma are sourcing water in various ways, including rivers, streams, groundwater, lakes and municipal effluent water. A transfer pipeline would directly offset demand of such sources and leave them available for other water users in central Oklahoma. In addition, successful evaporation projects would assist the state in bringing new water into the water cycle.

A transfer pipeline system would directly displace demand for water sourced from natural watercourses and aquifers (including Waters of the U.S. in the Cimarron river and other streams and rivers in the area) for hydraulic fracturing central Oklahoma in Blaine and Kingfisher Counties. Ongoing oil and gas operations in central Oklahoma use a variety of water sources (usually determined by cost) to deliver the water to the well site. The initial assessment of the potential pipeline capacity by the PWWG is in a range from 200,000 barrels per day to 500,000 barrels per day.

Criterion 5. Environment and Water Quality (15 points)

The projects being assessed here could have positive impacts on the environment and water quality. The evaporation of produced water would add volumes to the overall water cycle, but the local impacts would likely be minimal and not practical to evaluate. Nevertheless, the scale of the produced water evaporated would be sizable and could range from 100,000 barrels of water per day to over a million barrels per day. A transfer pipeline system would reduce demand and withdrawal from streams and rivers, particularly the Cimarron River, potentially having a positive impact on quality. Public data is not available to specifically indicate where water is sourced for hydraulic fracturing. However, if half of the pipeline volume displaced demand from the Cimarron River, the impact on the river could be between 100,000 and 250,000 barrels per day.

In addition to these potential positive impacts on the environment and water resources, the proposed project will additionally work to identify, understand, and consider mitigation strategies for risks to surface and groundwater resources from the alternative PW management options investigated. This would include improved understanding of the chemical and toxicological character of the produced water evaporated and transferred, understanding and assessing risks from storage and transportation practices (like spills and leaks), considering potential impacts to the environment from technologies utilized in the transfer and treatment of produced water, and other relevant environmental considerations.

Criterion 6. Legal and Institutional Requirements (10 points)

The project will be implemented with the oversight and coordination of the Produced Water Working Group (PWWG) led by the Oklahoma Water Resources Board (OWRB) and supported by other partner stakeholders. The PWWG has broad industry and regulatory representation and has previously assessed regulatory and other barriers to produced water reuse and recycling.

The proposed study will aim to evaluate potential legal and regulatory considerations including the following:

- Existing regulatory structures and permit requirements for alternatives proposed,
- Produced water ownership if it is sold,
- Produced water liability when ownership is transferred,
- Obtaining right-of-way for a shared pipeline,
- Solids disposal and management,
- Legal issues related to selling of mineral resources from solids and other issues.

Criterion 7. Renewable Energy and Efficiency (10 points)

The evaporation evaluation will assess applicable technologies with energy efficiency as a cost driver. In some cases, energy efficiency will be balanced by other feasibility factors. For example, a vaporizer may use the least energy per barrel of water, but may also increase environmental risks due to overspray of saline water.

Renewable energy sources will be evaluated as power source for pumps and other energy needs, especially since this region has a high percentage of sunny and windy days.

Criterion 8. Watershed Perspective (10 points)

The transfer pipeline aspect of this proposal has a regional water supply/demand component. The Mississippi Lime play in Woods, Alfalfa, Grant and Kay Counties has significantly more produced water than can be used with new hydraulic fracturing operations. In contrast, Blaine, Kingfisher and Canadian Counties in central Oklahoma do not produce enough water from oil and gas wells to meet the demand for reuse. Therefore, a broad prospective on water supply and demand is appropriate. The evaluation could cover multiple watersheds with benefits to both areas.

Letters of Support

Investigations by Oklahoma Governor Mary Fallin's Produced Water Working Group are a state priority and efforts that may help to find solutions to Oklahoma's PW issue commonly enjoy widespread support. Letters from a wide spectrum of organizations supporting this proposal including energy sector, environmental organizations, as well as state agencies may be found in Appendix A of this application.

