Scorecard for Evaluating Opportunities in Industrial Water Reuse

Proposal prepared for WaterSMART: Water Recycling and Reuse Research under the Title XVI Water Reclamation and Reuse Program form the U.S. Bureau of Reclamation

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Executive Summary

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In regards to industrial water reuse, it is common for management and leadership to have a lack of concrete information regarding the true cost of water that is needed to complete a comprehensive return on investment (ROI) evaluation. There is a widespread need to gather pertinent facility data and focus the necessary background information needed to conduct a high level evaluation to determine if viable water reuse opportunities exist. The decision whether or not to pursue a water reuse program is primarily driven by a variety of economic and social drivers. These drivers are largely based on factors such as the cost of treatment and disposal of wastewater, pumping costs, resource losses (e.g. energy, heat, byproducts), as well as the costs of a water reuse system. Social drivers may include corporate responsibility reporting at the board level or in the forms driven by the Dow Jones Sustainability Index. These factors differ by industrial sector and are often influenced by state, regional, and site specific conditions including existing regulations, discharge limits, and related policies. In addition, existing assessments often do not consider the hidden or secondary costs associated with existing supply and discharge costs including the costs associated with pumping, heating, pretreatment, post treatment, and any other transportation costs. To better understand these costs, an assessment tool will be developed evaluate opportunities for water reuse and provide decision makers with the information they need to make informed decisions from an economic perspective.

This study, described below, is expected to take 25 months. However, work on this study began in March so it is expected to be completed 18 months after a potential award from the Bureau of Reclamation in October.

Technical Research Study Description

Understanding the Problem

Access to a water supply that is reliable, of appropriate quality and affordable is a critical need for the vast majority of industrial manufacturing operations. As evidenced by the recent developments in California, the availability of water sources that meet the needs of industry is a significant challenge for most companies. The impact of water stress on industry is not limited to one region or industrial sector; it has become a distinct trend and will worsen as demand grows and the impacts of climate change on the world's water resources become more acute.

The World Economic Forum, the Carbon Disclosure Project, and others have signaled water as a fundamental business challenge. In spite of the pressing global pressure, many companies are not able to evaluate and address their water challenges effectively. The ongoing WateReuse Research Foundation (WRRF) project, "A Framework for the Successful Implementation on On-site Industrial Water Reuse" (WRRF-14-04) has identified many of the challenges that industries face as they act to address water challenges, as well as providing insights into the range of effective water treatment technologies that can be applied to water reduction and reuse by

industry. (Project WRRF-14-04 is being executed by Arcadis with WRRF.) It also includes many case studies from leading corporations about successful implementation of water reduction and reuse projects. Although the results form basis for industrial water reuse, the information alone does not provide a company with the tools needed to convert information to action. Industry needs its own method to efficiently define, track and communicate information on:

- how water is used
- the business value of water including the total cost of water
- the anticipated return on investment
- the business risks associated with water challenges including facility shutdown and supply chain interruptions

The following outlines the tools industry needs to successfully define the value of water for themselves, identify and assess the opportunities to improve water efficiency, reduce costs, and address water as a critical business driver.

Does water matter? – Companies routinely evaluate the range of risks that may impact their financial performance. For US companies, these risks are identified in each company's annual 10K report filed with the US Securities and Exchange Commission. These reports traditionally do not include statements of risk associated with water such as diminishing water supplies or failing water quality. A plausible reason for this gap in risk reporting is that the assessment of risks within companies is traditionally conducted by financial, legal, and business leaders at the company whose training and backgrounds are not honed to consider environmental concerns other than regulatory compliance. Water has been overlooked as a key supply chain risk, however today's more savvy investors are beginning to inquire how companies are positioned with respect to water for now industry cannot quantify their risk and therefore are subject to perception, fueled by unawareness, rather than reality.

Many companies are in need of tools that will allow water risks to be communicated in terms of the materiality of water use and water risks to the company. Such tools would evaluate the value of reduced costs, validate improved earnings and enhanced brand image to the company and substantiate corporate goals that capture the business value of water in terms that are meaningful to the company and garner a company-wide commitment to improving water efficiency.

What and where are the best opportunities? - Many companies have an idea about where water use is high or where water supply is limited. However, they often fail to identify opportunities where the highest risks and highest business value reside. They therefore struggle to act effectively to implement projects to improve water use efficiency and to recover the business value further veiling impact of water on their business. A comprehensive toolbox is needed to assist companies to bridge these gaps including tools to characterize the total cost of water, to calculate the returns on investment for capital projects, to evaluate the direct, as well as indirect economic impacts of water reuse projects, to prioritize water related risks throughout the company's facilities, and to overcome challenges that can be barriers to project implementation.

What is the "Business Case?" – In industry today there remains skepticism that water and other resource challenges are truly a business risk or a business opportunity. Companies have

traditionally been able to purchase the resources they need, sometimes at high costs; however, usually all needed resources were within the reach of the company. A dangerous assumption is often that water risks may only result in higher costs, but not impair the ability of the company to operate. The changing water environment trends towards an increased risk of companies not having enough water to operate their own facilities within some regions. These trends would similarly present a risk to the company's supply chain. This is a significant change that those within the company with a view to the water situation must communicate to management. Tools to effectively communicate this information are needed. These include tools that:

- use business terms rather than engineering or systems design language to present the water issues
- track project scope and implementation to assure that the water related expectations of the company are realized and the business value maintained throughout the life of the project
- capture the value of water in maintaining the brand value of the company

These tools will assist companies to create a quantitative and actionable view of their business objectives, water related challenges, and the economic and social value of reducing water demand. Empowered with these resources, companies will be able to overcome the traditional barriers to establishing water related goals, develop a meaningful water strategy, and implement projects that align with the company business objectives while diminishing water related risks that impact the company's business and threaten the viability of community water resources.

Background

The defining characteristic of industrial operations is the need to be financially viable with favorable revenue and profits. Undeniably, at a more granular level there are many other factors that are important to industry (compliance, innovation, their people, etc.), but without financial viability an industry will not exist. This fact helps explain why decisions made within industry are heavily influenced by commercial viability. At the industrial site level, facility investments are rarely made unless there is an appropriate financial benefit (e.g. direct cost savings, improved productivity, improved product quality, reduction of risk, etc.).

