

# RECLAMATION

*Managing Water in the West*

## Identifying Reclamation-Wide Water Quality Challenges That Affect Water Supply Deliveries and Operations

A Survey and Reporting Framework  
FINAL REPORT

Research and Development Office  
Science and Technology Program  
Final Report ST-2016-ID-5144



U.S. Department of the Interior  
Bureau of Reclamation  
Research and Development Office

October 2016



## **Mission Statements**

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.



**REPORT DOCUMENTATION PAGE***Form Approved  
OMB No. 0704-0188*

<b>T1. REPORT DATE</b> October 2016	<b>T2. REPORT TYPE</b> Research	<b>T3. DATES COVERED</b>
<b>T4. TITLE AND SUBTITLE</b>  Identifying Reclamation-Wide Water Quality Challenges That Affect Water Supply Deliveries and Operations, A Survey and Reporting Framework		<b>5a. CONTRACT NUMBER</b>
		<b>5b. GRANT NUMBER</b>
		<b>5c. PROGRAM ELEMENT NUMBER</b> 1541 (S&T)
		<b>5d. PROJECT NUMBER</b>
<b>6. AUTHOR(S)</b>  Collins Balcombe Katie Guerra Andrew Tiffenbach		<b>5e. TASK NUMBER</b>
		<b>5f. WORK UNIT NUMBER</b>
		<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b>		<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b> R&D: Research and Development Office BOR/USBR: Bureau of Reclamation DOI: Department of the Interior
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> Research and Development Office U.S. Department of the Interior, Bureau of Reclamation, PO Box 25007, Denver CO 80225-0007		<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b> Final report can be downloaded from Reclamation's website: <a href="https://www.usbr.gov/research/">https://www.usbr.gov/research/</a>		
<b>13. SUPPLEMENTARY NOTES</b>		
<b>14. ABSTRACT (Maximum 200 words)</b> This product was completed as a "scoping" study using \$20,000 in Fiscal Year (FY) 2016 funding under Reclamation's Science and Technology (S&T) program. Using the Great Plains (GP) Region's Oklahoma-Texas Area Office (OTAO) as a case study, we developed a survey and reporting framework that can be transferred across multiple offices and regions to identify Reclamation's mission-critical water supply and operational needs that may be addressed through the treatment of impaired water sources for beneficial use. Examples may involve storm water treatment; aquifer storage and recovery; desalination; the reuse of municipal, industrial, domestic, and agricultural wastewaters; or any other project that involves the treatment of impaired ground and surface waters. Results will help raise awareness of agency needs while guiding future investments under Reclamation's programs such as Title XVI and Research & Development (R&D). Such investments include deploying Reclamation's Technical Services Center (TSC) and funding targeted projects that result in faster, cheaper, or better ways of accomplishing Reclamation's mission, including the implementation of adaptive strategies that prolong Reclamation's water supplies or offset demands on Reclamation supplies through expansion or development of new supplies. At the same time,		

this will improve Reclamation's resiliency to drought and climate change, while also helping address broader research needs shared by the nation as a whole.

**15. SUBJECT TERMS**

<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>	<b>U</b>		<b>19b. TELEPHONE NUMBER</b>
U	U	U			<b>303-445-2125</b>

S Standard Form 298 (Rev. 8/98)  
P Prescribed by ANSI Std. Z39-18

# PEER REVIEW DOCUMENTATION

## Project and Document Information

Project Name: Identifying Reclamation-Wide Water Quality Challenges That Affect Water Supply Deliveries and Operations, A Survey and Reporting Framework

WOID: Z5144

Document Final Report ST- 2016-ID-5144

Document Author(s) Collins Balcombe, Katie Guerra, Andrew Tiffenbach

Document date: October 31, 2016

Peer Reviewer: Anna Hoag

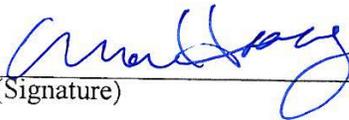
For Reclamation disseminated reports, a disclaimer is required for final reports and other research products, this language can be found in the peer review policy:

***"This information is distributed solely for the purpose of pre-dissemination peer review under applicable information quality guidelines. It has not been formally disseminated by the Bureau of Reclamation. It does not represent and should not be construed to represent Reclamation's determination or policy."***

## Review Certification

**Peer Reviewer:** I have reviewed the assigned items/sections(s) noted for the above document and believe them to be in accordance with the project requirements, standards of the profession, and Reclamation policy.

Reviewer

  
(Signature)

Date reviewed

11-1-16

# Acronyms and Abbreviations

AWT	Advanced Water Treatment
FY	Fiscal Year
GAO	Government Accountability Office
GP	Great Plains
GPRA	Government Performance and Results Act
MCWQ	Mission-Critical Water Quality
NAS	National Academy of Sciences
NEWAS	Net New Water Supply Study
O&M	Operations and Maintenance
OTAO	Oklahoma-Texas Area Office
QA/QC	Quality Assurance/Quality Control
R&D	Research and Development
S&T	Science and Technology
TDS	Total Dissolved Solids
TSC	Technical Service Center
U.S.	United States
USGS	United States Geological Survey

# Executive Summary

This product was completed as a “scoping” study using \$20,000 in Fiscal Year (FY) 2016 funding under Reclamation’s Science and Technology (S&T) program. Using the Great Plains (GP) Region’s Oklahoma-Texas Area Office (OTAO) as a case study, we developed a survey and reporting framework that can be transferred across multiple offices and regions to identify Reclamation’s mission-critical water supply and operational needs that may be addressed through the treatment of impaired water sources for beneficial use. Examples of needs and challenges addressed in the framework may involve storm water treatment; aquifer storage and recovery; desalination; the reuse of municipal, industrial, domestic, and agricultural wastewaters; or any other project that involves the treatment of impaired ground and surface waters to reduce total dissolved solids, microorganisms, disinfectants/ byproducts, heavy metals, organic chemicals, radionuclides, emerging contaminants, etc. The survey and reporting results will help raise awareness of agency needs while guiding future investments under Reclamation’s programs such as Title XVI and Research & Development (R&D). Such investments include deploying Reclamation's Technical Service Center (TSC) and funding targeted projects that result in faster, cheaper, or better ways of accomplishing Reclamation's mission, including the implementation of adaptive strategies that prolong Reclamation’s water supplies or offset demands on Reclamation supplies through expansion or development of new supplies. At the same time, this will improve Reclamation’s resiliency to drought and climate change, while also helping address broader research needs shared by the nation as a whole. Next steps include utilizing FY 2017 funds to conduct surveys across offices within Reclamation’s Great Plains Region, match mission-critical needs with program opportunities, and facilitate implementation.

# Contents

	<i>Page</i>
Acronyms and Abbreviations .....	i
Executive Summary .....	i
Contents .....	ii
Background and Need.....	1
Water Supply Augmentation: Quality versus Quantity .....	1
The National Perspective .....	2
Reclamation’s Perspective .....	4
Research Question .....	7
Research Strategy.....	7
Results.....	8
Task 1: Literature Review.....	8
Task 2: Mission-Critical Needs .....	9
Task 3: Previous Engagement and Road Mapping Efforts.....	11
Task 4: Survey Approach.....	11
Task 5: Survey Template .....	13
Task 6: Database .....	15
Task 7: Email Template .....	15
Task 8: AWT Expertise .....	16
Task 9: Case Study.....	17
Next Steps .....	17
References.....	18
Appendices.....	19

# Background and Need

## Water Supply Augmentation: Quality versus Quantity

Providing a dependable water supply is dependent upon implementing a portfolio of actions aimed at improving demand management, system operations, ecosystem resiliency, data and information, and supply augmentation (Reclamation, 2016). The subject of this report is water supply augmentation – more specifically, the role that “non-traditional” water supplies play in augmentation, and how Reclamation can identify and prioritize future investments to advance water supply augmentation through the treatment and development of non-traditional supply sources.

In the supply augmentation context, water supply most often depends on two key factors: (1) the *quantity* of water, and (2) the *quality* of water. Arguably, the former is somewhat dependent upon the latter, meaning that one simply cannot discuss the quantity of water without considering the quality of water. This inextricable linkage between water quality and quantity becomes readily evident as one considers the end use of that water, as well as the source of the water. This linkage, in fact, is rooted in a third key factor: *water treatment*.