Required Permits or Approvals

The OWRB does not anticipate the need for permits or prior approvals of any entities beyond those agreements necessary from the Funding Partners to fulfill the goals of this study.

Official Resolution

An Official Resolution will be presented to the Board for approval at its January meeting and will be submitted to the Grant POC within 30 days after application deadline.

Study Budget

Funding Plan

The OWRB will contribute to the project cost-share requirement through in-kind work. Time spent by OWRB staff regarding this study will be tracked through the OWRB's time-accounting software.

Cost-share Partners have written letters of commitment and may be found in Appendix B. The Partners and associated in-kind commitments are listed in Table 1. The expected roles and responsibilities of each Partner are expressed in the Budget Narrative section of this application. A portion of the In-Kind cost-share will be from ongoing relevant work done by Partners, and not attached with any federal funding, prior to project start and may be expressed as follows:

- $30,000 of GWPC research identifying environmental risks of alternatives, water quality, compiling current laws, and examination of treatment technologies, all of which lay the foundation necessary to build the feasibility of this investigation.
- $20,000 of EDF participation in PWWG, as well as research and policy development on relevant areas including produced water chemical/toxicological characterization, treatment technologies, spill and leak management from storage and transport or produced water, and other relevant subjects that contribute to the scope of work proposed in this feasibility assessment.

No additional funding from other Federal partners was necessary for this proposed study. All cost-share requirements have been met and no pending funding requests remain.

Table 1.Summary of Non-Federal and Federal Funding Sources

FUNDING SOURCES	Amount
Non-Federal Entities	
Oklahoma Water Resources Board (Applicant)	$16,000.00*
Environmental Defense Fund	$70,000.00*
Ground Water Protection Council	$50,000.00*
Bureau of Economic Geology (University of Texas)	$14,000.00*
Non-Federal Total	$150,000.00
Other Federal Entities	
None	$0.00
REQUESTED RECLAMATION FUNDING	$150,000.00

* Denotes In-Kind Contributions

Budget Proposal

Table 2 Budget Proposal by Category

BUDGET ITEM DESCRIPTION	$/Unit	Quantity	Type	Amount
[redacted]				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]
[redacted]				[redacted]
[redacted]				[redacted]
[redacted]				[redacted]
[redacted]				[redacted]
[redacted]		[redacted]	[redacted]	[redacted]
[redacted]				[redacted]
Total Direct Costs				$295,596.26
Indirect Costs	62.2		rate	$4,403.74*
Type of Rate	Percentage			$0.00
			TOTAL ESTIMATED PROJECT COSTS	$300,000.00

* Indirect Value Based solely from OWRB Salaries

Budget Narrative

Funding Partners will share the responsibility of the proposed study each within their field of expertise or position. A general outline of roles and responsibilities may be expressed:

- OWRB, as Chair and host of the PWWG, will administer the grant, consulting contractor, and study partners, acting as a point of contact and hub for activities and communication. This work will fulfill its In-Kind obligations.
- The contractor will act as lead for the feasibility study: directing research, facilitating meetings, compiling and interpreting data, develop study results, and write the findings in the final report.
- GWPC will hold dual roles as resource research most specifically related to risk management of PW as well as hold an active role planning and hosting sessions and workshops on PW, collecting

practical and stakeholder information, participate in the workgroup, provide review of draft reports and deliverables.

- EDF will hold dual roles as a resource for technical, legal, and policy sharing of results from recent and ongoing studies and actively participate in this feasibility study. EDF will share expertise, available research results, consultant input, and contribute to legal and technical research, assessment, and writing required to complete the relevant tasks outlined for this grant; including attendance and participation in meetings, phone calls, workshops, and the like. In addition, EDF will continue to participate in meetings, workgroups, and in-person workshops of the Oklahoma Water for 2060 Produced Water Working Group in contribution to the refinement of priority management and reuse scenarios for further feasibility evaluation.
- BEG/UT will act in an advisory capacity through phone conferences, meetings, as well as review and provide comment on study data and reports.