Implementation of on-site water reuse opportunities will be strongly, and often strictly, linked to whether or not the project demonstrates financial benefit. However, the way in which financial benefit is defined for water projects often puts these projects at a disadvantage. Specifically, when assessing the financial value of water reuse projects, industrial sites will often only take into account the costs shown on the water bill (i.e. cost to purchase water and cost to send water to the public wastewater plant). In reality, the benefits of most water projects extend beyond water purchase costs and include energy (to pump, heat, cool water), chemicals added to support the manufacturing operation (e.g. coolant, degreasers, acids, etc.), water purification prior to on-site use, on-site wastewater treatment, as well as several other cost components. As discussed in the WRRF-14-04, these costs, as well as the water bill costs, should be included when determining the operating cost benefits (and correspondingly the ROI) for a water reuse project. There is currently not a robust, complete, and user-friendly publicly available tool for determining ROI using the complete cost of water (i.e. the direct economic benefits). This

project will develop such a tool, herein referred to as the "ROI Calculator" tool; a more detailed description will be provided in subsequent pages.

In addition to the direct economic benefits from water conservation, there are also indirect benefits. The indirect benefits are frequently harder to quantify or assign a numerical value to; however, they can be equally important to the bottom line for the company. Some examples of indirect benefits include: company sustainability goals, public image/branding, regulatory/ wastewater compliance, water scarcity/availability, etc. There is not currently an accepted method to quantify/score the value of water reuse projects based on these indirect economic benefits. It is a key goal of this project to develop a scorecard tool (herein referred to as the "Water Conservation Scorecard") that enables one to assess the level of indirect economic value derived from water reuse projects. Further, this Water Conservation Scorecard will provide – as an output – a scoring of the overall economic benefit (i.e. direct + indirect) derived from water reuse projects. The features of this tool are discussed in greater detail in subsequent pages.

Development of the aforementioned "ROI Calculator" and "Water Conservation Scorecard" represent the critical deliveries and will be a main focus of this project. We believe that the (industry) acceptance, usefulness and execution of these two tools can be strengthened by expanding the activities (under the same budget) to include additional features. Our proposed approach for this project would include delivery of a toolbox that focuses on three main topic areas:

1. Importance of water to the company, will enable the company to understand how water impacts their operations, where their greatest water risks lie, and prioritize sites for water reuse focus. This set of tools will position the company to focus on the most viable and/or in-need sites.
2. Making the financial case for water reuse, will include user friendly tools to determine the true cost of water, as well as including the aforementioned "ROI Calculator" and "Water Conservation Scorecard".
3. Project execution and follow-through will be a collection of tools designed to help ensure that the predicted project benefits (i.e. via toolset #2, above) are correctly integrated during and following implementation.

The activities and lessons from WRRF-14-04 uniquely position our team for a greatly reduced learning curve in this project, allowing us to rapidly accelerate our activities and enabling us to deliver this expanded toolbox. Further, the project team has already developed and used components of a number of these tools on other projects and allows for greatly simplified integration during this project.

We are fortunate to offer a diverse and committed group of industrial partners for this project. The diversity of partners will help to ensure that the final product is robust and applicable to an array of industries, as well as helping with project efficiency. The partners are extremely excited for the opportunity to be involved in this work and eager to contribute. The knowledge and experience of our partners will be leveraged in the early conception/development stage to ensure: (i.) the tools look/feel right, (ii.) the user inputs are readily accessible and reasonable, (iii.) the right inputs are incorporated, and (iv.) outputs match industrial needs. The user-friendliness,

effectiveness, and accuracy of the toolbox will be assessed by trials with our industry partners. Trials will initially be performed with Arcadis support (on-site). Based on observations and feedback, the toolbox will be revised as-needed. Subsequently, trials will be conducted by partner facilities (with Arcadis support) to ensure the tools are sufficiently user-friendly. User feedback will be obtained through phone interviews and questionnaires. If needed, the tools will be revised following the second round of field trials.

The WateReuse Toolbox

As described above, we are proposing to deliver an expanded comprehensive toolbox to help drive use of the information and results developed in this project. To provide clarity to those reading this proposal, we provide a description of each of the following tools.

1. Importance of Water to the Company:

- Materiality Assessment: The term comes from the financial world and has the objective of elevating sustainability issues to the same level as traditional business issues, helping to convey the financial risks associated with those issues. Performing a materiality assessment helps companies understand what is most important (to the company) from a sustainability perspective, and helps to guide them where to focus efforts. This tool will allow a company to do a materiality assessment for water. Guidance will be provided on how to use the tool, as well as how to prepare for and perform the assessments (e.g. who attends, what's important, etc.)

- Site Prioritization: A common goal-execution challenge for corporations is determining where to focus (i.e. which sites need the most attention?). Prioritization should be determined based on overall water risk level presented by individual sites. This tool will be designed to help characterize/define risks at each facility, with an output that provides guidance for where efforts should be focused (i.e. site prioritization). Arcadis has performed several such assessments for large corporations and are well versed in how this tool should be built. When finished, the tool will allow users to select from an array of typical risk categories (water scarcity, drought risk, projected future scarcity, upstream storage capacity, flood risk, water usage, regulatory/wastewater compliance, cost, etc.). Water risk can be defined in many ways by industry; there is no standard-definition or scoring that fits universally among all companies because companies' business models differ widely and their interests in water, reputation and community engagement vary considerably. To this end, the tool will allow the user to assign weighting to each risk category such that the analysis best fits the company's needs/culture. The tool will be able to assess all company sites (or a subset if preferred by the user) on the same workbook. Subsequently, each site will be scored for each category based on a combination of reputable publicly available models and site data. The tool output will be numerical scores for each site and suggested overall prioritization for the sites.

- Benchmarking: This tool will characterize the water footprint of the company and among facilities in the company. The tool will also be able to perform a comparison to the

company's potential competitors. We will include data for a handful of companies in each sector, as well as guidance for where to find the data for other companies.

2. Making the Financial Case for Water Reuse:

- Standard Opportunities: Most manufacturing sites lack personnel with expertise in identifying opportunities and solutions for water conservation. Therefore, the tool will include a template populated with common opportunities for a wide range of manufacturing processes. This template will be designed to allow the user to input any new opportunities they might identify such that a company can have an ever-growing list of common opportunities to share with their sites.

- True Cost of Water: A common misconception within industry is that water is 'cheap', and the cost to conserve water lacks the necessary ROI required by the industrial facility (typical ≤ 2) to justify implementation. In truth, there are a number of 'hidden costs' related to water use that are typically overlooked (e.g. energy to move/heat/cool/purify water, chemicals to pre-treat water or added for a manufacturing process (coolant, cleaner, acid, etc.), on-site wastewater treatment, etc.). This user-friendly tool will be designed to accept easily obtained site data to calculate the 'true cost of water' for processes at the facility. The framework for this tool has been developed through WRRF-14-04; with this foundation, development of the tool will be very straightforward. In addition, the tool will be designed to project the future utility costs for water at the facility based on historical water rate trends from water utilities across the U.S. (The nation will be broken into ~10 regions with pricing trends determined for each region.) The user will be able to use the default water rate trend data or they can input their own water rate trend data (for their specific utility).