A wide variation exists among the quality of potential sources of any water supply that is put to some beneficial use: for example, the quality of water emanating from fresh snow melt in the headwaters of the Colorado Rocky Mountains is vastly different than the quality of water flowing in a natural stream at a location downstream of multiple “wastewater” discharge locations. The same applies to a comparison of saline water in the Pacific Ocean to fresh groundwater of the Ogallala Aquifer. The comparisons are limitless. A similar variation exists among the quality of water that is ultimately required for end use: for instance, the quality of water needed to irrigate a thirsty alfalfa field is vastly different than the quality of water required to yield safe passage of an endangered Chinook salmon beneath the Golden Gate Bridge versus that required to safely quench the thirst of a community drinking water out of a faucet. Indeed, the real challenge for a water supply project begins with reconciling the water quality factors of source and end use, factors which display an endless array of variation in both time and space. Of all the important engineering components required to develop and manage a water supply project (i.e., pumping, storage, and conveyance), only water treatment appears to reconcile these factors. But it does not end there. Water treatment itself is driven by a constantly changing array of technical, social, environmental, legal, institutional, regulatory, political, and financial factors, which in and of themselves, also vary both in both time and space. In short, the water quality challenges that affect the treatment and supply of various source waters for various end uses are extremely complex.

But how important are addressing these challenges critical to fulfilling Reclamation’s mission? And what Reclamation resources can and should be brought to bear to address these challenges? This report sets out to develop a framework to help answer these questions. First, a perspective is provided below on how non-traditional, impaired water sources may represent the future of water supply augmentation for the nation.

## The National Perspective

Populations continue to grow, and along with them are growing demands for more agricultural, municipal, and industrial water supplies. The needs of people place additional stress on environmental and instream flow needs. Existing fresh water supplies are extremely limited and projected to worsen, as demonstrated by water supply deficits that exist at most state and local levels across the western United States. Severe and prolonged droughts have and continue to plague many parts of the western United States. But even the most severe droughts our nation has recorded, including that of the 1930s dust bowl, do not come close to matching the level of severity of the so called “mega droughts” that are known to have occurred based on historic paleoclimate information from tree ring data (Colorado Water Conservation Board, 2012; Woodhouse and Brown, 2001). Looking towards the future, climate change and climate variability are projected to have substantial impacts on water demands and availability. In fact, net irrigation water requirements in the second half of the 21<sup>st</sup> century are projected to increase by six percent across the west, temperatures are projected to increase by five degrees Fahrenheit, and annual evaporation could increase from two to six inches by 2080 (Reclamation, 2015). This will place greater stress on storage reservoirs, which have already proven themselves to be vulnerable to drought, and it will add additional risk to future considerations on development of new reservoirs, which are costly and wrought with complexities over permitting, land acquisition, environmental impacts, etc.

To help address these challenges, much national attention is being placed on the treatment and use of non-traditional water supplies that often are impaired by poor water quality that may require advanced technologies to treat and develop for new water supply augmentation. This may include seawater; brackish ground and surface water; effluent emanating from agriculture, municipal, or industrial operations; storm water; or other sources impaired by naturally occurring contaminants such as radionuclides, heavy metals, etc. Countless strategic planning efforts at Federal and State levels exist, a few of which are described here. These efforts support the need to identify and prioritize future investments into water treatment technologies to utilize non-traditional supply sources as a means of creating new water supplies that are needed to meet the demands of a growing nation in an environmentally sound manner.

In 2008, the National Academy of Sciences (NAS) published a report titled “*Desalination, A National Perspective*” that contains an extensive inventory of desalination technologies and lays out a national strategic research agenda focusing on two overarching long-term research goals to: (1) Understand the environmental impacts of desalination and develop approaches to minimize these impacts relative to other water supply alternatives; and (2) Develop approaches to lower the financial costs of desalination so that it is an attractive option relative to other alternatives in locations where traditional sources of water are inadequate. Specific research strategies are detailed in the report. Overall, the NAS concluded that implementing the proposed research agenda will, “require federal leadership and a coordinated, strategic plan among multiple agencies...and will depend on participation by federal, state, local agencies, nongovernmental entities, and the private sector”. The following excerpt from the NAS Preface is worth noting:

---

*“Water is necessary for life. Provision of a safe, reliable, and sustainable water supply to communities is an essential function of water utilities in the United States. As climate changes, population grows, and local water scarcity concerns heighten, desalination of brackish water and seawater is increasingly considered as an option for a source of new water to meet anticipated water supply needs. Desalination opens the door to conversion of the vast ocean and brackish inland water bodies into usable water for municipalities. Given the possibilities for clean water supply, desalination technology adoption in the United States lags behind that of many other countries. Concerns have been raised that technological barriers and financial costs prohibit broader desalination implementation.”*

---

In December 2015, the White House published a report titled *“Water Resource Challenges and Opportunities for Water Technology Innovation”*, that describes the projected impacts of climate change on water resources and the President Obama Administration’s strategy for addressing water resources challenges (Water Resource Challenges and Opportunities for Water Technology Innovation, 2015). The report identifies a two-part water innovation strategy that includes increasing water use efficiency and technology innovation that will improve development and use of non-traditional source waters including seawater, brackish water, reuse of municipal reclaimed water, and storm water. The stated goals of the White House Water Innovation Strategy are: (1) Boosting water sustainability through the greater utilization of water-efficient and water reuse technologies; and (2) Promoting and investing in breakthrough research and development that reduces the price and energy costs of new water supply technology. Cost and energy consumption are stated as the primary barriers to further utilization of non-traditional water sources, and the report sets targets for total cost, specific energy consumption and specific carbon dioxide generation in order for desalination technologies to be more competitive with traditional water treatment and delivery approaches. Soft costs (i.e., financing, permitting, and environmental mitigation) and lengthy project development times are also cited as major non-technical cost drivers associated with developing non-traditional water sources.

In April 2016, the Government Accountability Office (GAO) published a technology assessment report titled *“Municipal Freshwater Scarcity – Using Technology to Improve Distribution system Efficiency and Tap Non-traditional Water Sources”*, that identifies numerous mature technologies that are available to treat non-traditional water sources (Municipal Water Scarcity: Using technology to improve distribution system efficiency and tap non-traditional water sources, 2016). This assessment found that treating non-traditional water for potable or nonpotable use is “becoming more economically feasible as technology improves and traditional freshwater supplies grow increasingly scarce.” In addition to cost (which varies substantially based on project location), many other factors were found to influence the implementation of new water treatment technology, including utility size, regulations, public perception, and technical familiarity. The GAO study cited some key drivers that help advance the development of non-traditional water supplies: (1) A sufficient need exists for additional water supplies; (2) A sufficient capacity exists, including the familiarity with advanced technologies, available land

area, favorable public perception, and economic conditions to adopt new technology; (3) Drinking water and wastewater or storm water were managed by the same utility; and (4) An ability to address financial and regulatory challenges.

Many states such as Texas and California also are evaluating how advanced water treatment could be used to solve current and projected water shortages by tapping into non-traditional supply sources. The 2017 Texas State Water Plan (developed by the Texas Water Development Board) identifies water management strategies needed to provide 8.5 million acre-feet per year in additional water supplies by 2070 (Water for Texas: 2017 State Water Plan, 2016). In addition to traditional water management strategies (such as conservation, construction of new surface water reservoirs, and additional groundwater development) a number of strategies are identified that could involve advanced water treatment technologies. Strategies such as reuse (direct potable, direct non-potable, and indirect), aquifer storage and recovery, and desalination (brackish and seawater) are projected to provide almost 1.5 million acre-feet per year in additional water supplies by 2070. Furthermore, the California Water Plan 2013 Update identified desalination of brackish and seawater as an important strategy to expand local water supplies, improve supply reliability, and provide emergency supplies while recognizing efforts are still needed to overcome challenges associated with permitting, energy use, and environmental concerns. The California Water Plan also identified the future role of municipal recycled water, setting a goal of 1,000,000 acre feet of reuse in 2020 and 1,300,000 acre feet in 2030.

Indeed, the nation as a whole recognizes the importance of investing in technologies and breaking down barriers that inhibit the development of non-traditional water supplies in meeting our water needs.