Salaries and Wages

The OWRB will have one employee charging in-kind-work hours to the project that will act as the Grant's Project Manager. The employee name, title, monthly wage rate and estimated in-kind time allotment (1.02 months), fringe benefits, and indirect cost are all described in Table 2. An estimated time allotment for the Project Manager's tasks are included in Table 3. Actual tasks in the study *may* differ upon grant award and a detailed project workplan is developed. No pay increase is anticipated during the project timeframe.

Table 3 Project Manager's Tasks

PROJECT MANAGER	**Amount**
Task	
Grant management - tracking of funds, progress reporting	15%
Team coordination and project direction – Attendance of meetings, conference calls, emails, and other communication	30%
Review of project reports and materials developed	30%
Assist with meeting facilitation	10%
Project close-out	15%
TOTAL	100%

Fringe Benefits

Fringe benefit costs have been delineated in the budget proposal of this application. Fringe benefit costs as well as Indirect costs are accounted for as a percentage of employee salaries. That percentage is derived from an annual negotiated rate between the OWRB and the USEPA. The FY 2016 agreement is included as Appendix C of this application.

Travel

Travel by OWRB staff is not anticipated for this study. Any travel expenses incurred by OWRB regarding this study will receive prior approval from USBR grant officer in accordance with USBR requirements or will not be accounted as In-Kind cost-share.

Equipment

Equipment purchases by OWRB staff are not anticipated for this study. Any equipment purchases

incurred by OWRB regarding this study will receive prior approval from USBR grant officer in accordance with USBR requirements or will not be accounted as In-Kind cost-share.

Materials and Supplies

Materials and/or supplies purchases by OWRB staff are not anticipated for this study. Any materials or supply purchases incurred by OWRB regarding this study will receive prior approval from USBR grant officer in accordance with USBR requirements or will not be accounted as In-Kind cost-share.

Contractual

An engineering consulting firm will be contracted to do much of the calculations and assessment necessary to complete a competent feasibility study with the Funding Partners acting as a resource of prior study information and extra hands for certain aspects that may require large blocks of time to accomplish.

Tasks performed by the contractor *may* include but will not be limited to: Workplan development, facilitation of partner meetings, facilitation of industry meetings, assessment of various technologies, economic assessment of such technologies, assessment of regulatory structures current and proposed, spatial and economic development of pipeline system scenarios, writing and presenting a completed study report with recommendations.

Other Expenses

Other expenses beyond those listed previously in the application by OWRB staff are not anticipated for this study. Any other expenses incurred by OWRB regarding this study will receive prior approval from USBR grant officer in accordance with USBR requirements or will not be accounted as In-Kind cost-share.

Indirect Costs

Indirect costs have been delineated in the budget proposal of this application. Indirect costs as well as fringe benefits costs are accounted for as a percentage of employee salaries. That percentage is derived from an annual negotiated rate between the OWRB and the USEPA. The FY 2016 agreement is included as Appendix C of this application.

Total Costs

The total costs of proposed feasibility study will be at least $300,000.00 . The total federal cost-share shall not exceed $150,000.00. The total non-federal cost-share in in-kind or cash match shall be equal to or greater than the total federal cost-share amount.

Appendix A – Letters of Support

Michael J. Teague
Secretary of Energy & Environment

Mary Fallin
Governor

STATE OF OKLAHOMA
OFFICE OF THE
SECRETARY OF ENERGY & ENVIRONMENT

January 4, 2017

Julie Cunningham
Interim Executive Director
Oklahoma Water Resources Board
3800 North Classen Blvd.
Oklahoma City, OK 73118

Re: OWRB's application under BOR-DO-17-F003, Development of Feasibility Studies

Dear Ms. Cunningham:

On behalf of the Office of the Secretary of Energy and Environment, I am pleased to support the application by the Oklahoma Water Resources Board (OWRB) and Oklahoma's Produced Water Working Group (PWWG) to the United States Bureau of Reclamation (USBOR) for a study to investigate the feasibility and potential impacts of select alternative produced water management and reuse scenarios. The proposed study responds to Governor Fallin's call to find methods to use produced water to benefit the state. All of which fits within the state's Water for 2060 Act goals. This Study will look at alternatives that could both reduce the industry's demand on fresh water resources of our state while, at least in part, making us more drought resilient.