- Return on Investment (ROI) Calculator: This will be a user-friendly tool allowing the user to determine the financial benefits derived from industrial water reuse projects. The user interface will be easy to understand with hints/suggestions provided for guidance and clarity. Inputs will be straightforward and flexible. As an example, when entering flowrate the tool will be designed to accept a variety of units (gal/min, gal/day, m^3/hr, etc.). During the execution of WRRF-14-04, graphical tools were developed for estimating CapEx and OpEx for water recycle technologies (e.g. reverse osmosis, ultrafiltration, activated carbon, bag filters, ozone, sand filters, etc.). These WRRF-14-04 activities will be directly leveraged in this next phase as the project team develops the (capital cost estimation) portion of the return on investment calculator. The overall outputs from this tool will be projected (i.) return on investment, (ii.) annual OpEx savings, (iii.) estimated CapEx, and (iv.) annual water savings.

- Water Conservation Scorecard: The direct financial impact of a project (i.e. ROI) plays a critical role in determining whether or not a project is funded for implementation within industry. However, there are a number of indirect economic impacts associated with water conservation that can also influence the (implementation) decision, and – in some cases – these factors can outweigh the importance of ROI. Some examples of indirect economic impacts include: corporate sustainability goals, company branding/perception,

regulatory/wastewater compliance capability, scarcity, drought, competing use within a watershed, etc. At present, there is no standard/accepted tool for evaluating/ scoring projects in a way that incorporates both direct and indirect economic impacts. This tool needs to be comprehensive as well as applicable to an array of industries. As such, development of this tool will represent a significant portion of our overall efforts in the project. Conceptualization and execution of the tool will leverage the output from WRRF-14-04, experiences/knowledge from the project team's industrial partners, and building upon information/tools uncovered in the literature.

As further key criteria for the tool, it must be user-friendly and flexible. A significant portion of the inputs for this scorecard could be imported from some of the other tools we have already discussed. For instance, direct financial impacts could be imported from the ROI Calculator tool; water scarcity, drought, regulatory/wastewater, etc. could be imported from the Site Prioritization tool. The tool will have the flexibility to allow the user to import data from these tools or to input the information manually. Any remaining inputs will be straightforward inputs by the user. Every company has unique needs, circumstances and culture. As such, it is very important that the scorecard tool have the flexibility to reflect the needs and culture of each company using the tool. To that end, the user will have the ability to place weighting factors on each of the direct and indirect economic impacts. (We will also provide standard default values for any user who prefers to use the default values.) The tool will provide three main pieces of output:

a. *Direct financial impacts* will compare the ROI versus company/site objectives. If the ROI is sufficiently strong, it may drive implementation regardless of indirect economic factors.
b. *Indirect financial impacts* will convey the rolled-up value of the project to the company based on user-input weightings, risk factors for the site and company sustainability goals. If this score is sufficiently strong, it may overwhelm an unfavorable ROI. This score also provides a way for users to convey (to leadership) the indirect financial value of the project.
c. *Cumulative financial impact/score* will reflect the combined influences of direct and indirect economic impacts, with weightings that correctly match the needs and culture of the company. Much like the materiality assessment is a strong tool for elevating sustainability issues to the same level as traditional business issues, we anticipate that this cumulative financial impact assessment will provide a means to incorporate the important – but traditionally very hard to quantify – indirect financial benefits derived from industrial water reuse.

3. <u>Project Execution and Follow-Through:</u>

- <u>Maintaining scope</u>: As noted during a 2015 workshop with our industrial partners (conducted as part of WRRF-14-04), the implementation phase of water reuse projects represents key risks. One key risk is the loss or reduction of water savings through the practice of value engineering. This tool will help position the user/site to minimize implementation risks. The user will input the "must have" and "should have" features for the project and clarify their relationship to the objective(s) of the project. This document

can be attached to project documentation and leveraged during implementation to ensure the key features are not being compromised during implementation.

- Benefit validation: This will be a tool within the Excel file to document the project CapEx, OpEx and water savings, and ROI after implementation to allow for confirmation of expectations (i.e. compare reality vs. projections).

- Maintaining project benefits: Following implementation of water reuse projects, it is important to position the site for sustained benefit from the project. As highlighted through the workshop in the 2015 WRRF project, there are two major risks following implementation: (1.) the equipment/process is operated in a water wasteful manner, and (2.) lack of maintenance. To help the end user minimize these risks, the project team will be developing a checklist that incorporates the risk mitigation approaches identified with our industrial partners in the 2015 workshop that was performed as part of WRRF-14-04. This tool will walk the user through the suggested steps for mitigating these two key risks.

Technical Approach and Scope of Work

Task 1: Literature Review and Evaluation

An investigation of published peer reviewed literature and other reports that address the business value of water will be conducted. Issues to be explored include methodologies used by businesses to perform materiality assessments and to evaluate financial performance of investments including determining the return on investment for capital projects. Included in this search will be any information published by financial firms regarding what information is to be considered when evaluating and assigning value to the reputation and brand of the company and when evaluating long term risks to the company. Peer-reviewed literature and financial industry reports will be searched for information about any existing tools that have been developed to determine return on investment or to assess other aspects of business value including quantifying the indirect benefits of water reductions and reuse projects.

The literature for the project, *A Framework for the Successful Implementation of On-site Industrial Water Reuse* (WRRF-14-04), revealed that there is very little peer reviewed literature published by industry regarding how water projects are initiated, evaluated internally or executed. There was also very limited information on motivations that cause industry to act to reduce water use and implement water reuse. Further, very little published peer-reviewed literature actually discusses the methodology used by companies to evaluate the true cost of water and the actual return on investment of water reduction and reuse projects. Therefore, publications by industry related organizations will be investigated to determine if they have addressed these issues in internal publications. Industry partners will be asked to provide information from sources they use to learn about these issues and to identify reports of how water pressures are being evaluated and addressed by their industries. A focus of these investigations will be to identify information about tools currently in use by industry to assess return on investment and to quantify the total indirect business value of water projects.

The literature review will also incorporate updated background on the challenges industries face related to water access and other water related risks. Partner firms represent a broad range of industry sectors and it is anticipated that their insights will facilitate identification of all available literature and reports concerning risks faced by industry as well as the strategies being used to evaluate and address these challenges.

Finally, literature reports regarding communications of risks and challenges associated with water use will be investigated. These include literature sources that provide information about how to influence management and plant leadership to think of water in the context of the business and to integrate water as a business issue of significance equal to that of other more traditional business challenges.