## **Reclamation's Perspective**

The mission of the Bureau of Reclamation (Reclamation) is to “manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public”. Although not stated explicitly in Reclamation’s mission statement, it is the author’s opinion that the heart of Reclamation’s mission is grounded in one very simple purpose: providing a dependable “supply” of water<sup>1</sup>. This includes supplies for power generation, agriculture, municipal drinking water, commercial and industrial use, recreation, or environmental resources. Today, Reclamation is the largest wholesaler of water in the nation. It provides more than 10 trillion gallons of water each year for municipal use and provides water to approximately 10 million acres of irrigated farmland that collectively produce 60 percent of the nation’s vegetables and 25 percent of its fruit and nuts. Reclamation also is the largest producer of hydroelectric power in the Western U.S. Its 53 power plants generate more than 40 billion kilowatt-hours of electricity annually, enough to serve some 3.5 million households and produce nearly a billion dollars in power revenues (Reclamation, 2016). Reclamation provides these supplies, in part, through the 350 dams/reservoirs that it currently owns and/or operates across the West. Reclamation also provides much-needed supplies for threatened and endangered species via Endangered Species Act compliance and to rural and tribal communities through congressionally authorized rural water and tribal projects. However, these supplies very much

---

<sup>1</sup> Most Reclamation projects also provide flood control benefits in addition to water supplies.

face the same threats described above that are shared by the nation, with significant needs emanating from growing demands on water, aging infrastructure, and competition for water supplies, all of which are being exacerbated by climate change and variability (Reclamation, 2016). And along with these threats come critical issues related to how Reclamation and recipients of project water can meet contractual obligations for water supply deliveries and project repayments within the constraints of laws and regulations it is bound to follow. The issues are technical, they are financial, and they are political. The needs are immediate, ongoing, and likely to worsen.

To help address these needs, Congress authorized a broader mission for Reclamation to “partner with others” to investigate and combat climate change through the Omnibus Public Land Management Act of 2009 (Public Law 111-11, Title IX, Subtitle F), known as the SECURE Water Act, for the purpose of protecting adequate and safe supplies of water that are fundamental to the health, economy, security, and ecology of the United States. This broad authorization made it clear that Congress intends Reclamation to address the risks of climate change for the entire western United States, not just for its contracted water supply deliveries at existing reservoirs and projects. Reclamation has done much to address the provisions of the Act, establishing multiple programs that provide funding and expertise to support research, planning, and construction activities across the West. In Reclamation’s 2016 SECURE Water Act Report (2016 Report) to Congress on Climate Change and Water, it lays out a strategy and update on how best to operate Reclamation reservoirs, prioritize investments in new or improved facilities, and protect species and habitat in a changing climate. Importantly, the 2016 Report stressed the need to evaluate a portfolio of multiple possible adaptation actions to meet water needs, highlighting five general categories of possible actions to adapt to climate change and ensure long-term supply reliability

(Figure 1). Within the water supply augmentation category, the subject of this report, are actions such as water reuse, desalination, storm water capture, and new or expanded water storage. Arguably, all these activities likely involve the treatment of impaired water sources. The 2016 Report goes on to provide a summary of basin-wide planning efforts completed by Reclamation across the West that have evaluated these supply augmentation strategies; yet countless other examples exist at local levels beyond those considered in the 2016 Report that involve supply augmentation through the treatment of total

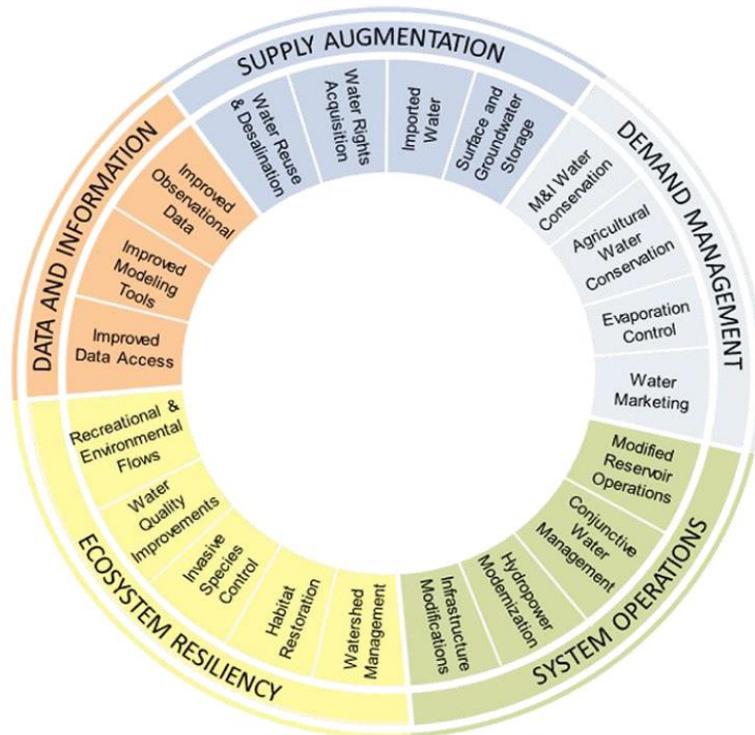


Figure 1. General categories of possible actions used in a water management portfolio to adapt to climate change

dissolved solids, microorganisms, disinfectants/ byproducts, heavy metals, organic chemicals, radionuclides, emerging contaminants, etc.

---

*Whether to meet the needs of a Reclamation project or the needs of a nation, it is this author's opinion that Reclamation's mission of providing water supply is clear. The role of augmentation among the portfolio of strategies needed to ensure reliable supplies is clear. And the role of water treatment plays in linking water quality and water quantity to augment supplies is clear. And thus, Reclamation has an interest and role in treating non-traditional impaired by poor water quality for the purposes of augmenting water supplies.*

---

To advance water supply augmentation strategies that involve the treatment of impaired water sources, Reclamation has numerous programs by which it can bring expertise and funding to bear to conduct research and planning activities, as well as construction and implementation. This includes Operations and Maintenance (O&M) and water resources and conservation planning program line-items located within Reclamation project budgets, as well as through centralized competitive programs like WaterSMART. Under WaterSMART, strategies include addressing non-traditional supplies through basin-wide planning (Basin Study Program), grants for water and energy improvement projects (WaterSMART Grants); research, studies, and implementation of water reclamation and reuse projects that provide flexibility during water shortages by diversifying the water supply (Title XVI Program); drought planning and implementation actions that address water shortages (Drought Response Program); developing collaborative watershed groups to enhance sustainability efforts (Cooperative Watershed Management Program); smaller-scale water conservation planning and improvements (the Water Conservation Field Services Program); and a program to identify resilient infrastructure investments that take into account potential effects of climate change while continuing to support healthy watersheds (Resilient Infrastructure Program). Reclamation's Research and Development Office also is engaged in activities to investigate and advance non-traditional water supplies; in fact, advanced water treatment has been identified as a high priority area for research investments, utilizing the Science and Technology and Desalination and Water Purification Research Programs, which leverage internal and external expertise (respectively), as well as Prize Competitions, a unique crowd sourcing approach.

Over all, under Reclamation's programs, Reclamation can provide facilities, expertise, and funding to support a broad spectrum of treatment activities, from technology development to full-scale usage and implementation. The challenge is that a clear path does not exist on how to match core, mission-related needs with these types of opportunities. Creating this path will help Reclamation deploy its expertise and funding towards projects that result in faster, cheaper, or better ways of accomplishing Reclamation's mission.

# Research Question

The research question addressed by the scoping project is as follows:

By using a survey-based approach to gather information on water quantity and quality challenges associated with Reclamation projects, can we better inform future investments under programs that address core, mission-related needs involving the treatment of impaired water sources?

# Research Strategy

The Research Strategy outlined in the scoping proposal is comprised of the following tasks:

1. Perform a literature review of previous Reclamation efforts that compiled a database of Reclamation Advanced Water Treatment (AWT) needs by project and region (e.g., Net New Water Supply Study (2006)).
2. Along with Reclamation-authorized projects, determine other “categories” of mission-critical needs, such as those related to the Endangered Species Act or tribal settlements.
3. Examine how area offices/projects are engaged by the Research Office in order to identify additional opportunities for project level involvement.
4. Develop a survey approach for engaging regional and area offices (i.e., timing, method of initial contact, follow-up).
5. Develop a survey template that will be used to AWT needs at the regional and project level.
6. Determine how the survey data will be compiled, formatted, and analyzed once received (e.g., map, matrix, etc.).
7. Develop email and/or phone script for contacting offices.
8. Develop a team of Reclamation AWT experts (e.g., S&T regional coordinators and TSC) for conducting surveys and collecting information in future fiscal years.
9. Conduct a small case study of one or two offices in Reclamation.

# Scoping Study Results

The results are described below and organized to address the research strategies described above:

## Task 1: Literature Review

A review of literature was performed to identify previous Reclamation efforts related to identifying Reclamation AWT needs by project and region. The past efforts, identified and reviewed here, were either incomplete or were very focused on one specific region. The intent of this literature review is to identify methods, outcomes, and lessons learned from past efforts that can be used to improve the usefulness of this current effort. Previous works reviewed pertaining to Reclamation include the Net New Water Supply Study and subsequent references (e.g., Net New Water Supply Study (2006)) and Basin Study reports from the GP region. Another effort worth documenting here is the United States Geologic Survey (USGS) assessment on the availability of brackish groundwater across the United States. Of particular interest to Reclamation is identifying if a Project-specific water supply need exists in a locale identified by USGS as having available brackish groundwater resources that could be treated and developed to offset demands on that Reclamation project. Details are provided below.