Cost-effective strategies that conserve fresh water and better handle the large volumes of produced water is vital to the state of Oklahoma and this proposed study would result in a positive step in that direction.

Our office would be pleased to provide peer review of draft reports and other technical assistance in partnership with the OWRB and USBOR in regard to this important feasibility study. Please do not hesitate to contact me.

Sincerely,

Michael J. Teague
Secretary of Energy and Environment

204 N. ROBINSON, SUITE 1010 • OKLAHOMA CITY, OK 73102 • 405-285-9213 • FAX 405-285-9212

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OIL & GAS ASSOCIATION
Since 1919

January 4, 2017

Ms. Julie Cunningham
Interim Executive Director
Oklahoma Water Resources Board
3800 N. Classen
Oklahoma City, OK 73118

Re: Produced Water Working Group Feasibility and Impact Study

Dear Ms. Cunningham:

Oklahoma Oil & Gas Association (OKOGA), is a non-profit association composed of oil and gas producers, operators, purchasers, pipelines, transporters, processors, refiners and service companies. OKOGA represents a substantial sector of the oil and natural gas industry and is dedicated to the advancement and improvement of the industry within the State of Oklahoma and the United States. The Association advocates the development of an environment that enables the oil and gas industry and related businesses to grow and prosper through the responsible development of Oklahoma's natural resources.

OKOGA is pleased to support the application by the Oklahoma Water Resources Board (OWRB) and Oklahoma's Produced Water Working Group (PWWG) to investigate the feasibility and potential impacts of select alternative produced water management and reuse scenarios. The proposed study compliments work already being done by several oil and natural gas companies in the state and should go a long way toward answering questions concerning the development of cost-effective, energy-efficient strategies to better handle large volumes of produced water. This proposed study could be a positive step in confirming the work done by the PWWG.

OKOGA would also be willing to provide technical assistance and helping in communication with OKOGA member companies to assist and coordinate discussion with operatiors. Please do not hesitate to contact me, at (405)843-5741 with any questions that you may have.

Sincerely,

Howard Ground

Howard Ground
Regulatory & Environmental Affairs Consultant

cc: Arnella Kargas, EVP
Oklahoma Oil and Gas Association
Owen Mills , Director of Water Planning
Oklahoma Water Resources Board

EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

January 6, 2017

Julie Cunningham
Interim Executive Director
Oklahoma Water Resources Board
3800 Classen Boulevard
Oklahoma City, OK 73170
Julie.cunningham@owrb.ok.gov

RE: Environmental Defense Fund Letter of Support and Commitment – Oklahoma Water Resources Development Board Funding Application for Bureau of Reclamation WaterSMART Funding for the Project Titled: *Feasibility Study of Potential Impacts of Selective Alternative Produced Water Management and Reuse Scenarios*; Funding Opportunity No. BOR-DO-17-F003

Ms. Cunningham:

The Environmental Defense Fund (EDF) submits this letter in support of the Oklahoma Water Resources Board (OWRB) application for funding, and to affirm EDF's commitment to working with OWRB and partners toward successful achievement of the tasks identified in the narrative funding proposal.

EDF strongly supports the efforts of OWRB and its partners in efforts to investigate the technical, economic, and environmental feasibility of alternative produced water management scenarios identified by the Oklahoma for 2060 Produced Water Working Group. As such, EDF is committed to in-kind contributions of available research results, along with EDF staff and relevant subcontractor time and expenses. Exemplary contributions include providing technical, legal, and policy expertise related to the following subjects, in support of proposed project tasks:

- Produced water chemical and toxicological characterization and identification of constituents of concern;
- Leading practices to minimize spill and leak risks associated with produced water storage and transportation;
- Technologies and systems necessary to implement scenarios considered in application, including environmental and health considerations; and
- Other environmental and regulatory considerations for scenarios assessed.