Task 2: Methodology for Evaluation Tool

This task will provide the overall methodology for the tools that will be delivered through this project. At the completion of Task 2, the project team will have defined the inputs and outputs for each tool, collected and organized and reference data needed in support of the tools, and identified and developed all key equations that will be used in each of the tools. These Task 2 outputs will be used when making the tool in Task 3.

The Principal Investigators for this project, Dr.'s Brian Moore and Mary Buzby, both played major roles in the identification and financial justification of water reuse projects while they were in industry. Moreover, they were intimately engaged in the economic discussions and decision making processes for many projects. Through these experiences, they understand how decisions are made in industry, as well as being aware of the gaps industry faces when making these decisions. Further, they both have experience developing as well as using tools aligned with much of the proposed work scope. As appropriate, these previously-developed tools will be leveraged as a starting point for this project, helping to accelerate progress on the project. Throughout the execution of WRRF-14-04, the project team has done a portion of the groundwork needed for execution of some of the items in this next phase of research. For example, the project team has developed the framework for determining the true cost of water, which can readily springboard into this next phase of work. Similarly, a wide array of water treatment technologies have been costed (equipment cost and OpEx) out covering a range of influent flow rates. The project team would directly integrate this cost database into the ROI calculator tool to aid the user in costing projects.

To ensure that the methodology developed in Task 2 is robust and aligned to the needs of industry, we have developed an execution plan that will leverage the experience of the Arcadis team, as well as the experience and "voice of the customer" of industry (via our industry partners). Task 2 is divided into three specific steps:

<u>Step 1: Develop preliminary framework for each tool</u>. For each tool in the overall toolbox, the project team will develop a preliminary framework including: (i.) key objectives of the tool, (ii.) why/when/ how it would be used by industry, (iii.) the inputs and outputs, (iv.) units that will be used for the inputs and outputs, (v.) rough vision for the layout of the tool, and (vi.) a detailed plan describing equations and/or conceptual relationships that will be used to take the user inputs

and generate output(s) for each tool. The framework (for each tool) is intended to clearly convey our initial vision for each tool.

Step 2: Refine and optimize tool framework/methodology. After completion of Step 1, the project team will host a workshop with our industrial partners. (The WRRF project manager and Project Advisory Committee members will also be invited to the workshop.) It is envisioned this workshop would take place 3-4 months into the project, and is anticipated to be a 1.5 day workshop. The objective of the workshop would be to critically review the preliminary framework for each of the tools (i.e. output of Step 1). During this workshop Arcadis and the industry partners will scrutinize and revise (real-time) the preliminary framework for each of the tools, such that the final output of the workshop is a finalized framework for the toolbox that is user-friendly and tailored to meet the needs of industry. We see this workshop as an incredibly vital part of the project, providing the concise direction needed to develop a toolbox that will be well-received by industry.

Step 3: Finalize tool methodology/structure. The project team will review the finalized framework for each of the tools (following Step 2). It is anticipated that there will be gaps for some of the tools that need to be addressed – e.g. need to develop, modify, or finalize equations/relationships. Activities of Step 3 will ensure that we have all of the data, information, and equations needed to begin development of the computer based tool (Task 3). Based on the central role that computers play in our day-to-day lives, some of these relationships, equations, etc. may be developed directly in Excel, slightly blurring the lines between this aspect of Task 2 and Task 3.

Task 3: Development of User-Friendly Toolbox

The 'WateReuse Toolbox" being developed in the work described herein will be a web-based toolset. Each tool within the toolbox will represent an integrated compilation of complex equations and mathematical relationships. During Subtask 3.1 the underlying structure for of each tool will be developed using MS Excel. After these tools have been developed and vetted for functionality and accuracy, the project will move to Subtask 3.2. In Subtask 3.2 the tools (i.e. the collection of equations and data relationships making up each tool) will be migrated to a web-based format. The final product will be a web-based application.

Subtask 3.1: Development of the Tools within MS Excel

Each tool will be functionally developed using MS Excel during Subtask 3.1; tools will be developed using the output of Task 2 as a roadmap. It is envisioned that each tool will be developed on a separate tab within Excel, such that all tools reside on a single Excel file. The prescribed user inputs, standard data sets, and underlying equations/relationships (specified from Task 2) will be programmed into Excel along with functionality to generate the prescribed outputs. We have included personnel on our team with strong expertise in MS Excel to enable the development of a complex tool that is clearly and efficiently laid out so as to simplify transfer of the tools over to a web-based format.

Although the scope of our proposed toolbox addresses diverse needs for the industrial user, we recognize that the number of tools included in the toolbox could create confusion during the QA/QC process and also during the transfer of tools from MS Excel into the final web application. To this end, careful attention will be paid to the development of each tool in a clear and efficient manner. Tools will be developed on separate tabs in the Excel file so as to maintain clarity on the contents of each tool. Further, each tool will be cleanly laid out and will contain the following discrete sections:

- A description of the tool, highlighting (as appropriate) the technique(s)/approach(es) from which the tool has been developed as well as explaining who the typical end user will be and how the tool outputs would be used. This section will also provide a list of each of the main steps performs to generate the final output(s).
- A preliminary set of instructions for the user (which will be refined when the tool progresses to a web-based interface)
- User inputs with footnotes briefly conveying how the inputs are used in the tool
- A calculations section containing all relevant calculations performed within the tool. Where needed/appropriate notes will be included to explain the intention or relevance of calculations
- Outputs, which may include numerical values (e.g. annual savings, return on investment, etc.), tables (e.g. site water risk breakdown), or figures (e.g. Materiality Assessment).

It is intended that each tool within the Excel file be able to execute all the functions needed to provide the prescribed tool outputs. This will allow for efficient QA/QC of each tool. At the same time, the tools will be developed in a transparent manner so as to allow for the seamless transfer of the tools from Excel to the web-based format. Each tool will provide a clear and easy-to-understand output, allowing the user to execute based on the output.

Dr. Brian Moore, our Principal Investigator, was involved in the development of a very complete ROI calculator tool while in industry. The tool was designed to be very user friendly including multiple iterations of review with end-users to make the tool increasingly easy to use. Learnings from that previous experience will be leveraged during the development of the MS Excel-based toolset.

As noted previously, the most critical tools (in the toolbox) are the “ROI Calculator” and the “Water Conservation Scorecard”. Particular focus will be placed on these tools to ensure user-friendliness, versatility, and powerful and actionable outputs.

To ensure the tools are being developed as envisioned during the workshop, the project team will have frequent internal meetings to review the tools. In addition, the team will have monthly web-based teleconference calls with the partners to share progress and get feedback on the tools through the development cycle. Obtaining and executing on feedback from our industry partners is considered essential and directly correlated to the quality of the final product.