### Net New Water Supply (NEWAS) Study

The NEWAS Study, which ended in 2006, was conducted to address the Congressional request that the Commissioner of Reclamation assess the potential use of AWT technologies to create new water supplies. A secondary objective was to establish awareness within Reclamation to facilitate active involvement in new water supply planning activities by introducing managers, engineers, and planners to the potential role of AWT in reclaiming impaired waters to resolve water supply shortages across the western United States.

The NEWAS Study used a survey approach to collect information from Reclamation regions about water supply issues and impaired water sources that could be treated and developed as new supplies. However, rather than focusing directly on mission-critical needs, the NEWAS Study sought to identify AWT-related needs across the entire geographic area covered by Reclamation and included needs/opportunities of locales with no direct Reclamation nexus. Data were collected and organized in an Excel database and issues which were then developed into one page monographs. Overall, due to limitations in funding and management support, case studies were not completed. And due to the limited responses provided internally from surveys, little value came from the NEWAS. The following are lessons-learned from the NEWAS Study that should be addressed as part of any future effort identifying water quality and treatment challenges for Reclamation:

- Focus on Reclamation project needs to better align project outcomes with Reclamation mission responsibilities;
- Focus on Reclamation projects rather than taking on the cumbersome task of identifying countless area-specific needs across the country;

- Focus on identifying water quality and quantity challenges first and foremost, and let AWT opportunities be identified based on those findings;
- Data processing and management should be straightforward; develop a simplified Excel database to summarize results rather than a narrative approach.

### **Basin Studies**

Reclamation’s WaterSMART Basin Study program funds collaborative studies that are cost-shared with non-Federal partners to evaluate the impacts of climate change and identify strategies to address water supply and demand imbalances. We sought to identify water treatment-related strategies identified or evaluated within basin studies completed in the GP Region. We identified three basin studies: (1) Lower Rio Grande Basin Study; (2) St. Mary River and Milk River Basin Study; and (3) Republican River Basin Study. Only the Lower Rio Grande Basin Study considered AWT strategies to address basin needs. Specifically, due to the limited supplies available, the study placed a heavy emphasis on seawater desalination, brackish groundwater desalination, and water reuse, with regional brackish groundwater desalination selected for more detailed engineering and cost analyses. However, because the Lower Rio Grande Basin Study area does not include Reclamation projects or include needs considered to be of “mission significance” (see Task 2), it is not considered further in this effort.

Nevertheless, it should be recognized that the WaterSMART Basin Study Program, in general, provides a powerful mechanism to identify AWT-related needs and any effort seeking to prioritize AWT investments should consider the findings of completed basin studies.

### **USGS Brackish Groundwater Assessment**

The USGS is conducting an assessment on the availability of brackish groundwater under a WaterSMART initiative aimed at enhancing water supply reliability and contributing to water security of the country<sup>2</sup>. Brackish groundwater resources are in abundant supplies across the West and could be used to augment or replace freshwater. However, a better understanding of the location and character of brackish groundwater is needed to expand development of the resource and provide a scientific basis for making policy decisions. To address these needs, the USGS Groundwater Resources Program is compiling existing data on chemical and hydrogeologic characteristics of major brackish aquifers across the country to help water resource planners better assess the availability and potential viability of treating and utilizing brackish groundwater as a resource to meet future water needs. Of particular interest to Reclamation is identifying if a Project-specific water supply need exists in a locale identified by USGS as having available brackish groundwater resources that could be treated and developed to offset demands on that Reclamation project. Reclamation will coordinate with USGS and utilize whatever USGS data/tools are available and incorporate this into our AWT needs assessment.

## **Task 2: Mission-Critical Needs**

We defined “mission-critical” needs, first and foremost, as those that directly relate to Reclamation projects and help address contractual obligations, including water supply or

---

<sup>2</sup> [http://water.usgs.gov/ogw/gwrp/brackishgw/files/brackish\\_infosheet\\_v8.pdf](http://water.usgs.gov/ogw/gwrp/brackishgw/files/brackish_infosheet_v8.pdf)

repayment contracts, at either reserve or transferred works<sup>3</sup>. As such, we define high priority activities best suited for AWT strategies as those that do one or more of the following:

- Better utilize an existing Reclamation reservoir supply in so far as poor water quality at a Reclamation reservoir may impact the availability of water for supply purposes.
- Increase the supply of a Reclamation reservoir through direct augmentation using an external supply source such as highly treated wastewater effluent.
- Prolong the existing supply of a Reclamation reservoir by reducing demands on the reservoir, perhaps through expanding or developing non-traditional supplies from an outside source such as impaired groundwater or surface water.

We also sought to identify other key authorities, programs, commitments, etc. that could be considered mission critical because they encumber the agency budget to some level of significance or otherwise are required by Federal law. We identified the following as high priority areas that should be addressed for any effort seeking to identify AWT solutions:

- Endangered Species Act
- Interstate Compact
- Tribes/Tribal Settlements
- Other special authorizations, such as Rural Water Projects
- Regulatory Issues

Finally, it is worth noting that the deployment of AWT solutions to address mission-critical needs also may help Reclamation meet its Government Performance and Results Act (GPRA) goals, either directly or indirectly. These goals are provided in Appendix A.

---

<sup>3</sup> A “reserved work” is an asset that is owned, operated, and maintained by Reclamation; a “transferred work” can be an asset that is owned by Reclamation, but which is operated and maintained by a third party under contract with Reclamation; other definitions apply (FAC TRMR-90)

### **Task 3: Research and Development Engagement and Road Mapping Efforts**

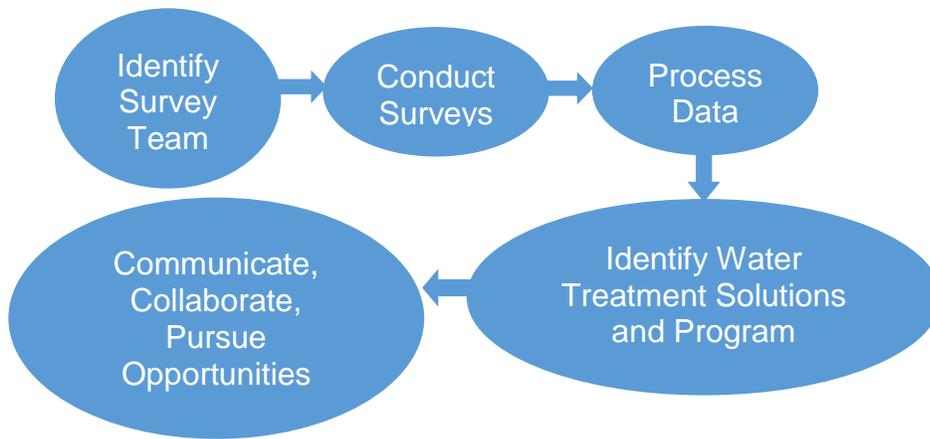
In an effort to align research investments with science gaps and needs, Reclamation's Research and Development Office (R&D) has been and is still in the process of undertaking road mapping efforts in core mission areas including, (1) Sustainable water infrastructure and safety, including needs for dam, canal, and pumping plant infrastructure research<sup>4</sup>; (2) Renewable energy and energy conservation; (3) Invasive mussels; (4) Open water data; (5) Ground and surface water interaction; and (6) Environmental stewardship; and (7) AWT. Road mapping for AWT activities is focused on developing an update to the 2008 NAS Report previously cited. We found that the structure and process of road mapping across core areas varies, but in general, road mapping is comprised of various levels of engagement in terms of reaching out to regions and offices, performing interviews, soliciting needs, and hosting workshops. Beyond these specific efforts, the R&D Office is in the process of developing a formalized approach to establish broader research needs on a quadrennial basis by engaging the Reclamation Leadership Team. Whatever the result may be, we hope that the structure and process laid out in this effort may be useful and at best, provide a template that future mapping efforts may follow.