EDF will provide in-kind cost-share in the amount of **$70,000** towards this effort.

Related to the scope of the proposed project, EDF is conducting ongoing scientific, technical, and regulatory research to fill knowledge gaps regarding produced water chemical and toxicological characterization and produced water treatment technologies, alongside efforts to identify leading practices for produced water storage, transportation, and disposal that minimize risks for leaks and spills alongside other potential negative impacts to land, water, and community health. EDF will share expertise, available research results, consultant input, and contribute to legal and technical research, assessment, and writing required to complete the relevant tasks outlined for this grant, including attendance and participation in meetings, phone calls, workshops, and the like. In addition, EDF will continue to participate in meetings, work-groups, and in-person workshops of the Oklahoma Water for 2060 Produced Water Working Group in contribution to the refinement of priority management and reuse scenarios for further feasibility evaluation.

No in-kind contributions from EDF are funded through Federal grants or awards. All in-kind contributions are available immediately to OWRB and as necessitated within the scope of the project timeline. There are no additional time constraints or contingencies on EDF's in-kind commitment.

Please feel free to contact EDF at any time with questions or comments with respect to our commitment to and participation in the above referenced proposal.

Thank you,

Scott Anderson
Senior Policy Director
Environmental Defense Fund
sanderson@edf.org
512-691-3410

The Ground Water Protection Council
13308 N. MacArthur Blvd.
Oklahoma City, OK 73142

Tel: (405) 516-4972
Fax: (405) 516-4973
www.gwpc.org

Dedicated to protecting our nation's ground water

January 4, 2017

Julie Cunningham – Interim Executive Director
Oklahoma Water Resources Board
3800 Classen Boulevard
Oklahoma City, OK 73170

Julie,

On behalf of the Ground Water Protection Council (GWPC), I am pleased to support the application by the Oklahoma Water Resources Board (OWRB) and Oklahoma's Produced Water Working Group for Funding Opportunity Announcement No. BOR-DO-17-F003 titled Feasibility Study of Potential Impacts of Selective Alternative Produced Water Management and Reuse Scenarios. The proposed study complements ongoing GWPC projects.

GWPC will provide cost share in the amount of $50,000. Of this amount, $20,000 will be provided as in-kind match for planning and hosting sessions and workshops on produced water that will aid in collecting practical information for the studies as described. Additionally, GWPC will provide $30,000 in cash match for research on identifying key environmental risks that need to be addressed in order to safely manage produced water in ways other than deep well injection through research to identify available information on produced water quality, compiling current laws related to produced water reuse, and examining treatment technology. GWPC will seek input from various stakeholders on a draft of the results and produce a final report. Advanced copies of the work will be provided to OWRB for use in this BOR project. Additionally, we would be pleased to participate in the workgroup and provide review of draft reports and deliverables. There are no contingencies associated with this in-kind commitment. Funds/activities will be available to OWRB starting immediately on award date and throughout the first 12 months of the project. There are no time constraints on the availability of this support.

The GWPC is a national nonprofit 501(c)6 organization whose members consist of state groundwater regulatory agencies that come together to mutually work toward the protection of the nation's groundwater supplies. The purpose of the GWPC is to promote and ensure the use of best management practices and fair but effective laws regarding comprehensive groundwater protection. Our mission is to promote the protection and conservation of groundwater resources for all beneficial uses, recognizing groundwater as a critical component of the ecosystem. We provide an important forum for stakeholder communication and research in order to improve governments' role in the protection and conservation of groundwater. The proper management and reuse of produced water is a key focus area currently for GWPC.