Subtask 3.2: Transferring the MS Excel-Based Tools into a Web-Based Format

Following the completion of the Excel-based tools, the team will transition the tools to a web-based format. We have included personnel on our team with the needed expertise for migration

of the tools from Excel to a web-based format. These team members have experience with the execution of very similar tasks in other projects (i.e. migration of complex tools over from MS Excel to a web based application).

For those not experienced in the design of web-based applications, the process of tool migration (Excel to web-based) is likely not immediately obvious. MS Excel and web-based interfaces are coded/structured rather differently. As such, one cannot simply cut (from Excel) and paste (into a web application). Rather, each of the functions/equations in the Excel file must be recreated in a code library that will contain these business rules; this is called the business layer of the architecture. The main idea behind the structure of a web application architecture is the separation of concerns between business rules, user interfaces, and data access elements. This separation improves code maintainability protecting our development investments as rules need to be updated or user interfaces modified months or years from now. A good web application architecture also ensures meeting the demands for security, scalability, and performance imposed by the web and large numbers of concurrent users accessing the online application. The inherent nature of this process helps to emphasize the importance of developing the Excel tool in a very transparent manner.

As the tools are being recreated in a web-based application, it is very important to ensure they are performing as intended. To this end, the business layer outputs will be calibrated against the MS Excel tools. To illuminate this process, for each tool the team will have developed multiple reference scenarios or sets of input data. These reference scenarios are run in both the MS Excel tool as well as implemented in “unit tests” that are part of the web-based code library and that can be executed independently to verify the expected outcomes. These “unit test” will allow the team to validate that no issues are introduced to the code library during the development cycle as they can be executed automatically upon every incremental release of functionality of the web application. The team will compare final outputs produced by each tool as well as the outputs/results from each of the calculations throughout the tools, ensuring uniformity between the web-based tools and the MS Excel counterpart. This process provides a key value: ensuring the web-based toolbox performs identical to the parent MS Excel-based tools.

- During development of the web-based toolset, our team will emphasize user friendliness. Some of the planned features include:
- Easily accessible and sufficiently detailed descriptions of each tool, allowing the end user to understand the intended purpose of the tool and its outputs.
- As the toolbox will consist of multiple tools, the user will be able to select the desired tool for their use.
- Upon selecting a tool, the required user inputs will appear on the page in one clear/distinct area. Users will directly enter inputs in this area.
- Where applicable/appropriate, the tool will be designed to accept user inputs expressed in different (common) units. For example, if the user is required to enter flow the user will be able to enter flow values in terms of gallons per minute, millions of gallons per year, cubic meters per hours, or cubic meters per year.
- If any required user inputs are omitted the tool will alert the user
- Pull-down lists and check-box features will be leveraged wherever possible for the user inputs section

- Functionality of user registration and log-in with the ability to save input data

As discussed at greater length in Task 5 section (below), the final package will also include PowerPoint slides which can walk a user through example applications with each tool. These instructional presentations will also be viewable directly via the web site to further aid the end user.

Once development of the web-based WateReuse Toolbox has been completed, it will be trialed by a group of industry partner sites (Task 4). Feedback will be solicited based on ease-of-use as well as identification of any technical issues/bugs. Following site feedback, updates will be applied to the MS Excel tool (as needed). Any changes to the MS Excel toolset will be clearly tracked/documented. Changes will then be applied to the web-based toolbox. Although the desired final product in this project is a web-based application, it is important to apply any changes to both the MS Excel file as well as the web-based toolbox. By doing this we will ensure that the MS Excel tools can be used for validation of the web-based toolbox. A final QA/QC step will be performed following any such updates to ensure all tool functions work accurately and as intended.

Task 4: Piloting the WateReuse Toolbox

Task 4 will include real-world validation of the (web-based) WateReuse Toolbox, with particular focus on the "ROI Calculator" and the "Water Conservation Scorecard" tools. The initial phase of tool piloting/ validation will be performed at industry partner facilities. Regarding the "ROI Calculator" and the "Water Conservation Scorecard" tools, we will assess the tool efficacy for evaluating/scoring specific water reuse projects being considered at the facility. One to two Arcadis personnel will be present during these piloting events; however, it is intended that industrial partner site personnel be the ones using the tool such that we can obtain their feedback about the tools. The objectives of these piloting events are: (1.) identify aspects of the tool (inputs and application) that were confusing or not user-friendly, (2.) ensure the output makes sense, and (3.) ensure the output meets their needs. Feedback from the industrial users during the piloting phase will be documented and the revisions will be made to the tool(s) following each piloting event.

Task 5: Case Examples

In Task 5, we will be sharing an array of case examples; these case studies originate from experiences of our industrial partners through the piloting phase of the project (Task 4). Case examples will incorporate efforts by companies working through each of the steps necessary to successfully implement water reduction and reuse projects. This can begin with determining the materiality of water to the company and assessing the business value of a project, including the return on investment through implementation and tracking of project performance. In each case example the challenges encountered and strategies to address them will be discussed. The partner firms represent a range of industry categories so it is anticipated that the case examples will reflect a wide diversity of industry sectors and implementation approaches. These examples will include details of the tools used by companies to evaluate costs and returns on investment and

how these tools were used to document and communicate the value of water projects to the business.

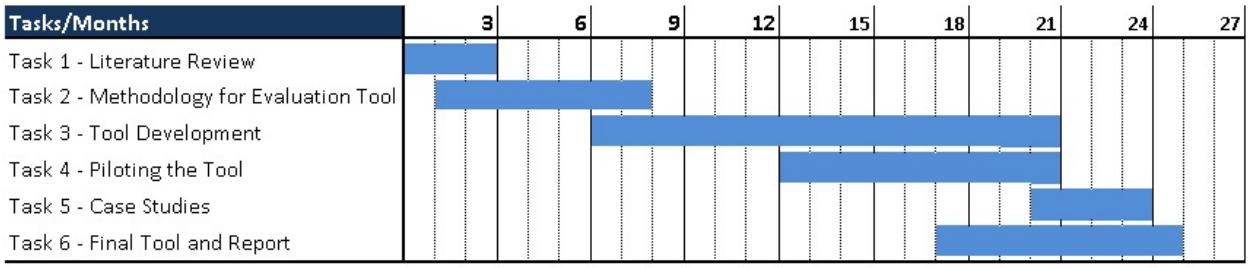
In addition, to the extent possible, a few case examples will be included that are based on using the newly developed tools that are produced by the project. Case examples that use the new tools in their entirety may be difficult to develop because of the long time frame associated with project identification and development within a company. However, applications of discrete elements/portions of the complete tool(s) will certainly be used as specific case examples for the project. This will include the core components of performing the return on investment assessment using the ROI Calculator. These examples will also be used to develop a set of PowerPoint slides that will walk the user step-by-step through the use of the tools (with tool screenshots) for these case examples.