### **Task 4: Survey Approach**

The research strategy stated previously included development of a survey-based approach to gather information on water quantity and quality challenges associated with Reclamation projects so we can better inform future investments under programs such as Title XVI and R&D that address core, mission-related needs involving the treatment of impaired water sources. The survey was designed under the perspective of being conducted by the regional Title XVI coordinator, who has responsibility (among other things) to help facilitate and match regional needs with program opportunities, although anyone may conduct the survey. This effort does not focus on planning and implementation programs managed by the Policy and Administration office beyond Title XVI research activities and feasibility studies. The intent here is to identify program opportunities that can utilize Reclamation expertise to advance the research and science associated with water treatment needs, which could contribute to more grants being pursued as cooperative agreements that employ Reclamation expertise; the intent is not to facilitate the pass through of Reclamation grants through financial assistance agreements, although this may certainly be an opportunity well worth pursuing should an applicant wish to do so. The general approach to conducting surveys is illustrated below and detailed in the narrative below:

---

<sup>4</sup> The Infrastructure Road Map can be found here: <http://www.usbr.gov/research/projects/detail.cfm?id=151>. Other road maps are in draft form and not yet posted on Reclamation's website.



### Step 1: Identify Survey Team

The survey team could be comprised of the following members, although this may be adjusted as needed depending on resource availability, knowledge expertise, etc..

- Regional Title XVI coordinator
- Reclamation’s AWT Research Coordinator
- At least one subject matter water treatment expert from TSC.
- Regional S&T coordinator

### Step 2: Conduct Surveys

Utilize survey template provided under Task 5 below. We recommend starting with the perspective of regional office supervisors/managers because these individuals likely have direct knowledge of issues or have contacts with knowledgeable staff, including regional water quality issues. Next, utilizing the information gathered from regional managers as a foundation, the next step is to interview/survey area and field offices. The survey framework developed here considers scenarios where (1) the regional or area office staff may either have direct knowledge of water quality related challenges or (2) the water quality challenges may not be apparent or may not exist altogether. The survey we developed intends to solicit information in either scenario. Another important consideration regarding projects/assets is narrowing down your focus on mission-critical needs; for instance, the GP Region alone covers a vast geographic area containing nearly 100 dams and reservoirs associated with dozens of projects spread across six area offices. It is infeasible to inventory the water quality related challenges of each and every reservoir. To the extent that impacts exist may exist at multiple projects, it may be important to narrow down the needs into those related to a few key “flagship” projects that serve as surrogates to the broader needs shared by other areas.

- *Survey Regional Office*
  - Understand the organizational structure of the regional office, and identify and contact division chiefs or other senior regional office personnel considered the most knowledgeable in regional issues/needs, preferably supervisors, branch chiefs, and/or program managers.
  - Transmit survey in advance, set up meetings and/or conference calls, conduct interview, and document responses.

- *Survey Area Office*
  - Understand the organizational structure of the area office, and identify and contact either the deputy area manager, division chiefs or other senior area office personnel considered the most knowledgeable in regional issues/needs.
  - Transmit the survey in advance, set up meetings and/or conference calls, conduct interview/survey, and document responses.

### **Step 3: Process Data**

- Compile data into the “Mission Critical Water Quality Challenges (MCWQ) Database” (See Task 6 below and Appendices A-D).
- Transmit data to the survey recipient for quality assurance/quality control (QA/QC) to ensure that survey results were captured accurately.

### **Step 4: Identify Water Treatment Solutions and Program Opportunities**

- The MCWQ Database includes a “one stop shop” of eight commonly employed water treatment technologies/applications that may be used to address various categories of impaired water sources such as TDS, biological, organics, inorganics, disinfection byproducts, radionuclides, turbidity, and emerging contaminants.
- The MCWQ Database also includes an executive summary of program opportunities, including eligibility criteria, cost share, points of contact, etc. related to water treatment. Programs are divided into research, planning, and implementation.
- The survey team matches needs with opportunities.
- The MCWQ Database also includes a list of Reclamation’s GPRA goals that could be matched with opportunities, as applicable.

### **Step 5: Collaborate, Communicate, and Pursue Opportunities**

- If pursuing funding under the S&T Program, contact the regional S&T coordinator. Build a team that is comprised of (1) Reclamation regional/area office, as well as subject matter experts and (2) external parties including Federal, state, local, academic, and/or private entities. Also, identify technical sufficiency review team which is required for investigations carried out under the S&T program.
- If pursuing a Reclamation grant, then communicate grant opportunities to potential external applicants and help facilitate, within allowable means, the transfer of knowledge regarding how program opportunities can help address mission-critical AWT needs.

## **Task 5: Survey Template**

As previously described, the survey encompasses questions are designed to identify water quality challenges and treatment opportunities associated with mission-critical needs *that exist and are known by the interviewee*. Additional questions are designed to mission-critical needs *that may or may not exist and are not known by the interviewee*.

- 
1. To what extent have water quality issues or impaired water sources directly affected water deliveries or operations in your region or area? What are the sources of impairment? What steps have been taken to resolve these issues? What barriers remain?
  2. To what extent have water quality issues affected existing water supplies that serve as alternative supplies to a recipient/contractor of Reclamation project water? What are the sources of impairment? What steps have been taken to resolve these issues? What barriers remain?
  3. To what extent has consideration been given by a recipient/contractor of Reclamation project water towards developing new water supplies? Do these potential sources have water quality impairments? For example, are you aware of any activities or consideration being given to storm water treatment and/or recharge, water reuse, brackish desalination, or treatment of any impaired ground or surface waters for beneficial use?
  4. Are you aware of any water resources planning efforts/documents, either prepared by Reclamation, a contractor, state/local entities, etc. that identify existing and future water supply needs and strategies? What about West Wide Climate Risk Assessments or Basin Studies? Where can these be found?
  5. What do you consider to be the high priority projects or activities for your region or area? We are looking for a minimum of three projects. For example, what projects in your region or area receive the most attention in terms of having the most budgetary impact or are politically sensitive? Why?
    - a. What are the project's primary authorized purposes and beneficial uses?
    - b. Who do you have contracts with and who are the primary users (i.e., agriculture, municipal, rural, tribal, commercial, industrial, power, environmental)?
    - c. What are the primary challenges associated with this project (i.e., O&M/aging infrastructure, limited supplies/competing uses, etc.)
    - d. Do water supply imbalances exist or are projected to exist? To what extent? If so, what steps have been taken to address imbalances?
    - e. Do upstream discharges from wastewater treatment plants, agricultural, or industrial/commercial operations exist upstream from the project?

6. To what extent have water quality issues affected your obligations associated with compacts, treaties, and water rights issues in your region or area involved in?
7. To what extent have water quality issues affected any activities related to tribal settlements or negotiations?
8. To what extent have water quality issues affected any other special authorizations that are considered high priority (i.e., Rural Water Projects)?
9. To what extent have water quality issues affected federally threatened and endangered species or Reclamation's obligations associated with the ESA?

## Task 6: Database

A MCWQ Database in Microsoft Excel was developed to compile survey data and help match mission-critical needs with AWT program opportunities. The tabs of the Excel file are provided as Appendices A-D. Appendix A includes the main table of fields to be filled out for the survey. Appendix B includes a list a "one stop shop" of eight commonly employed water treatment technologies/applications that may be used to address various categories of impaired water sources such as TDS, biological, organics, inorganics, disinfection byproducts, radionuclides, turbidity, and emerging contaminants. The MCWQ Database also includes an executive summary of program opportunities, including eligibility criteria, cost share, points of contact, etc. related to water treatment (Appendix C). Programs are divided into research, planning, and implementation. Finally, the MCWQ Database includes a list of Reclamation's current regional Title XVI and S&T coordinators (Appendix D).

## Task 7: Email Template

We recommend sending an email in advance of the telephone survey that describes why the survey is being conducted and the potential benefits to Reclamation. Below is a potential email template:

---

*I would like to set up a conference call with you to discuss mission-critical needs in your region/area that may be addressed through the treatment of impaired water supply sources for beneficial use. Results will help raise awareness of mission-critical needs while guiding future investments under Reclamation's Title XVI and Research & Development Programs. Such investments include deploying Reclamation's TSC and funding targeted projects that result in faster, cheaper, or better ways of accomplishing Reclamation's mission, including the implementation of adaptive strategies that prolong Reclamation's water supplies or offset demands on Reclamation supplies through expansion or development of new supplies. At the same time, this will improve Reclamation's resiliency to drought and climate change, while also helping address broader research needs shared by the nation as a whole. Attached is a short list of questions I would like to discuss with you on a conference call. I will be accompanied by at least one subject matter water treatment expert from TSC. I would encourage you to invite whomever you*

*need on your end that can help with the discussion. We greatly appreciate your time and assistance.*

---

## **Task 8: AWT Expertise**

Reclamation's Water Treatment Group within the TSC employs several individuals with expertise in various forms of water treatment that can provide assistance in conducting the survey and identifying potential opportunities. Below is a list of current staff within the Water Treatment Group.

### **Water Treatment Group – 86-68190**

<b><u>Name</u></b>	<b><u>Email</u></b>	<b><u>Phone</u></b>
Scott Irvine (Manager)	<a href="mailto:sirvine@usbr.gov">sirvine@usbr.gov</a>	303-445-2253
Erika Focht (Secretary)	<a href="mailto:efocht@usbr.gov">efocht@usbr.gov</a>	303-445-2206
Miguel Arias-Paic	<a href="mailto:mariaspaic@usbr.gov">mariaspaic@usbr.gov</a>	303-445-2132
Saied Delagah	<a href="mailto:sdelagah@usbr.gov">sdelagah@usbr.gov</a>	303-445-2248
Steve Dundorf	<a href="mailto:sdundorf@usbr.gov">sdundorf@usbr.gov</a>	303-445-2263
Leah Flint	<a href="mailto:lflint@usbr.gov">lflint@usbr.gov</a>	303-445-3902
Dan Gonzales	<a href="mailto:dgonzales@usbr.gov">dgonzales@usbr.gov</a>	303-445-2250
Katie Guerra	<a href="mailto:kguerra@usbr.gov">kguerra@usbr.gov</a>	303-445-2013
Rick Huggins	<a href="mailto:rhuggins@usbr.gov">rhuggins@usbr.gov</a>	303-445-2252
Bob Jurenka	<a href="mailto:rjurenka@usbr.gov">rjurenka@usbr.gov</a>	303-445-2254
Anthony Kennedy	<a href="mailto:akennedy@usbr.gov">akennedy@usbr.gov</a>	303-445-3230
Julie Korak	<a href="mailto:jkorak@usbr.gov">jkorak@usbr.gov</a>	303-445-2264
Mike Kramer	<a href="mailto:mkramer@usbr.gov">mkramer@usbr.gov</a>	303-445-2946
Frank Leitz	<a href="mailto:fleitz@usbr.gov">fleitz@usbr.gov</a>	303-445-2255
Andrew Tiffenbach	<a href="mailto:atiffenbach@usbr.gov">atiffenbach@usbr.gov</a>	303-445-2393
Chris Weachter	<a href="mailto:cwaechter@usbr.gov">cwaechter@usbr.gov</a>	303-445-3893

## **Task 9: Case Study**

A case study survey was performed on the Oklahoma-Texas Area Office (OTAO) to identify mission-critical needs that could be addressed by AWT solutions. Within OTAO, we found that almost all of the 11 reservoirs under its jurisdiction have mission-critical needs that could be addressed through AWT solutions. This highlights the strategy recommended in the “Survey Approach” above that needs can be narrowed down to a few key “flagship” projects when one is seeking to limit the time invested into this effort. For OTAO, we limited the survey to three reservoirs. Appendix E displays survey results structured within the MCWQ Database.

## **Next Steps**

The S&T Program funds two types of studies: “scoping” and “conducting”. The purpose of scoping is to identify needs and opportunities that are intended to be further investigated as part of a more in depth conducting study. This product was completed as a “scoping” study using \$20,000 in FY 2016 funding under Reclamation’s S&T Program. A proposal was submitted for FY 2017 funding that included expanding the survey to all offices within the GP Region. The proposal was identified as a high priority Regional Director need and awarded \$65,000 under the S&T program. As such, next steps include completing the tasks set forth in the FY 2017 S&T proposal as follows:

**Task 1:** Review findings/report of FY 2016 scoping effort including (1) documents that identify state and/or national AWT-related priorities; and other AWT-related needs documents such as NEWAS; (2) survey form and (3) database.

**Task 2:** Coordinate with area and field offices in GP, as well as regional office in Billings; conduct surveys through video conferencing.

**Task 3:** Compile data into database (excel-based)

**Task 4:** Interpret data and prepare draft report; the information will be organized by project and area office and identify any impaired water supply issues that may be unique to specific projects as well as those common across multiple projects/offices. We also will identify programmatic opportunities (i.e., R&D, Title XVI, etc.) that involve using technical expertise at TSC and grant funding.

**Task 5:** Submit draft report to area offices, regional office, TSC, and research office. Follow-up with area offices to ensure data was properly processed and to ensure they understand and can take advantage of future opportunities.

**Task 6:** Address comments and finalize report. Distribute report to offices.

# References

- Bureau of Reclamation. 2012. Colorado River Basin Water Supply and Demand Study, Executive Summary.
- Bureau of Reclamation. 2015. West-Wide Climate Risk Assessments: Irrigation Demand and Reservoir Evaporation Projections. Technical Memorandum No. 86-68210-2014-01.
- Bureau of Reclamation. 2016. SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water 2016. U.S. Department of the Interior.
- California Department of Water Resources. 2014. California Water Plan Update 2013. Sacramento, California.
- Colorado Conservation Board. 2012. Colorado River Water Availability Study.
- National Research Council. 2008. Desalination, A National Perspective. National Academy of Sciences. National Academies Press, Washington D.C.
- Texas Water Development Board. 2016. Water For Texas: 2017 State Water Plan. Austin, TX.
- United States White House. 2015. Water Resource Challenges and Opportunities for Water Technology Innovation. Washington D.C.
- United States Government Accountability Office. 2016. Municipal Water Scarcity: Using technology to improve distribution system efficiency and tap non-traditional water sources. Washington, D.C.: United States Government Accountability Office.
- Woodhouse, C.A. and Brown, P.M. 2001. Tree-Ring Evidence for Great Plains Drought. Tree Ring Research, Vol. 57(1), 89-103.

# Appendices

## Appendix A. Mission-Critical Water Quality Database

				Area Office		
				Project 1	Project 2	Project 3
Purpose & Need		Project Purpose/Benefits				
		Project Contractor(s)				
		Project Water Recipient(s)				
		Impaired Water Supply Sources	Direct, Project Supplies			
			Indirect, Alternative Supplies			
		Water Quality Parameter(s) of Concern	Direct, Project Supplies			
			Indirect, Alternative Supplies			
		Current or Future Water Supply Shortages				
		Project Benefit Threat/Impact				
		ESA Compliance/Mitigation?				
		Interstate Compact Issue?				
		Tribal settlement/negotiation?				
		Special Authorization? (i.e., Rural Water)				
		Other: <b>Direct</b> impacts/needs (i.e., regulatory violations, etc)				
Other: <b>Indirect</b> impacts/needs						
Water Treatment Solutions		Conventional Water Treatment (sediment/particulate removal)				
		Membrane Filtration (i.e. Microfiltration, Ultrafiltration)				
		Biological Treatment Processes				
		Desalination/Concentrate Management Technologies				
		Other Advanced Technologies for Targeted Constituent Removal (i.e., Ion Exchange, GAC, Advanced Oxidation, etc.)				
		Water Recycling & Reuse Technologies				
		Aquifer Storage & Recovery/Artificial Recharge with Soil Aquifer Treatment				
Program Opportunities	Research	Science & Technology				
		Desalination Water Purification & Research				
		Title XVI Research				
		Prize Competitions				
		Pitch to Pilot				
	Planning	Title XVI Feasibility Studies				
GPRA Goals	Mission Area 1, Celebrating & Enhancing America's Great Outdoors	Goal 1, Protect America's Landscapes				
		Goal 2, Protect America's Cultural, Tribal, and Heritage Resources				
		Goal 3, Enhance Recreation and Visitor Experience				

				Area Office		
				Project 1	Project 2	Project 3
	<b>Mission Area 2, Strengthening Tribal Nations and Insular Communities</b>	Goal 1, Meet our Trust, Treaty, and Other Responsibilities to American Indians and Alaska Natives				
		Goal 2, Improve the Quality of Life in Tribal and Native Communities				
		Goal 3, Empower Insular Communities				
	<b>Mission Area 3, Powering Our Future &amp; Responsible Use of Resources</b>	Goal 1, Secure America's Energy Resources				
		Goal 2, Sustainably Manage, Timber, Forage, and Non-Energy Minerals				
	<b>Mission Area 4, Engaging the Next Generation</b>	Goal 1, Create New, Systemic Opportunities for Outdoor Play				
		Goal 2, Provide Educational Opportunities				
		Goal 3, Provide Volunteers on Public Lands				
		Goal 4, Develop the Next Generation of Lifelong Conservation Stewards and Ensure our own Skilled and Diverse Workforce Pipeline				
	<b>Mission Area 5, Ensuring Healthy Watersheds &amp; Sustainable, Secure Water Supplies</b>	Goal 1, Manage Water & Watersheds for the 21st Century				
		Goal 2, Extend Water Supplies Through Conservation				
		Goal 3, Availability of Water to Tribal Communities				
	<b>Mission Area 6, Building a Landscape Level Understanding of our Resources</b>	Goal 1, Provide Shared Landscape Level Management & Planning Tools				
		Goal 2, Provide Science to Understand, Model and Predict Ecosystem, Climate and Land Use				
		Goal 3, Provide Scientific Data to Protect, Instruct, and Inform Communities				
		Goal 4, Provide Water and Land Data to Customers				

Appendix B. Categories of treatment solutions that may be used to address different categories of water quality concerns.