Sincerely,

Dan Yates
Associate Executive Director
The Ground Water Protection Council

OKLAHOMA
CORPORATION COMMISSION
P.O. BOX 52000
OKLAHOMA CITY, OKLAHOMA 73152-2000

253 Jim Thorpe Building
Telephone: (405) 521-2240
FAX: (405) 521-3099
www.occeweb.com

OIL & GAS CONSERVATION DIVISION

Tim Baker, Director

January 4, 2017

Julie Cunningham
Interim Exutive Director
Oklahoma Water Resources Board
3800 N. Classen Blvd.
Oklahoma City, OK 73118

Re. OWRB's application under BOR-DO-17-F003,
Development of Feasibility Studies

Dear Ms. Cunningham:

On the behalf of the Oil and Gas Conservation Division of the Oklahoma Corporation Commission, I am pleased to support the application by the Oklahoma Water Resources Board and Oklahoma's Produced Water Working Group to investigate the feasibility and potential impacts of select alternative produced water management and reuse scenarios. The proposed study responds to Governor Fallin's call to find ways to use produced water to *benefit* the state while solving the problem of excessive produced water disposal into the Arbuckle Formation. This Study will look at alternatives that could both reduce the industry's demand on fresh water resources of our state while, solving, at least in part, the problem of induced seismicity.

If you need any further assistance please feel free to contact me.

Sincerely,

Tim Baker
Director,
Oil and Gas Conservation Division

XC. Tim Rhodes, Director of Administration

SCOTT A. THOMPSON
Executive Director

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

MARY FALLIN
Governor

January 4, 2017

Julie Cunningham
Interim Executive Director
Oklahoma Water Resources Board
3800 N Classen Blvd
Oklahoma City, OK 73118

Re: OWRB's application under BOR-DO-17-F003, Development of Feasibility Studies

Dear Ms. Cunningham:

The Oklahoma Department of Environmental Quality (DEQ) is pleased to support the application by the Oklahoma Water Resources Board (OWRB) and Oklahoma's Produced Water Working Group (PWWG) for funding to investigate the feasibility and potential impacts of select alternatives for the management and reuse of produced water from oil and gas operations. The proposed study comports with Governor Fallin's call to find ways to use produced water to benefit the state while alleviating problems associated with deep-well injection. We understand that the study will look at alternatives that could both reduce the industry's demand on fresh water resources and mitigate the potential for induced or triggered seismicity, both of which obviously are extremely important to Oklahoma.

DEQ would be glad to provide peer review of draft reports as well as other technical assistance to OWRB, PWWG and the Bureau of Reclamation in connection with this important feasibility study. Please do not hesitate to contact me or my staff for any assistance DEQ can offer.

Sincerely,

Scott Thompson
Executive Director
Oklahoma Department of Environmental Quality

Appendix B – Letters of Commitment

The Ground Water Protection Council
13308 N. MacArthur Blvd.
Oklahoma City, OK 73142

Tel: (405) 516-4972
Fax: (405) 516-4973
www.gwpc.org

Dedicated to protecting our nation's ground water

January 4, 2017

Julie Cunningham – Interim Executive Director
Oklahoma Water Resources Board
3800 Classen Boulevard
Oklahoma City, OK 73170

Julie,

On behalf of the Ground Water Protection Council (GWPC), I am pleased to support the application by the Oklahoma Water Resources Board (OWRB) and Oklahoma's Produced Water Working Group for Funding Opportunity Announcement No. BOR-DO-17-F003 titled Feasibility Study of Potential Impacts of Selective Alternative Produced Water Management and Reuse Scenarios. The proposed study complements ongoing GWPC projects.

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Sincerely,

Dan Yates
Associate Executive Director
The Ground Water Protection Council

EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

January 6, 2017

Julie Cunningham
Interim Executive Director
Oklahoma Water Resources Board
3800 Classen Boulevard
Oklahoma City, OK 73170
Julie.cunningham@owrb.ok.gov

RE: Environmental Defense Fund Letter of Support and Commitment – Oklahoma Water Resources Development Board Funding Application for Bureau of Reclamation WaterSMART Funding for the Project Titled: *Feasibility Study of Potential Impacts of Selective Alternative Produced Water Management and Reuse Scenarios*; Funding Opportunity No. BOR-DO-17-F003

Ms. Cunningham:

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Please feel free to contact EDF at any time with questions or comments with respect to our commitment to and participation in the above referenced proposal.