Task 6: Final Report

The final project deliverables will be the WateReuse Toolbox and a written report, which will summarize the development of the methodology and WateReuse Toolbox. The final report will include the literature review, a summary of the approach used to develop the toolbox (and tools therein.

Research Plan and Work Schedule

Our proposed project schedule is summarized in the following figure. This project is expected to be completed within 18 months after a potential award from the Bureau of Reclamation (beginning October 1, 2016), with work having already begun in March 2016. The schedule includes time for the WateReuse Research Foundation Project Advisory Committee (PAC) to formally review each Task. Among the deliverables will be the semi-annual reports to be submitted to the Bureau of Reclamation, a Final Report communicating the results of the work completed, the Excel-based tool, and an online tool.



List of Key Personnel on Project

Justin Mattingly	WateReuse Research Foundation
	Role: WateReuse Project Manager
Brian Moore, PhD	Arcadis U.S. Inc.
	Role: Principal Investigator
Mary Buzby, PhD	Arcadis U.S. Inc.
	Role: Co-Principal Investigator

Alex J. Santos, PE	Arcadis U.S. Inc. Role: Chemical Engineer
Joseph Osso Jr.	Arcadis U.S. Inc. Role: Project Environmental Scientist
Matthew J. DeMarco, PE	Arcadis U.S. Inc. Role: Technical Manager
John M. Mastracchio, PE	Arcadis U.S. Inc. Role: Financial Analyst
Melissa R. Butcher, EI	Arcadis U.S. Inc. Role: Water/Wastewater Engineer

Evaluation Criteria

The proposed WateReuse toolbox project will develop a toolset to assist industry to evaluate the business value of substituting reclaimed water for fresh potable water in their operations. Use of reclaimed water by industry will help address watershed-based water resource management problems by providing industrial users of potable water the information they need to evaluate the business value of alternative water supplies. Tools within the toolset will address three main topic areas: (i.) defining the importance of water to industry, (ii.) developing the business case for water resource management, and (iii.) project execution. Together these tools will help a company assess the reliability of existing water supplies, the business risks associated with unsustainable water practices and supplies, and the best approach to address these business risks. Water is critical to the operation of nearly all industrial operations. Water supply reliability and water use efficiency are increasingly a focus in business planning and company strategy/culture. This is due to the realization in industry that climate change is impacting water resources and threatening access to water volumes and quality needed by industry. The set of tools being developed through this research effort will enable industry to understand their water risks and develop the proper business case needed to adequately address this challenge. This project is not intended to address the needs of a specific locale, but would directly benefit arid regions of the West and California in particular.

V.A.2 – Water Reclamation and Reuse Opportunities

The toolset being developed will allow industry to quantify the economic and social advantages associated with water reuse. Traditionally, industry has failed to implement water reuse projects broadly because water has been assumed to be of very low expense and of ample supply. Water efficiency was often thought of as non-essential to core operations. Clearly that is no longer the case; however, industry is uncertain about how to integrate water resource management into their business planning. These tools will help to eliminate obstacles to using reclaimed water (on-site water reuse as well as off-site municipal effluent reuse), and support more informed decisions by industry. When industry is better informed about the true cost of water, the market for water reuse can expand by targeting industries that may not necessarily view themselves as part of the "water sector". Water reuse market expansion can also be enhanced by making it clear how rising costs and water supply reliability can affect their business. With greater access to information on the costs and benefits of pursuing water reuse, it can be expected that a facility that had not considered on-site or off-site water reuse in the past may pursue implementation. This project will be applicable in many regions of the country, but particularly in California and

other regions in the West where supply concerns and rising costs are affecting businesses in many industrial sectors.

V.A.3 – Description of Potential Alternatives

This project is not intended to evaluate different technology options for water reuse. Rather, this project will provide tools needed by industry to evaluate water reuse as an alternative to traditional potable water supplies. As previously mentioned, this project will expand knowledge in water reclamation by providing a user-friendly tool for fully evaluating the costs and benefits of water reuse. The objective is helping potential industrial water reuse users determine if they have a viable water reuse opportunity based on their current and future operations. Case studies will also be reviewed to develop an in-depth understanding of the drivers for water reuse. This project is being led by Dr. Brian Moore and Dr. Mary Buzby of Arcadis who have greater than 50 combined years of experience in industry. While in industry, their roles were focused on driving water conservation and reuse within their respective company's manufacturing and R&D facilities. This experience gives the project team in-depth knowledge of the economic and technological drivers that impact decisions related to water supply and implementing corporate water strategies.

V.A.4 – Stretching Water Supplies

By providing greater clarity regarding the cost of water and the business value of water reuse, this project and the set of tools it will develop will help empower industrial water users to secure alternative water supplies, thereby reducing diversions and withdrawals from existing water sources. This will help stretch overall watershed resources by reusing water, resulting in a direct offset of potable water use. This will reduce, postpone, or eliminate the need to develop new or expanded water supplies.

V.A.5 – Environment and Water Quality

It is anticipated that 1/3 to 1/2 of this research effort will be dedicated to the development of the Water Conservation Scorecard tool. This particular tool will assist industry to assess the direct and indirect business value of water conservation projects. This will include financial returns to a company related to direct cost savings, as well as social and ecological value that are derived from protecting water resources and aquatic habitats. If the tools developed in the research are embraced by industry, demand of potable water will be decreased, potentially improving flow conditions of water bodies through decreased withdrawals and enhancing the quality of surface or groundwater through decreased wastewater discharges.

V.A.6 – Legal and Institutional Requirements

The primary institutional barrier that this project will address is the failure of industry to recognize the true cost of water use within their operations and supply chains. This project will provide the necessary tools to enable industry to identify and implement water reuse projects that are aligned with their business objectives, including return on investment and social and ecological value. Currently, industries do not use a comprehensive methodology for evaluating on-site water reuse and this project will help fill that knowledge gap to allow for more informed decisions.

V.A.7 – Renewable Energy and Energy Efficiency

It has been established that a significant portion (4 to 19%) of the nation's electricity use goes to moving and treating water by public and private entities. Energy costs account for a significant portion of the true cost of water to industry. Energy efficiency will result from water conservation and adoption of water reuse strategies by industry. These benefits can come through decreased demand on potable water and the attendant energy savings from reduced treatment and the potential for reduced transfers of imported water in regions such as California.