Treatment Solution*	Water Quality Concern							
	Disinfection Byproducts	Inorganics	Radionuclides	Organics	Biological	TDS	Turbidity/TSS	Contaminants of Emerging Concern (e.g., Pharmaceuticals, personal care products, flame retardants)
Conventional Water Treatment (sediment/particulate removal)	x	x			x		x	
Membrane Filtration (i.e. Microfiltration, Ultrafiltration)	x				x		x	x
Biological Treatment Processes		x					x	x
Desalination/Concentrate Management Technologies	x	x		x		x		x
Other Advanced Technologies for Targeted Constituent Removal (i.e., Ion Exchange, GAC, Advanced Oxidation, etc.)	x	x	x	x	x			x
Alternative Disinfection Strategy	x	x		x	x			x
Water Recycling & Reuse Technologies	x			x	x	x	x	x
Aquifer Storage & Recovery/Artificial Recharge with Soil Aquifer Treatment		x		x			x	

Appendix C. Reclamation programs

Phase	Reclamation Program	Program Office	Program Lead	Brief Description	Program Webpage	Eligible Applicants	Minimum Non-Federal Cost Share	Maximum Federal Funding	Typical Duration	Other Requirements
Planning	Water Conservation Field Services	Regional Offices	Josh German, P&A Designated WCFS Regional Coordinator	Studies that evaluate water conservation, options to better manage or more efficiently utilize water and energy, optimizing use, designing water management improvements, and demonstration of water conservation technologies. Education may be eligible pending Policy decision.	<a href="http://www.usbr.gov/waterconservation/">http://www.usbr.gov/waterconservation/</a>	Varies based on Regional Office priorities; Preference can be given to entities that have a contract with Reclamation; States, Indian Tribes, Irrigation Districts, Water Districts, or other organizations with water or power delivery authority located in the Reclamation states or Hawaii	50%	Typically < \$100,000	12 to 24 months	
	Title XVI Feasibility Studies	Policy & Administration	Katharine Dahm, P&A	Studies that evaluate the market, use, costs, and economics of desalination, water reuse, or any project that treats impaired water sources for beneficial use.	<a href="http://www.usbr.gov/watersmart/title/index.html">http://www.usbr.gov/watersmart/title/index.html</a>	States, Indian Tribes, Irrigation Districts, Water Districts, or other organizations with water or power delivery authority located in the Reclamation states or Hawaii	50%	\$150,000	18 months	
	Drought Contingency Planning	Policy & Administration	Darion Mayhorn, P&A	Planning activities that improve drought resiliency by evaluating drought monitoring, vulnerabilities, mitigation actions, and response actions. Funding can be for a new plan or an update of an existing plan.	<a href="http://www.usbr.gov/drought/">http://www.usbr.gov/drought/</a>	States, Indian Tribes, Irrigation Districts, Water Districts, or other organizations with water or power delivery authority located in the Reclamation states or Hawaii	50%	\$200,000	24 months	
	Basin Studies	Policy & Administration	Amanda Erath, P&A	Collaborative studies that address issues on a basin-wide scale; evaluate long-term supplies, demands, vulnerabilities (including climate change) and the reliability of infrastructure and operations to meet challenges; identifies and evaluates appropriate strategies to adapt and mitigate; Federal funding is typically used to support Reclamation staff and our contractors.	<a href="http://www.usbr.gov/watersmart/bsp/index.html">http://www.usbr.gov/watersmart/bsp/index.html</a>	States, Indian Tribes, Irrigation Districts, Water Districts, or other organizations with water or power delivery authority located in the Reclamation states or Hawaii	50%	No Maximum	36 months	
	Cooperative Watershed Management	Policy & Administration	Avra Morgan, P&A	Development of locally led watershed groups and encouragement of diverse stakeholders to form local solutions to water management needs; promotes the sustainable use of water resources and improved water conservation, water quality, and ecological resilience.	<a href="http://www.usbr.gov/watersmart/cwmp/index.html">http://www.usbr.gov/watersmart/cwmp/index.html</a>	States, Tribes, local governments, non-profit organizations, and other entities capable of supporting the sustainable use of water resources within the watershed.	None	\$100,000	24 months	

Phase	Reclamation Program	Program Office	Program Lead	Brief Description	Program Webpage	Eligible Applicants	Minimum Non-Federal Cost Share	Maximum Federal Funding	Typical Duration	Other Requirements
Construction and Implementation	Water & Energy Efficiency Grants	Policy & Administration	Josh German, P&A	Projects that conserve water or use water more efficiently, improve water management, increase the use of renewable energy, protect endangered species, and/or facilitate water markets.	<a href="http://www.usbr.gov/watersmart/weeg/index.html">http://www.usbr.gov/watersmart/weeg/index.html</a>	States, Indian Tribes, Irrigation Districts, Water Districts, or other organizations with water or power delivery authority located in the Reclamation states	50%	Group 1: \$100,000 Group 2: \$300,000 Group 3: \$1,000,000	Group 1: 24 months Group 2: 36 months	
	Drought Resiliency Grants	Policy & Administration	Darion Mayhorn, P&A	Projects or tools that help communities monitor, prepare for, and respond to drought. Additional priority placed on projects that are identified under an existing drought contingency plan.	<a href="http://www.usbr.gov/drought/">http://www.usbr.gov/drought/</a>	States, Indian Tribes, Irrigation Districts, Water Districts, or other organizations with water or power delivery authority located in the Reclamation states or Hawaii	50%	\$300,000	24 months	
Research	Science & Technology	Research & Development	John Whitler, R&D	Funds internal research led or conducted by Reclamation staff directed at the highest priority problems identified by Reclamation's Regions and Projects	<a href="http://www.usbr.gov/research/programs/science-technology/index.html">http://www.usbr.gov/research/programs/science-technology/index.html</a>	Reclamation staff are typically Principal Investigators and submit applications for funding; activities usually conducted in partnership with area and regional office and often involve outside entities including state or local governments, academia, and the private sector				
	Desalination Water Purification & Research	Research & Development	Yuliana Porras-Mendoza, R&D	Competitive program funding external proposals targeted to Reclamation's priority needs in the area of advanced water treatment	<a href="http://www.usbr.gov/research/programs/desalination/index.html">http://www.usbr.gov/research/programs/desalination/index.html</a>	Individuals, Institutions of Higher Education, Commercial or Industrial Organizations, Federally Funded R&D Centers, Private Entities, Public Entities (State and Local), Non-Profit Organizations, Indian Tribal Governments	Lab: 50% Pilot: 50% Demonstration: 50%	Lab: \$150,000 Pilot: \$400,000 Demonstration: \$1,500,000	Lab: 13 months Pilot: 25 months Demonstration: 37 months	Institutions of Higher Education exempt from cost share requirements for lab scale projects
	Title XVI Research	Policy & Administration	Katharine Dahm, P&A	This program helps communities address water supply challenges by providing much-needed funding for research to establish or expand water reuse markets, improve or expand existing water reuse facilities, and streamline the implementation of clean water technology at new facilities.	<a href="http://www.usbr.gov/watersmart/title/index.html">http://www.usbr.gov/watersmart/title/index.html</a>	State, Regional, or Local Authorities, Indian Tribes or Tribal Organizations, Other Entities such as Water and Wastewater Districts or Rural Water Districts - Applicants must be located in the Western US as identified in the Reclamation Act of 1902	75%	Group 1: \$75,000 Group 2: \$150,000 Group 3: \$300,000	Group 1: 18 months Group 2: 24 months Group 3: 36 months	

Phase	Reclamation Program	Program Office	Program Lead	Brief Description	Program Webpage	Eligible Applicants	Minimum Non-Federal Cost Share	Maximum Federal Funding	Typical Duration	Other Requirements
	Prize Competitions	Research & Development	Yuliana Porras-Mendoza, R&D	Through Reclamation's Water Prize Competition Center we are partnering with other Federal agencies, non-profit organizations, and the private sector to conduct prize competitions to harness the creative capacity of the American public and private sector to identify solutions to some of our most critical water and water-related resource problems.	<a href="http://www.usbr.gov/research/challenges/index.html">http://www.usbr.gov/research/challenges/index.html</a>	Section 24 of the American COMPETES Reauthorization Act of 2010 limits eligibility to win a prize to entities/individuals that: 1. Have agreed to the rules of the competition 2. Are either (a) in the case of an entity, incorporated in and maintain a primary place of business in the United States, or (b) in the case of an individual, a citizen or permanent resident of the United States 3. Are not a Federal entity or Federal employee acting within the scope of employment 4. Assume risks and waive claims against the Federal Government and its related entities 5. Obtain liability insurance or demonstrate financial responsibility, in amounts determined by the head of an agency, for claims by third parties and the Federal Government	Varies	Prize amounts vary by competition, but can range from \$10,000 for an idea gathering competition with whitepaper submissions to \$1,000,000 or more for grand challenges involving field demonstration of new technology or methods	N/A	Prize competition topics selected by Reclamation staff and other Federal participants based on agency needs and suitability to the prize competition framework
	Pitch to Pilot	Research & Development	Yuliana Porras-Mendoza, R&D	Reclamation is interested in new, innovative technologies and processes that have gone past the idea and bench scale phase and are ready to go into development of prototypes and pilot scale systems to be tested with real waters.	<a href="http://www.usbr.gov/research/programs/science-technology/pitch-topilot.html">http://www.usbr.gov/research/programs/science-technology/pitch-topilot.html</a>	Individuals, Institutions of Higher Education, Commercial or Industrial Organizations, Federally Funded R&D Centers, Private Entities, Public Entities (State and Local), Indian Tribal Governments	None	\$100,000	18 months	Testing at Reclamation's Brackish Groundwater National Desalination Research Facility, only pilot scale projects (typically 1-20 gpm)

## Appendix D. Coordinators

Region	Program	Coordinator	Email	Telephone
Great Plains	Title XVI	Collins Balcombe	<a href="mailto:cbalcombe@usbr.gov">cbalcombe@usbr.gov</a>	512-899-4162
	S&T	Collins Balcombe	<a href="mailto:cbalcombe@usbr.gov">cbalcombe@usbr.gov</a>	512-899-4162
Upper Colorado	Title XVI	Brandi Rose	<a href="mailto:brose@usbr.gov">brose@usbr.gov</a>	801-524-3639
	S&T	Mark McKinstry	<a href="mailto:mmckinstry@usbr.gov">mmckinstry@usbr.gov</a>	801-524-3835
Lower Colorado	Title XVI	Dennis Wolfe	<a href="mailto:dwolfe@usbr.gov">dwolfe@usbr.gov</a>	951-695-5319
	S&T	Nathanial Gee	<a href="mailto:ngee@usbr.ov">ngee@usbr.ov</a>	702-293-8029
Mid Pacific	Title XVI	Vanessa Emerzian	<a href="mailto:vemerzian@usbr.gov">vemerzian@usbr.gov</a>	916-978-5083
	S&T	Jobaid Kabir	<a href="mailto:jkabir@usbr.gov">jkabir@usbr.gov</a>	916-978-5091
Pacific Northwest	Title XVI	Alan Monek (Acting)	<a href="mailto:amonek@usbr.gov">amonek@usbr.gov</a>	208-678-0461
	S&T	Jennifer Johnson	<a href="mailto:jmjohnson@usbr.gov">jmjohnson@usbr.gov</a>	208-378-5225

Appendix E. Survey results for a case study on the Oklahoma-Texas Area Office.

				Oklahoma-Texas Area Office		
				Choke Canyon Reservoir Nueces River Project	Foss Reservoir Washita Project	Lake Thunderbird Norman Project
Purpose & Need		Project Purpose/Benefits		M&I, Fish & Wildlife, Recreation	M&I, Fish & Wildlife, Recreation, Flood Control	M&I, Fish & Wildlife, Recreation, Flood Control
		Project Contractor(s)		Corpus Christi, Nueces River Authority	Foss Reservoir Master Conservancy District	Central Oklahoma Master Conservancy District
		Project Water Recipient(s)		Dozens of M&I subcontractors along the Gulf of Mexico	Clinton, New Cordell, Hobart, Bessie, Washita NWR	Norman, Midwest City, Del City
		Impaired Water Supply Sources	Direct, Project Supplies	None	Reservoir	Reservoir; Groundwater
			Indirect, Alternative Supplies	Seawater, Brackish Surface Water, Brackish Groundwater, WWTP Effluent	Brackish Groundwater, WWTP Effluent; Produced Water from Oil & Gas	WWTP Effluent
		Water Quality Parameter(s) of Concern	Direct, Project Supplies	None	Total Dissolved Solids	Arsenic, Hexavalent Chromium; CECs; Dissolved Oxygen, Nutrients
			Indirect, Alternative Supplies	Total Dissolved Solids	Total Dissolved Solids; Organics; Inorganics; Radionuclides	Total Dissolved Solids; CECs; Biological
		Current or Future Water Supply Shortages		Future	Future	Current
		Project Benefit Threat/Impact		M&I Water Supply	M&I Water Supply; Fish & Wildlife	M&I Water Supply
		ESA Compliance/Mitigation?		No	No	No
		Interstate Compact Issue?		No	No	No
		Tribal settlement/negotiation?		No	No	No
		Special Authorization? (i.e., Rural Water)		No	No	No
		Other: <b>Direct</b> impacts/needs (i.e., regulatory violations, etc)		N/A	Concentrate discharge violations (i.e., Whole Effluent Toxicity) from ODEQ; Washita NWR water supply	TMDL 2013, 303d Impairment for DO, Chlorophyll-a, turbidity
	Other: <b>Indirect</b> impacts/needs		Bays & Estuaries Water Quality; T&E species in the Gulf of Mexico	N/A	N/A	
Water Treatment Solutions		Conventional Water Treatment (sediment/particulate removal)		x	x	x
		Membrane Filtration (i.e. Microfiltration, Ultrafiltration)		x	x	x
		Biological Treatment Processes				x
		Desalination/Concentrate Management Technologies		x	x	x
		Other Advanced Technologies for Targeted Constituent Removal (i.e., Ion Exchange, GAC, Advanced Oxidation, etc.)				x
		Water Recycling & Reuse Technologies		x	x	x

				Oklahoma-Texas Area Office		
Program Opportunities	Research	Aquifer Storage & Recovery/Artificial Recharge with Soil Aquifer Treatment		x		
		Science & Technology		x	x	x
		Desalination Water Purification & Research		x	x	x
		Title XVI Research		x	x	x
		Prize Competitions		x	x	x
		Pitch to Pilot		x	x	x
Planning		Title XVI Feasibility Studies		x	x	x
GPRA Goals	Mission Area 1, Celebrating & Enhancing America's Great Outdoors	Goal 1, Protect America's Landscapes				
		Goal 2, Protect America's Cultural, Tribal, and Heritage Resources		x	x	x
		Goal 3, Enhance Recreation and Visitor Experience				
	Mission Area 2, Strengthening Tribal Nations and Insular Communities	Goal 1, Meet our Trust, Treaty, and Other Responsibilities to American Indians and Alaska Natives				
		Goal 2, Improve the Quality of Life in Tribal and Native Communities				
		Goal 3, Empower Insular Communities				
	Mission Area 3, Powering Our Future & Responsible Use of Resources	Goal 1, Secure America's Energy Resources				
		Goal 2, Sustainably Manage, Timber, Forage, and Non-Energy Minerals				
	Mission Area 4, Engaging the Next Generation	Goal 1, Create New, Systemic Opportunities for Outdoor Play				
		Goal 2, Provide Educational Opportunities				
		Goal 3, Provide Volunteers on Public Lands				
		Goal 4, Develop the Next Generation of Lifelong Conservation Stewards and Ensure our own Skilled and Diverse Workforce Pipeline				
	Mission Area 5, Ensuring Healthy Watersheds & Sustainable, Secure Water Supplies	Goal 1, Manager Water & Watersheds for the 21st Century				
		Goal 2, Extend Water Supplies Through Conservation		x	x	x
		Goal 3, Availability of Water to Tribal Communities				
	Mission Area 6, Building a Landscape Level Understanding of our Resources	Goal 1, Provide Shared Landscape Level Management & Planning Tools				
		Goal 2, Provide Science to Understand, Model and Predict Ecosystem, Climate and Land Use				
		Goal 3, Provide Scientific Data to Protect, Instruct, and Inform Communities				
		Goal 4, Provide Water and Land Data to Customers				