Thank you,

Scott Anderson
Senior Policy Director
Environmental Defense Fund
sanderson@edf.org
512-691-3410

OFFICE OF SPONSORED PROJECTS
THE UNIVERSITY OF TEXAS AT AUSTIN
101 E. 27th, Suite 5.300 • A9000 • Austin, TX 78712-1532
(512)471-6424 • Fax (512)471-6564 • osp@austin.utexas.edu

Date: 1/6/2017

Julie Cunningham
Interim Executive Director
Oklahoma Water Resources Board
3800 Classen Boulevard, Oklahoma City OK 73170
Julie.cunningham@owrb.ok.gov

Re: Funding Opportunity Announcement No. BOR-DO-17-F003

Dear Ms. Cunningham,

The University of Texas at Austin is pleased to endorse the following proposal enclosed for your review.

Title of Application:	Feasibility Study of Potential Impacts of Selective Alternative Produced Water Management and Reuse Scenarios	**OSP Number:**	201700058-001
Principal Investigator:	SCANLON, BRIDGET R		
Project Total Costs:	0	**Cost Share amount (if applicable):**	$14,000
DUNS:	170230239	**Cage Code:**	9B981
Project Dates:	**5/1/2017 to 10/31/2017**		

LEGAL IDENTITY
The University of Texas at Austin is an agency of the State of Texas and a component institution of The University of Texas System, governed by the Board of Regents. All awards and agreements must be executed by an authorized official of The University. Individuals, Departments, or Organized Research Units may not directly enter into sponsored research agreements or legally bind The University.

The Office of Sponsored Projects (OSP) serves as the coordinating office for externally funded research projects submitted by The University of Texas at Austin. All proposals to external funding sources for sponsored projects must be submitted through OSP and all awards received for sponsored research must be processed by OSP.

Mailing Address: The University of Texas at Austin
Office of Sponsored Projects
North Office Building-A
101 E. 27th Street

Suite 5.300 (Mail Code A9000)
Austin, Texas 78712-1532

Telephone Number (512) 471-6424
FAX Number (512) 471-6564

AWARD NEGOTIATION

The University of Texas at Austin reserves the right to negotiate the terms and conditions of any awarded grant or contract. As an institution of higher education, The University of Texas at Austin intends to perform the work under any awarded grant or contract as fundamental research and reserves the right to: 1) require that the provider notify the University if it is to provide any export controlled information; 2) to deny receipt of any export controlled materials; and 3) to reject any restrictions on the University's right to publish or otherwise disseminate information relating to this research.

AUTHORIZED OFFICIAL

_____
Elena V. Mota, Assistant Director, Office of Sponsored Projects
The University of Texas at Austin

ADDITIONAL CONTACTS

Administrative and budgetary matters regarding the proposal:
Yvette T. Cañedo, Grants & Contracts Specialist
The University of Texas at Austin
Office of Sponsored Projects
Phone: (512) 471-6424;
Email: ybtrujillo@austin.utexas.edu

Negotiation and execution of agreement:
The University of Texas at Austin
Office of Sponsored Projects
North Office Building-A
101 E. 27th Street, Suite 5.300 (Mail Code A9000)
Austin, Texas 78712-1532
Phone: (512) 471-6424; FAX: (512) 471-6564
Email: osp@austin.utexas.edu

Appendix C – OWRB-USEPA FY 2016 Negotiated Agreement for Indirect and Fringe Costs

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

COGNIZANT AGENCY
NEGOTIATION AGREEMENT

Oklahoma Water Resources Board
Oklahoma City, OK

Date: May 11, 2016

Filing Ref: May 12, 2015

The indirect cost rates contained herein are for use on grants and contracts with the Federal Government to which Office of Management and Budget Circular A-87 applies, subject to the limitations contained in the Circular and in Section II, A below.

SECTION I: RATES

Type	Effective Period From	To	Rate	Base
Fixed:				
Fringe Benefits	7/1/2016	6/30/2017	63.79%	(a)
Indirect Costs	7/1/2016	6/30/2017	62.20%	(a)

Basis for Application
(a) Direct salaries and wages

Treatment of Fringe Benefits: FICA, Retirement, Health Insurance, Unemployment Compensation, Longevity Pay, terminal leave and Annual, Sick and Administrative Leave applicable to direct salaries are included in the fringe benefit rate.

SECTION II: GENERAL

A. LIMITATIONS: The rates in this Agreement are subject to any statutory and administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the department/agency or allocated to the department/agency by an approved cost allocation plan were included in the indirect cost pool as finally accepted; such costs are legal obligations of the department/agency and are allowable under governing cost principles; (2) The same costs that have been treated as indirect costs have not been claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the department/agency which was used to establish the rates is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. CHANGES. The fixed rate contained in this agreement is based on the organizational structure and the accounting system in effect at the time the proposal was submitted. Changes in the organizational structure or changes in the method of accounting for costs which affect the amount of reimbursement resulting from use of the rate in this agreement, require the prior approval of the authorized representative of the responsible negotiation agency. Failure to obtain such approval may result in subsequent audit disallowances.

C. THE FIXED RATE contained in this agreement is based on an estimate of the cost which will be incurred during the period for which the rate applies. When the actual costs for such a period have been determined, an adjustment will be made in the negotiation following such determination to compensate for the difference between the cost used to establish the fixed rate and that which would have been used were the actual costs known at the time.

D. NOTIFICATION TO FEDERAL AGENCIES: Copies of this document may be provided to other Federal agencies as a means of notifying them of the agreement contained herein.

E. SPECIAL REMARKS: Please confirm your acceptance of the terms of the indirect cost rate agreement by signing and returning this letter to me. Please retain a copy for your records.

ACCEPTANCE

The undersigned official warrants that he/she has the proper authority to execute this agreement on the behalf of the State Agency:

(Signature)

J.D. Strong
(Name)

Executive Director
(Title)

OK Water Resources Board
(Agency)

May 13, 2016
(Date)

By the Federal Agency:

Jacqueline Smith

Digitally signed by Jacqueline Smith
DN: cn=Jacqueline Smith, o, ou, email=smith.jacqueline@epa.gov, c=US
Date: 2016.05.12 15:09:08 -04'00'

(Signature)

Jacqueline Smith, Rate Negotiator
Financial Analysis and
Oversight Service Center
U.S. Environmental
Protection Agency

Negotiated by: Jacqueline Smith
Telephone: 202-564-5055

ATTACHMENTS FORM

Instructions: On this form, you will attach the various files that make up your grant application. Please consult with the appropriate Agency Guidelines for more information about each needed file. Please remember that any files you attach must be in the document format and named as specified in the Guidelines.

Important: Please attach your files in the proper sequence. See the appropriate Agency Guidelines for details.

1) Please attach Attachment 1	Proposal and Appendices.pdf	Add Attachment	Delete Attachment	View Attachment
2) Please attach Attachment 2		Add Attachment	Delete Attachment	View Attachment
3) Please attach Attachment 3		Add Attachment	Delete Attachment	View Attachment
4) Please attach Attachment 4		Add Attachment	Delete Attachment	View Attachment
5) Please attach Attachment 5		Add Attachment	Delete Attachment	View Attachment
6) Please attach Attachment 6		Add Attachment	Delete Attachment	View Attachment
7) Please attach Attachment 7		Add Attachment	Delete Attachment	View Attachment
8) Please attach Attachment 8		Add Attachment	Delete Attachment	View Attachment
9) Please attach Attachment 9		Add Attachment	Delete Attachment	View Attachment
10) Please attach Attachment 10		Add Attachment	Delete Attachment	View Attachment
11) Please attach Attachment 11		Add Attachment	Delete Attachment	View Attachment
12) Please attach Attachment 12		Add Attachment	Delete Attachment	View Attachment
13) Please attach Attachment 13		Add Attachment	Delete Attachment	View Attachment
14) Please attach Attachment 14		Add Attachment	Delete Attachment	View Attachment
15) Please attach Attachment 15		Add Attachment	Delete Attachment	View Attachment