V.A.8 – Watershed Perspective

This project will support water reuse in a number of different regions depending on the specific drivers present. Typically, water reuse will be most attractive in arid regions with uncertain supply, including California, or in regions with strict discharge requirements. Industry will act to reduce water use if they are located in a region where access could impact their ability to operate. This project will develop a tool to help industry to quantify water-related risks where their facilities are located. Tools developed through this project will utilize publically available models that report risk on a watershed basis. Therefore, use of these tools will inform industry of watershed related risks and opportunities. While the tools developed through this project will be valuable to many California industries, they will be applicable to industrial operations nationally and globally. In regards to collaboration with other parties, there are two utility partners (West Basin Municipal District and Washoe County, Nevada) as well as ten industry partners, including 3M, Coca-Cola, Covestro (formerly Bayer Material Science), Duke Energy, General Motors, Huntsman, Kimberly Clark, PPG, The Ford Motor Company, and United Technologies Aerospace Division (UTAS). In addition, this research study is based off of recommendations from prior studies sponsored by the WateReuse Research Foundation as well as the Foundation's Research Advisory Committee.

Environmental Compliance

Because this is an economics-based study there will be no field work, ground-disturbing research, or any other activity that will impact the natural environment in any way. Because of this, there will be no issues with environmental compliance as a result of this project.

Required Permits or Approvals

There will be no required permits or approvals because this is an economics-based study with no field work, ground-disturbing research, or any other activity that will affect the natural environment.

Official Resolution

On the State Water Board adopted Resolution No. 2003-0008 that demonstrates the applicant has met the financial and legal obligations associated with receiving Federal Financial Assistance. Resolution No. 2003 – 0008 can be found here: http://www.swrcb.ca.gov/board_decisions/adopted_orders/resolutions/2003/rs2003-0008.pdf

The State Water Board is capable of providing the required funding contributions and the WateReuse Research Foundation and subcontractors are also capable of providing $126,190 in-

kind contributions. For additional detail regarding the budget, funding sources, and in-kind contributions, please see below.

The State Water Board's funds for this project have been approved by the Executive Director of the State Water Board, the Agency Secretary of California Environmental Protection Agency, and the Program Budget Manager in the State's Department of Finances. The funds are encumbered under contract #15-053-250 and $200,000 of the total funds for that contract has been budgeted for this project. The contact was approved under Governor Brown's April 1, 2015 Executive Order resolution B-29-15 that stressed the need for water conservation and the development of new and underutilized water supply options (e.g. water recycling) to respond to California's severe drought conditions. If the USBR grant is awarded, the contract approved under Executive Order B-29-15 would be revised.

The State Water Board will work with Reclamation to meet established deadlines for entering into a cooperative agreement.

Research Study Funding Plan and Budget Proposal

Funding Plan and Letters of Commitment

The cost share requirement for this project will be provided primarily through $200,000 in cash funding from the California State Water Resources Control Board. The rest of the funding will be provided in the form of in-kind support from the following sources:

In-Kind Service Contributions	Cash	Service	Total
WateReuse Research Foundation	-	$5,390	$5,390
Black & Veatch	-	$27,000	$27,000
Coca-Cola Bottling Co. Consolidated	-	$15,000	$15,000
Duke Energy	$15,000	-	$15,000
Ford Motor Company*	-	$6,300	$6,300
General Motors	-	$15,000	$15,000
UTC Aerospace Systems	-	$15,000	$15,000
Huntsman Corporation*	-	$15,000	$15,000
West Basin Municipal Water District*	-	$5,000	$5,000
PPG Industries*	-	$7,500	$7,500
Total	**$15,000**	**$111,190**	**$126,190**

*These letters are not included due to the length restrictions of this proposal. They are available upon request. All other letters of commitment are included at the end of this document.

To date, no research study expenses have been reported. However, work on this project began on March 14, 2016 and expenses are expected to be reported in the coming months. The work that will be done will follow the scope of work identified earlier in this proposal.

No additional funding has been requested from another Federal entity and there are no pending funding requests that have not yet been approved. Further detail on the funding plan can be seen in the following table:

Funding Sources	Funding Amount
Non-Federal entities	
Recipient Cash Contributions	$200,000
In-kind Service Contributions*	$126,190
Non-Federal Subtotal	*$326,190*
Other Federal Entities	**N/A**
Requested Reclamation Funding	**$75,000**
Total research study funding	*$401,190*

Budget Proposal

Funding Sources	Percent of total project cost	Total cost by source
Recipient funding	81%	$326,190
Reclamation funding	19%	$75,000
Other Federal funding	0%	$0
Totals	**100%**	**$401,190**

Budget Item Description	Computation		Type	State Water Board/ USBR Cost	In-Kind	Total Cost
	$/Unit	Quantity				
Salaries and Wages						
N/A	-	-	-	-	-	-
Fringe Benefits						
N/A	-	-	-	-	-	-
Travel						
N/A	-	-	-	-	-	-
Equipment						
N/A	-	-	-	-	-	-
N/A	-	-	-	-	-	-
Contractual						
WateReuse Research Foundation				$275,000	$126,190	$401,190
Environmental and Regulatory Compliance Costs						
N/A	-	-	-	-	-	-
Reporting						
Quarterly Reports	-	-	-	-	-	-
Final Reports	-	-	-	-	-	-
Final Presentation	-	-	-	-	-	-
Total Direct Costs	-	-	-	-	-	-
Indirect Costs	-	-	-	-	-	-
Total Costs	**-**	**-**	**-**	**$275,000**	**$126,190**	**$401,190**

California State Water Resources Control Board Contract with the WateReuse Research Foundation

Personnel	Hours	Rate $/hour	Direct Labor Cost	Labor w/ 173.3% Fringe Benefit	USBR/ State Water Board Cost	In-Kind Cash	In-Kind Service	Total Cost
Justin Mattingly	-	-	-	-	-	-	$5,390.00	$5,390.00
Brian Moore (PI)	334	$74.22	$27,789.48	$67,749.65	$55,249.65	-	$12,500.00	$67,749.65
Mary Buzby (Co-PI)	255	$55.00	$14,025.00	$38,330.33	$25,830.33	-	$12,500.00	$38,330.33
Matt Demarco	25	$67.31	$1,682.75	$4,598.96	$4,598.96	-	-	$4,598.96
Mel Butcher	344	$36.06	$12,404.64	$33,901.88	$33,901.88	-	-	$33,901.88
Joseph Osso	101	$36.74	$3,710.74	$10,141.45	$10,141.45	-	-	$10,141.45
Alex Santos	270	$38.39	$10,365.30	$28,328.36	$28,328.36	-	-	$28,328.36
John Mastracchio	53	$86.54	$4,586.62	$12,535.23	$12,535.23	-	-	$12,535.23
Alfonso Da Fonseca	76	$65.00	$4,940.00	$13,501.02	$13,501.02	-	-	$13,501.02
Je Fang	114	$34.00	$3,876.00	$10,593.11	$10,593.11	-	-	$10,593.11
Awanthi Koneru	114	$34.00	$3,876.00	$10,593.11	$10,593.11	-	-	$10,593.11
Derek Norman	152	$28.00	$4,256.00	$11,631.65	$11,631.65	-	-	$11,631.65
Ben Wagner	152	$28.00	$4,256.00	$11,631.65	$11,631.65	-	-	$11,631.65
Kunal Lanjewar	152	$15.00	$2,280.00	$6,231.24	$6,231.24	-	-	$6,231.24
Dana Bryant	25	$39.42	$985.50	$2,693.37	$2,693.37	-	-	$2,693.37
Patricia Gladle	9	$17.59	$158.31	$432.66	$432.66	-	-	$432.66
Jocelyn Fairlee	18	$30.74	$553.32	$1,512.22	$1,512.22	-	-	$1,512.22
Travel					**$14,886.00**	**-**	**-**	**$14,886.00**
Shipping and Incidentals					**$337.74**	**-**	**-**	**$337.74**
Total Direct Cost					**$254,629.63**	**-**	**$25,000.00**	**$279,629.63**
Fee (16% of Malcolm Pirnie Total Labor)					**$20,370.37**	**-**	**$2,000.00**	**$22,370.37**
Other In-kind Contributions						**$15,000**	**$78,800**	**$93,800**
Total					**$275,000**	**$15,000**	**$111,190**	**$401,190**

Other In-Kind Contributions	Cash	Service	Total
Coca-Cola Bottling Co. Consolidated		$15,000	$15,000
Duke Energy	$15,000		$15,000
Ford Motor Company		$6,300	$6,300
General Motors		$15,000	$15,000
UTC Aerospace Systems		$15,000	$15,000
Huntsman Corporation		$15,000	$15,000
West Basin Municipal Water District		$5,000	$5,000
PPG Industries		$7,500	$7,500
Total	**$15,000**	**$78,800**	**$93,800**

Budget Narrative

Indirect Costs

No indirect costs will be claimed as part of this project. All California State Water Resources Control Board salaries and expenses, aside from contractual costs, will be considered in-kind contributions.

Total Costs

The total cost of this project, including in-kind contributions, will be $401,190. Of this amount, $126,190 will be in-kind contributions from the WateReuse Research Foundation and subcontractors. The federal cost-share will be $75,000 and the California State Water Resources Control Board share will be $200,000.

BUDGET DETAIL

15-03 Scorecard for Evaluating Opportunities in Industrial Reuse, FED ID #R16-FOA-DO-011
(Start Date:July 1, 2016 End Date: January 31, 2018)

CATEGORIES				FEDERAL	STATE MATCH	TOTALS
A. PERSONNEL	Annual Salary	PY(s)	F or S			
				$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
Subtotals:		0.0		$0	$0	$0
B. FRINGE BENEFITS @			43.21%	$0	$0	$0
TOTAL PERSONAL SERVICES:				$0	$0	$0
C. TRAVEL						$0
D. EQUIPMENT						$0
E. SUPPLIES						$0
F. CONTRACTUAL (insert additional lines if needed)						$0
WateReuse Research Foundation				$75,000	$200,000	$275,000
						$0
TOTAL CONTRACTS:				$75,000	$200,000	$275,000
G. CONSTRUCTION						$0
H. OTHER						$0
I. TOTAL DIRECT (C through I)				$75,000	$200,000	$275,000
J. *INDIRECT CHARGES @			94.64%	$0	$0	$0
TOTAL GRANT REQUEST:				$75,000	$200,000	$275,000

NOTES:

The total cost of this project, including in-kind contributions, will be $401,190. Of this amount, $126,190 are in-kind contributions from the WateReuse Research Foundation and sub-contractors. The federal cost-share will be $75,000 and the State Water Board share will be $200,000.

April 19, 2016

Mr. Michael Dieterich,
Grants Management Specialist
Bureau of Reclamation Financial Assistance
Services
Mail Code; 84-25007
P.O. Box 25007
Denver, Co 80255

Dear Mr. Dieterich:

APPLICATION FOR FEDERAL ASSISTANCE: Water Reclamation Research under the Title XVI Water Reclamation and Reuse Program for Fiscal Year 2016 (**R16-FOA-DO-011**).

The State Water Resources Control Board is pleased to submit a request for federal assistance for the above referenced agreement. This application requests $75,000 in federal assistance and a state match of $200,000 for a total project amount of $275,000. The proposed project period extends from July 1, 2016, through January 31, 2018.

If there are technical or program questions, please telephone Ms. Claire Waggoner, the Project Manager, at (916) 341-5582. Fiscal or administrative questions should be directed to Marco Meza, the Federal Grants Coordinator, at (916) 341-5132.

Sincerely,

Eric Oppenheimer
Chief Deputy Director

Form Approved OMB No: 2030-0020 Approval Expires 06/30/2017

U.S. ENVIRONMENTAL PROTECTION AGENCY
Washington, DC 20460

KEY CONTACTS FORM

Authorized Representative: *Original awards and amendments will be sent to this individual for review and acceptance, unless otherwise indicated.*

Name: Eric Oppenheimer
Title: Chief Deputy Director
Complete Address: P.O. Box 100, Sacramento, CA 95812-0100
1001 I Street, Sacramento, CA 95814
Phone Number: (916) 445-5960

Payee: *Individual authorized to accept payments.*

Name: Jerrel Bolds
Title: Chief, Accounting Branch
Mail Address: P.O. Box 100, Sacramento, CA 95812-0100
1001 I Street, Sacramento, CA 95814
Phone Number: (916) 341-5100

Administrative Contact: *Individual from Sponsored Program Office to contact concerning administrative matters (i.e., indirect cost rate computation, rebudgeting requests etc.)*

Name: Marco Meza
Title: Federal Grants Coordinator
Mailing Address: P.O. Box 100, Sacramento, CA 95812-0100
1001 I Street, Sacramento, CA 95814
Phone Number: (916) 341-5132
FAX Number:
E-Mail Address: MOMeza@waterboards.ca.gov

Principal Investigator: *Individual responsible for the technical completion of the proposed work.*

Name: Claire Waggoner
Title: Senior Environmental Scientist
Mailing Address: P.O. Box 100, Sacramento, CA 95812-0100
1001 I Street Sacramento, CA 95812-2815
Phone Number: 916-341-5582
FAX Number:
E-Mail Address: claire.waggoner@waterboards.ca.gov
Web URL: