AGENDA

SOUTHERN NEVADA WATER AUTHORITY

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS

REGULAR MEETING
9:00 A.M. – DECEMBER 10, 2014

BOARD CHAMBERS, SOUTHERN NEVADA WATER AUTHORITY
100 CITY PARKWAY, SEVENTH FLOOR, LAS VEGAS, NEVADA
(702) 258-3100

Board of Directors
Mary Beth Scow, Chair
Sam Bateman, Vice Chair
Susan Brager
Bob Coffin
Duncan McCoy
Steve Sisolak
Anita Wood

John J. Entsminger, General Manager

Date Posted: 12/04/14

The Southern Nevada Water Authority makes reasonable efforts to assist and accommodate persons with physical disabilities who desire to attend the meeting. For assistance, call Mitch Bishop at (702) 870-2011 at least 24 hours prior to the meeting.

THIS MEETING HAS BEEN PROPERLY NOTICED AND POSTED IN THE FOLLOWING LOCATIONS:

City of Boulder City, City Hall
401 California Street
Boulder City, Nevada

City of Henderson, City Hall
240 Water Street
Henderson, Nevada

City of North Las Vegas, City Hall
2250 Las Vegas Boulevard North
North Las Vegas, Nevada

City of Las Vegas, City Hall
495 South Main Street
Las Vegas, Nevada

Clark County Government Center
500 S. Grand Central Parkway
Las Vegas, Nevada

Clark County Water Reclamation District
5857 E. Flamingo Road
Las Vegas, Nevada

Southern Nevada Water Authority
100 City Parkway, Suite 700
Las Vegas, Nevada

Las Vegas Valley Water District
1001 S. Valley View Boulevard
Las Vegas, Nevada

All items on the agenda are for action by the Board of Directors, unless otherwise indicated. Items may be taken out of order. The board may combine two or more agenda items for consideration, and the board may remove an item from the agenda or delay discussions relating to an agenda item at any time.

CALL TO ORDER

COMMENTS BY THE GENERAL PUBLIC

NO ACTION MAY BE TAKEN: This is a period devoted to comments by the general public pertaining to items on this agenda. If you wish to speak to the Board about items within its jurisdiction, but not appearing on this agenda, you must wait until the "Comments by the General Public" period listed at the end of this agenda. Please limit your comments to three minutes or less and refrain from making comments that are repetitious, offensive, or amounting to personal attacks. No action may be taken upon a matter not listed on the posted agenda.

ITEM NO.

1. *For Possible Action:* Approve agenda with the inclusion of tabled and/or reconsidered items, emergency items and/or deletion of items, and approve the minutes of the regular meeting of September 18, 2014.

BUSINESS AGENDA

2. *For Possible Action:* Conduct a Public Hearing to consider and adopt the recommendations from the Integrated Resource Planning Advisory Committee, including the adoption of a drought protection charge, or take other action as appropriate.

3. *For Possible Action:* Approve and authorize the General Manager to execute, in substantially the same form, a Memorandum of Understanding among the United States, acting through the Bureau of Reclamation, Central Arizona Water Conservation District, Metropolitan Water District of Southern California, Arizona Department of Water Resources, Colorado River Board of California, Colorado River Commission of Nevada and the Authority for Pilot Drought Response Actions.

4. *For Possible Action:* Approve and authorize the General Manager to sign an agreement between Carollo Engineers, Inc., and the Authority for the "Blending Requirements for Water from Direct Potable Reuse Treatment Facilities" study, and accept funds for this research work.

5. *For Possible Action:* Approve and authorize the General Manager to sign an agreement between the Water Research Foundation and the Authority for the "Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration" study, authorize the Authority to contribute in cost-share services as its co-participant portion, and accept funds.

6. *For Possible Action:* Approve and authorize the General Manager to sign an agreement between Hazen and Sawyer, P.C., and the Authority for the "GAC Control of Regulated and Emerging Disinfection Byproducts of Health Concern" study, and accept funds for this research work.

7. *For Possible Action*: Approve and authorize the General Manager to sign a cooperative agreement between the Nevada Division of Forestry and the Authority to conduct inmate conservation camp work detail services for the period from December 10, 2014, through November 30, 2016.

8. *For Possible Action:* Approve and authorize the General Manager to sign a funding contribution agreement between the Nevada Division of Water Resources and the Authority for surface and groundwater data collection services within Nevada to be performed by the U.S. Geological Survey.

9. *For Possible Action:* Approve and authorize the General Manager to sign an agreement between Spring Valley Associates, LLC, and the Authority for professional staffing services for the Authority's Northern Resources properties, annually for a three year term, with an option to extend for another three year term.

10. *For Possible Action:* Approve and authorize the General Manager to sign an agreement between Quantum Spatial, Inc., and the Authority for digital aerial imagery services for the period ending on December 31, 2015.

11. *For Possible Action:* Approve an agreement, in substantially the same form, retaining Marsh Risk and Insurance Services, the Authority's current insurance broker, and approve an extension of the Builders Risk Insurance and Terrorism Insurance on the Lake Mead Intake No. 3 Project.

12. *For Possible Action:* Adopt the 2009 Water Resource Plan for the 2015 calendar year.

13. *For Possible Action:* Adopt the 2013 Water Budget for the 2015 calendar year.

14. *For Possible Action:* Adopt the Annual Operating Plan for the Southern Nevada Water System.

15. *For Possible Action:* Accept the Authority's Comprehensive Annual Financial Report for the period ending June 30, 2014, as presented by the Authority's external auditors, Piercy Bowler Taylor & Kern, and authorize its submission to the Nevada Department of Taxation.

16. *For Information Only:* Receive an update from staff on water resources including, but not limited to, drought conditions in the Colorado River Basin, the results of the implementation of the Authority's Water Resource and Conservation Plans, activities on the Colorado River, the development of in-state water resources, and the status of the third intake project.

COMMENTS BY THE GENERAL PUBLIC

NO ACTION MAY BE TAKEN: At this time, the Board of Directors will hear general comments from the public on matters under the jurisdiction of the Southern Nevada Water Authority. Please limit your comments to three minutes or less and refrain from making comments that are repetitious, offensive, or amounting to personal attacks. No action may be taken upon a matter not listed on the posted agenda.

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
REGULAR MEETING
SEPTEMBER 18, 2014
MINUTES

CALL TO ORDER	9:03 a.m., SNWA Board Chambers, Southern Nevada Water Authority 100 City Parkway, Seventh Floor, Las Vegas, Nevada
BOARD MEMBERS PRESENT	Mary Beth Scow, Chair Sam Bateman, Vice Chair Susan Brager Bob Coffin Duncan McCoy (by telephone) Steve Sisolak Anita Wood
BOARD MEMBERS ABSENT	
STAFF PRESENT	John Entsminger, Phil Speight, Julie Wilcox, Dave Johnson, Greg Walch, Dave Wright
OTHERS PRESENT	Kathy Ong, Brian Thomas

Unless otherwise indicated, all members present voted in the affirmative.

COMMENTS BY THE GENERAL PUBLIC
For complete comments, audio is available online at snwa.com

There were no persons wishing to speak.

1. *For Possible Action:* Approval of Agenda & Minutes

Staff requested that item five be moved up in the agenda to accommodate Director McCoy, who participated in the meeting by telephone.

FINAL ACTION: A motion was made by Director Brager to approve the agenda for this meeting with item five being heard at the beginning of the agenda, and to approve the meeting minutes of July 17, 2014. The motion was approved.

5. *For Possible Action:* Adopt a resolution approving the issuance of Las Vegas Valley Water District refunding bonds in the maximum principal amount of $317,185,000 to refinance certain outstanding bonds for the Authority.

Dave Wright, Chief Financial Officer, gave an overview presentation on the resolution. A copy of his presentation is attached to these minutes. Director Coffin asked if staff had factored in the impact of possible Federal interest rate increases in the recommendation to refinance the outstanding bonds. Mr. Wright said that this resolution before the board initiated the lengthy process of refinancing the bonds, and that the process could be halted should interest rates become unfavorable.

Director Sisolak asked if the savings represented by staff included the costs of refinancing the bonds. Mr. Wright said that the cost-saving estimates were net savings, which included the costs of refinancing. Director Sisolak asked if refinancing the bonds through the Las Vegas Valley Water District would negatively impact the District's ability to secure financing for its projects or its bond rating. Mr. Wright said that the measure would not impact the District's borrowing capacity since the bonds were secured by Authority revenues.

Director Sisolak asked why the bonds were originally issued through the state and not through the District. Kathy Ong, Hobbs Ong & Associates, said that at the time the bonds were issued, the state had a better credit rating than the District so the interest rate was more favorable.

FINAL ACTION: A motion was made by Director Sisolak to follow staff's recommendation. The motion was approved.

CONSENT AGENDA **Items 2 - 4 are routine and can be taken in one motion unless a Director requests that an item be taken separately.**

2. ***For Possible Action:*** **Ratify the approval of the assistance agreement between the Bureau of Reclamation and the Authority to accept a grant in an amount not to exceed $300,000 to support the Authority's Water Smart Landscape Rebate Program, and authorize the General Manager to approve future modifications only if the future modifications do not fiscally impact the Authority.**

3. ***For Possible Action:*** **Ratify the approval of an assistance agreement between the Bureau of Reclamation and the Authority to accept a grant in an amount not to exceed $100,000 to support the Authority's Water Smart Landscape Rebate Program, and authorize the General Manager to approve future modifications only if the future modifications do not fiscally impact the Authority.**

4. ***For Possible Action:*** **Approve and authorize the General Manager to sign an interlocal agreement between the City of Las Vegas and the Authority for a landscape conversion at Angel Park Golf Course, for an amount not to exceed $300,000.**

FINAL ACTION: A motion was made by Vice Chair Bateman to follow staff's recommendations. The motion was approved.

BUSINESS AGENDA

6. ***For Possible Action:*** **Approve and authorize the General Manager to sign an agreement between Grove Madsen Industries and the Authority for the purchase and installation of Allen-Bradley medium voltage contactors to retrofit motor control centers at three pump stations for an amount not to exceed $662,088.**

FINAL ACTION: A motion was made by Director Brager to follow staff's recommendation. The motion was approved.

7. ***For Possible Action:*** **Approve and authorize the General Manager to sign a joint funding agreement between the U.S. Geological Survey and the Authority for hydrologic data collection for an amount not to exceed $232,600.**

FINAL ACTION: A motion was made by Director Brager to follow staff's recommendation. The motion was approved.

8. ***For Possible Action:*** **Approve and authorize the General Manager to sign a Water Lease Agreement between the Authority and the Virgin Valley Water District, execute any ministerial documents necessary to effectuate the transaction, and pay the associated option and lease payments for an amount not to exceed $4,000,000.**

FINAL ACTION: A motion was made by Vice Chair Bateman to follow staff's recommendation. The motion was approved.

9. ***For Possible Action:*** **Approve and authorize the General Manager to sign an agreement between the Water Research Foundation and the Authority to conduct research on bromate formation during ozone treatment, authorize the Authority to contribute $100,000 in monetary funds and $30,000 in cost-share services as its co-participant portion, and accept funds and in-kind services in a combined amount of $207,000.**

FINAL ACTION: A motion was made by Director Wood to follow staff's recommendation. The motion was approved.

10. ***For Possible Action:*** **Approve and authorize the General Manager to sign a task order between Carollo Engineers, Inc., and the Authority for the Authority's continued participation in the Texas Water Development Board study, "Testing Water Quality in a Municipal Wastewater Effluent Treated to Drinking Water Standards," and accept additional funds in the amount of $38,000.**

Director Coffin said that participating in studies that advance water treatment technologies ultimately benefits the Authority and that he supported the item.

FINAL ACTION: A motion was made by Director Brager to follow staff's recommendation. The motion was approved.

11. ***For Possible Action:*** **Authorize a membership for the Authority to include its purveyor members in the Water Research Foundation for fiscal year 2014/2015 for the subscription amount of $304,369.**

FINAL ACTION: A motion was made by Director Wood to follow staff's recommendation. The motion was approved.

12. ***For Possible Action: M*****ake appointments to fill two vacancies on the Integrated Resource Planning Advisory Committee.**

John Entsminger, General Manager, said that Brian McAnallen had left the Las Vegas Metro Chamber of Commerce, so the Chamber had recommended that Paul Moradkhan be appointed in Mr. McAnallen's stead to the Integrated Resource Planning Advisory Committee. Also, Garry Goett had desired to step down from the committee and asked that Olympia Companies' Vice President, Chris Armstrong, be appointed in his stead.

FINAL ACTION: A motion was made by Vice Chair Bateman to follow staff's recommendations. The motion was approved.

13. ***For Information Only:*** **Receive an update from staff on water resources including, but not limited to, drought conditions in the Colorado River Basin, the results of the implementation of the Authority's Water Resource and Conservation Plans, activities on the Colorado River, the development of in-state water resources, and the status of the third intake project.**

Mr. Walch gave a presentation on drought conditions, which is attached to these minutes. Director Brager asked what impact the recent rains had on the level of Lake Mead. Mr. Entsminger said that heavy rainfall in the Las Vegas Valley has a small effect on Lake Mead. Director Sisolak said that many residents think that large rainfall events signal the end of the drought, and he suggested that more be done to educate the public. Mr. Entsminger said that staff agreed and would continue to use its speaker's bureau and advertising to help convey that message. Director Coffin said that advertising should continue to focus on conservation messaging.

Director Coffin asked what effects, if any, the floods had on Lake Mead water quality. Dave Johnson, Deputy General Manager of Engineering/Operations, said that staff monitored flood inflows at the lake, and the impacts to water quality at the intake locations were negligible.

Marc Jensen, Director of Engineering, provided a brief update on Lake Mead Intake No. 3, also attached to these minutes. Director Sisolak asked how much progress the Tunnel Boring Machine made on average per day. Mr. Jensen said on average the crew advanced about 28 feet per day over the last three months.

NO ACTION NECESSARY

Public Comment
There were no persons wishing to speak.

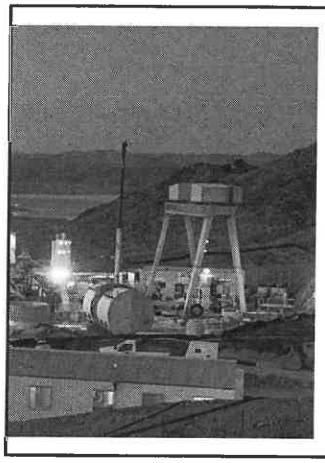
Adjournment
There being no further business to come before the board, the meeting adjourned at 9:48 a.m.

APPROVED:

Mary Beth Scow, Chair

John J. Entsminger, General Manager

Copies of all original agenda items and minutes, including all attachments, are on file in the General Manager's office at the Las Vegas Valley Water District, 1001 South Valley View Boulevard, Las Vegas, Nevada.

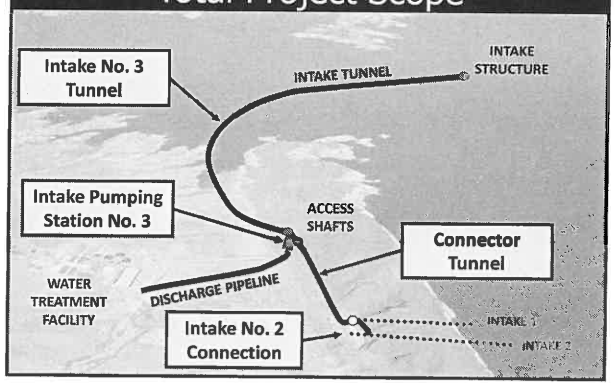


Southern Nevada Water Authority

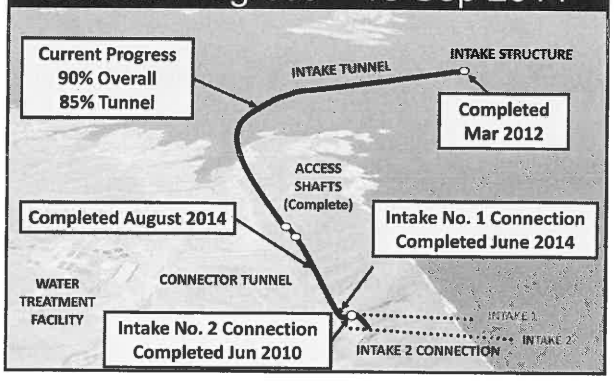
Lake Mead Intake No. 3 Update

SNWA Board of Directors
September 18, 2014

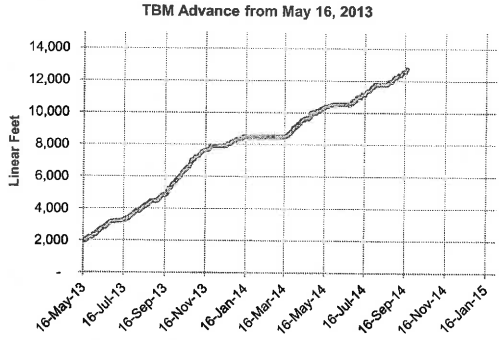
Lake Mead Intake No. 3 Total Project Scope

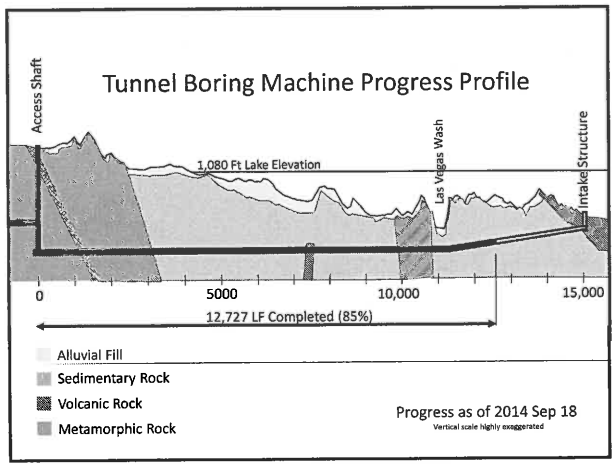


Lake Mead Intake No. 3 Current Progress – 18 Sep 2014



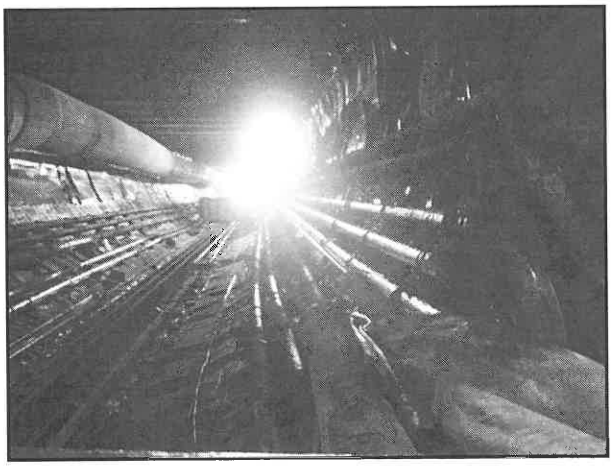
Tunnel Excavation Progress





Assuring Successful Intake Docking

- On-target arrival at Intake Structure:
  - Frequent checks of TBM location
  - 3rd party verification using advanced survey equipment
  - Remote underwater video monitoring to position the TBM at the optimum point within the Intake Structure
- Preventing water ingress:
  - Concrete encasement around structure
  - Closed-mode TBM operation
  - Grouting around the TBM during structure penetration
  - Controlled drainage of water from structure to verify water-tight bulkhead seal
  - Secondary seal with welded plate around the TBM front shield



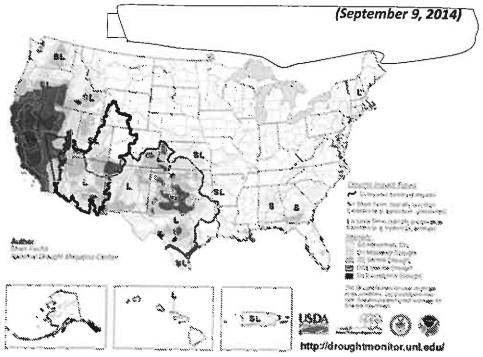
SOUTHERN NEVADA WATER AUTHORITY

Update on Drought Conditions and Water Use

September 18, 2014

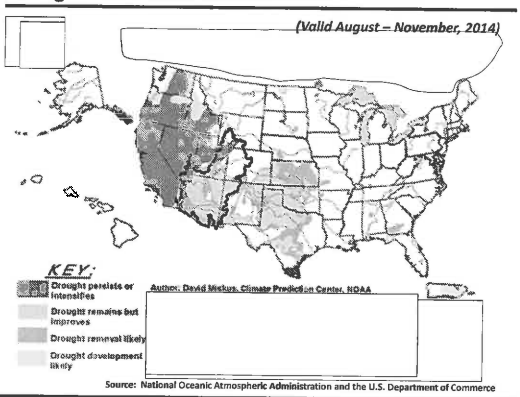
Drought Monitor

(September 9, 2014)



Drought Outlook

(Valid August – November, 2014)

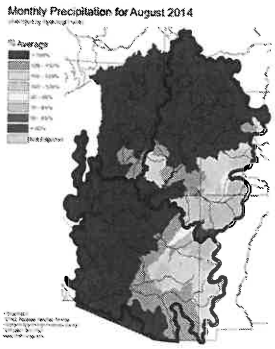


Source: National Oceanic Atmospheric Administration and the U.S. Department of Commerce

3

Colorado River Basin Conditions

- **August 2014 precipitation:** 180% of average



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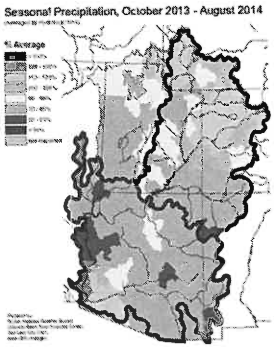
Colorado River Basin Conditions

- **August inflow to Lake Powell:** 103% of average
- **Snow Pack:** N/A
- **Water Year 2014 Precipitation:** 103% of average
- **Forecasted Water Year 2014 Inflow to Lake Powell:** 95% of average



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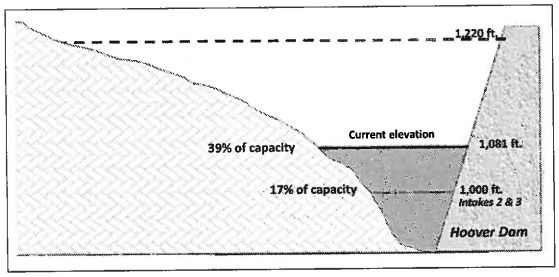
Precipitation and Inflow Forecast – Lake Powell

	2013 Water Year		2014 Water Year	
Month	Actual Precipitation	Inflows Forecast	Actual Precipitation	Inflows Forecast
Jan	72%	61%	96%	93%
Feb	78%	54%	102%	96%
Mar	76%	49%	103%	105%
Apr	78%	42%	103%	103%
May	80%	45%	101%	100%
Jun	77%	44%	97%	95%
Jul	80%	41%	101%	94%
Aug	81%	40%	103%	95%
Sept	90%	46%		
Actual	91%	47%		

Source: Bureau of Reclamation, Lower Colorado Water Supply Reports

Current Lake Mead Elevation



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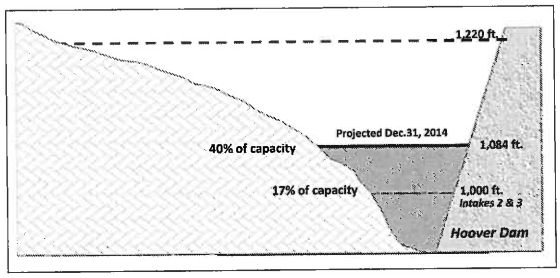
Projected Lake Mead Elevation



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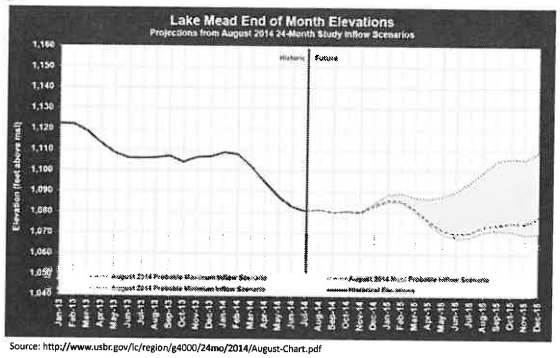
Water Year 2015 Operations

- Pursuant to the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead
- Lake Powell's operation will be governed by the Upper Elevation Balancing Tier with an initial release volume of 8.23 maf
- Highly likely an April adjustment to equalization or balancing will occur
- The most probable release based upon the projected adjustments in April is 9.0 maf

9

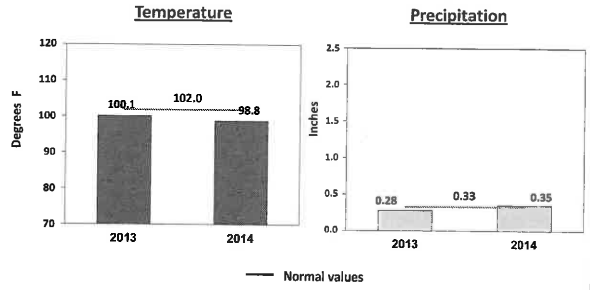
August 2014 24-Month Study Projections



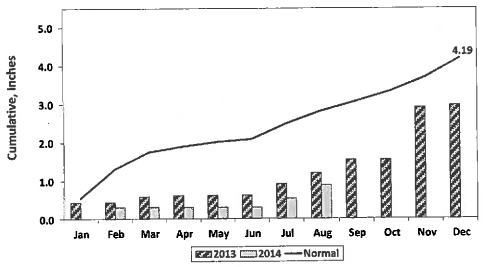
Source: http://www.usbr.gov/lc/region/g4000/24mo/2014/August-Chart.pdf

SNWA Water Use

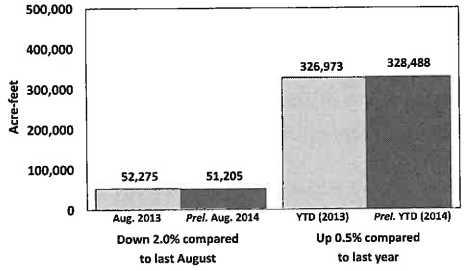
Weather Comparison (August 2014)



Annual Precipitation



SNWA Total Water Use



Questions?

Bond Refunding Opportunities

September 18, 2014

BOND REFUNDING

- Similar to refinancing a home mortgage
- Originally issued as 20-30 year bonds
  - Callable at 10 years
- Not extending the life of the bonds - refunding bonds will be repaid over 10-20 years
- Savings structured similar to original bond structure
- SNWA Bonds issued through:
  - State Bond Bank
  - County Bond Bank
  - Las Vegas Valley Water District

2

BOND REFUNDING PLAN

- Up to $1.24 billion in outstanding debt can be refunded for savings over the next two years
  - $915 million of SNWA Obligations
  - $325 million of LVVWD Debt
- At today's interest rates - Present Value (PV) savings equal $150 million
  - Above 10% of refunded par
  - Significantly greater than 3% threshold

3

REFUNDING SAVINGS ARE SIGNIFICANT

- At today's interest rates present value savings estimates:
  - $108 million for the SNWA
  - $42 million for the LVVWD
- Even if interest rates rise 100 basis points (1.0%) – estimated present value savings are significant:
  - $50 million for SNWA
  - $19 million for LVVWD
- Approximate annual cash flow savings at today's interest rates
  - $9 million from 2018-2027 for SNWA
  - $3.5 million from 2017-2027 for LVVWD

4

THREE TYPES OF OUTSTANDING DEBT

$313 million of SNWA Obligations Issued Through the State
- $317.185 million of Refunding Bonds to be issued through LVVWD
  - Addresses timing concerns
  - Takes advantage of LVVWD's higher credit ratings
- **Requires Debt Management Commission (DMC) approval**

$602 million of SNWA Obligations Issued Through the County
- Refunding Bonds to be issued through the County Bond Bank
- **Does not require DMC approval**

$325 million of LVVWD Debt
- Refunding Bonds will be issued by LVVWD
- **Does not require DMC approval**

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SEVERAL TRANSACTIONS ARE NECESSARY

Phase 1
- Refund $451 million of Debt
- Issue LVVWD Bonds in June 2015
- Refund State Bonds Series 2005F, 2005H, 2005I (A)
- Refund LVVWD Bond Series 2005A
- NPV Savings $31.3 - $59.6 million

Phase 2
- Refund $383 million of Debt
- Issue LVVWD Bonds and County Bonds in April 2016
- Refund State Bond Series 2006D (A)
- Refund County Bond Series 2006 (June) (A)
- Refund LVVWD Bond Series 2006A
- NPV Savings $18.9 - $45.3 million

Phase 3
- Refund $41.6 million of Debt
- Issue County Bonds in August 2016
- Refund County Bond Series 2006 (A) (November)
- NPV Savings $19.1 - $46.1 million

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SUMMARY OF REFUNDINGS

	SNWA	LVVWD
Final maturity date	2031	2036
Average annual savings ($mm)	$ 6.6	$ 2.4
Phase	1, 2, 3	1, 2
Refunding Bonds Par Amount ($mm)	$ 868.7	$ 296.2
Refunded Bonds Par Amount ($mm)	$ 914.9	$ 324.8
Average Interest Rate of Refunded Bonds	4.73%	4.88%
True Interest Cost on Refunding Bonds	2.91%	3.05%
NPV Savings ($mm)	$ 103.8	$ 42.1
NPV Savings (%)	11.90%	12.98%

Note: All estimates are based on current interest rates

Schedule and Actions

- Phase 1 and 2: September 18, 2014 – SNWA Board Resolution Request (Series 2005F, 2005H, 2005I, Series 2006D)
- Phase 1 and 2: October 7, 2014 – LVVWD Board DMC Resolution (Series 2005F, 2005H, 2005I, Series 2006D)
- Phase 1 and 2: October 9, 2014 – DMC Meeting (Series 2005F, 2005H, 2005I, Series 2006D)
- Phase 1 and 2: November 4, 2014 – LVVWD Board Resolution of Intent (Series 2005F, 2005H, 2005I, Series 2006D)
- Phase 1 and 2: December 2, 2014 – LVVWD Board Public Hearing (Series 2005F, 2005H, 2005I, Series 2006D)
- Phase 1: May 5, 2015 – LVVWD Board considers Bond Resolution (Series 2005A, 2005F, 2005H, 2005I)
- Phase 1: June 18, 2015 – Bond Closing (Series 2005A, 2005F, 2005H, 2005I)
- Phase 1: July 2015 - Results shared with SNWA and LVVWD Boards (Series 2005A, 2005F, 2005H, 2005I)
- Phase 2: January 21, 2016 - SNWA Board Resolution Request (Series 2006A, 2006D, 2006-June)
- Phase 2: March 1, 2016 – Board of County Commissioners considers Bond Ordinance and LVVWD Board considers Bond Resolution (Series 2006A, 2006D, 2006-June)
- Phase 3: March 17, 2016 – SNWA Board Request Resolution (Series 2006 - November)
- Phase 2: April 21, 2016 – Bond Closing (Series 2006A, 2006D, 2006-June)
- Phase 2: April 2016 - Results shared with SNWA and LVVWD Boards (Series 2006A, 2006D, 2006-June)
- Phase 3: May 17, 2016 – Board of County Commissioners considers Bond Ordinance (Series 2006 - November)
- Phase 3: May 19, 2016 – SNWA Board considers Bond Resolutions (Series 2006 - November)
- Phase 3: August 3, 2016 – Bond Closing (Series 2006 - November)
- Phase 3: August 2016 - Results shared with SNWA Board (Series 2006 - November)

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CONCLUSION AND RECOMMENDATION

- Opportunity to lower SNWA and LVVWD debt service cost over the next 2 years = up to $150 million on a present value basis
- Action:
  - The SNWA Board adopt a Resolution approving the issuance by the Las Vegas Valley Water District of refunding bonds in the maximum principal amount of $317,185,000 to refinance certain outstanding bonds for the SNWA

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SOUTHERN NEVADA WATER AUTHORITY®

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Conduct Public Hearing	**Director's Backup**
Petitioner: John J. Entsminger, General Manager	
Recommendations: That the Board of Directors conduct a Public Hearing to consider and adopt the recommendations from the Integrated Resource Planning Advisory Committee, including the adoption of a drought protection charge, or take other action as appropriate.	

Fiscal Impact:
The drought protection charge is estimated to generate approximately $40 million in revenue in 2018. If approved, this revenue supports debt service for a new low lake level pump station at Lake Mead.

Background:
On April 19, 2012, the Board of Directors established the 21-member Integrated Resource Planning Advisory Committee (IRPAC) to consider the interrelated aspects of water issues affecting Southern Nevada and develop formal recommendations for Board consideration. During the IRPAC's first phase in 2012-2013, the committee addressed issues related to a significant increase in debt service. On September 26, 2013, the IRPAC presented nine recommendations to the Board, which were unanimously approved and have since been implemented.

In February 2014, the IRPAC began meeting to address issues related to resources and facilities, specifically the risk of Lake Mead elevations dropping below 1,000 feet. Since that time, the IRPAC has met eight times in public meetings and participated in one facility tour. Committee deliberations included topics such as climate change, water conservation, Colorado River drought, existing facilities, water resources and funding scenarios.

Early in the process, the IRPAC determined that the risk of Lake Mead's elevation falling below 1,000 feet is not acceptable for Southern Nevada due to the potential impacts on water delivery and resource availability. After reaching that finding, the IRPAC formulated the recommendation that a new low lake level pump station is needed to ensure Southern Nevada's access to Colorado River water should Lake Mead fall below an elevation of 1,000 feet. In order to fund this pumping station with a projected design and construction cost of $650 million, the IRPAC evaluated a number of rate scenarios and considered impacts to a broad spectrum of committee-selected sample customers including residents, schools and businesses. Ultimately, the IRPAC recommended generating the revenue through a fixed charge based upon meter size, noting that this would provide more reliability than variable charges and more accurately reflect the nature of the shared benefits and stability provided by the pump station. The IRPAC also recommended phasing in the increase to fixed monthly charges over a three-year period to allow customers time to adjust to the new charge.

AGENDA ITEM # 2

The IRPAC's deliberations resulted in eight recommendations. In addition to the recommendations related to funding and constructing a new pump station, other recommendations address conservation and water resources. The IRPAC's Recommendations Report summarizes activities and discussions, and details IRPAC's final recommendations.

If approved, the Authority will work closely with its member agencies and the IRPAC members to inform and educate the public about the IRPAC process and its recommendations. The Authority will host informational public meetings and utilize outreach tools including its *Water Ways* public access show, bill inserts, *Water Smart Living* newsletter, website, social media platforms, radio advertisements and public meetings to inform and educate the public about rate impacts.

Because this action only creates an obligation on the Authority's member agencies and not customers directly, it does not require a Business Impact Statement; however, the Authority's member agencies are required to prepare and adopt at a subsequent meeting a Business Impact Statement pursuant to NRS Chapter 237. If the Board adopts the IRPAC recommendations, the Authority's member agencies will begin the notification process for determining business impacts.

This action is authorized pursuant to Section 6(c) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved this agenda item.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:JAW:AMB:KH
Attachments

IRPAC Recommended Rate Model
Phased-in Increases to Infrastructure Charge

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Beginning Fund Balance	$339,492	$356,108	$350,445	$326,912	$322,771	$316,736	$303,708	$294,814	$287,287	$282,415	$280,265
Total Expenses and Debt Service	($199,895)	($250,923)	($273,560)	($273,662)	($275,060)	($276,525)	($275,881)	($278,187)	($279,404)	($280,657)	($281,948)
Total Expected Revenues	$216,511	$235,575	$251,563	$261,024	$264,161	$267,177	$270,161	$273,272	$276,494	$279,788	$283,114
Expected Net Revenues	$16,616	($15,348)	($21,997)	($12,638)	($10,899)	($9,348)	($5,720)	($4,915)	($2,910)	($869)	$1,166
Low Lake Level Pumping Station Debt Service*			($25,944)	($25,944)	($34,829)	($43,784)	($43,784)	($43,785)	($43,787)	($43,787)	($43,784)
Infrastructure Charge Revenue**		$9,685	$24,408	$34,441	$39,693	$40,103	$40,610	$41,173	$41,825	$42,505	$43,138
Total New Revenues		$9,685	$24,408	$34,441	$39,693	$40,103	$40,610	$41,173	$41,825	$42,505	$43,138
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Increases to SNWA Infrastructure Charge per month per meter (No Changes to Fireline Meters)											
Residential - 5/8" & 3/4" meter sizes		$2.41	$3.61	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81
Residential - 1" meter size		$4.56	$6.84	$9.11	$9.11	$9.11	$9.11	$9.11	$9.11	$9.11	$9.11
Residential - 1.5" meter size		$9.13	$13.67	$18.22	$18.22	$18.22	$18.22	$18.22	$18.22	$18.22	$18.22
Residential - 2" meter size		$14.61	$21.88	$29.15	$29.15	$29.15	$29.15	$29.15	$29.15	$29.15	$29.15
Residential - 3" meter size		$29.21	$43.76	$58.30	$58.30	$58.30	$58.30	$58.30	$58.30	$58.30	$58.30
Residential - 4" meter size		$45.64	$68.37	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10
Residential - 6" meter size		$91.29	$136.74	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20
Residential - 8" meter size and larger		$146.06	$218.79	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52
Non-Residential - 5/8" & 3/4" meter sizes		$2.41	$3.61	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81
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Non-Residential - 8" meter size		$146.06	$218.79	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52
Non-Residential - 10" and larger meter sizes		$209.96	$314.51	$419.05	$419.05	$419.05	$419.05	$419.05	$419.05	$419.05	$419.05

Base Case refers to revenue and expense projections as reviewed and confirmed by IRPAC during the 2013 rate review.

* Debt service net of capitalized interest

** Assuming January rate increases with no changes to fire meters

SOUTHERN NEVADA WATER AUTHORITY®

Integrated Resource Planning Advisory Committee
RECOMMENDATIONS REPORT
Phase II: Resources and Facilities

November 2014

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EXECUTIVE SUMMARY

The Southern Nevada Water Authority (SNWA) has consistently relied upon input from citizen committees since its inception in 1991. Panels convened by the SNWA Board of Directors have explored and deliberated over issues ranging from water quality and environmental initiatives to the development of water resources for Southern Nevada's future. In the mid-1990s, the first iteration of the Integrated Resource Planning Advisory Committee (IRPAC) evaluated a range of water resource options based upon prevailing hydrologic conditions at the time.

During the ensuing two decades, conditions on the Colorado River—which represents 90 percent of the community's water supply—changed dramatically, compelling the SNWA to take a number of measures to securitize Southern Nevada's access to a reliable water supply. Even as the SNWA was initiating mitigation measures to address the drought, the global economy entered a prolonged recession. Nowhere in the United States was the recession felt more profoundly than in Southern Nevada, which virtually overnight was transformed from one of the nation's most robust economies to the epicenter for home foreclosures and unemployment. The financial impact on the SNWA was profound; connection charges, which per previous IRPAC recommendations represented nearly 60 percent of the funds used to pay for the community's water system, decreased from a high of $188 million in 2005 to only $3 million in 2008.

To address the challenges associated with economic conditions in a comprehensive way, the SNWA Board again initiated an integrated resource planning process in 2012; Phase I of this process had a relatively narrow focus, identifying the optimal fiscal formula to pay for approved and largely constructed water infrastructure projected to result in an increase in annual debt service spike of $80 million by 2016. Between June 2012 and September 2013, the IRPAC met more than a dozen times to analyze a myriad of funding formulas and evaluate them against a number of criteria related to stability, affordability and equity. The panel ultimately identified and recommended a funding plan that balanced the stability of a fixed monthly rate with the conservation incentives of a variable usage-based rate. Further, IRPAC recommended that the increases be phased in over a three-year period to provide municipal water customers sufficient time to adjust to the additional monthly costs.

In February 2014, the committee reconvened to develop recommendations related to a number of infrastructure- and resource-related issues, including conservation goals, Colorado River system conservation projects, the development of in-state water resources, and the construction of a low-elevation water pumping facility to provide access to Lake Mead should the reservoir's elevation drop below 1,000 feet, at which point neither of the SNWA's existing pumping stations will remain operational.

This report summarizes the activities and results of the IRPAC Phase II process as it relates to the aforementioned issues. Section I is an overview of the committee process. Section II

reviews committee discussion topics. Section III provides the committee's eight recommendations.

Committee Finding

The members of the Integrated Resource Planning Advisory Committee assert that the risk of Lake Mead's elevation falling below 1,000 feet is not acceptable to our community due to the potential impacts on water delivery and resource availability.

Recommendations Summary

Below is a summary of the Committee's recommendations:

1. Evaluate an increased water conservation target upon achieving the currently established goal of reducing gross water usage to 199 Gallons Per Capita Per Day (GPCD) by 2035.
2. Present water usage information to the Board of Directors and the community in both "gross" and "net" terms for the purposes of 1) more accurately communicating the water resource implications associated with various conservation measures, and 2) improving comparability of our community's water consumption with that of others.
3. Continue to partner with other Colorado River Basin States to undertake system conservation projects designed to protect critical elevations in Lake Powell and Lake Mead, conditional upon the identification of mutually agreeable projects and shared funding responsibilities.
4. Classify expenditures associated with Colorado River system conservation projects as one-time capital expenditures, thereby making funds available for these costs from Connection Charge revenues as identified in Recommendation Nos. 7 and 8 from the September 2013 Integrated Resource Planning Advisory Committee Recommendations Report.
5. Begin design and construction of a new low lake level water pumping station within the swiftest feasible timeframe.
6. Generate needed revenue for the construction of a new low lake level water pumping station exclusively through fixed charges based upon meter size.
7. Phase in the increase to fixed monthly charges over a three-year period.
8. Continue to include the Groundwater Development Project within the SNWA's Water Resource Portfolio with future resource options.

ADVISORY COMMITTEE

Membership

The SNWA Board appointed twenty-one (21) individuals, representing diverse stakeholder groups with an interest in the SNWA's long-term planning efforts. With the exception of four new members, all members of the IRPAC Phase II process participated in Phase I either on IRPAC or its subcommittees during 2012-13.

A list of IRPAC Phase II members is provided in Appendix A.

Process

To coordinate and manage committee meetings, the SNWA utilized an independent, neutral facilitator from outside Southern Nevada (David Ebersold, CDM Smith, Los Angeles), who served in the same capacity for Phase I of the IRPAC process. Mr. Ebersold was responsible for soliciting dialogue and interaction among committee members, ensuring all perspectives had an opportunity to be heard and considered, and suggesting appropriate process tools to assist the committee members in problem-solving and other aspects of their deliberations.

Consensus served as the basis for formulation of the IRPAC's recommendations. Members worked together to identify positions that were generally acceptable to the committee as a whole. Mr. Ebersold was diligent about soliciting feedback and ensuring that all IRPAC members had an opportunity to voice their opinions.

To encourage public involvement, IRPAC meetings were publicly posted in accordance with Nevada's Open Meeting Law. Presentations and audio recordings of each meeting are posted on SNWA.com, and written meeting summaries are available to the public within the posting period for the following meeting. In addition, the SNWA Board received updates about IRPAC activities at the regularly-scheduled public Board meetings.

DISCUSSION TOPICS

Having become well-versed in issues related to Southern Nevada's water demands, key infrastructure components, resource management, water rate structures and other related elements during Phase I of the process, IRPAC focused extensively upon the Colorado River drought, exacerbating factors such as climate change, and the implications of declining reservoir levels on the reliability of Southern Nevada's municipal water system. A summary of meeting topics is included in Appendix B. More detailed meeting summaries are available at SNWA.com.

Critical topics addressed by the committee included:

- Historical and projected hydrology on the Colorado River
- Climate change's influence on inflows and water uses within the Colorado River Basin
- The acceptable level of risk to the community of losing access to Lake Mead
- Costs and benefits associated with various water conservation target levels
- Alternative matrices for evaluating community water use and their implications for comparisons among metropolitan areas
- The attributes for evaluating potential infrastructure and supply alternatives
- The appropriate mix of fixed and variable fees within water bills and their relationship to infrastructure projects
- Benefits and drawbacks associated with phased increases to water charges

COMMITTEE FINDING

The members of the Integrated Resource Planning Advisory Committee assert that the risk of Lake Mead's elevation falling below 1,000 feet is not acceptable to our community due to the potential impacts on water delivery and resource availability.

RECOMMENDATIONS

1. **Evaluate an increased water conservation target upon achieving the currently established goal of reducing gross water usage to 199 Gallons Per Capita Per Day (GPCD) by 2035.**
   The committee deliberated over the benefits and costs associated with adopting a more aggressive water efficiency target in the near term. Among the issues discussed were the additional investments and policy changes that would likely be necessary to alter the current trajectory of water use, as well as the necessity of those measures in the near term to meet resource demands. Based upon those discussions, the group reached consensus that the existing goal should be maintained until it is achieved; at that point, IRPAC recommends that a more aggressive goal be evaluated.

2. **Present water usage information to the Board of Directors and the community in both "gross" and "net" terms for the purposes of 1) more accurately communicating the water resource implications associated with various conservation measures, and 2) improving comparability of our community's water consumption with that of others.**
   The SNWA historically has utilized "gross" Gallons Per Capita Per Day (GPCD) as a metric for evaluating the community's water efficiency. This serves as the framework upon which the current goal of 199 GPCD by 2035 is constructed. Gross GPCD is effective for this purpose because the SNWA is able to hold all variables constant, comparing present and past water efficiency with remarkable accuracy and consistency. However, media and other stakeholders regularly attempt to compare Southern Nevada's water efficiency to other cities' using the gross GPCD metric, which is scientifically inappropriate due to a variety of factors, including weather, development type and Las Vegas' large tourism base. Additionally, gross GPCD fails to reflect Southern Nevada's exceptional achievements in the area of water reuse; through the return flow credit mechanism, nearly all water used indoors is captured and recovered. SNWA technical staff has developed a "net GPCD" metric that accurately captures the community's "net water footprint" and emphasizes the importance of conservation with relation to consumptive uses.

3. **Continue to partner with other Colorado River Basin States to undertake system conservation projects designed to protect critical elevations in Lake Powell and Lake Mead, conditional upon the identification of mutually agreeable projects and shared funding responsibilities.**
   SNWA staff provided an overview of existing and potential Colorado River system conservation projects and requested of the committee recommendations related to these

investments. The primary benefit of such projects would be to forestall or reduce the rate of decline in Lake Mead and Lake Powell, the Colorado River's two primary reservoirs. Examples of projects include agricultural irrigation upgrades, brackish desalination, weather modification and land fallowing. Water gleaned from these investments would not be allocated to the funding entities, but rather would remain in the Colorado River to contribute to the system's hydrologic stability. For Southern Nevada, the benefits of participating in such endeavors are, 1) to help maintain the elevation of Lake Mead, and 2) to further fortify positive relationships with partnering entities on the Colorado River. After discussion of funding sources and project scale, IRPAC recommended pursuing such agreements as opportunities arise provided that other parties to these types of project agreements fulfill their commitments.

4. **Classify expenditures associated with Colorado River system conservation projects as one-time capital expenditures, thereby making funds available for these costs from Connection Charge revenues as identified in Recommendation Nos. 7 and 8 from the September 2013 Integrated Resource Planning Advisory Committee Recommendations Report.**
   Because the timing and scale of potential Colorado River system conservation projects is unpredictable, the committee evaluated various options for developing a funding pool. After discussing the creation of a separate account specifically for this purpose, IRPAC determined that the SNWA's existing capital expense account could be used for this purpose, consistent with Recommendations 7 and 8 from the committee's Phase I process.

5. **Begin design and construction of new low lake level water pumping station within the swiftest feasible timeframe.**
   Having reached a finding that the risk associated with Lake Mead declining below 1,000 feet elevation—at which Southern Nevada would no longer be able to draw water from the reservoir using existing infrastructure—the committee received a presentation related to an infrastructure solution that would preserve the community's access to Lake Mead, even if conditions deteriorate to a point where downstream users in California, Arizona and Mexico could no longer access the Colorado River. However, because pumping technologies at extremely low lake elevations were not fully demonstrated at the time construction began on the new intake, and economic conditions at the time remained deteriorated, the SNWA Board of Directors deferred construction of new water pumping facilities. The committee unanimously recommended that the SNWA proceed with construction of a new low-elevation water pumping station.

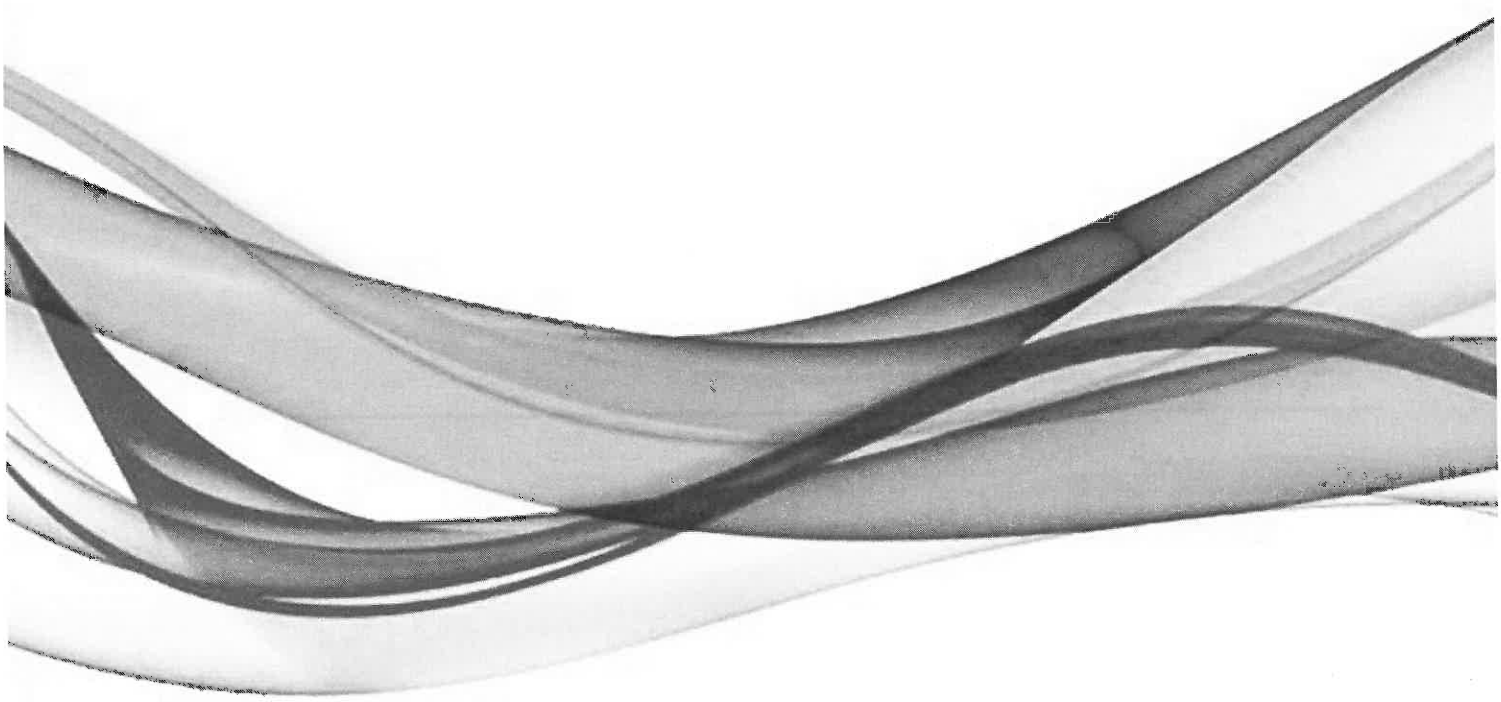
6. **Generate needed revenue for the construction of a new low lake level water pumping station exclusively through fixed charges based upon meter size.**
   The committee received an extensive presentation related to the SNWA's current financial condition, the ranking of local water rates compared with more than 60 cities throughout the West, key factors and assumptions related to rate structures, and four potential funding models to address the projected $650 million cost of the recommended low-elevation pumping station. The rate impact for the vast majority of single-family customers ranged

from $3.67 to $4.81 per month. There was considerable discussion of whether fixed or variable usage-based charges were more appropriate to fund infrastructure needed to guarantee continued access to Lake Mead. Another point of emphasis among IRPAC members was ensuring that the funds generated through the increase were sufficiently reliable to pay the bonds, and that no additional charges would be required for this purpose. The committee ultimately reached consensus that fixed charges were more appropriate than usage-based increases for this purpose, because the value of the low-elevation pumping facilities is equal for both low-usage and high-consumption customers. IRPAC also recommended that the fixed charge should be based upon each customer's meter size.

7. **Phase in the increase to fixed monthly charges over a three-year period.**
   Several committee members emphasized the importance of phasing the increase into water bills over a three-year period rather than implementing them in full all at once. They stressed that providing customers sufficient time to adjust to the new charge would be critical to public acceptance of the increase, and noted that the increase in the ultimate "peak" charge is nominal compared to the phased approach.

8. **Continue to include the Clark, Lincoln and White Pine Counties Groundwater Development Project within the SNWA's Water Resource Portfolio with future resource options.**
   Recognizing that the SNWA's Groundwater Development Project is not needed immediately and projects of such magnitude require significant lead time, the committee opted to affirm the project's place within the SNWA's Water Resource Plan. The committee agreed that it would be prudent to continue legal and permitting activities for the project.

APPENDICES



APPENDIX A

IRPAC Membership

Member	Stakeholder Category
Chris Armstrong	Golf Courses
Tom Burns	General Business
Yvanna Cancela	Labor
Thalia Dondero	Southern Nevada Residents
Bob Ferraro	Senior Citizens
John Guedry	Henderson Chamber
Joyce Haldeman	Education
Warren Hardy	General Contractors
Katherine Jacobi	Restaurants
Carol Jefferies	Southern Nevada Residents
Jennifer Lewis	Development
April Mastroluca	Environmental
Otto Merida	Latin Chamber of Commerce
Bobbi Miracle	Real Estate
Paul Moradkhan	Las Vegas Chamber
Terry Murphy	Ratepayers/Small Business
Phil Ralston	Industrial/Commercial Business
John Restrepo	General Business
David Scherer	Small Industrial/Commercial Bus.
Danny Thompson	Building Trades
Virginia Valentine	Hospitality/Gaming

APPENDIX B

IRPAC Phase II Meeting Synopses

The following provides a brief synopsis of discussion topics during the second phase of the IRPAC process. A detailed summary with an audio recording was developed for each meeting and is available on SNWA.com or by contacting the SNWA.

Meeting 1 – Feb. 26, 2014: Introduction of new IRPAC members, review of IRPAC Phase I process and previous committee processes, overview of Phase II topics, discussion of attribute development, review and update of drought conditions affecting Southern Nevada.

Meeting 2 –March 26, 2014: Discussion of agreements governing the Colorado River, review of activities undertaken by Basin States in response to drought, update on Colorado River drought conditions.

Meeting 3 – April 23, 2014: Climate change presentation by Director of the Getches-Wilkinson Center at the University of Colorado, Boulder, presentation on the Colorado River Basin Study by Bureau of Reclamation technical staff.

Tour – May 23, 2014: Tour of Alfred Merritt Smith Water Treatment Facility and Lake Mead, discussion of existing infrastructure, associated limitations and implications of continued decline in reservoir elevation.

Meeting 4 – July 23, 2014: Update on Colorado River drought conditions, discussion and development of attributes to be used for evaluating alternatives, overview of opportunities for cooperation among Colorado River Basin States, presentation on potential low-elevation pumping station in Lake Mead.

Meeting 5 – Sept. 10, 2014: Update on Colorado River drought conditions, discussion of topics suggested by the SNWA Board of Directors for consideration by IRPAC, finalization of attributes, presentation on water conservation initiatives and goals, update related to low-elevation pumping station conceptual design.

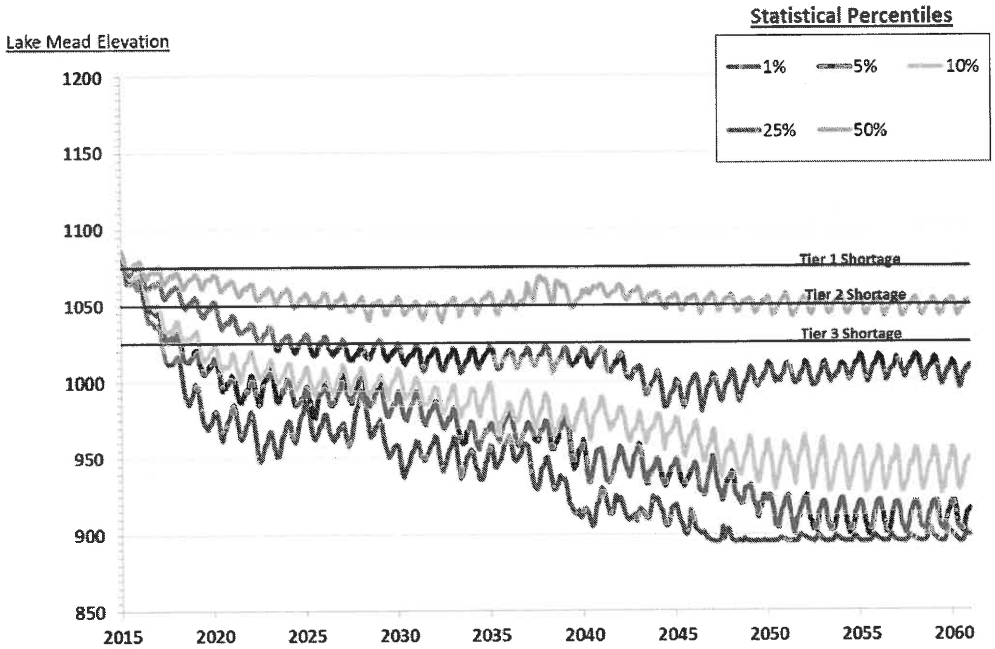
Meeting 6 – Oct. 15, 2014: Presentation on SNWA water resource planning approach, history, and assumptions; development of recommendations related to water conservation, presentation on Colorado River system conservation projects and development of recommendations, development of recommendations related to low-elevation pumping station.

Meeting 7 – Nov. 5, 2014: Discussion of underlying assumptions for Phase I funding recommendations, review of low-elevation pumping station, presentation on SNWA's financial status and regional current rate comparison, presentation and discussion of potential rate models, development of recommendations related to increased charges and implementation timeframe.

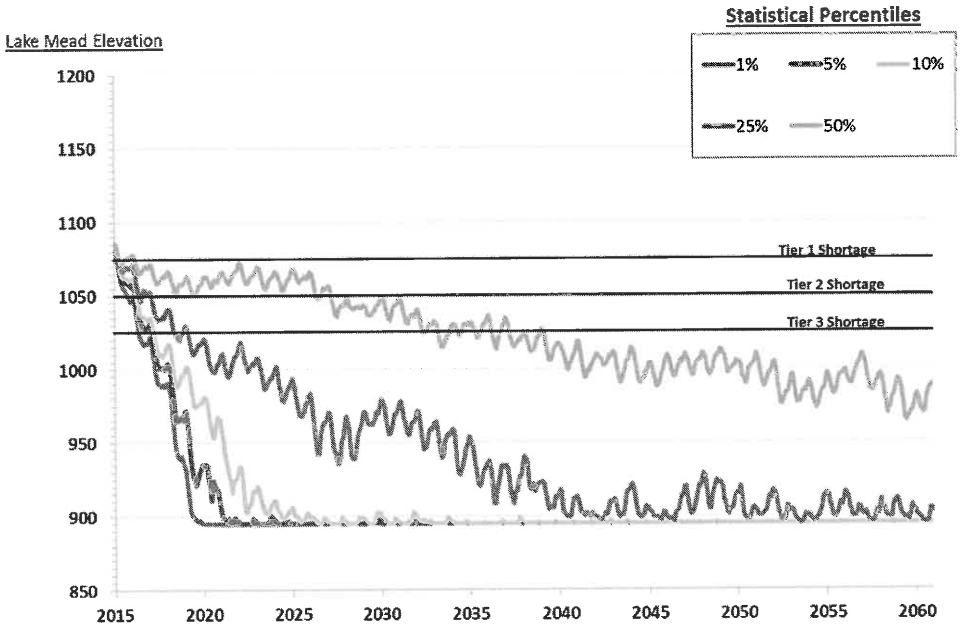
Meeting 8 – Nov. 19, 2014: Discussion of the SNWA's Clark, Lincoln and White Pine Counties Groundwater Development Project, long-term water resources and finalization of the committee's Recommendations Report.

Appendix C

Lake Mead Elevation Modeling Scenarios



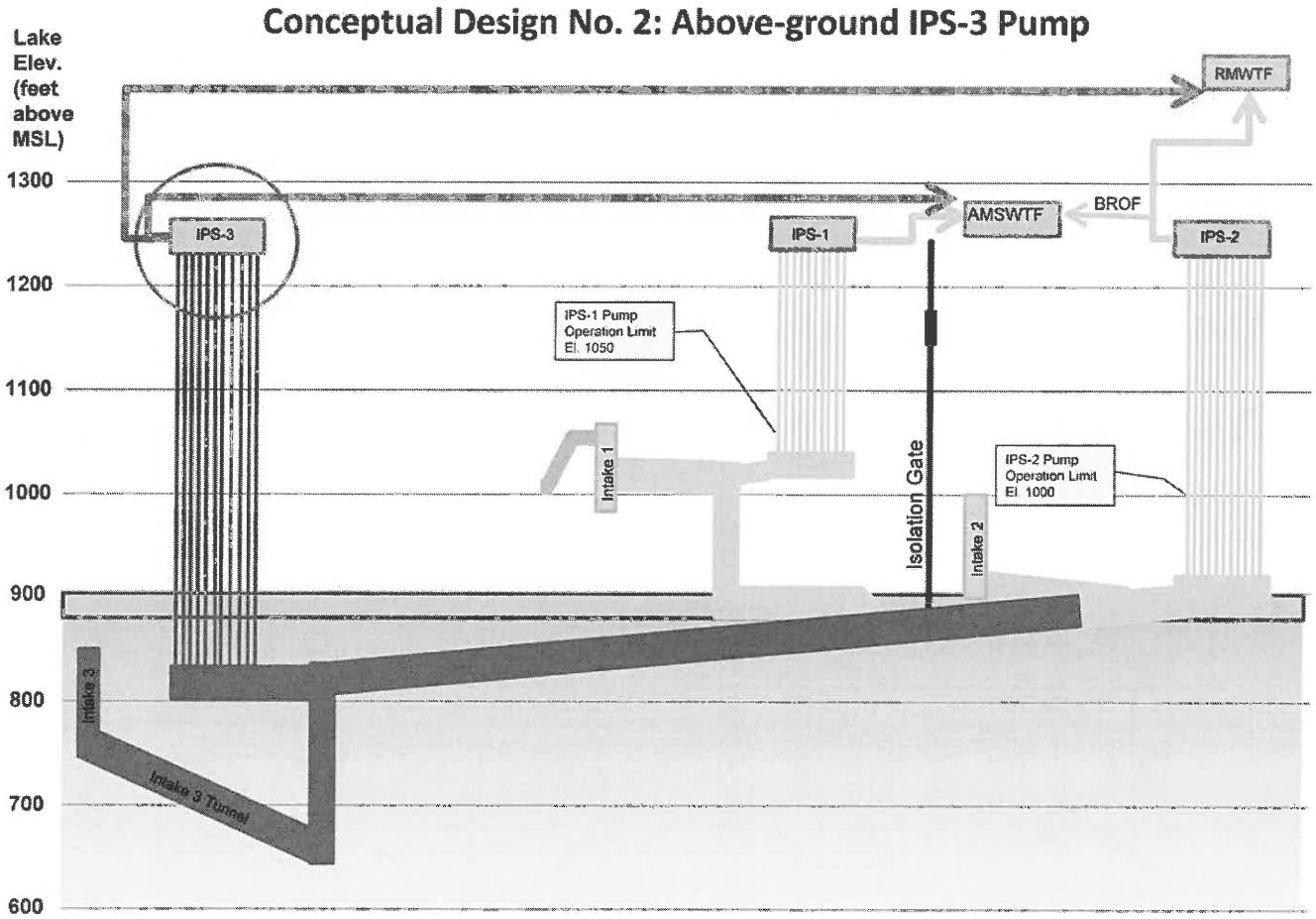
Percentiles Based on Observed Conditions



Percentiles Based on Climate Change Models

Appendix D

Low Lake Elevation Pumping Station Conceptual Design Diagram



Appendix E

Funding Modeling Scenario

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Beginning Fund Balance	$339,492	$356,108	$350,445	$326,912	$322,771	$316,736	$303,708	$294,814	$287,287	$282,415	$280,265
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Low Lake Level Pumping Station Debt Service*			($25,944)	($25,944)	($34,829)	($43,784)	($43,784)	($43,785)	($43,787)	($43,787)	($43,784)
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Residential - 4" meter size		$45.64	$68.37	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10
Residential - 6" meter size		$91.29	$136.74	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20
Residential - 8" meter size and larger		$146.06	$218.79	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52
Non-Residential - 5/8" & 3/4" meter sizes		$2.41	$3.61	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81	$4.81
Non-Residential - 1" meter size		$4.56	$6.84	$9.11	$9.11	$9.11	$9.11	$9.11	$9.11	$9.11	$9.11
Non-Residential - 1.5" meter size		$9.13	$13.67	$18.22	$18.22	$18.22	$18.22	$18.22	$18.22	$18.22	$18.22
Non-Residential - 2" meter size		$14.61	$21.88	$29.15	$29.15	$29.15	$29.15	$29.15	$29.15	$29.15	$29.15
Non-Residential - 3" meter size		$29.21	$43.76	$58.30	$58.30	$58.30	$58.30	$58.30	$58.30	$58.30	$58.30
Non-Residential - 4" meter size		$45.64	$68.37	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10	$91.10
Non-Residential - 6" meter size		$91.29	$136.74	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20	$182.20
Non-Residential - 8" meter size		$146.06	$218.79	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52	$291.52
Non-Residential - 10" and larger meter sizes		$209.96	$314.51	$419.05	$419.05	$419.05	$419.05	$419.05	$419.05	$419.05	$419.05

Appendix F

62-City Rate Comparison Chart

Utility	$10 - $20	$20 - $30	$30 - $40	$40 - $50	$50 - $60	$60 - $70	$70 - $80	$80 - $90	$90 - $100	Over $100
Santa Barbara, CA (OC)										113.37
Santa Fe, NM										110.33
Colorado Springs, CO (OC)										109.22
Seattle, WA (OC)									96.33	
Santa Cruz, CA (OC)									94.23	
Reno, NV (Unmetered)									91.37	
San Francisco, CA								89.33		
Santa Barbara, CA								87.20		
Seattle, WA								84.46		
Portland, OR								83.08		
San Diego, CA							74.05			
Santa Cruz, CA							73.97			
Colorado Springs, CO							72.78			
Flagstaff, AZ (OC)							72.43			
Marin, CA (MMWD)						66.82				
Flagstaff, AZ						65.83				
Los Angeles, CA						63.40				
Santa Rosa, CA						60.52				
San Jose, CA (Company)					59.44					
Oakland, CA (EBMUD)					59.36					
San Jose, CA (City)					56.00					
Pasadena, CA (OC)					51.53					
62 City Average					51.24					
Houston, TX				48.94						
Tacoma, WA (OC)				48.59						
Phoenix, AZ (OC)				48.16						
Cheyenne, WY				45.92						
Tucson, AZ				45.17						
Reno, NV (Metered)				45.14						
Las Vegas, NV (SNWA Phase II Full Rate)				44.07						
Riverside, CA (OC)				43.73						
Kingman, AZ (OC)				42.74						
Pasadena, CA				42.14						
Victorville, CA				41.90						
San Antonio, TX (OC)				41.02						
Long Beach, CA				40.81						
Tacoma, WA				40.48						
Las Vegas, NV (SNWA Phase I Full Rate)			39.26							
Henderson, NV			38.60							
North Las Vegas, NV			38.37							
Boulder, CO (OC)			38.30							
Scottsdale, AZ			37.01							
Denver, CO (OC)			36.78							
Billings, MT (OC)			36.07							
Billings, MT			35.47							
San Antonio, TX			35.30							
Dallas, TX			34.47							
Boulder, CO			33.60							
Denver, CO			33.38							
Kingman, AZ			32.85							
Pheonix, AZ			32.35							
Anaheim, CA (OC)			32.12							
Salt Lake City, UT (OC)			31.51							
Boise, ID			31.43							
San Bernardino, CA			30.95							
Albuquerque, NM		29.93								
Anaheim, CA		29.20								
Riverside, CA		29.15								
St. George, UT		28.62								
Cedar City, UT		26.20								
El Paso, TX		26.18								
Redding, CA		25.91								
Salt Lake City, UT		25.13								
Boulder City, NV		22.53								

Based on LVVWD Average Monthly Single-Family Consumption of 10,000 gallons and a 5/8 or 3/4 Inch Service Charge for Comparison.

OC - Outside City
MMWD - Marin Municipal Water District
EBMUD - East Bay Municipal Utilities District

Appendix G

Attributes for Evaluating Resource Alternatives

Attribute	Measure
Reliability	Reduces vulnerability to hydrologic variability of Colorado River: Score 1 if reduces vulnerability to river hydrology, 5 if no change from current condition
	Resilience to climate change: Score 1 if no impact from climate change, 5 if high susceptibility to climate change
	Reduces probability of not meeting water demands
	Reduces amount of water demand shortfall
Minimize Implementation Risk	Score 1 if not complex regulatory/technical/public process, 5 if highly complex
	Score 1 if multi-state and/or federal cooperation not required, 5 if extensive multi-state and/or federal cooperation required
	Timeline required to implement
Cost Effectiveness	Initial Capital Cost ($)
	NPV (Capital and O&M) ($)
Impact to Ratepayer	Competitiveness of average SFR water rate with other cities: Score 1 if no change, 5 for maximum change from current position on 62-City Municipal Water Rates Survey
Impacts to quality of life	Score 1 allows water efficient consumptive water use, 5 restricts existing consumptive water use
Water Use Efficiency	Score 1 for most change, 5 if no change from existing condition
Environmental Impact	Relative environmental impact: Score 1 if low impact, 5 if high impact

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Memorandum of Understanding	**Director's Backup**
Petitioner: Gregory J. Walch, General Counsel	

Recommendations:
That the Board of Directors approve and authorize the General Manager to execute, in substantially the same form, a Memorandum of Understanding among the United States, acting through the Bureau of Reclamation, Central Arizona Water Conservation District, Metropolitan Water District of Southern California, Arizona Department of Water Resources, Colorado River Board of California, Colorado River Commission of Nevada and the Authority for Pilot Drought Response Actions.

Fiscal Impact:
None by approval of this recommendation.

Background:
The Colorado River is suffering from the effects of a drought that began over 14 years ago, leading to substantially decreased water levels in Lake Mead. Recent Colorado River modeling projections show a serious near-term risk that water elevations in Lake Mead could decline to levels that would trigger shortages and interrupt the ability of municipal and hydropower users to draw water from the lake. Water supplies, hydropower production, water quality, and environmental resources are all at risk in the next several years. To address these issues the Authority, in conjunction with other Colorado River Basin partners, seeks to engage in proactive measures to protect critical Lake Mead elevations from the effects of drought.

A fundamental component of drought contingency planning for the Authority and other Lower Basin stakeholders is the goal to voluntarily develop additional quantities of water stored in Lake Mead to reduce the risk of reaching critical reservoir elevations (Protection Volumes). The Memorandum of Understanding regarding Pilot Drought Response Actions (MOU) identifies mechanisms that allow for the Authority, the Bureau of Reclamation (BOR), Metropolitan Water District (MWD), and the Central Arizona Water Conservation District (CAWCD) to create Protection Volumes. Each agency will use its best efforts to create a cumulative total of 740,000 acre-feet of Protection Volumes between 2014 and 2017. The Authority's portion of this total is 45,000 acre-feet while BOR's goal is 50,000 acre-feet, CAWCD's goal is 345,000 acre-feet, and MWD's goal is 300,000 acre-feet. These Protection Volumes are part of a larger goal advanced by all of the participants to create between 1.5 and 3 million acre-feet of Protection Volumes in Lake Mead over the next five years. The MOU also sets out a timeline for consultation with the participants and other Colorado River Basin stakeholders to address additional drought response actions, long-term sustainability issues, and actions that may be necessary to address urgent operating conditions.

AGENDA ITEM # 3

This MOU is being entered into pursuant to NRS 277.180 and Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the MOU.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:GJW:CNP:cmc
Attachment

MEMORANDUM OF UNDERSTANDING AMONG
THE UNITED STATES OF AMERICA, THROUGH THE
DEPARTMENT OF THE INTERIOR,
BUREAU OF RECLAMATION,
THE CENTRAL ARIZONA WATER CONSERVATION DISTRICT,
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA,
THE SOUTHERN NEVADA WATER AUTHORITY,
THE ARIZONA DEPARTMENT OF WATER RESOURCES,
THE COLORADO RIVER BOARD OF CALIFORNIA
AND
THE COLORADO RIVER COMMISSION OF NEVADA
FOR PILOT DROUGHT RESPONSE ACTIONS

I. PARTICIPANTS

This Memorandum of Understanding, (hereinafter referred to as "MOU"), is made and entered into this ____ day of _____, 2014 ("Effective Date"), by and between the UNITED STATES OF AMERICA ("United States") represented by the Secretary of the Interior ("Secretary") acting through the Bureau of Reclamation ("Reclamation"), the CENTRAL ARIZONA WATER CONSERVATION DISTRICT, a multi-county water conservation district duly organized and existing under the laws of the State of Arizona ("CAWCD"), THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA, a regional public water district duly organized under California law ("MWD"), and the SOUTHERN NEVADA WATER AUTHORITY, a political subdivision of the State of Nevada ("SNWA", and together with CAWCD and MWD, the "Municipal Water Agencies"). The ARIZONA DEPARTMENT OF WATER RESOURCES, an agency of the State of Arizona acting pursuant to A.R.S. Section 45-107 ("ADWR"), the COLORADO RIVER BOARD OF CALIFORNIA, an agency created under California Water Code Sections 12500-12541 ("CRB"), and the COLORADO RIVER COMMISSION OF NEVADA, an agency of the State of Nevada under NRS Sections 538.041 to 538.251 ("CRCN"), are participants to this MOU for purposes of Sections II., III.E, IV, and V. Additional entities that may be of assistance in implementing drought response actions

contemplated by this MOU may be added from time to time in the manner set forth in Section IV.B.

II. RECITALS

A. WHEREAS, in December 2007, the Secretary executed the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead ("2007 Guidelines") for implementing the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act;

B. WHEREAS, the Colorado River System suffers from the effects of a drought that began 15 years ago, leading to substantially decreased water elevation levels in both Lakes Mead and Powell;

C. WHEREAS, Colorado River System modeling projections show increasing near-term risk that water elevations in both Lakes Mead and Powell could decline to levels that would not only trigger shortage conditions in Lake Mead operations as set forth in the 2007 Guidelines, but could also impact the ability to draw or benefit from water in the lakes, including severely impacting hydropower resources;

D. WHEREAS, in December 2012, Reclamation and the seven Colorado River Basin States completed the Colorado River Basin Water Supply and Demand Study ("Basin Study"), with the purpose of defining future imbalances in water supply and demand in the Colorado River System through the year 2060, and developing and analyzing options and strategies to resolve those imbalances. The Basin Study concludes that without further proactive actions, there may be a long-term potentially significant imbalance in future water supply and demand. Options to address these imbalances include, without limitation, augmentation of the system and increased agricultural and municipal water conservation;

E. WHEREAS, water agencies in the Colorado River Basin provide water to over 30 million residents in the United States, meeting basic human needs and sustaining vital economic functions regionally and nationally. Based on their many shared interests, the Municipal Water Agencies and other agencies within the Colorado River Basin have worked together for over 20 years on initiatives to develop water supplies, manage demand through conservation, and operate facilities to use Colorado River System water for the benefit of multiple interests;

F. WHEREAS, all CAWCD municipal customers supplied by the Central Arizona Project, including Phoenix and Tucson, have been successful in reducing per capita consumption by making significant investments in conservation, reuse, and infrastructure. The City of Phoenix has reduced water use by 35 percent since 1980, while approximately 97 percent of the City of Scottsdale's reclaimed water is reused for turf irrigation or recharge efforts. CAWCD municipal customers remain committed to expand these investments;

G. WHEREAS, in MWD's service area, southern California urban agencies have funded a wide variety of agricultural and urban conservation measures that have allowed the State of California to reduce its use of Colorado River water by 20 percent since 2002. In addition, through investments in water conservation and local supply management, including recycling, urban southern California imports less water today than it did 20 years ago, despite a significant increase in the region's population. MWD remains committed to expand these efforts;

H. WHEREAS, through significant investment in a variety of aggressive conservation measures, SNWA's annual consumptive use of water from the Colorado River decreased by nearly 100,000 acre-feet between 2002 and 2013, despite a population increase of 480,000 people over that same period. This equates to a reduction of approximately 30 percent in southern Nevada's gallons per capita per day demand. Southern Nevada currently reclaims

nearly all of its wastewater, either through Colorado River return flow credits or direct reuse. SNWA remains committed to expand these efforts;

I. WHEREAS, the Municipal Water Agencies and Reclamation provided funding for design and construction of the Warren H. Brock (Drop 2) Reservoir that saves approximately 70,000 acre-feet of water annually; provided funding for a pilot project for operation of the Yuma Desalting Plant from May 2010 to March 2011, which conserved over 30,000 acre-feet; and agreed to contribute capital for the pilot program of water infrastructure improvements in Mexico to conserve water, in exchange for 124,000 acre-feet of water;

J. WHEREAS, MWD and SNWA have used Extraordinary Conservation, Imported, and Tributary Conservation Intentionally Created Surplus ("ICS") programs to fund conservation programs resulting in a total of more than one-half million acre-feet of conserved water stored in Lake Mead at the beginning of 2014;

K. WHEREAS, the United States acting through Reclamation, the Municipal Water Agencies, and Denver Water, separate and apart from this MOU, entered into an agreement for a Pilot Program for Funding the Creation of Colorado River System Water Through Voluntary Water Conservation and Reductions in Use dated July 30, 2014 ("System Conservation Pilot") in an effort to examine the efficacy of basin-wide solutions to the increasing near-term risk that Lakes Powell and Mead could continue to decline. For the first time, the parties in the System Conservation Pilot committed to spending up to $11,000,000 during the next two years to develop water for the system rather than any individual user. Reclamation and the Municipal Water Agencies recognize that measures in addition to those contemplated by the System Conservation Pilot are needed in both the short and long term;

L. WHEREAS, in addition to the actions identified above, the States of California, Arizona, and Nevada (the "Lower Division States") and a number of water users located in those states (together with the Lower Division States, the "Lower Division States and Water Users")

have worked cooperatively with the Secretary and Reclamation since 2013 to identify approaches and additional voluntary proactive measures that federal, state and local entities can take in a coordinated fashion to plan for and respond to drought and address long-term supply and demand sustainability in the Lower Basin;

M. WHEREAS, a fundamental component of Lower Basin drought contingency planning is voluntary development of additional quantities of water stored in Colorado River reservoirs, in particular Lake Mead, necessary to reduce the risk of Lake Mead reaching critical reservoir elevations ("Protection Volume(s)"). From those cooperative discussions, the Lower Division States and Water Users identified the goal of developing between 1.5 and 3.0 million acre-feet of Protection Volume between 2014 and 2019. Protection Volumes could be generated, for example, through new or expanded programs to create ICS (as such term is defined in the 2007 Guidelines), reductions in water use, reductions in off-stream storage of Colorado River water, or other actions that result in increased Lake Mead elevations; and

N. WHEREAS, Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN desire pursuant to the terms of this MOU to work among the Lower Division States and Water Users to reduce the risks associated with the ongoing historic drought in the Colorado River Basin.

THEREFORE, mindful of the circumstances outlined in these Recitals, Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN express their mutual understanding as follows:

III. PILOT DROUGHT RESPONSE ACTIONS

A. PURPOSE

Reclamation and the Municipal Water Agencies desire to take initial steps between 2014 and 2017 towards generating additional water in Lake Mead to reduce the risk of reaching

critical reservoir elevations in a manner consistent with the Law of the River including, but not limited to, the Consolidated Decree in *Arizona v. California,* 547 U.S. 150 (2006) and the 2007 Guidelines.

B. PROTECTION VOLUMES

i. Working together, Reclamation and the Municipal Water Agencies will use their best efforts to create Protection Volumes between 2014 and 2017, as set forth in more detail in this MOU. Some methods of creating Protection Volumes may already be in use, but the creation of Protection Volumes may involve expansion, additions or changes to existing methods or programs, as appropriate.

ii. SNWA will use best efforts to create 45,000 acre-feet of Protection Volume between 2014 and 2017. SNWA may use a combination of the following to create Protection Volumes: restarting Coyote Spring Valley groundwater deliveries to Lake Mead, recovery of banked groundwater in Arizona or Nevada, additional leases or purchases of Muddy or Virgin River water rights, and reductions in off-stream storage of Colorado River water.

iii. CAWCD will use best efforts to create 345,000 acre-feet of Protection Volume between 2014 and 2017. CAWCD may intentionally create system water and anticipates using creation of Extraordinary Conservation ICS to create Protection Volumes.

iv. MWD will use best efforts to create 300,000 acre-feet of Protection Volume between 2014 and 2017 for the dual purpose of providing short-term drought relief in California and reducing the likelihood of Lake Mead reaching critical reservoir elevations. MWD may fund conservation projects to create or defer delivery of ICS water to create Protection Volumes. To meet these Protection Volumes, MWD will need flexibility during low reservoir conditions.

v. Reclamation will use best efforts to create 50,000 acre-feet of Protection Volume between 2014 and 2017 that will be dedicated as system water. Reclamation is

anticipated to use a combination of the following to create Protection Volumes: efficiency improvements, operational improvements, and creation of system water.

vi. Reclamation and the Municipal Water Agencies will consult on the suitability and appropriateness of adding additional mechanisms to create Protection Volumes, if and when such mechanisms are identified.

C. MISCELLANEOUS PROTECTION VOLUME TERMS

Water generated through the initial funding of $11 million for the System Conservation Pilot will not be counted towards Reclamation's and the Municipal Water Agencies' Protection Volumes; provided, however, Reclamation and the Municipal Water Agencies may agree that upon any expansion of the System Conservation Pilot, water generated through such expansion may be counted towards Reclamation's and the Municipal Water Agencies' Protection Volumes in any proportion agreed upon by Reclamation and the Municipal Water Agencies.

D. IDENTIFICATION AND TRACKING OF PROTECTION VOLUMES

Reclamation and the Municipal Water Agencies will work together to identify and track achievement of Protection Volume goals set forth in Section III.B of this MOU, and will consult at least annually to discuss actions taken under this MOU.

E. FURTHER ASSURANCES

Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN will cooperate with the others, and with any additional participants that are included in the MOU pursuant to Section IV.B, as appropriate, to implement voluntary actions undertaken to create Protection Volumes. From time to time, and when requested, Reclamation and the Municipal Water Agencies will share information about the identification and tracking of Protection Volumes with the Lower Division States and Water Users and the Upper Division States. Reclamation and the Municipal Water Agencies will consult at least annually with ADWR, CRB, and CRCN to discuss actions taken under this MOU.

F. URGENT NEEDS

If any Municipal Water Agency is faced with operating conditions that have the potential to adversely affect its ability to meet Direct Delivery Domestic Use needs, as defined in the 2007 Guidelines, a consultation will be initiated as requested by any Municipal Water Agency to discuss ways to address such potential impacts.

IV. FURTHER ACTIONS AND ASSISTANCE OF OTHER ENTITIES

A. CONSULTATION

Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN recognize that voluntary actions by other entities from each of the Lower Division States will be essential to implement and build on the voluntary actions identified in this MOU. In addition to consulting with each other, Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN agree to seek the participation of additional entities within the Lower Division States at the times and for the purposes set forth below:

i. Implementation of Additional Drought Response Actions: After gaining experience related to the successes and challenges associated with voluntary actions to create Protection Volumes, Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN agree to initiate consultation not later than August 2016 with the specific objective of developing additional Protection Volumes, by extending, revising or adding to the activities implemented in this MOU.

ii. Planning to Address Long Term Sustainability: Voluntary actions identified in Section III.B of this MOU represent and contain elements of both drought response and sustainability actions. Notwithstanding the importance of implementing these voluntary actions, Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN recognize that additional actions among Reclamation and the Lower Division States and Water Users will be

needed to address the existing water supply and demand imbalance and long-term sustainability of the Colorado River system within the Lower Basin, and will necessarily include additional flexibility for water users during low reservoir conditions. It is with this recognition that Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN commit, throughout the term of this MOU, to continued and increased focus on identifying and addressing these concerns and will discuss the progress of discussions related to the prioritization, funding and implementation for such additional actions during the August 2016 consultation process with the goal of implementing additional actions prior to 2020. In addition to these consultations, Reclamation will work to plan and implement actions to replace, recover and reduce system losses from the Colorado River System.

iii. Initiating Further Drought Response Actions: In any year that Lake Mead is projected, based on the Minimum Probable forecast contained in the April 24-Month Study, to be at or below 1,060 feet on December 31st of that year, Reclamation will request that the Lower Division States and Water Users immediately reinitiate consultations with the specific objective of identifying additional actions to significantly reduce the potential of reaching Lake Mead elevation 1,020 feet and initiating actions to begin to achieve that objective by December 31st of that year.

iv. Revisiting Necessity for Drought Response Actions: In any year that Lake Mead is projected, based on the Most Probable forecast contained in the April 24-Month Study, to be above 1,105 feet on December 31st of that year, Reclamation will reinitiate consultations, with the specific objective of revisiting whether it is appropriate to continue, revise, or terminate ongoing drought response actions.

B. <u>ADDITIONAL PARTICIPANTS</u>

Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN acknowledge that other entities may be of assistance from time to time in the generation of Protection Volumes

contemplated hereunder, and agree that such entities may upon approval of Reclamation, the Municipal Water Agencies, ADWR, CRB, and CRCN which approval shall not be unreasonably withheld, become participants in this MOU for purposes of activities set forth in Section III.E, this Section IV, and Section V; provided, however, the addition of such entities shall not materially alter the terms of this MOU.

V. GENERAL PROVISIONS

A. This MOU will become effective upon the date set forth in Article I of this MOU (the Effective Date) and will remain in effect until December 31, 2019 ("Term").

B. Nothing in this MOU is intended to or shall be construed to limit or affect in any way the authority or legal responsibilities of any participant. Nothing in this MOU binds any participant to perform beyond their respective authorities.

C. Nothing in this MOU may be construed to obligate Reclamation, the United States, any Municipal Water Agency, ADWR, CRB, or CRCN to any current or future expenditure of resources in advance of the availability of appropriations. Nor does this MOU obligate Reclamation, any Municipal Water Agency, ADWR, CRB, or CRCN to spend funds on any particular project or purpose, even if funds are available.

D. The mission requirements, funding, personnel, and other priorities of the participants may affect their ability to undertake actions to achieve the goals identified in this MOU.

E. Specific activities that involve the transfer of money, services, or property between Reclamation and another participant are not contemplated under the scope of this MOU. To the extent that any such activities are subsequently considered between or among any of the participants, execution of separate agreements or contracts will be required.

F. Nothing in this MOU is intended to or shall be construed to restrict the participants from participating in similar activities or arrangements with other public or private agencies, organizations, or individuals.

G. This MOU is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any person or entity against any participant, including a participant's Departments, Agencies, entities, officers, employees, or agents.

H. Any information furnished between the participants under this MOU may be subject to the Freedom of Information Act, 5 U.S.C. § 552, et seq. (FOIA) and respective state authorities. Reclamation and the other participants agree to consult each other regarding any such relevant requests and prior to releasing potentially privileged or exempt documents.

I. This MOU is subject, as applicable, to the laws of the United States of America.

J. All cooperative work under the provisions of this MOU will be accomplished without discrimination against any employee because of race, sex, creed, color, national origin, or any other legally protected class as identified in Federal or applicable state law.

K. This MOU shall remain in effect for an initial term as set forth in this MOU and may be renewed if the participants agree.

L. Each participant in this MOU will consult with the other participants in a timely manner to ensure coordination prior to release of any written statements intended for widespread publication that refer to this MOU.

M. Nothing in this MOU may be interpreted to imply that a participant endorses any product, service, or policy of the other participants, except as specifically set forth in this MOU. No participant will take any action or make any statement that suggests or implies such type of endorsements.

N. No participant in this MOU will be considered to have waived any policy, administrative or legal right hereunder.

O. This MOU may be amended, modified, or supplemented only by the written, signed agreement of the participants.

P. No Member of or Delegate to the Congress, or Resident Commissioner, or official of CAWCD, MWD, SNWA, ADWR, CRB, or CRCN or any Elector or Electors may benefit from this MOU other than as a water user or landowner in the same manner as other water users or landowners.

Q. No participant in this MOU intends for this MOU to confer any benefit upon any person or entity not a signatory to this MOU, whether as a third-party beneficiary or otherwise.

R. This MOU may be executed in counterparts, each of which will be an original and all of which, together, constitute only one MOU.

S. POINTS OF CONTACT

To the extent that written notices and/or requests are undertaken under the terms of this MOU, the participants may be contacted at the following addresses:

RECLAMATION:

Regional Director
Lower Colorado Region
Attention: LC-1000
500 Fir Street
Boulder City, NV 89005

CAWCD:

Central Arizona Water Conservation District
23636 North 7th Street
Phoenix, AZ 85024-3801
Attn: General Manager

MWD:

The Metropolitan Water District of Southern California
P.O. Box 54153
Los Angeles, CA 90054-0153
Attn: General Manager

SNWA:

Southern Nevada Water Authority
1001 South Valley View Boulevard, MS #485
Las Vegas, NV 89153
Attn: General Manager

ADWR:

Arizona Department of Water Resources
3550 North Central Avenue
Phoenix, AZ 85012
Attn: Director

CRB:

Colorado River Board of California
770 Fairmont Avenue, Suite 100
Glendale, CA 91203-1068
Attn: Executive Director

CRCN:

Colorado River Commission of Nevada
555 E. Washington Avenue, Suite 3100
Las Vegas, NV 89101
Attn: Executive Director

A participant may change its address by giving the other participants notice of the change in writing.

IN WITNESS WHEREOF, the participants hereto have executed this MOU on the day and year first written above.

Approved as to legal sufficiency:

By: _____

THE UNITED STATES OF AMERICA

By: _____

Terrance J. Fulp
Lower Colorado Regional Director
Bureau of Reclamation

Approved as to form:

By: _____
Jay M. Johnson
General Counsel

CENTRAL ARIZONA WATER CONSERVATION DISTRICT

By: _____
David V. Modeer
General Manager

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

By: _____

Jeffrey Kightlinger
General Manager

Approved as to form:

By: Dana Walch FOR
Gregory J. Walch
General Counsel

SOUTHERN NEVADA WATER AUTHORITY

By: _____
John J. Entsminger
General Manager

Approved as to form:

By: _____
Kenneth C. Slowinski
Chief Counsel

ARIZONA DEPARTMENT OF WATER RESOURCES

By: _____
Michael J. Lacey
Director

COLORADO RIVER BOARD OF CALIFORNIA

By: _____

Tanya Trujillo
Executive Director

Approved as to form:

By: _____
Jennifer Crandell
Special Counsel Attorney General

COLORADO RIVER COMMISION OF NEVADA

By: _____
Jayne Harkins
Executive Director

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Agreement	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors approve and authorize the General Manager to sign an agreement between Carollo Engineers, Inc., and the Authority for the "Blending Requirements for Water from Direct Potable Reuse Treatment Facilities" study, and accept funds in an amount not to exceed $111,376 for this research work.	

Fiscal Impact:
If the above recommendation is approved, funds in an amount not to exceed $111,376 will be accepted by the Authority.

Background:
Indirect Potable Reuse (IPR) is a critically important component of the current and future water supplies throughout the world. IPR relies upon the use of an environmental buffer, such as a groundwater basin or surface water area, between the wastewater treatment plant effluent and the drinking water treatment plant (WTP) influent. The environmental buffer provides a measure of treatment, blending, and response time in the event of a treatment process failure. Direct Potable Reuse (DPR) eliminates the environmental buffer, thus requiring a more detailed understanding of treatment process goals, performance, and monitoring. Water produced from a DPR facility can be inserted directly into the potable water distribution system, added upstream of a WTP, or added directly within a WTP between various processes. Little is known about the impact of blending in relation to treatability at the WTP and water quality issues within both the WTP and the finished water. This study will provide recommendations and guidance for the appropriate use of blending as part of a DPR project, including evaluations of treatment, impact of different water qualities and blending locations, summary of corrosion issues, and the impact on engineered storage buffer design.

The Authority's Water Quality Research and Development (R&D) Division is a nationally recognized premier research laboratory with expertise in the study of water quality issues and treatment approaches associated with potable reuse and has worked closely and successfully with Carollo Engineers, Inc. (Carollo), and the Water Research Foundation (WaterRF) on several water-reuse related research projects. Recognizing this, Carollo requested the Authority's Water Quality R&D Division to perform bench- and pilot-scale testing and water quality analytical work in support of the WaterRF Study #4536, "Blending Requirements for Water from Direct Potable Reuse Treatment Facilities," that was awarded to Carollo.

AGENDA ITEM # 4

If approved, the Authority would receive $111,376 from Carollo under the attached agreement to conduct bench- and pilot-scale testing and water quality analytical research work for this study. The Authority is also a participant in this study, providing additional cost-share services, which includes the value of existing equipment use. This research directly complements the mission of developing solutions that will ensure adequate high quality future water supplies for the Las Vegas Valley.

This agreement is being entered into pursuant to Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:KPF:DJR:ED:jf
Attachments

DISCLOSURE OF OWNERSHIP/PRINCIPALS

Business Entity Type						
☐ Sole Proprietorship	☐ Partnership	☐ Limited Liability Company	☒ Corporation	☐ Trust	☐ Non-Profit Organization	☐ Other

Business Designation Group					
☐ MBE	☐ WBE	☐ SBE	☐ PBE	☐	☐
Minority Business Enterprise	Women-Owned Business Enterprise	Small Business Enterprise	Physically Challenged Business Enterprise		

Corporate/Business Entity Name:	Carollo Engineers, Inc.	
(Include d.b.a., if applicable)	N/A	
Street Address:	2700 Ygnacio Valley Road, Suite 300	**Website:www.carollo.com**
City, State and Zip Code:	Walnut Creek, CA 94598	**POC Name and Email: Eva Steinle-Darling esd@carollo.com**
Telephone No:	925-932-1710	**Fax No:**
Local Street Address:	376 East Warm Springs Road, Suite 250	**Website:www.carollo.com**
City, State and Zip Code:	Las Vegas, NV 89119	**Local Fax No:702-792-4533**
Local Telephone No:	702-696-6217	**Local POC Name Email: Lisa Freestone, lfreestone@carollo.com**
Number of Clark County, Nevada Residents Employed: 18		

All entities, with the exception of publicly-traded and non-profit organizations, must list the names of individuals holding more than five percent (5%) ownership or financial interest in the business entity appearing before the SNWA Board of Directors.

Publicly-traded entities and non-profit organizations shall list all Corporate Officers and Directors in lieu of disclosing the names of individuals with ownership or financial interest. The disclosure requirement, as applied to land-use applications, extends to the applicant and the landowner(s).

Entities include all business associations organized under or governed by Title 7 of the Nevada Revised Statutes, including but not limited to private corporations, close corporations, foreign corporations, limited liability companies, partnerships, limited partnerships, and professional corporations.

Full Name	Title	% Owned (Not required for Publicly Traded Corporations/Non-profit organizations)
N/A – no single shareholder holds more than 5%		

This section is not required for publicly-traded corporations.

1. Are any individual members, partners, owners or principals, involved in the business entity, an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please note that SNWA employee(s), or appointed/elected official(s) may not perform any work on professional service contracts, or other contracts, which are not subject to competitive bid.)

2. Do any individual members, partners, owners or principals have a spouse, registered domestic partner, child, parent, in-law or brother/sister, half-brother/half-sister, grandchild, grandparent, related to an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please complete the Disclosure of Relationship form on Page 2. If no, please print N/A on Page 2.)

I certify under penalty of perjury, that all of the information provided herein is current, complete, and accurate. I also understand that the SNWA will not take action on land-use approvals, contract approvals, land sales, leases or exchanges without the completed disclosure form.

Signature: [signature]

Print Name: LISA M. FREESTONE

Title: VICE PRESIDENT

Date: 9/17/14

Revised 3/1/11

DISCLOSURE OF RELATIONSHIP

List any disclosures below:
(Mark N/A, if not applicable.)

NAME OF BUSINESS OWNER/PRINCIPAL	NAME OF SNWA EMPLOYEE OR OFFICIAL AND JOB TITLE	RELATIONSHIP TO SNWA EMPLOYEE OR OFFICIAL	SNWA EMPLOYEE'S/OFFICIAL'S DEPARTMENT
N/A			

"Consanguinity" is a relationship by blood. "Affinity" is a relationship by marriage.

"To the second degree of consanguinity" applies to the candidate's first and second degree of blood relatives as follows:

- Spouse – Registered Domestic Partners – Children – Parents – In-laws (first degree)
- Brothers/Sisters – Half-Brothers/Half-Sisters – Grandchildren – Grandparents – In-laws (second degree)

For SNWA Use Only:

If any Disclosure of Relationship is noted above, please complete the following:

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in the contracting/selection process for this particular agenda item?

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in any way with the business in performance of the contract?

Notes/Comments: No relationships noted.

David L. Johnson
Signature

David L. Johnson
Print Name
Authorized Department Representative

CAROLLO ENGINEERS, INC.

WATER RESEARCH FOUNDATION CONSULTANT AGREEMENT FOR GOVERNMENT OR NOT-FOR-PROFIT ORGANIZATIONS

AGREEMENT FOR PROFESSIONAL SERVICES

Carollo Project No. 9589A.00

This AGREEMENT made and entered into this _____ day of November, 2014 by and between Carollo Engineers, Inc., (hereinafter "ENGINEER"), and the Southern Nevada Water Authority (hereinafter "CONSULTANT").

WITNESSETH:

WHEREAS, the ENGINEER and the CONSULTANT wish to enter into an Agreement (hereinafter "Agreement") for the furnishing of services in connection with the Water Research Foundation (hereinafter "the Foundation" or "WaterRF") **Project #4536 Blending Requirements for Water From Direct Potable Reuse Treatment Facilities** (hereinafter "Project"), and

WHEREAS, the CONSULTANT possesses the qualifications to perform the necessary services for the ENGINEER in connection with the Project, and

NOW THEREFORE, in consideration of the mutual promises and covenants of the parties hereto, it is agreed as follows:

SECTION 1 - GENERAL

1.1 The services herein required, shall be set forth in the attached Task Order. In performance of these services, the CONSULTANT shall provide qualified personnel. The Task Order shall include designation of a Project Manager and a list of proposed personnel. The CONSULTANT shall promptly notify the ENGINEER of any changes in his initial organization.

1.2 It is intended that each additional Task Order sequentially numbered setting forth the CONSULTANT's Services, Time of Performance, and Payment, or any other conditions, shall become a supplement to and a part of this Agreement.

SECTION 2 - PAYMENT

2.1 Compensation for providing services referred to in Section 1 shall be detailed in the attached Task Order.

2.2 The CONSULTANT may submit invoices to the ENGINEER once per month. Invoices shall be prepared in such form and supported by documentation as the ENGINEER may reasonably require. All such invoices shall be reviewed and approved by the ENGINEER before submittal to THE FOUNDATION together with THE FOUNDATION's Progress Billing statement, attached to this Agreement.

2.3 The payment schedule will be based on progress increments over the Project life. Following receipt of reimbursement from THE

FOUNDATION, payment will be made to the CONSULTANT within 15 days for the value of the partially completed services.

2.4 Final payment of any balance will be made upon completion of the CONSULTANT's services and acceptance by THE FOUNDATION.

SECTION 3 - TIME OF PERFORMANCE

3.1 The Time of Performance under this Agreement shall be defined in the attached Task Order.

3.2 The CONSULTANT shall report from time to time as requested by the ENGINEER, its progress under this Agreement. The CONSULTANT shall plan its performance of services to accomplish its timely completion, and shall promptly notify the ENGINEER of any anticipated delay which may affect the CONSULTANT's Time of Performance.

3.3 CONSULTANT shall use all reasonable efforts to complete the proposed work on schedule.

SECTION 4 - LEGAL RELATIONS

4.1 The CONSULTANT is for all purposes an independent contractor. In no event shall the CONSULTANT or any personnel retained by the CONSULTANT be deemed to be an agent or employee of the ENGINEER or engaged by THE FOUNDATION for the account of or on behalf of the ENGINEER. Full control of means and methods of work including provisions for required safety precautions shall be the responsibility of the CONSULTANT.

4.2 The CONSULTANT shall not make, sublet or assign any of the services covered by this Agreement, except with the prior written approval of the ENGINEER and in compliance with the terms, provisions and conditions of the Agreement.

4.3 The CONSULTANT shall, upon request and without cost, provide ENGINEER and THE FOUNDATION copies of all deliverables and all supporting material.

SECTION 5 - INSURANCE

5.1 Business Insurance. ENGINEER acknowledges that CONSULTANT is self-insured. CONSULTANT shall promptly furnish to ENGINEER evidence of self-insurance in a form satisfactory to ENGINEER.

5.2 Workers' Compensation Insurance. A current Workers' Compensation and Employer's Liability insurance certificate with limits pursuant to state law is required. ENGINEER acknowledges that CONSULTANT is self-insured. **CONSULTANT shall attach evidence of self-insurance in a form satisfactory to the ENGINEER to the signed Agreement before returning to ENGINEER.** This Agreement is not final and invoices cannot be paid until an insurance certificate evidencing such policy is received.

SECTION 6 - INDEPENDENT INVESTIGATIONS

6.1 The CONSULTANT has reviewed the services required under the Agreement and has made his own investigation concerning services. The CONSULTANT has determined they have sufficient information and qualified personnel to enter into the Agreement and perform the services called for herein. The CONSULTANT agrees and acknowledges that the ENGINEER has made no representations or warranties

concerning the services provided and that the CONSULTANT has relied solely upon his own review and investigation prior to entering into this Agreement.

SECTION 7 - TERMINATION OF AGREEMENT

7.1 ENGINEER may terminate this Agreement by providing CONSULTANT with ten (10) days written notice thereof and, if the event of default or breach, thereafter, ten (10) days to undertake a cure. Absent any default or breach of contract, CONSULTANT will be reimbursed for that portion of the work completed prior to termination, including obligations that could not be canceled prior to termination.

7.2 In the event termination is the result of breach or default, absent ENGINEER's breach or default, CONSULTANT will be reimbursed for that portion of the work completed prior to termination and such other relief as may be provided by the Funding Agency pursuant to the Funding Agency's project agreement.

SECTION 8 - ENTIRE AGREEMENT

8.1 This Agreement including attachments incorporated herein by reference represents the entire Agreement and understanding between the parties and any negotiations, proposals or oral agreements are intended to be superseded by this written Agreement. Any supplement or amendment to this Agreement to be effective shall be in writing and signed by the parties.

SECTION 9 - REQUIRED PROVISIONS

9.1 The CONSULTANT shall, in the performance of this Agreement, comply with all federal, state and local laws; and all regulations and orders issued under any applicable law.

9.2 The CONSULTANT shall perform all services in accordance with the attached Funding Agency's agreement specifically relating to CONSULTANT. Except for Section 10 of this Agreement, if there is a conflict between this Agreement and the Funding Agency's agreement, the Funding Agency's agreement shall control. To the extent that Section 10 of this Agreement conflicts with the Funding Agency's agreement, this Agreement shall control.

SECTION 10 - GOVERNING LAW

10.1 This Agreement is to be governed and construed in accordance with the laws of the state of Nevada.

10.2 The venue for any dispute not directly involving the Funding Authority, arising from the terms of this Agreement, shall be Clark County, Nevada.

10.3 Except as otherwise set forth in this Agreement, the Parties shall bear their own attorneys' fees and costs incurred in resolving the claims, as well as on the preparation of this Agreement. In the event that any Party commences an action to enforce or interpret this Agreement, or for any other remedy based on or arising from this Agreement, the prevailing party therein shall be entitled to recover its reasonable and necessary attorneys' fees and costs incurred. For the purposes of this provision, the "prevailing party" shall be that party which has been successful with regard to the main issue, even if that Party did not prevail on all issues.

IN WITNESS WHEREOF, duly authorized representatives of the parties have signed in confirmation of this Agreement, with effective date the day and year first above written.

CAROLLO ENGINEERS, INC.

By: _____

[Title]

By: _____

[Title]

SOUTHERN NEVADA WATER AUTHORITY

By: _____

John J. Entsminger, General Manager

P.O. Box 99954

Address

Las Vegas, NV 89193-9954

City State Zip

APPROVED AS TO FORM:

By: _____

Laura Ellen Browning, Deputy Counsel

Date _____

Phone (702) 856-3668

Fax (702) 856-3647

E-mail eric.dickenson@snwa.com

Fed Tax ID # 88-0278492

Certified MBE, WBE or SBE? _____ Yes, if so which? _____ No

PROGRESS BILLING

Please submit invoice in one pdf format to: accountspayable@carollo.com

Subject/Project Title: _____

THE FOUNDATION
Project No. _____

Carollo Project No. _____

Reimbursement Request for: Period No.: _____

From: _____ To: _____

To: Carollo Engineers, Inc.
4600 E. Washington Street, Suite 500
Phoenix, AZ 85034
Attention: Accounts Payable

If mailing the invoice, please send to address at left.

From: [Consultant]
[Address]
[City, State Zip Code]

Sent By: _____ Date: _____

Category	Budget		Spent This Period		Spent to Date	
	%	$	%	$	%	$
EXPENDITURES:						
Labor (including benefits and overhead)						
Travel						
Materials and Supplies						
Computer/Phone/Postage						
SUBTOTAL	100%					[A]
IN-KIND CONTRIBUTION RECORD:						
Labor						
Travel						
Materials and Supplies						
Computer/Phone/Postage						
SUBTOTAL	100%					
TOTAL						

CONTRACT AMOUNT	
Less 20% Retainage	
Funds Available	[B]

Amount of [A] or [B], whichever is less	

Less Previous Payments	
Amount Due This Period	

BACKUP DOCUMENTATION

Project Funding Agreement 04536 between funding agency and Carollo Engineers.

SNWA is a subcontractor to this agreement.

Project Funding Agreement 04536

This Project Funding Agreement (hereafter "PFA") is entered into on _____, 20__, (the "Effective Date") by and among the Water Research Foundation (the "Foundation"), a Delaware non-profit corporation whose principal place of business is located at 6666 W. Quincy Ave., Denver, Colorado 80235, and Carollo Engineers, Inc. ("Researcher"), a an environmental engineering company whose principal place of business is located at 2700 Ygnacio Valley Road, Suite 300, Walnut Creek, California 94598.

The Foundation has selected said Sub-recipient to receive a research and development grant as more specifically detailed in this PFA. The parties mutually agree as follows:

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

A. "Cost Share" the portion of allowable costs that the sub-recipient, subcontractor or third-party participant contributes toward completing the Foundation project. Cost share includes any non-federal cash and non-cash contributions from the sub-recipient and subcontractors, and non-federal cash contributions from participants. All Cost Share must meet Code of Federal Regulations (CFR) requirements in 2 CFR Part 215.23 or the requirements of OMB Circular A-102.24 as applicable.

B. "Foundation Award" is that portion of the Project Funds which the Foundation has agreed to contribute to fund the Project under this PFA, as detailed in Exhibit C.

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

D. "PAC" is the Project Advisory Committee that consists of independent volunteers selected by the Foundation and Co-funders to provide technical review, assistance, and/or expertise related to the Project. The number of volunteers to serve on the PAC will be determined by the Foundation.

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

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

G. "Project Funds" is the aggregate maximum amount of cash award which the Foundation agrees to provide to Sub-recipient to fund its performance of the Project pursuant to this PFA.

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

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

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

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

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

II. GENERAL OBLIGATIONS OF THE PARTIES

A. The Sub-recipient.

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

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

3. All disbursements of Project Funds will be paid directly to Sub-recipient. Sub-recipient shall remain solely responsible for payment of its Subcontractors, and for procurement of all equipment, materials, and other resources necessary for performance of the Project hereunder. *Equipment procured under this PFA and associated with the Project Scope of Work detailed in Exhibit A is solely owned by the Sub-recipient.*

4. Focus Area Annual Research Summit

Projects that are funded with the Foundation's Focus Area funds are required to participate in the Focus Area Annual Research Summit. The Summit brings together focus area Technical Advisory Committee (TAC) members, Focus Area Council (FAC) members, and project PIs on an annual basis to review the technical progress and results of projects funded within an individual focus area. The summits may also include researchers for projects that are related to the Focus Area, but not funded by Focus Area funds. Focus area research summits are held on an annual basis via web conference and are usually held in the fall or winter. PIs for projects funded under a particular focus area will be required to present project information at the Focus Area Annual Research Summit every year. Researchers should include time and resources in the proposal budget to cover the creation and presentation of a 15-30 minute presentation, to be given via webcast, on an annual basis for the duration of the project period.

B. The Foundation. The Foundation will disburse the Project Funds to the Sub-recipient as detailed in this PFA and Exhibit C. The Foundation's disbursement of the Project Funds may further be subject to the Foundation's receipt of its own funding from appropriate sources.

III. DISBURSEMENT OF PROJECT FUNDS

A. Advance Payment. All payments of the Project Funds will be disbursed by the Foundation directly to the Sub-recipient. The amount of Project Funds was determined on the basis of the budget submitted by the Sub-recipient, and set forth in Exhibit C. The Project Funds is a "not to exceed" amount and no payments in excess of such amount are authorized or required. Following the Effective Date the Foundation will advance to the Sub-recipient 10% of the Project Funds. All subsequent disbursements of the Project Funds shall be governed by the requirements described in Section III.B below and in Exhibit C.

B. Invoicing and Payments.

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

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

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

(a) The ten percent (10%) advance payment must be shown on all invoices, including the final invoice, as an advance payment received. Subject to the hold back provision below, invoices will be paid to the extent actual costs incurred exceed the advance payment.

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

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

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

IV. COMPLIANCE MONITORING

A. Financial Management System. The Sub-recipient shall maintain an accounting system and accurate and complete accounting records that, at a minimum but without limitation, allow for the identification, tracking, and verification of costs, expenses, Cost Share, in-kind contributions, invoiced items, and funding received, all in a manner that is segregated and allocable solely to performance of the Project. All costs incurred must be supported by original receipts and be made available to the Foundation upon request.

B. Cost Principles. The Sub-recipient represents and warrants that the budget disclosures included in the Project Proposal and presented to the Foundation was prepared by Sub-recipient in full compliance with the cost principles governing determination of reimbursable costs and expenses in Sub-recipient's type of organization. Sub-recipient shall throughout the Project, and in the preparation of every invoice, report, and maintenance of its accounting system, remain in compliance with the cost principles by which it is governed. It shall be Sub-recipient's obligation to determine and comply with its governing cost principles.

- State, local or Indian tribal government, 2 CFR 225.
- Non-profit Organization (NPO), 2 CFR 230.
- Institution of Higher Education, 2 CFR 220.
- Hospitals, 45 CFR 74 Appendix E.
- Commercial (For Profit) and selected Non-Profit Organizations 48 CFR 31.2

C. Indirect Costs and Allocation of Costs:

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

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

E. Audit and Monitoring.

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

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

3. Any deficiencies or non-compliance in Sub-recipient's systems, procedures, record keeping, finances, and performance of other obligations under this PFA discovered in the audit, review or monitoring process, or discovered otherwise, may, at the Foundation's option, require Sub-recipient to take corrective action that has been detailed by the Sub-recipient and approved by the Foundation for the Sub-recipient to remedy the deficiency or noncompliance, or may result in the Foundation exercising its termination rights under Section VII below.

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

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

V. PROCUREMENT STANDARDS

A. Procurement Standards. It is an express requirement under the Proposal Guidelines and this PFA that the Sub-recipient remain in compliance with the U.S. Federal standards for procurement as are outlined in the U.S. Federal Uniform Administrative Requirements applicable to Sub-recipient's organization type. These standards govern procedures for procurement of supplies, equipment, and other services for which cost is incurred in whole or in part under this PFA. These standards include but are not limited to the following:

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

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

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

VI. IP RIGHTS AND PUBLICATION

A. Work Product.

1. The Foundation shall own all worldwide copyrights in all the Work Product, including the Scope of Work, all Periodic Reports, all Draft Reports, the Final Report, and all drafts of these works and reports. Sub-recipient shall and hereby does assign exclusively to the Foundation all right, title, and interest in and to the Work Product and the copyrights embodied therein. The Sub-recipient may use without restrictions all data from the Work Product such as innovations, creations, processes, designs, methods, formulas, plans, technical data and specifications.

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

3. The Foundation hereby grants the Sub-recipient a royalty free, perpetual, irrevocable, world-wide, nonexclusive license, without the requirement for any accounting, to utilize Foundation's Intellectual Property solely for educational purposes.

B. Inventions and Patents.

1. All proprietary or patentable ideas, devices, methods, formulations, designs, and other inventions developed or conceived by or on behalf of the Sub-recipient in the course of

performing under the Project, including, but not limited to, the right to apply for patent protection thereon (collectively, "Inventions"), shall remain the property of the Sub-recipient.

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

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

4. All IP rights that were owned and developed by the Sub-recipient or third parties prior to the Effective Date and outside the scope of the Project (collectively, "Preexisting IP"), and which the Sub-recipient will use in the performance of the Project, or incorporate in whole or in part into any Deliverables, has been fully disclosed and identified by the Sub-recipient in the Project Proposal. The Sub-recipient represents and warrants that all Preexisting IP is used with full authorization and permission from its respective owner, and copies of such permissions and licenses shall be provided to the Foundation by the Effective Date. The Sub-recipient shall obtain all appropriate permissions on the Foundation's behalf to the extent necessary to enable the Foundation to exercise its ownership and publication rights in the Work Product, including the Final Report, such right shall be transferable, sublicenseable, and shall not be subject to any payment or other obligation on the part of the Foundation. Such agreements to procure rights for the Foundation shall be subject to the Foundation's prior approval, in its sole discretion.

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

C. Publication. As the owner of Work Product, all rights to publish, distribute, publicly perform, and publicly present the Reports belong solely to the Foundation. Sub-recipient may publish or present based on the Work Product, in whole or in part, and only with the prior written permission of the Foundation, which may be withheld or conditioned at the Foundation's sole discretion. Any such request for permission from the Foundation must be made to the Foundation at least three (3) weeks prior to the requesting party's proposed date of publication or presentation based on any portion of the Work Product, and the request must be accompanied by copies of the proposed publication or presentation material. The Sub-recipient may in no event publish or present based on or exercise any other copyrights with respect to the Interim Reports or the Draft Report. All

copies of or presentations based on the Work Product authorized to be made by the Foundation shall furthermore conspicuously display the following notice:

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

D. Acknowledgement. Any public presentation or publication by the Sub-recipients, including a student writing a thesis, dissertation, or report, based on the Inventions or any portion of the Work Product, if permitted by the Foundation, shall include a statement substantially as follows: *"Carollo Engineers, Inc. recipient gratefully acknowledges that the Water Research Foundation are funders of certain technical information upon which this publication [manuscript] [presentation] is based. Carollo Engineers, Inc. thanks the Water Research Foundation, for their financial, technical, and administrative assistance in funding the project through which this information was discovered."*

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

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

VII. TERM AND TERMINATION

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

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

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

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

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

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

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

VIII. DISPUTE RESOLUTION

A. In the event of the Sub-recipient's performance, or other acts or omissions in performing the Project or under this PFA, Foundation's final determination, following reasonable consultation with the PAC, shall govern.

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

IX. STANDARD TERMS AND CONDITIONS

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

B. Quality Assurance. The Sub-recipient shall use its best efforts to *provide* all data and test results developed during the course of this PFA and included, or relied upon, in the Final Report are accurate to the best of its knowledge, information, and belief, *in accordance with the standard of care delineated in Section IX.C below.* In the event the Sub-recipient obtains any data, test results, information derived from such data or test results, or other information to be included in the Project from water utilities or any Subcontractor, the Sub-recipient will utilize reasonable and customary efforts to *determine* the accuracy of the information obtained; *notwithstanding, Sub-recipient shall be entitled to use and rely upon information, including data and test results, provided by the Foundation, any other Sub-recipient's of the Foundation, water utilities or other third parties.*

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

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

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

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

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

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

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

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

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

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

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

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

K. Integration. This PFA, including all attachments hereto and the documents and requirements referenced herein, contains the entire understanding between the parties relating to this PFA. This

PFA supersedes all prior and contemporaneous understandings, representations, negotiations, and agreements between the parties whether written or oral. In the event of a conflict between the terms of an Exhibit or other document referenced herein and this PFA, the terms of this PFA shall control.

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

M. Foundation Right of Approval. The Foundation shall have the right, in their sole discretion, to refuse to permit any employee of the Sub-recipient, or employee of an approved agent, assignee, or subcontractor of the Sub-recipient, to be located at a Foundation work location, or to provide services to the Foundation pursuant to this PFA.

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

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

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

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

R. Limitation of Liability. IN NO EVENT SHALL EITHER PARTY OR ANY OF THEIR OFFICERS, DIRECTORS, EMPLOYEES, AFFILIATES, AGENTS OR REPRESENTATIVES BE LIABLE TO ANY OTHER PARTY, OR ANY THIRD PARTY FOR ANY SPECIAL, INDIRECT, INCIDENTAL, EXEMPLARY OR CONSEQUENTIAL DAMAGES OR LOSS OF GOODWILL OR EXPECTED PROFITS OR REVENUES, IN ANY WAY RELATING TO THIS PFA, INCLUDING, WITHOUT LIMITATION, THE FAILURE OF ESSENTIAL PURPOSE, EVEN IF IT HAS BEEN NOTIFIED OF THE POSSIBILITY OR LIKELIHOOD OF SUCH DAMAGES OCCURRING, AND WHETHER SUCH LIABILITY IS BASED ON CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY, STATUTE, PRODUCTS

LIABILITY OR OTHERWISE. IN NO EVENT SHALL EITHER PARTY'S LIABILITY HEREUNDER EXCEED THEIR RESPECTIVE CONTRIBUTION ALREADY MADE UNDER THIS PFA.

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

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

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

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

Water Research Foundation

By: Robert C. Renner, P.E., B.C.E.E.
Title: Executive Director

P Falor

Date: 10/06/2014

pf

Carollo Engineers, Inc.

By: _____
Title: _____

Date: _____

Water Research Foundation

for: John Whitler

By: John Y. Whitler
Title: Research Manager

Date: 7 Oct 2014

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

Carollo Engineers, Inc.

By: Andrew Salveson. P.E.
Title: Principal Investigator

Date: _____

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

Signature Page Instructions

1. Review document and have a duly authorized representative and the Principal Investigator sign this page.
2. Only this signature page is required to be returned back to the Foundation.
3. Please **Email** a scanned PDF of the executed signature page to the following:
   a. Peggy Falor at pfalor@WaterRF.org
4. Do not return the entire agreement, only the signature page.
5. Please return no later than **ten (10) calendar days** from receipt.

The Foundation will email a PDF of this fully executed agreement to you for your files.

Exhibit A
Project 04536

Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

Project proposal, & all subsequent correspondence.

Attachment 1
Emerging Opportunities Program Proposal Cover Worksheet

Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

Organization: *(Legal name as it should appear in the contract)*
Principal Investigator: Andrew Salveson, P.E.
Organization: Carollo Engineers, Inc.
Address: 2700 Ygnacio Valley Road, Suite 300, Walnut Creek, CA 94598
Phone: 925-977-3060 E-mail: asalveson@carollo.com

Personnel:
Principal Investigator: Andrew Salveson, P.E.
Organization: Carollo Engineers, Inc.
Address: 2700 Ygnacio Valley Road, Suite 300, Walnut Creek, CA 94598
Phone: 925-977-3060 E-mail: asalveson@carollo.com

Anticipated Co-Principal Investigator: Shane Trussell, Ph.D., P.E.
Organization: Trussell Technologies
Address: 6540 Lusk Boulevard, Suite C175, San Diego, CA 92121
Phone: 858-458-1030 E-mail: shane.trussell@trusselltech.com

Anticipated Co-Principal Investigator: Prof. Marc Edwards, Ph.D.
Organization: Virginia Polytechnic Institute and State University
Address: Department of Civil Engineering, 407 Durham Hall, Blacksburg, VA 24061
Phone: 540-231-7236 E-mail: edwardsm@vt.edu

Authorized Representative: *Original Awards and amendments will be sent to this individual for review and acceptance, unless otherwise indicated.*
Principal Investigator: Andrew Salveson, P.E.
Organization: Carollo Engineers, Inc.
Address: 2700 Ygnacio Valley Road, Suite 300, Walnut Creek, CA 94598
Phone: 925-977-3060 E-mail: asalveson@carollo.com

Accounting Contact: *Individual authorized to accept payments.*
Name: Jane M. Anderson
Title: Senior Billing Administrator
Organization: Carollo Engineers, Inc.
Address: 4600 E. Washington Street, Suite 500, Phoenix, AZ 85034
Phone: 602-263-9500 E-mail: jmanderson@carollo.com

All Other Anticipated Participating Organizations (not listed above):

Organization	City/State/Country
Baribeau Environmental Engineering	Alta Loma, CA, US
National Water Research Institute	Fountain Valley, CA, US
Southern Nevada Water Authority	Las Vegas, NV, US
Denver Water	Denver, CO, US
City of Norman	Norman, OK, US
Orange County Water District	Fountain Valley, CA, US
City of Oxnard	Oxnard, CA, US
City of Peoria	Peoria, AZ, US
City of San Diego	San Diego, CA, US
Santa Clara Valley Water District	San Jose, CA, US
City of Santa Rosa	Santa Rosa, CA, US
Upper Occoquan Service Authority	Centerville, VA, US
Ventura Water	Ventura, CA, US
West Basin Municipal Water District	Carson, CA, US

Project Period: 21 months

Foundation Funds Requested: $ 325,000

Anticipated In-Kind or other Contributions: $ 389,310 (including $100,000 cash)

TOTAL PROJECT BUDGET: $ 714,310 **(Total of Foundation Funds and In-kind)**

PROPOSAL

Background and Statement of Need

Indirect Potable Reuse (IPR) is a critically important component of the current and future water supplies throughout the world. IPR relies upon the use of an environmental buffer, such as a groundwater basin or a surface water, between the wastewater treatment plant (WWTP) effluent and the drinking water treatment plant (WTP) influent. The environmental buffer provides a measure of treatment, blending, and response time in the event of a treatment process failure. Direct Potable Reuse (DPR) eliminates the environmental buffer, thus requiring a more detailed understanding of treatment process goals, performance, and monitoring. Water produced from a DPR facility can be inserted directly into the potable water distribution system, added upstream of a WTP, or added directly within a WTP between various processes (Figure 1).

Little is known about the impact of blending in relation to treatability at the WTP and water quality issues both within the WTP and in the finished water. The result of our efforts for this project will be recommendations and guidance for the appropriate use of blending as part of a DPR project, including evaluations of treatment, impact of different water qualities and blending locations, summary of corrosion issues, and the impact on Engineered Storage Buffer (ESB) design.

Key Definitions of Recycled Water Quality

- **Secondary effluent** – wastewater that has gone through primary and secondary treatment.
- **Advanced treated recycled water** – secondary effluent that has additional advanced treatment.
- **Purified water** – secondary effluent that has been purified by a reverse osmosis (RO) process or another equivalent level of treatment.
- **De facto potable reuse** – raw water supplies that have a substantial and consistent portion of flow coming from upstream wastewater discharges (Trussell et al., 2012).

Blending Issues and Concerns

For blending of recycled water with raw or finished water, there are key issues to be addressed:

- Aesthetics.
- Regulated and Emerging Contaminants.
- Microbiology.
- Corrosion.
- Location of Blending.

The quality of the recycled water used for blending depends strongly on the level of advanced treatment provided, which is in many cases controlled by treatment regulations. The proposed literature review will cover the range of regulations and treatment requirements impacting existing DPR facilities, proposed DPR treatment criteria (Trussell

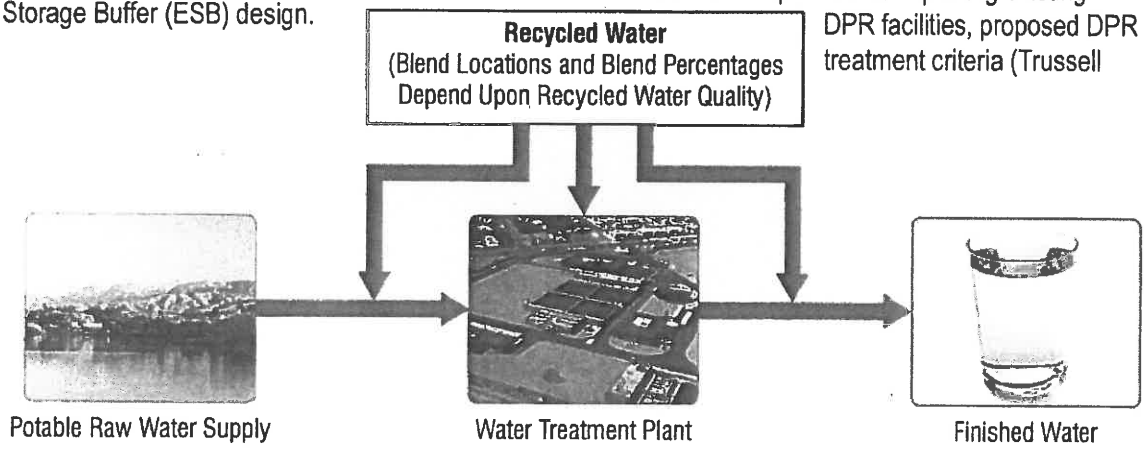

Figure 1. Blending Locations Proposed for Analysis

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et al., 2013), and criteria used in previous studies (WateReuse Research Foundation, 2013). Recent research on DPR has focused on pathogen barriers, treatment, risk, and engineered storage, providing a roadmap for DPR treatment from untreated wastewater to potable water, but not addressing what happens after final treatment at a WTP. Water quality may degrade significantly in the distribution system once the water leaves the WTP, with the largest problems occurring in the premise plumbing. "Premise plumbing" is a "worst case" location for microbial growth, corrosion and generation of aesthetic (taste and odor) problems because of the large surface area to volume ratios, long stagnation times, reactive materials, higher temperatures, high capital cost and other factors present in building plumbing (National Research Council, 2006).

The key parameters controlling potential water quality problems associated with blending include pH, hardness, alkalinity, conductivity and total dissolved solids (TDS), turbidity, color, disinfectant residuals, chloride, sulfate, organic material, dissolved inorganic carbon, and the calcite saturation indices (Peet et al., 2001). Because of this complexity, a literature review is needed that considers each of the different treatment and blending options, the beginning of which is presented here.

Aesthetics

When blending water from multiple sources, the resulting blends can lead to aesthetic challenges including taste, odor, color, turbidity, formation of scum, lack of lathering with soap, if hardness changes, etc. (Peet et al., 2001). Taste issues may be particularly important in RO-treated recycled waters that lack hardness, alkalinity, and minerals. Upon blending, most of these parameters cannot be evaluated by the law of mixtures or chemical theory, and must be tested using bench- or pilot-scale testing. From a DPR public perception standpoint, maintaining the aesthetic quality of the water is of particular importance when blending with recycled water, because some consumers will relate the aesthetics of the water to its safety.

Regulated and Emerging Contaminants

Recycled water may contain more chemicals than conventional water supplies, depending upon the level of recycled water treatment and the origin of existing raw water supplies. Of critical importance are those pollutants that may present health risks, including regulated inorganic, radiologic, industrial, and pesticide contaminants (Tchobanoglous et al., 2011). NWRI (2013) lists a number of chemicals of potential health concerns that may be present in wastewater, including non-regulated contaminants, such as pharmaceuticals, hormones, and consumer chemicals. Trussell et al. (2013) has determined the level of both pathogen reduction and pollutant reduction needed for safe implementation of both IPR and DPR treatment.

Depending on the characteristics of each water and location of blending, disinfectant residuals and disinfection byproducts (DBPs) can be influenced. For example, free chlorine reacts quickly with many substances including phenols, aromatic compounds, humic substances, iron, sulfides, and ammonia, some of which may be present in greater concentrations in recycled water than in drinking water, depending on treatment processes. Highly purified recycled water may have less total organic carbon (TOC) than many surface waters, resulting in decreased DBP formation and increased disinfectant stability. Secondary effluent and lesser degrees of advanced treatment will have more TOC than many surface waters, resulting in increased DBP formation, decreased disinfectant stability, taste and odor, and other impacts (WaterStats, 1996). Increased formation of nitrosamines, such as NDMA, is a significant concern.

Microbiology

Microorganisms that may remain in treated recycled water represent a threat to water quality. Problems can be from pathogen concerns, chemical concerns, or general aesthetics. As mentioned by Tchobanoglous et al. (2011) and demonstrated in Trussell et al. (2013), blending of (purified) recycled water should ***not*** be necessary to protect public health.

NRC (2006) identified the high risks associated with regrowth in premise plumbing and the Centers for Disease Control has acknowledged that opportunistic pathogens (OPs), such as Legionella, Pseudomonas, and Mycobacterium, proliferating in building plumbing systems are now the primary source of waterborne disease outbreaks (and a majority of associated deaths) in the U.S. (CDC, 2011; Brunkard et al., 2011). Incidents involving OPs have led to school closures (Fehr Snyder, 2011; Patrick, 1999), rejection of green plumbing devices in hospitals in green buildings (Sydnor and Bova, 2011; Nguyen et al., 2012; Chaberny and Gastmeier, 2004; Yapicioglu et al., 2012), and high profile disease outbreaks and deaths such as those recently observed at the Veterans Hospital in Pittsburg (VA OIG, 2013). Concerns are also emerging regarding the potential to spread antibiotic resistance genes (ARGs) via microbial re-growth[1] in water reuse systems, a topic that is of concern to policy makers in the U.S. and world-wide (Fahrenfeld et al., 2013; Pruden, 2013; Wellington et al., 2013). Increasingly, the water environment is being scrutinized as a potentially important pathway by which antibiotic resistance may spread (Wellington et al., 2013). Addressing knowledge gaps related to opportunistic pathogens and antibiotic resistance will help to advance water reuse system design, including water treatment and distribution, in order to minimize potential risks of emerging microbiological constituents of concern.

Regrowth of OPs, bacteria with ARGs, microbes influencing corrosion (MIC) and indicator organisms such as HPCs is a function of many parameters including disinfectant residual, type of disinfectant, temperature, nutrient concentrations, turbidity, pH, and alkalinity. Distribution system materials and corrosion control programs, the presence of sediments, hydraulic conditions, and water age also affect microbial growth. The most important nutrients for the growth of heterotrophic bacteria are carbon, nitrogen, and phosphorus, which sustain growth at a molar ratio of approximately 100:10:1.

- Organic carbon is utilized by heterotrophic bacteria as an energy source (dissimilation) or for the maintenance and production of cellular material (assimilation). Organic carbon in drinking water is usually expressed as TOC or dissolved organic carbon (DOC). However not all organic compounds are susceptible to microbial decomposition: the fractions that can be readily used to provide energy for growth are the biodegradable dissolved organic carbon (BDOC), or the assimilable organic carbon (AOC). BDOC is the portion of the organic carbon in water that can be mineralized by heterotrophic microorganisms, while AOC is the portion of the biodegradable organic carbon that can be converted to cell mass (Huck, 1990). The impact of these bulk parameters on end user water quality, with different levels and applications of DPR, can be better understood through this project.
- In distribution systems, nitrogen may be present as organic nitrogen, ammonia, nitrate and nitrite, all of which may adversely affect water quality. In chloraminated distribution systems, ammonia may lead to nitrification through biological conversion to nitrite by ammonia oxidizing bacteria (AOB), then subsequently to nitrate by nitrite oxidizing bacteria (NOB), with both nitrite and nitrate posing a health concern. Ammonia may be naturally present in the source water, recycled water, or from being dosed to form monochloramine (such as chloramine addition ahead of RO), or formed during degradation of the chloramine residual. Therefore, if the water quality of the recycled water increases the rate of chloramine decay when blended with the traditional water supply, additional free ammonia will be formed in the distribution system, increasing the potential for nitrification. Once established, nitrification can

1. Current thinking is that ARGs have transferred from dead bacterial DNA in the water into the newly growing bacteria that did not originally have ARGs (Fahrenfeld et al., 2013; Pruden, 2013).

be almost impossible to eradicate, especially in premise plumbing systems, and often results in depleted chloramine residuals. The resulting lack of a disinfectant residual may allow heterotrophic, coliform and disease causing OPs to grow. Nitrification may also be responsible for decreases in pH, DO, and alkalinity, which can often enhance corrosion (AWWA, 2013; Zhang et al., 2009).

- While carbon is usually considered the limiting factor for microbial growth in water in North America, phosphorous is essential to the growth of bacteria and has been found as the limiting factor in certain types of water (Sathasivan and Ohgaki, 1999). As such, blending with phosphate-containing waters (as may be the case in recycled water, depending on the treatment strategy used), or using phosphorus-based corrosion inhibitors (which may contain either orthophosphate, polyphosphate, or a blend of the two) may be of concern to water utilities.

Corrosion

Increased corrosiveness or aggressiveness of water following blending is another concerning issue. This corrosion can be directly linked to corrosive water quality (e.g., RO permeate), or can be the result of microbiologically induced corrosion. Microbially-induced corrosion is estimated to be responsible for roughly half of all water pipeline failures (Uhlig and Revie, 1985; De Araujo-Jorge et al., 1992) which would translate to $4-18 billion annually for water utilities (USEPA, 2002; USFWA, 2002) and even higher costs are likely borne by building owners (NRC, 2006; Edwards, 2004). Microbial activity during stagnation has been linked to rapid loss of disinfectant (Zhang and Edwards, 2009; Nguyen et al., 2012), contamination of potable water with high levels of copper, lead and iron (McNeill and Edwards, 2001; Edwards et al., 2000; Zhang et al., 2009), microbial corrosion failures (Videla, 1996) and aesthetic problems (taste and odor) of potable water (NRC, 2006).

The corrosion influencing parameters that are most relevant to recycled waters are listed here (Vik et al., 1996):

- Temperature and pH, which influence all chemical and biological reactions.
- Alkalinity and dissolved inorganic carbon (DIC), responsible for corrosion of both metallic and non-metallic structures. While higher alkalinity may help form a protective film of $CaCO_3$ and control pH changes, it may also increase certain types of copper, lead, and zinc corrosion.
- Oxidants, including dissolved oxygen and disinfectants. Oxidants may contribute to the corrosion of metals, but on the other hand, higher disinfectant residuals reduce microbial-induced corrosion.
- Total dissolved solids (TDS), which tends to increase conductivity and corrosion rates.
- Calcium hardness may precipitate as $CaCO_3$, thereby providing protection and reducing corrosion rates in some cases for some materials.
- Chloride and sulfate increase corrosion of iron, copper and galvanized steel.
- Hydrogen sulfide (H_2S) may dramatically increase corrosion rates for iron and copper.
- Ammonia may increase the solubility of some metals, including copper.
- Natural organic material (NOM) may decrease corrosion by coating pipe surfaces, but some organics can complex metals and accelerate corrosion or metal release.

Studies conducted by Peet et al. (2001) involved bench-scale testing during which water quality was modified, leading to a range of corrosion indices. These tests allowed an understanding of the way water quality may change during blending, and indicated that many parameters (those that are conservative) can be assessed using simple mixing laws, except for pH, turbidity and chlorine (and therefore, DBPs most likely). Peet et al. (2001) also developed the MULTIBLEND model to

predict numerous aspects of water quality when two or more waters blend together. Other Water Research Foundation (WRF) studies have also investigated the effects of blending multiple source waters on distribution system water quality. For example, Taylor et al. (2005) modeled water quality changes in pilot distribution systems receiving finished waters, which were produced entirely from blends of desalinated seawater and treated surface and ground waters using advanced and conventional treatment processes that simulated full-scale water treatment facilities. Duranceau et al. (2011) investigated alternatives for post-treatment stabilization of RO permeate and provided recommendations for water quality goals of stabilized desalinated water to limit impacts in the distribution system. Our new research will build upon the findings and recommendations from these previous studies to develop specific recommendations for blending recycled water.

Many corrosion indices have been developed as tools to evaluate the corrosivity of water given relatively basic water quality information. The applicability and interpretation of each corrosion index, however is limited by the conditions of its development and applicability. Several indexes have been developed on the basis of hypothesized corrosion control through calcium carbonate saturation (slight oversaturation may promote the precipitation of a thin layer of calcite that would protect the underlying iron scales). Common indices based on calcium carbonate stability include the Langlier Saturation Index (LSI), Calcium Carbonate Precipitation Potential (CCPP), Ryznar Index, Driving Force Index, Momentary Excess, and Aggressiveness Index. Other indices (e.g., the Larson Ratio and Chloride to Sulfate Mass Ratio) are based on the role of anions (chloride, sulfate) in promoting iron corrosion. The selection of the best corrosion index is ultimately site specific and requires verification testing. Our team has used corrosion indices to track potential impacts of blending different waters on distribution system water quality in Miami-Dade, Palm Beach, and Lee Counties; City of Lodi; and the Otay Water District. In these studies, the incidence of corrosion problems was compared with up to nine different indices to determine which was best correlated with specific corrosion problems. For example, at Miami-Dade County, of the nine indices tested, the Larson Ratio best predicted corrosion problems observed in the distribution system, whereas the LSI did not. For this new project, we recognize that there is no universal corrosion index capable of predicting corrosion control for all metals, thus we will carefully monitor pH, alkalinity, calcium, chloride, and sulfate to calculate changes in LSI, CCPP, Larson Ratio, and Chloride/Sulfate Mass Ratio. Finished water quality goals may then be set on a site specific basis.

Location of Blending

Another important aspect of blending water of different quality pertains to the location of blending. Blending water of different quality may locally disrupt the natural "ecology" of the receiving environment. Because of this, blending in a storage reservoir or within a treatment plant will have a different impact compared to blending in the distribution system, as measured by biofilm detachment, or disruption of passive protective scale layers. Our goal is to better understand the issues and avoid the serious consequences seen in Tucson upon introduction of Central Arizona Project (CAP) water or in Washington, D.C., after a change in disinfectant (Reiber et al.,1997; Edwards, 2004).

Depending on water quality, blending recycled water upstream of a WTP may result in positive or negative impacts on the existing treatment processes. For example, blending recycled water pretreated with RO upstream of an existing conventional surface WTP may adversely affect the existing coagulation process by 1) reducing the alkalinity to a point where coagulation is impacted or 2) decreasing the turbidity to the extent that minimizes particle removal, reducing the pathogen removal "credit" often granted to conventional treatment. The California Department of Public

Health (CDPH) has expressed this very concern related to DPR integration. In other cases blending upstream of a water treatment plant can be expected to improve treated water quality, as in the case of blending purified re-use water, resulting in decreased TOC, potentially leading to more stable disinfectant residuals and reduced microbial growth.

Objectives

Our proposed goal for this project is to provide recommendations and guidance for the appropriate use of blending as part of a DPR project, including evaluations of treatment, impact of different water qualities, and corrosion control issues, impact on engineered storage, blending location, and blending percentages.

Technical Approach

Our proposed project approach includes the requested task items in the Request for Proposals (RFP) as well as additional research items as detailed here. Results of the proposed work will be documented in a series of draft and final reports. Our team preference is to have a final report, which is essentially an extended executive summary with attached reports for each task; however, we can compile one comprehensive report if so requested.

Our proposal is to examine the impact of three blending variables: different proportions of recycled water to raw water, different qualities of recycled water (based on the treatment process), and different points of introduction/blending. This approach is listed in Table 1, and previously illustrated in Figure 1. Our approach will examine the water quality of these treatment and blending scenarios at bench, pilot, and full-scale. We also recognize that blending impacts are complex and the testing done as part of this project will be instructional and informative, but cannot represent all of the issues for all utilities. As such, the results from our testing will be used to develop general guidelines for blending.

Task 0 - Pre-Project Workshop

As part of a National Science Foundation (NSF) grant, *Workshop on Evaluating Approaches for Implementing Direct Potable Reuse*, the National Water Research Institute (NWRI) is assembling a team of academic and regulatory experts to address some of the remaining DPR challenges. Jeff Mosher with NWRI will facilitate the workshop. Carollo is working directly with NWRI to make this event happen. In the planned (March 2014) 2-day workshop, these experts will be presented with several real-world scenarios of blending wastewater with our potable water supply, as follows:

- Unfiltered and undisinfected secondary effluent added to an existing raw water supply.

Table 1. Treatment and Blending Matrix

Tertiary Treatment Processes	Proposed Blending Locations	Proposed Blending Amounts
Secondary Effluent + MF/O_3/BAF/UV AOP	Raw water, Finished water	0%, 10%, 50%
Secondary Effluent + MF/RO/UV AOP	Raw water, within the WTP, Finished water	0%, 10%, 50%
Secondary Effluent + Sand Filtration/ Pasteurization/MF/RO/UV AOP	Raw water, within the WTP, Finished water	0%, 10%, 50%
Secondary Effluent	Raw water	0%, 5%, 10%
Secondary Effluent + MF/O_3/BAF	Raw water	0%, 5%, 10%

NOTES:

CAS = Conventional Activated Sludge
MF = Microfiltration
O_3 = Ozone
BAF = Biologically Active Filtration
UV = Ultraviolet Disinfection
RO = Reverse Osmosis
AOP = Advanced Oxidation Process

- Sand filtered and disinfected tertiary effluent added to an existing raw water supply.
- Membrane filtered and disinfected tertiary effluent added to an existing water supply.
- Membrane and reverse osmosis filtered and oxidized (advanced oxidation) purified water added to an existing water supply.

With these scenarios in mind, the research forum will proceed as follows:

- Review recently completed and ongoing IPR and DPR research.
- Review state and national efforts to develop regulations and guidelines for IPR and DPR.
- Evaluate the level of treatment required to meet a raw water standard, based upon pathogen and pollutant risk.
- Brainstorm the impact of the level of recycled water treatment and the level of blending of the recycled water with other raw water supplies on downstream drinking water treatment, including cost issues, disinfection byproducts, premise plumbing corrosion, OPs regrowth, and other water quality concerns.
- Summarize findings and recommendations for publication.

As can be seen, this 2-day workshop will focus on the issues of water quality and public health that are important to WRF Project 4536. The findings will form some of the first directions as we look to define the acceptable parameters and issues associated with blending and DPR.

Deliverable: The result of the workshop will be a detailed report on the perspectives and conclusions of the expert panel, and will be presented to WRF for review and comment.

Task 1: Literature Review

The literature review will focus on expanding upon the literature reviewed above. In addition, the literature review will also incorporate the latest findings in the IPR and DPR field related to public health and treatment, including:

- Discussion of potable reuse regulations and their impact on water quality: The literature review will cover regulations and treatment requirements impacting existing DPR facilities (e.g., Namibia, Texas, New Mexico, and Colorado), as well as proposed DPR treatment criteria (Trussell et al., 2013) and criteria used in previous studies (WRRF, 2013). Where it is useful, comparisons will also be made with existing IPR regulations (e.g., CDPH proposed groundwater recharge reuse regulations). One example of the impact of regulations is TOC – requirements that are very strict (e.g., < 0.5 mg/L) may necessitate RO, which has impacts on many other factors, including taste, treatability, corrosivity, and others.
- This review will include a discussion of risk, including the levels that are used in drinking water contexts, and how we might achieve those same risk levels in DPR settings under various blending scenarios. For example, an advanced treated water blended with the finished water of a WTP would need to achieve the low risk levels through the DPR treatment train alone (since no additional treatment would be provided with the WTP). On the other hand, a DPR water blended upstream of a WTP could contain higher levels of contaminants since it will undergo additional treatment within the WTP. Assumptions about source water pathogen levels in existing drinking water regulations (e.g., SWTR) will be discussed as a reference.
- Identification of DPR treatment scenarios: including an overview of various potable reuse trains in operation (Gerrity et al., 2013), as well as those alternatives currently under evaluation (in WRRF Project 11-02). Trains will include both RO-based and non-RO-based options.
- Description of water qualities provided by different DPR treatment options: including a table with typical water qualities achieved by the relevant DPR treatment scenarios identified

above. This information will be obtained from published data well as data available only to this team through complementary research studies (e.g., WRRF Project 11-02).

- Perspectives and data will be shared from water quality testing at the ***only operational DPR facility in the United States***, the Colorado River Municipal Water District's Raw Water Production Facility, in Big Spring, TX, to be constructed by members of our team.

Deliverable: The draft literature review will be presented to WRF in a report format for review and comment, concurrent with a video-based interactive meeting to review critical highlights and findings. The final literature review can either be a stand alone final document or woven into a larger summary report, whichever better suits WRF.

Task 2: Utility Perspectives and Water Quality Data

Task 2.1 – Interviews: Our team will interview a range of utilities that are a) implementing IPR or DPR, b) considering DPR, c) interested in exploring IPR or DPR, or d) part of a "de facto" IPR scheme. These interviews will be in person and will include a presentation of the literature review to each utility, a review of standardized questions related to IPR and DPR and blending water quality issues, and an open discussion of the issues. The goal of these interviews is to better inform the testing planned under Task 3. All information will remain anonymous, unless granted permission by each utility in writing. Our preliminary list of utilities was developed based upon a combination of geographic diversity, type of water and wastewater treatment processes, and utility interest. Our team can supplement these utilities with select additional utilities at the recommendation of WRF. At this point, we intend to interview the following utilities: the Santa Clara Valley Water District (CA), the Southern Nevada Water Authority (NV), Ventura Water (CA), West Basin Municipal Water District (CA), Oxnard (CA), the Orange County Water District (CA), Upper Occoquan Services Authority (VA), Colorado River Municipal Water District (TX), Laguna Madre Water District (TX), Miami-Dade County (FL), Norman (OK), Denver Water (CO), and Peoria (AZ).

Task 2.2 – Utility Description: A description of utilities, raw (source) water qualities, potable water, use of corrosion inhibitors, wastewater, and recycled water treatment trains (including product water stabilization), product water quality, and potential site(s) of introduction of recycled water, will be detailed for the participating utilities. A description of each utility's distribution system will be completed, including make-up of pipes and percent of system composed of different materials, as well as detention times in systems. This information will be collected by each respective participating utility and compiled by our project team for analysis. All information will remain anonymous, unless granted permission by each utility in writing.

For each participating utility, we will conduct a desk-top evaluation of pipeline, service line and premise plumbing materials inventory, history of consumer complaints related to corrosion (e.g., blue water, red water), corrosion related water quality concerns including tastes, odors, and regrowth. Our evaluation will rely upon information previously collected or to be supplied by the participating utilities. For select utilities, we will also make inquiries of local plumbers for observations of premise plumbing corrosion incidence including pinhole leaks, erosion corrosion, hot water system scaling and dezincification issues. Thereafter, corrosion indices most relevant to each utility's specific problem (e.g., scaling, lead from solder, iron corrosion, dezincification) will be identified and quantified under the range of mixing scenarios. The pilot and full-scale data collected as part of Task 3 will be used to refine the modeling effort.

Deliverable: The draft utility survey, data, and corrosivity analysis will be presented to WRF in a report format for review and comment, concurrent with a video-based interactive meeting to review critical highlights and findings. The final survey and data can either be a stand alone final document

or woven into a larger summary report, whichever better suits WRF.

Task 3: Evaluation of Blending Impacts

As listed in Table 1 and illustrated in Figure 1, our research plan is to examine the blending impacts prior to water treatment, within a treatment plant, and by direct injection into the distribution system.

Our intent for this work is to provide quality data that illustrates the potential issues for a wide range of DPR blending scenarios. Our participating utilities represent real world situations where such scenarios may become reality. As an example, Ventura, CA, is looking into blending purified recycled water with surface water supplies and groundwater supplies for DPR. The Santa Clara Valley Water District, CA, is interested in blending different qualities of purified water (RO permeate or O_3/BAF water) with surface water supplies, and the resulting treated water has the potential to blend with extracted groundwater. One of our ongoing potable reuse projects in Texas is looking into finding "new" high quality secondary effluent and blending it with raw water supplies. Thus, the work described within this proposal requires a range of water types and qualities, including groundwater, surface water, secondary effluent, and different levels of treatment of recycled water and conventional potable water. Full-scale, pilot-scale, and bench-scale treatment will be employed.

There are three main components of work to address the blending impacts, all of which are discussed below. Sample and test conditions listed in Table 2 are single event sampling. Duplication of several test conditions will be performed as part of the overall quality assurance and quality control (QA/QC) plan, which is presented further on in this proposal.

Task 3.1 – Water Quality Analysis. This component of work includes:

- Testing, presented in Table 2 (Testing Plan) and Table 3 (Analytical Testing).
- Simulation of water treatment plant operations at different blend ratios and blending locations, and measurement of water quality post treatment. Blending ratios are higher for higher quality recycled waters, hence the use of 10% and 50% for purified water and the use of 5% and 10% for secondary effluent. The use of 0% blending sets the baseline for comparative analysis.
- Two water treatment trains will be simulated on the bench-top. The simulations will match existing water treatment operations for two utilities that may implement DPR in the near future. Additional treatment trains may be considered depending upon WRF preferences.
  - **Ventura Water Avenue WTP Simulation –** NaOCl, coagulant (SWT2500), ultrafiltration, NaOCl disinfection, and ammonia addition for chloramine formation and corrosion inhibitors.
  - **Santa Clara Valley Water District Rinconada WTP Simulation** – coagulation, NaOCl, cationic polymer, nonionic polymer, flocculation, sedimentation, intermediate ozonation, biofiltration (deep bed filtration), and NaOCl (free residual, treatment optional).
- The participating utilities will perform sampling and ship samples to SNWA for analysis, blending, and simulated treatment on the bench-top (simulating the WTP processes reviewed above, or modified as directed by WRF).

QA/QC testing, which includes replicate sampling, is included in this testing effort and is described further on.

Task 3.2 – Post WTP Corrosion and Pathogen Issues. Work will include a detailed evaluation of post WTP issues related to disinfectant residual stability, chemistry stability, corrosion issues, opportunistic pathogens and bacteria, and ARG

Table 2. Testing Plan

Site	Water[1]	Task 3.1						Task 3.2							
		Pathogens	Nutrients	Bulk WQ Parameters	NDMA	Trace Pollutants (e.g. pharmaceuticals)	DBPs	Taste and Odor	Disinfectant Residual Stability	DBPs	Nutrients	Chemistry Stability	Opportunistic Premise Plumbing Pathogens and Bacteria[3]	Corrosion Influencing Assays (BART)[3]	Antibiotic Resistant Gene Regrowth[3]
A.	Raw H_2O (Surface Water)	X	X	X	X	X	X								
	Raw H_2O (Groundwater)	X	X	X	X	X	X								
	Sand Filtration/Pasteurization/UF/RO/UVAOP Product Water	X	X	X	X	X	X								
	UF/RO/UV AOP Product Water	X	X	X	X	X	X	X							
	0% Blending[1], then simulated WTP		X	X	X	X	X	2X[2]	X	X	X	X	X	X	X
	Simulated WTP, then Blending Surface Water with the Finished Water at 10% & 50%			X	X		X	X	X	X	X	X	X	X	X
	Simulated WTP, then Blending Groundwater with the Finished Water at 10% & 50%			X	X		X	X	X	X	X	X	X	X	X
	10% & 50% Blending with Surface Water, then simulated WTP		X	X	X		X	X	X	X	X	X	X	X	X
	10% & 50% Blending Surface Water ahead of the coagulation/filtration step in the WTP simulation		X	X	X	X	X	X	X	X	X	X	X	X	X
B.	Raw H_2O (Surface Water)	X	X	X	X	X	X								
	MF/RO/UV AOP Product Water	X	X	X	X	X	X								
	0%, 10%, and 50% Blending with Surface Water, then simulated WTP		X	X	X	X	X								
	Raw H_2O (Surface Water)	X	X	X	X	X	X								
	MF/O_3/BAF Product Water	X	X	X	X	X	X								
	0%, 10%, and 50% Blending with Surface Water, then simulated WTP		X	X	X	X	X								
C.	Raw H_2O	X	X	X	X	X	X								
	Secondary Effluent	X	X	X	X	X	X	X							
	0%, 5%, and 10% Blending with Surface Water, then simulated WTP		X	X	X	X	X	2X[2]	X	X	X	X	X	X	X
	Raw H_2O	X	X	X	X	X	X								
	Sand Filtration/O_3/BAF Product Water	X	X	X	X	X	X	X							
	0%, 10%, and 50% Blending with Surface Water, then simulated WTP		X	X	X	X	X	2X[2]	X	X	X	X	X	X	X
Total Number of Samples (single testing for each occasion)		12	31	33	33	27	33	21	15	15	15	15	15	15	15

SITES:

A. Raw water sampled from Ventura Water's raw water supply lines. Recycled water effluents sampled from the Ventura Water Reclamation Facility, including pilot and full-scale processes. WTP simulations will be based upon Ventura Water's Avenue WTP processes. Water for Task 3.2 to be shipped to SNWA.

B. Raw water sampled from SCVWD's raw water. MF/RO/UV AOP effluent sampled from the Silicon Valley Advanced Water Purification Center (SVAWPC). WTP simulations will be based upon the Santa Clara Valley Water District's Rinconada WTP processes.

C. Raw water sampled from SNWA's raw water. Other processes sampled from full-scale and pilot treatment trains at a local Las Vegas WWTP. WTP simulations will be based upon the feedback from WRF input and internal team discussion.

NOTES:

1. Blending percentage refers to the percentage of recycled water in the mixture.
2. Samples taken at times 0 and 48 hours, as marked by the term "2X"
3. Both bulk water and biofilm samples taken for OPPP and ARG testing. Combined bulk water and biofilm sample taken for BART testing.

Table 3. Analytical Testing

Bulk Parameter	Specific Analyte			Test Lab
Pathogens	Noroviruses and Enteric Viruses Protozoa Bacteria			SNWA
Nutrients	NH_3 NO_2	NO_3 TN	TP	SNWA
Bulk Water Quality Parameters	Turbidity pH TOC	DOC DIC EC or TDS	SUVA alkalinity ATP	SNWA
NDMA	NDMA			SNWA
Trace Pollutants	A range of pharmaceuticals and personal care products			SNWA
DBPs	HAAs	THMs		SNWA
Disinfectant Residual Stability	Total and Combined Chlorine			SNWA
Chemistry-based Corrosion	pH alkalinity hardness	calcium chloride sulfate	H_2S taste and odor metals	SNWA
Biological Corrosion	Biological Activity Reaction Test (BART) provide qualitative and semi-quantitative determinations of corrosion influencing bacteria			Virginia Tech support by SNWA
Opportunistic Premise Plumbing Pathogens and Bacteria	Quantification of total 16S rRNA genes by qPCR determines total bacteria, and other qPCR quantifies established opportunistic premise plumbing pathogens *(L. pneumophila*, and *P. aeruginosa M. avium)* or protozoan host organisms *(Acanthamoeba, Hartmanella)*			Virginia Tech
Antibiotic Resistant Gene Regrowth	Antibiotic resistance gene targets by qPCR will include a subset that encode resistance to antibiotics that are critically important to human health, including Vancomycin (*van*A), cephalosporins (bla_{CTX}); and fluoroquinolones (*qnr*A), and the *int*I genes.			Virginia Tech

regrowth[2], as listed in Tables 2 and 3, using simulated premise plumbing.

Each blended water will be placed in simulated premise plumbing rigs consisting of 2 meter long, 5 cm diameter PVC pipes containing a standard leaded yellow brass (60% copper, 35% zinc, and 3% Pb) coupon made from reference grade stock provided by the Copper Development Association as described for WRF Project 4317, "Non-Intrusive Testing of Lead and Copper Corrosion." Each rig will be pre-conditioned and pre-tested using the QA/QC protocol developed during Project 4317, which was proven necessary to control for outlier metal samples exhibiting anomalous corrosion behavior. Every condition will be tested in duplicate making 30 rigs total (15 waters x duplicate).

After shipping the rigs to the participating utilities, they will be conditioned with different disinfected blended waters by filling and changing the pipe segment with "fresh" water twice weekly for 2 months to allow establishment of biofilms under worst case (e.g., weekend) stagnation conditions, similar to those recently demonstrated to cause T&O and corrosion problems in "green buildings" (e.g., Nguyen et al., 2012; Elfland et al., 2010). At the end of the conditioning period, aliquots of water will be taken from the pipe and analyzed for chlorine decay kinetics and water chemistry changes after

2. Bacteria under stressed conditions are proven to assimilate and use genetic material and then multiply.

0 and 48 hours of incubation. Both bulk water samples and samples of biofilms from the pipe segments (when appropriate) will be analyzed as follows:

- **Disinfectant Residual Stability and DBPs** - Monitoring disinfectant decay in the pipe segment with biofilms (compared to a glass control), would allow the differentiation of disinfectant decay due to chemical (pH, bromide, etc.) or biological (biofilm) conditions to be quantified. Measurement of DBP concentrations is included in this analysis.
- **Chemistry-based Corrosion** - Water chemistry parameters that influence corrosion will be sampled to allow for the calculation of selected corrosion indices for each utility. For the blending scenarios, our bench-top testing will use the current corrosion control strategies for the tested utilities. The goal is to adjust the new blended water to achieve the same pH of the current water to the extent possible, and/or use the same type/dose of corrosion inhibitor. These data will serve as a basis for desktop predictions of corrosion impacts for the range of materials in main and premise plumbing distribution systems, with analysis by the project team included in this work effort. Taste and odor testing is included to address aesthetic concerns.
- **Biological Corrosion** - Activity of microbes that may influence or induce non-uniform corrosion will be determined using BART tests provided by Droycon, including Sulfate Reducing Bacteria (SRB), Heterotrophic Aerobic Bacteria, Heterotrophic Anaerobic Bacteria, Nitrifiers, De-nitrifiers, Slime Forming Bacteria, and Acid Producing Bacteria (APB). Relative differences between the blends will be quantified.
- **Opportunistic Premise Plumbing Pathogens (OPPPs)** - Biofilm and bulk water samples will be analyzed by qPCR. Quantification of total 16S rRNA genes by qPCR determines total bacteria, and other qPCR quantifies established opportunistic premise plumbing pathogens (*L. pneumophila*, and *P. aeruginosa M. avium*) or protozoan host organisms (*Acanthamoeba, Hartmanella).*
- **Antibiotic Resistant Gene (ARG) Regrowth** - ARG targets by qPCR will include a subset that encode resistance to antibiotics that are critically important to human health. In particular, work will quantify Vancomycin (*van*A), cephalosporins (bla_{CTX}), fluoroquinolones (*qnr*A), and the *int*I genes.

QA/QC testing, which includes replicate sampling, is detailed further on.

Task 3.3 – Integration of Engineered Storage Buffers (ESBs). Pending the results of Tasks 3.1 and 3.2, the project team will update the design of ESBs. The original approach to ESB design is the core of WRRF Project 12-06, led by members of this project team (Salveson and Steinle-Darling, 2013). These modifications to ESB design will reflect the water quality impacts of blending, including monitoring, holding time, and treatment modifications.

Note on Ventura Water - Ventura Water has volunteered to provide $100,000 in cash contribution and $27,000 of "in-kind" support. Ventura Water operates the Ventura Water Reclamation Plant, and is now running a demonstration-scale pasteurization system for final effluent disinfection. A portion of the cash funding from Ventura Water (~$50,000) would cover the costs of the rental of advanced membrane treatment processes (UF and RO), which would be pilot tested both before and after pasteurization. Such testing would provide good information to Ventura as they look to implement potable reuse in the future and would also provide good information to the industry regarding the added value of pasteurization ahead of membrane treatment for potable reuse.

Deliverables: The draft testing protocol for Task 3 will be presented to WRF for review and approval prior to conducting field testing. The draft testing results will be presented to WRF in a report

format for review and comment, concurrent with a video-based interactive meeting to review critical highlights and findings. The results will include analysis and interpretation of the data, examining water quality (pollutants and pathogens) and post treatment issues of corrosion, OPPPs, and antibiotic resistent gene regrowth. The final testing results can either be a stand-alone final document or woven into a larger summary report, whichever better suits WRF.

Task 4: Reporting

Our proposal is to provide a summary report in the format of an expanded executive summary, properly referencing previously completed reports from the tasks above. The summary report will summarize the water conditioning and corrosion concerns for this project, as well as look closely at the entire picture of water treatment, including pathogens, trace pollutants, treatment impacts, and cost. Blending/conditioning water quality strategies will be developed and discussed in person with WRF prior to the completion of the draft summary report.

Our team will also provide the necessary QAPP and quarterly reporting required by WRF. Our deliverables have been set to meet these quarterly timelines.

Deliverables: One draft and one final summary report will be prepared for WRF. It is our expectation that most WRF technical comments will be made in one of the sub-reports (reports for each task), and thus the comments on the draft summary report will be mostly related to formatting and final conclusions and recommendations (thus, only one draft report is listed here). The draft summary report will be presented to WRF in a report format for review and comment, concurrent with a video-based interactive meeting to review critical highlights and findings.

Quality Control and Replicate Sampling

SNWA. QA/QC will be conducted with carefully controlled procedures that maximize accuracy and precision. Results will be validated using a QA program, and Standard Operating Procedures for sample handling and measurements will be followed by all project personnel.

Standard methods or other published methods will be used for measuring each analyte. ACS and/or analytical grade materials, reagents, solvents and gases used will be assessed for any potential background effects. Cleaning procedures for glassware and other laboratory equipment will be carefully outlined and followed. Instrument detection limits and method detection limits will be determined based on published procedures. Objectives for precision will be established with a relative standard deviation of < 20% and for accuracy with a percent recovery of 80-120%. Laboratory fortified blanks will be used to check the precision and accuracy of sample preparation and all analytical techniques. Precision and accuracy will further be examined with replicate standards and standard-spiked samples. When precision and accuracy objectives are not met, analyses will be re-run.

Instrumental QC will be conducted via scheduled instrument calibration and preventative maintenance. Logbooks will be kept to track 1) results and date of previous calibrations and maintenance, 2) scheduled calibration and maintenance intervals, and 3) reference to calibration procedures.

All data from calibration standards, sample preparation, and sample measurements will be carefully recorded in bound laboratory notebooks. Raw data will be maintained in an original format and copies of the original will be made for all data manipulation.

Virginia Tech. QA/QC will be implemented to ensure integrity of measurements of gene copy numbers of target ARGs and OPs as determined by DNA extraction and qPCR, and semi-quantitative evaluation of corrosion influencing bacteria by Biological Activity Reaction Test assay kits.

ARG and OPs. For microbial analyses, water and biofilm sampling protocols developed and

demonstrated for Pruden and Edwards' current Sloan Foundation grant (Pruden, 2013) will be implemented. Two liter water samples will be collected in duplicate, representing each of the 15 conditions in the standard plumbing rigs, amounting to 30 samples per event, for two events, totaling 60 samples. Biofilm samples will be collected immediately following water sample collection by swabbing a defined area of each of the outlet pipes.

Corrosion Influencing Bacteria. BART testing will be conducted following manufacturers instructions and interpreted accordingly. Each test will be conducted in duplicate for biofilm and bulk water samples providing significant replication. Control samples for each test will include the influent water to the pipe rigs and a field blank using reagent grade water from the laboratory at SNWA. These field protocols and QA/QC were successfully implemented for BART testing in WRF Project 3015 (Edwards et al., 2008).

Benefit to Foundation Subscribers

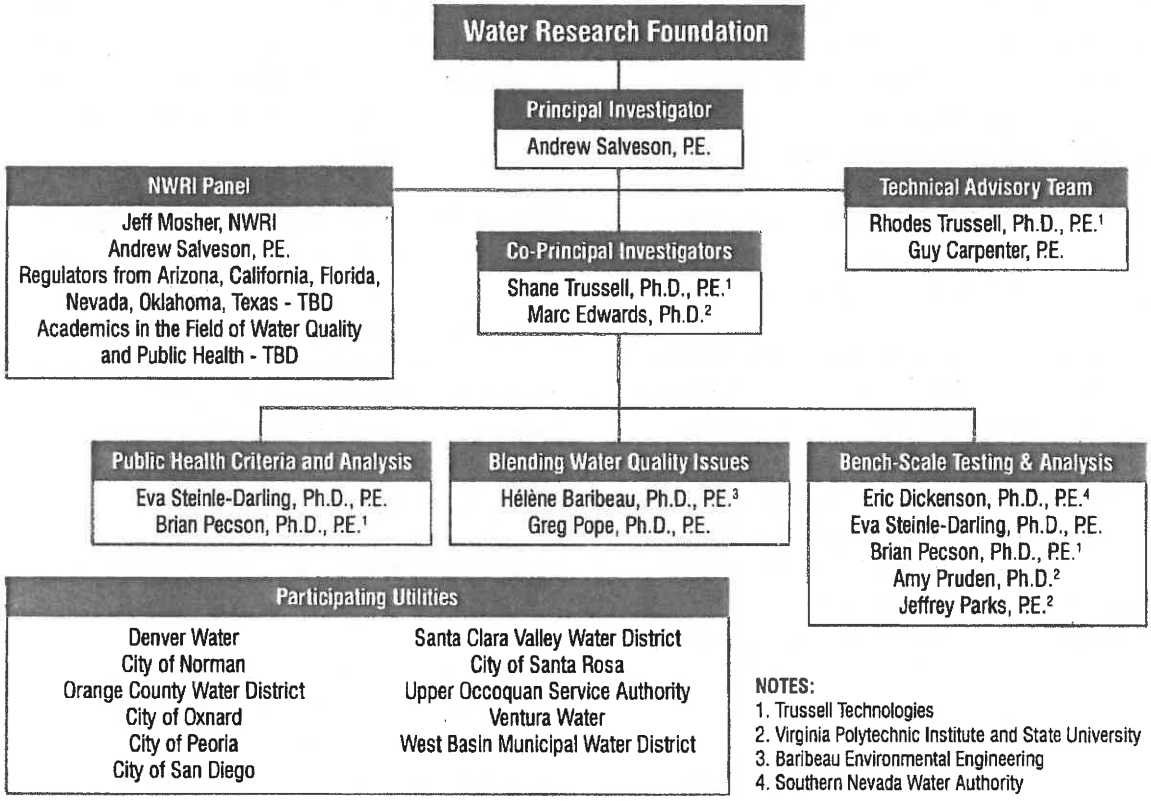
Water shortages are a reality in many parts of the southwestern and southeastern U.S. There is talk of the next "mega-drought" in California and some Texas communities have less than 6 months of water supply. DPR has quickly moved from a research niche to a main-stream idea, and guidance is necessary. Through various WRRF grants, many of which are run by members of this team, we now understand the level of treatment and the technologies required for treatment to make DPR safe. What is missing are implementation methods, including monitoring and engineered storage (currently researched under another project) and water quality issues associated with blending (this project).

Our proposal has described the key blending related issues, ranging from standard pathogens to trace pollutants to corrosion to premise plumbing issues and antibiotic resistant gene regrowth. The result of our efforts for this project will be recommendations and guidance for the appropriate use of blending as part of a DPR project, including evaluations of treatment, impact of different water qualities, summary of corrosion issues, and impact on engineered storage, blending location, and blending percentages.

Research Team & Other Participants

Carollo Engineers (Carollo), Trussell Technologies (Trussell), and Virginia Polytechnic Institute and State University (Virginia Tech) are the proposed core team members. Dr. Hélène Baribeau (Baribeau Environmental Engineering), the National Water Research Institute (NWRI), and the Southern Nevada Water Authority (SNWA) will be providing substantial technical and laboratory expertise in support of this team. We have also secured experienced utility help from across the nation, as listed in our organization chart (on the next page).

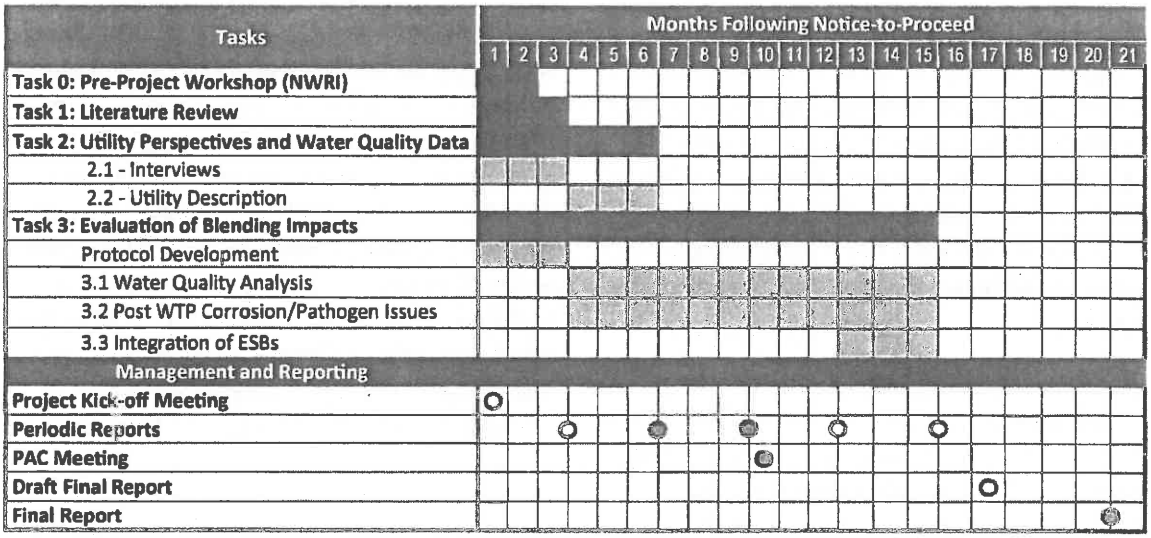
Our team is built to address the challenges of this project, which are to a maintain public health and water quality. Carollo and Trussell have demonstrated our understanding of indirect and direct potable reuse, through research grants (WRRF Projects 06-019, 02-009, 11-10, 11-02, 12-06), regulatory and design work (expert analysis for DPR in Big Spring, TX, and Cloudcroft, NM, DPR design in Laguna Madre, TX, and expert panel work for the National Academy of Sciences (NRC report on Potable Reuse). The Virginia Tech team is equally skilled on the issues of water quality and corrosion, including WRF, NSF, and Sloan grants on corrosion, OPPPs, and ARGs. Much of the lab work will be overseen by SNWA, in our view one of the finest research labs nationally. Finally, we have included Dr. Baribeau to provide various engineering services, relying upon her expertise in disinfection processes (disinfectant stability and DBPs formation and decay), biological treatment and biological stability of water in distribution systems (including nitrification), and corrosion of distribution system materials, including corrosion related to blending situations. Please refer to our resumes for details on all key team members.



Schedule

Our project team is ready to complete this work over a period of 21 months, as listed below.

Project Schedule



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carollo
Engineers...Working Wonders With Water®

January 21, 2014

Mr. John Whitler
Water Research Foundation
6666 West Quincy Avenue
Denver, Colorado 80235-3098

Re: In-kind Support for Water Research Foundation (WRF), Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536)

Dear Mr. Whitler:

This letter confirms our in-kind support for Water Research Foundation (WRF) Project 4536, Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536). Carollo is donating 15% of our effort as in-kind. This amounts to $18,188 of contribution.

Sincerely,

CAROLLO ENGINEERS, INC.

Andrew Salveson

Andrew Salveson, P.E.
Vice President
Water Reuse Chief Technologist

2700 Ygnacio Valley Road, Suite 300, Walnut Creek, California 94598
P. 925-977-3060 F. 925.930.0208
carollo.com

Trussell
TECHNOLOGIES INC

January 16, 2014

Andy Salveson, P.E.
Carollo Engineers
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Re: Water Research Foundation RFP #4536 – Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

Dear Mr. Salveson,

Trussell Technologies is pleased to be a project sponsor for the proposed Water Research Foundation study entitled "Blending Requirements for Water from Direct Potable Reuse Treatment Facilities (#4536)." Potable reuse is vital to future growth in water-stressed regions, offering communities an opportunity to augment their resources with a local and sustainable supply. Potable reuse is a particular specialty of Trussell Technologies, and we are actively involved in numerous direct and indirect potable reuse efforts through both municipal and research projects.

Our firm's role in the project includes an examination of the public health aspects related to DPR blending, development of protocols for the pilot and benchtop studies, and review and input on all remaining tasks. Trussell Technologies' efforts amount to a total of $43,022, of which Trussell Technologies will donate a total of $4,302 as "in-kind" services. As a Co-PI on your study, I will personally manage the Trussell Technologies efforts. If you have any questions, please feel free to contact me at (858) 458-1030 x103.

We greatly look forward to working with you and your team on this important research topic.

Sincerely,

R. Trussell

R. Shane Trussell, Ph.D., P.E., B.C.E.E.
President

Baribeau
Environmental
Engineering

January 14, 2014

Mr. Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, California 94598

Subject: Water Research Foundation, Request For Proposal No. 4536
Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

Dear Mr. Salveson:

It is my pleasure to confirm the interests of Baribeau Environmental Engineering (BEE) to participate in the Water Research Foundation project titled Blending Requirements for Water from Direct Potable Reuse Treatment Facilities (Request for Proposal No. 4536).

BEE was founded early 2013 to provide quality engineering and consulting services in drinking water quality, treatment and distribution. The firm specializes in a number of fields, including water treatment processes, disinfectants and disinfection by-products (DBPs), distribution system water quality (such as microbiological challenges, nitrification, and corrosion), and regulatory compliance.

For this project, BEE will prepare the literature review of water quality, corrosion and blending issues seen throughout the industry (Task 1), and contribute to the project reports (Task 5). For these tasks, BEE will provide $1,408 of in-kind contribution, which represent 10% of BEE's total budget.

Again, it will be my pleasure to participate in this exciting project. Feel free to contact me by phone at (714) 488-0496 or via email at HBaribeau@BaribeauEnvironmental.com should you have any questions or require further information.

Sincerely,

Hélène Baribeau, Ph.D., P.E.
Baribeau Environmental Engineering

Baribeau Environmental Engineering, 10801 Lemon Avenue #227, Alta Loma, California, USA 91737
Phone: +1-714-627-9294 - Email: Info@BaribeauEnvironmental.com - Skype: BaribeauEnvironmental

SOUTHERN NEVADA WATER AUTHORITY
SOUTHERN NEVADA WATER SYSTEM
River Mountains Water Treatment Facility
1299 Burkholder Boulevard • Henderson, NV 89015
MAILING ADDRESS: P.O. Box 99954 • Las Vegas, NV 89193-9954
(702) 856-3500 • snwa.com

January 16, 2014

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

RE: PARTICIPATION IN WATER RESEARCH FOUNDATION RFP #4536, *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities.*

Dear Mr. Salveson,

This letter confirms The Southern Nevada Water Authority's (SNWA) support to participate in your proposal in response to the Water Research Foundation RFP #4536, *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities*. This project is intended to develop recommendations and provide guidance for the appropriate use of blending as part of a Direct Potable Reuse project, including evaluations of treatment, impact of different water qualities, impact on Engineered Storage, blending location and blending percentages.

In this project, SNWA will be a subcontractor to Carollo Engineers for $111,376 for performing bench- and pilot-scale tests and analytical work as specified in the proposal. SNWA will also provide as in-kind the use of advanced treatment pilot skids (ozone and biological filtration) to the project team, estimated at a value of $75,000. We acknowledge that SNWA will be presented anonymously for any data associated with the testing of local Southern Nevada water for the project without prior written permission.

Please contact me at (702) 856-3664, if you have any questions or comments. We sincerely look forward to working with your team on this important research topic.

Sincerely,

David J Rexing
SNWA W.Q. R&D Manager
P O Box 99954 M/S 1970
Las Vegas NV 89193-9954
702.856.3664 T
702.856.3647 F
D.Rexing@SNWA.com

NWRI National Water Research Institute

Joint Powers Agreement Members

Inland Empire Utilities Agency

Irvine Ranch Water District

Los Angeles Department of Water and Power

Orange County Sanitation District

Orange County Water District

West Basin Municipal Water District

Jeffrey J. Mosher
Executive Director

E-mail
jmosher@NWRI-USA.org

18700 Ward Street
P.O. Box 8096
Fountain Valley, California
92728-8096

(714) 378-3278
Fax: (714) 378-3375

www.NWRI-USA.org

December 9, 2013

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Re: Participation in the proposed Water Research Foundation (WRF) project on *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities* (RFP #4536)

Dear Mr. Salveson:

The National Water Research Institute (NWRI), a 501c3 nonprofit based in Fountain Valley, California, is pleased to provide this letter confirming our support of the proposed Water Research Foundation (WRF) project, *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities* (RFP #4536), to be undertaken by a team made up of representatives from Carollo Engineers, Trussell Technologies, Inc., and the Southern Nevada Water Authority.

Specifically, we would like to contribute $20,000 in in-kind support.

The proposed WRF project is intended to develop recommendations and provide guidance for the appropriate use of blending for a direct potable reuse (DPR) project, including treatment processes, impacts of different water qualities, impacts on engineered storage, blending location, and blending percentages. It directly relates to DPR activities that NWRI is involved in currently – notably, a National Science Foundation (NSF)-funded workshop we are facilitating to address outstanding DPR implementation issues.

NWRI is a research organization that sponsors projects and programs focused on ensuring safe, reliable sources of water now and for future generations. One of our research interests includes DPR as a means to develop drought-proof, sustainable water supplies. The NSF-NWRI workshop on DPR will span 2 days in February 2014 and include a full-day technical session on *Defining When Reclaimed Water Becomes Raw Water for Future Potable Water Treatment and Consumption: A Forum to Review Public Health and Water Quality Issues*. Carollo has been invited to lead this session. The workshop will involve up to 30 invited participants, all with expertise in potable reuse.

Working with Carollo, we plan to use the NSF-NWRI workshop on DPR to evaluate many of the same issues being posed in the proposed WRF project. The timing of our workshop is advantageous, as it would precede the start of the research for the proposed WRF project and, as a result, provide valuable feedback that would better inform the project team on key issues.

Our NSF grant for the workshop is $50,000. We would provide a pre-publication summary of the workshop outcomes to the WRF project team. We estimate the value of this effort and the resulting information to be $15,000 in in-kind support, as it will focus on issues pertaining to the proposed WRF project. In addition, we would be willing to provide an additional $5,000 in NWRI staff time to support the WRF effort through:

- Reviewing the NSF-NWRI workshop outcomes.
- Reviewing and participating in other aspects of the proposed WRF project, as needed.

Altogether, NWRI would be pleased to provide a total of $20,000 as in-kind support to assist the WRF project team.

Please contact me for any questions or suggestions. We look forward to working with WRF and Carollo on this important project to address issues relevant to the future implementation of DPR.

Sincerely,

NATIONAL WATER RESEARCH INSTITUTE

Jeffrey J. Mosher
Executive Director

DENVER WATER
1600 West 12th Avenue • Denver, Colorado 80204-1412
Phone 303-628-6800 • Fax No. 303-628-6199 • www.denverwater.org

January 9, 2013

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Re: Participation in Water Research Foundation (WRF), Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536).

Dear Mr. Salveson,

This letter confirms our support to the Carollo/Trussell Technologies/Virgina Tech/Southern Nevada Water Authority team for conducting the Water Research Foundation (WRF), Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536). This project is intended to develop recommendations and provide guidance for the appropriate use of blending as part of a Direct Potable Reuse (DPR) project, including evaluations of treatment, impact of different water qualities, impact on Engineered Storage, blending location and blending percentages.

Denver Water will provide substantial support of this project, including:

- Meeting with the project team to discuss DPR perspectives, implementation issues, and raw water/recycled water blending concepts.
- Providing the project team with water quality data, including raw water, treated potable water, and reclaimed water, as appropriate.
- Providing the project team with a summary of corrosion issues in the potable water distribution system and corrosions inhibitors employed.
- Providing the project team a summary of theoretical potable water distributions system information, including make-up of pipes, % of system composed of different materials, and detention times in the system.

Overall, the time required to provide assistance is estimated at 40 hours, amounting to $5,000 of in-kind support.

Regards,

Sarah Dominick

Sarah Dominick, P.E.
Water Resource Engineer
Denver Water

DIRECTORS
PHILIP L. ANTHONY
KATHRYN L. BARR
DENIS R. BILODEAU, P.E.
SHAWN DEWANE
CATHY GREEN
VINCENT F. SARMIENTO, ESQ.
STEPHEN R. SHELDON
HARRY S. SIDHU, P.E.
BRUCE WHITAKER
ROGER C. YOH, P.E.

SINCE 1933
Celebrating 80 Years

ORANGE COUNTY WATER DISTRICT

ORANGE COUNTY'S GROUNDWATER AUTHORITY

OFFICERS
President
SHAWN DEWANE

First Vice President
CATHY GREEN

Second Vice President
ROGER C. YOH, P.E.

General Manager
MICHAEL R. MARKUS, P.E., D.WRE

January 14, 2014

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Re: Participation in Water Research Foundation (WRF), *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities (RFP #4536)*.

Dear Mr. Salveson,

This letter confirms our support to the Carollo/Trussell Technologies/Virginia Tech/Southern Nevada Water Authority team for conducting the Water Research Foundation (WRF), *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities (RFP #4536)*. This project is intended to develop recommendations and provide guidance for the appropriate use of blending as part of a Direct Potable Reuse (DPR) project, including evaluations of treatment, impact of different water qualities, impact on Engineered Storage, blending location and blending percentages.

The Orange County Water District (OCWD) will provide the following support of this project:

- Meeting with the project team to discuss DPR perspectives, implementation issues, and raw water/recycled water blending concepts.
- Providing the project team with historical water quality data from our Groundwater Replenishment System (GWRS) potable reuse facility. Should actual water samples be desired, OCWD may be able to provide sampling, packing and shipping support; however, the Carollo-led team will need to provide sample bottles, shipping containers, and pay for all shipping costs.
- Providing the project team with a summary of corrosion issues in the GWRS water distribution system and corrosions inhibitors employed.

Overall, the time required to provide assistance is estimated at 40 hours, amounting to $5,000 of in-kind support. Should you have any questions, do not hesitate to contact me at (714) 378-3364 or via email to jdadakis@ocwd.com.

Sincerely,

Jason Dadakis
Director of Health & Regulatory Affairs

PO Box 8300
Fountain Valley, CA 92728-8300
18700 Ward Street
Fountain Valley, CA 92708
(714) 378-3200
(714) 378-3373 fax
www.ocwd.com

CITY OF PEORIA

PUBLIC WORKS-UTILITIES DEPARTMENT
ENVIRONMENTAL RESOURCES

8401 WEST MONROE STREET
PEORIA, ARIZONA 85345
T 623.773.7286
F 623.773.7291

January 14, 2014

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Re: Participation in Water Research Foundation (WRF), *Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536)*.

Dear Mr. Salveson,

This letter confirms our support to the Carollo/Trussell Technologies/Virginia Tech/Southern Nevada Water Authority team for conducting the Water Research Foundation (WRF), *Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536)*. This project is intended to develop recommendations and provide guidance for the appropriate use of blending as part of a Direct Potable Reuse (DPR) project, including evaluations of treatment, impact of different water qualities, impact on Engineered Storage, blending location and blending percentages.

The City of Peoria will provide support of this project, including:

- Meeting with the project team to discuss DPR perspectives, implementation issues, and raw water/recycled water blending concepts.
- Providing peer review of all project deliverables.

Overall, the time required to provide assistance is estimated at 60 hours, amounting to $9,000 of in-kind support.

Sincerely,

Robin E. Bain

Robin E. Bain, P.E.,BCEE, PWLF
Environmental Resources Manager

5750 Almaden Expressway, San Jose, CA 95118-3614 | (408) 265-2600 | www.valleywater.org

Santa Clara Valley Water District

December 19, 2013

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Re: Participation in Water Research Foundation (WRF), *Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536)*.

Dear Mr. Salveson,

This letter confirms our support to the Carollo/Trussell Technologies/Southern Nevada Water Authority team for conducting the Water Research Foundation (WRF), *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities (RFP #4536)*.

The Santa Clara Valley Water District (SCVWD) will provide substantial support of this project, including the following:

- Assist the team in the framework of water quality concerns and the test plan for blending of different water qualities with raw and finished water.
- Sampling and analysis of raw water, SVAWPC product water (after RO with UV AOP), after the pilot scale O_3 with biological filtration system, and blended water.
- Laboratory testing of various pollutants to the extent possible.
- The use of a District-rented O_3 and biological filtration pilot, valued at $75,000.
- In-kind funding for this project is estimated at 200 hours, which amounts to $30,000 of support.

In return for this time, information, data, and cash value of the pilot system, the SCVWD expects that this project will demonstrate the issues and costs associated with blending of raw and finished water with advanced treated and purified reclaimed water, with specific information to the SCVWD and general information to the industry.

Sincerely,

Hossein Ashktorab, Ph.D.
Recycled Water Unit Manager
Santa Clara Valley Water District

Cc: Joan Maher

City of
Santa Rosa

17 January 2014

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek, CA 94598

Re: Participation in Water Research Foundation (WRF), *Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536)*.

Dear Mr. Salveson,

This letter confirms our support to the Carollo/Trussell Technologies/Virgina Tech/Southern Nevada Water Authority team for conducting the Water Research Foundation (WRF), *Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536)*. This project is intended to develop recommendations and provide guidance for the appropriate use of blending as part of a Direct Potable Reuse (DPR) project, including evaluations of treatment, impact of different water qualities, impact on Engineered Storage, blending location and blending percentages.

The City of Santa Rosa will provide substantial support of this project, including:

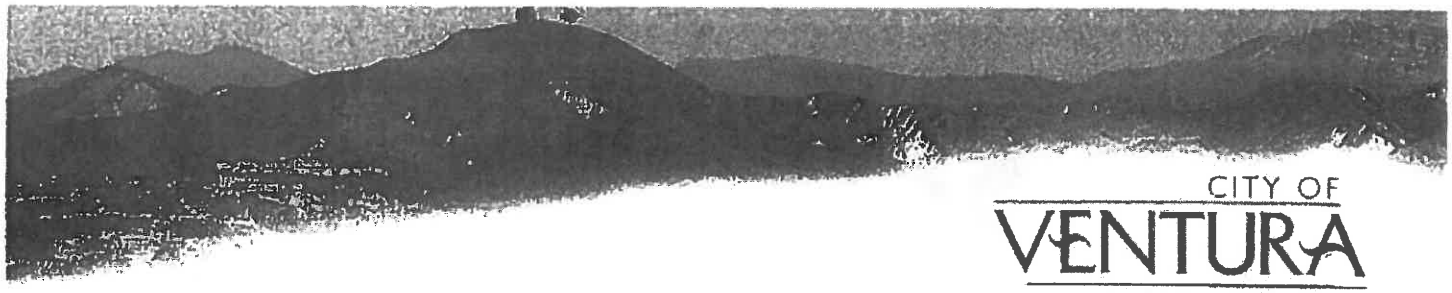
- Meeting with the project team to discuss DPR perspectives, implementation issues, and raw water/recycled water blending concepts.
- Providing the project team with routinely collected and publicly available water quality data, including raw water data, treated potable water data, and reclaimed water data, as appropriate.
- Providing the project team with a summary of known corrosion issues in the potable water distribution system and corrosion inhibitors employed.
- Providing the project team a summary of potable water distributions system information, including make-up of pipes, % of system composed of different materials, and approximate detention times in the system.

Overall, the time required to provide assistance is estimated at 60 hours, amounting to $9,000 of in-kind support.

Sincerely,

Mike Prinz, P.E.
Deputy Director, Subregional Operations

Utilities Department
4300 Llano Road • Santa Rosa, CA 95407
Phone: (707) 543-3350 • Fax: (707) 543-3399
www.santarosautilities.com



CITY OF
VENTURA

City Council

Cheryl Heitmann, Mayor
Erik Nasarenko, Deputy Mayor
Neal Andrews, Councilmember
James L. Monahan, Councilmember
Carl E. Morehouse, Councilmember
Mike Tracy, Councilmember
Christy Weir, Councilmember

January 15, 2014

Andrew Salveson, P.E.
Carollo Engineers, Inc.
2700 Ygnacio Valley Road, Suite 300
Walnut Creek CA 94598

Re: Participation in Water Research Foundation (WRF), *Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536).*

Dear Mr. Salveson:

This letter confirms the City's support of the Carollo/Trussell Technologies/Virginia Tech/Southern Nevada Water Authority team for conducting the Water Research Foundation (WRF), *Blending Requirements for Water From Direct Potable Reuse Treatment Facilities (RFP #4536).* This project is intended to develop recommendations and provide guidance for the appropriate use of blending as part of a Direct Potable Reuse (DPR) project, including evaluations of treatment, impact of different water qualities, impact on Engineered Storage, blending location and blending percentages.

Ventura Water will seek authority to provide substantial support of this project, in exchange for specific pilot testing at the Ventura Water Reclamation Facility (WRF) as detailed in the attached scoping document. The specific support from Ventura Water will include:

- Project Support Cash Contribution of $48,000.
  - Funding to support overall project goals, including sample shipping, analytical costs, data analysis, and reporting by the project team.

- Equipment Rental/Procurement Cash Contribution of $52,000.
  - Rental of UF Toray HF-2020 membrane pilot. Costs include shipping ($5,000), monthly rental ($12,000 for four months), and training ($4,000).

- Rental of Carollo RO pilot. Costs include shipping ($3,000), monthly rental ($20,000 for four months), and training ($4,000).
- Purchase of a small (1 gpm) Trojan UV reactor for AOP testing. Costs estimated at $5,000.
- Purchase of a flow meter, valving, and piping ($5,000).

- Equipment Installation and Training – Estimated at 60 hours, at an in-kind value of $9,000.

- Equipment Operation – Estimated at 0.5 hour per day for four months, amounting to 60 hours and an in-kind value of $9,000.

- Meetings, Data Review, Report Review – Estimated at 60 hours spread over the duration of the project, amounting to an in-kind value of $9,000.

Overall, the total cash contribution will not exceed $100,000. The in-kind contribution will not exceed $27,000. Upon grant approval from your organization, the City will submit a memorandum of understanding for City Council to approve these funds.

Sincerely,

Mark D. Watkins
City Manager

17140 S. Avalon Blvd., Suite 210, Carson CA 90746 310-217-2411 www.westbasin.org

January 6, 2014

Andrew Salveson, P.E.
Associate Vice President
Carollo Engineers
2700 Ygnacio Valley Road
Walnut Creek, CA 94526

RE: WRF Project No. 4536 - *Blending Requirements for Water from Direct Potable Reuse Treatment Facilities*

Dear Mr. ~~Salveson~~ Andy,

The West Basin Municipal Water District (West Basin) is pleased to support Carollo Engineers on WRF Project No. 4536 "Blending Requirements for Water from Direct Potable Reuse Treatment Facilities" (Project). West Basin is interested in exploring direct potable reuse (DPR) options and blending requirements to augment future water supplies by providing flexibility and reliability for the arid southern Los Angeles region. West Basin currently produces five (5) different recycled water qualities through conventional and advanced treatment technologies at its Edward C. Little Water Recycling Facility and three satellite recycling facilities. This includes an indirect potable reuse (IPR) system suitable for this study. West Basin is looking forward in supporting WRF Project #4536 to advance industry practice and guidelines for blending requirements of DPR waters.

West Basin will provide an in kind contribution to the project of ***$10,000*** which includes labor and overhead of West Basin staff to provide the following: Participation in workshops, water samples, site visits, operational and water quality data, current IPR practices and project product . In return for the in-kind support, West Basin expects that this Project will provide guidelines for blending purified waters with groundwater supplies as well as other raw and potable water supplies. We look forward to participating in this exciting and important project.

For further information please contact me at (310) 660 - 6234 or Ms. Uzi Daniel at (310) 660 – 6245. Thank you.

Sincerely,

Shivaji Deshmukh, P.E.
Assistant General Manager

Cc: Uzi Daniel

BUDGET NARRATIVE

The Carollo Team is proposing to complete this project in under 2 years (21 months). We estimate that approximately $244,000 of the Foundation share of the project will be expended in the first year of the project, with the remaining $81,000 expended in the second year. Cash funds of **$100,000** from Ventura, which will be paid directly to WRF for distribution to the project team, will be equally split, with $75,000 being spent within the first year and the remaining $25,000 being spent in the second year. Substantial in-kind funding greater than $290,000 for this project is included in the budget spreadsheets, but not detailed here.

Primary Contractor Budget Justification – Carollo Engineers

Salaries and Wages (Total: $111,067)

Salary rates for the nonfederal employees (Andrew Salveson, Dr. Eva Steinle-Darling, Dr. Greg Pope, Guy Carpenter, with support staff [word processing/ graphics]) are established in conjunction with their employer, Carollo Engineers, Inc. (Carollo). Indirect costs of 126% are included in the hourly rates budget for each of these researchers. A 0% wage increase has been incorporated for each staff person for each year of the project. Overall, 15% of all Carollo salaries are being contributed as an in-kind contribution to this project.

Fringe Benefits

For Carollo personnel, fringe benefits are 50% of direct labor.

Equipment Rental ($24,000)

Ventura Water requires the rental of advanced treatment equipment, totaling $32,000. The funds for this equipment are covered by the cash contribution from Ventura Water. The breakdown of pilot equipment costs are as follows:

- Pasteurization demonstration system, no charge.
- UF membrane (Toray HF-2020). $12,000 rental ($3,000/month for 4 months).
- RO membrane (Harn 2-stage pilot system), $20,000 rental ($5,000/month for 4 months). Total of $20,000 ($8,000 of the cost is contributed as an in-kind contribution to this project).

Materials and Supplies

No materials, other than listed above, are expected as part of this proposal for Carollo's portion of work. Materials for Southern Nevada Water Authority (SNWA) and Virginia Polytechnic Institute and State University (Virginia Tech) are detailed further on.

Travels ($3,000)

Travel costs for Carollo are to provide training on the pilot unit and sampling assistance in Ventura ($1,000 for travel expenses during training, plus $1,000 for travel expenses during sampling), training to provide sampling assistance at the Santa Clara Valley Water District (local, $200), and travel to attend a project meeting in Las Vegas, amounting to airline costs and hotel for the PI (Salveson). Other Carollo staff will attend via WebEx. Airline and hotel costs are estimated at $800 (Oakland to Las Vegas, one night in Las Vegas). Any other travels for project meetings, conference presentations, and WRF annual research updates, etc. will be covered as an in-kind contribution by Carollo (this in-kind is not included in the budget sheets).

Subcontract

Carollo will enter into a subcontract with four entities. The subcontracts include Trussell Technologies (Trussell) for $38,720, Virginia Tech for $102,165, Baribeau Environmental Engineering (Baribeau) for $12,672, and SNWA for $111,376. We will be renting and purchasing equipment as previously mentioned.

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

Other Direct Costs ($22,000)
Other direct costs include:

- Sample shipping. In the event that participating utilities do not cover this, the costs are $5,000.
- Pilot shipping. Costs for shipping the RO pilot are $3,000. Costs for shipping the UF membrane pilot are $5,000. Funds for pilot shipping are covered by cash contribution from Ventura Water.
- Costs for the purchase of a 1 gpm Trojan UV Reactor for AOP testing at Ventura Water (funds are covered by cash contribution from Ventura Water) are $4,500.
- Costs for the purchase of various parts needed for pilot mobilization (e.g., valves, flow meters, and piping) are estimated to be $4,500. Funds are covered from the cash contribution from Ventura Water.

Indirect Costs
As noted earlier, 126% indirect costs for non-federal researcher salaries have been included in the Salaries and Wages budget estimate, as these costs are more accurately described for this project as Direct Costs incurred by Carollo.

Subcontractor Budget Justification Virginia Polytechnic Institute and State University

Salaries and Wages (Total: $61,120)
We note that Virginia Tech, like most universities, accounts for personnel on the basis of percentage-of-effort and not on a per-hour basis; this method of accounting is in accordance with OMB Circular A-21, Cost Principles for Educational Institutions. Any hours reflected in the proposal for these personnel have been shown for the convenience of the sponsor. The hourly rates are not auditable either as proposed or as incurred hours. They are auditable on a percentage-of-effort basis. The conversion is made by applying a standard 2,080 hours per year (1,040 hours per year for graduate students) to the cost estimated by using percentage-of-effort to determine the total salary cost. A Virginia Tech budget form is also attached as the basis for the conversion. The budgeted amount covers 32 hours of Dr. Marc Edwards' time, 104 hours of Dr. Amy Pruden's time, 567 hours of Research Scientist Dr. Jeff Parks' time, and 637 hours of a graduate research assistant's time. $7,551 is also allocated to a tuition remission for a graduate research assistant.

Indirect Costs ($21,833)
Indirect costs of 30% are applied to all budget items except tuition.

Equipment Rental
No equipment rentals are expected as part of this proposal.

Materials and Supplies ($17,212)
$17,212 will cover the analytical costs and supplies for Virginia Tech's portion of the project. This includes reagents, BART test kits, plumbing rigs, ARG and OPPPs analysis, and inspection of the metal coupons at the end of the study.

Travel ($2,000)
$2,000 of travel funding has been allocated to cover one Virginia Tech staff member's attendance at a meeting in Las Vegas and a presentation of research results at an American Water Works Association or similar conference.

Subcontract
No subcontract is expected.

Other Direct Costs
No other direct costs are expected.

Trussell Technologies

Salaries and Wages ($38,720)
Salary rates for the nonfederal employees (Dr. Shane Trussell, Dr. Rhodes Trussell, Dr. Brian Pecson) are established in conjunction with their employer, Trussell. Indirect costs of 126% are included in the hourly rates budget for each of these researchers. A 0% wage increase has been incorporated for each staff person for each year of

the project. Overall, 10% of all Trussell salaries are being contributed as an in-kind contribution to this project.

Fringe Benefits
For Trussell personnel, fringe benefits are 50% of direct labor.

Equipment Rental
No equipment rental is part of Trussell's work effort.

Materials and Supplies
No materials for Trussell's portion of work.

Travels
No travel is scheduled for Trussell as part of this project.

Baribeau Environmental Engineering

Salaries and Wages ($12,672)
Salary rates for the nonfederal employees (Dr. Hélène Baribeau) are established in conjunction with her employer, Baribeau. Indirect costs of 15% are included in the hourly rates budget for each of these researchers. A 0% wage increase has been incorporated for each staff person for each year of the project. Overall, 10% of all Baribeau's salaries are being contributed as an in-kind contribution to this project.

Fringe Benefits
For Baribeau personnel, fringe benefits are 5% of direct labor.

Equipment Rental
No equipment rental is part of Baribeau's work effort.

Materials and Supplies
No materials for Baribeau's portion of work.

Travels
No travel is scheduled for Baribeau as part of this project.

Southern Nevada Water Authority

Salaries and Wages (Total: $15,546)
The salary rates of the professional research staff and associates are established by SNWA and its Board of Directors. The amount will include $1,642 (30 hours) for Dr. Eric Dickenson, $634 (10 hours) for chemist Brett Vanderford, $3,150 (90 hours) for a postdoctoral researcher, and $10,120 (300 hours) for a graduate intern.

Fringe Benefits ($2,170)
The rate for fringe benefits is established by SNWA and is currently 40%. Grad interns are not overheaded. The total fringe benefit cost is estimated at $2,170.

Equipment Rental
No equipment rentals are expected as part of this proposal.

Materials and Supplies ($88,660)
$88,660 will cover the analytical costs and supplies for SNWA's portion of the project.

Travel ($5,000)
We estimate that a SNWA team member will travel to project workshops located in the U.S., and at least one scientific meeting to present research results from this project. The total travel cost is estimated at $5,000.

Subcontract
No subcontract is expected.

Other Direct Costs
No other direct costs are expected.

Indirect Costs
SNWA has no indirect costs.

Cost Share
SNWA will provide its advanced treatment pilot facilities, including ozone, biological filtration, and estimated at a rental value of $75,000.

carollo
Engineers...Working Wonders With Water®

February 14, 2014

John Whitler
Research Manager
Water Research Foundation
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jwhitler@waterrf.org
303.347.6105

Hi John

Thank you for the nice comments on our proposal. We put a lot of effort into the approach and I am glad it was well received. Below are your questions, followed by our thoughts. Please keep in mind that we remain flexible and will alter our proposal to the extent requested by your organization and the PAC.

1) **Task 0** – It appears that this pre-project workshop is scheduled to occur prior to the official beginning of this project, based on information we found on the NWRI website. Will this workshop still address the needs of this workshop even if it occurs before this project is initiated? Will there be additional opportunities to bring together outside experts and the PAC to review the interim results of this research?

   Responses -
   Workshop Content: The pre-project workshop content is being developed now, and is based upon the outline in the proposal. We would be happy to discuss the content in advance of the meeting with the Water Research Foundation and with the PAC. We would also be happy to have participation from the Water Research Foundation at the workshop and receive input from the Water Research Foundation and PAC members on the results of the meeting.
   Workshop Timing: The pre-project workshop will be held in late March or early April. There is another NWRI workshop funded under the same grant that is occurring in February. This is a different workshop than the one listed in our proposal.
   Workshop Location: We have been considering holding the workshop in Austin Texas, which appears to work well with comment #3 below.

2) **Task 4** – Based on the information provided in the proposal, it is not clear how the final product and research results will be provided in order to give utilities the necessary guidance based on the research results. As stated it only appears the report will provide information about the research results without translating this into guidance for utilities so that can more readily apply the research results. Please explain how the final report will include guidelines to utilities to integrate DPR water with existing water supplies.

Response -
Within each task we have listed the deliverables, including a literature review (Task 1), utility survey, data and corrosivity analysis (Task 2), testing and analytical results (Task 3), and a final report (Task 4). You are correct that nowhere do we explicitly state that we will create Blending Guidelines. It was my impression that we did in fact list Guidelines in our proposal. Apparently during our final cuts of text to meet the length requirement, we removed a discussion which highlighted our intent to provide Guidelines, the original text was as follows: *"We also recognize that blending impacts are complex and the testing done as part of this project will be instructional and informative, but cannot represent all of the issues for all utilities. As such, the results from our testing will be used to develop guidelines for blending and the use of corrosion guidance to highlight different impacts for other systems."* Thus, we agree that Guidelines are an important result of this project and we will utilize the deliverables from Tasks 1, 2, and 3 within Task 4 to make Guideline for Blending in Direct Potable Reuse Projects.

3) Several utilities approached WRF as being interested in joining the winning proposal as utility partners. If selected, are you able to accommodate additional utility or organizational partners, such as LADWP, SFPUC, Austin, and FLDEP?

Response -
Absolutely. We are very happy to engage additional utilities from the standpoint of peer review, interviews, etc. The only limitation to utility participation is the research and testing listed in Task 3 of our proposal. Because of logistical and cost issues, we are currently scheduled to perform testing on waters from Ventura, the Santa Clara Valley Water District, and waters in the Las Vegas area. Should other utilities wish to have original research done at their facilities, we would need to remove one of the current utilities from the test plan or we would need to have additional funding to include the new utility. Please let us know to what extent these utilities wish to participate and we will find a way to get it done.

Thank you once again, I am personally very happy to have been selected for this project and look forward to working with you and the PAC.

CAROLLO ENGINEERS, Inc.

Andrew Salveson, P.E.,
Vice President
Water Reuse Chief Technologist

Water Research Foundation
Research Project Budget

Instructions for budgets are at http://www.waterrf.org/funding/pages/quicklinks.aspx

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

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

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536

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

Sources of Award, Cost Share, and Non-Cash In-Kind Contributions (Insert rows to list more third parties.)		Award			Cost Share		Third-Party Non-Cash In Kind
		Foundation Funds	*Sub-recipient*	*Third-Party Cash to Foundation*	*Sub-recipient*	*Third-Party Cash to Sub-recipient*	
Water Research Foundation			n/a	n/a	n/a	n/a	n/a
Sub-recipient (including subcontract contributions)		n/a	325,000	n/a	108,310	n/a	n/a
Third Parties	NWRI	n/a	n/a		n/a		20,000
	Santa Clara Valley Water District (SCVWD)	n/a	n/a		n/a		105,000
	Ventura Water	n/a	n/a	100,000	n/a		27,000
	City of Peoria, AZ	n/a	n/a		n/a		9,000
	West Basin Municipal Water District	n/a	n/a		n/a		10,000
	Orange County Water District	n/a	n/a		n/a		5,000
	Denver Water	n/a	n/a		n/a		5,000
	City of Norman	n/a	n/a		n/a		0
	City of Oxnard	n/a	n/a		n/a		0
	City of San Diego	n/a	n/a		n/a		0
	City of Santa Rosa	n/a	n/a		n/a		0
	Upper Occoquan Services Authority	n/a	n/a		n/a		0
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
	Subtotal	***0***	***325,000***	***100,000***	***108,310***	***0***	***181,000***
Total Award, Cost Share, and Third-Party Non-Cash In Kind			**425,000**		**108,310**		**181,000**
Total Project Value				**714,310**			

Water Research Foundation
Research Project Budget

Instructions for budgets are at http://www.waterrf.org/funding/pages/quicklinks.aspx

* Required fields are highlighted in yellow.

* Required fields are highlighted in yellow.

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536
Note: The information above will carry over to subsequent pages/worksheets.

REVISED 9/9/14

Sources of Award, Cost Share, and Non-Cash In-Kind Contributions (Insert rows to list more third parties.)	Award			Cost Share		Third-Party Non-Cash In Kind
	Foundation Funds	*Sub-recipient*	*Third-Party Cash to Foundation*	*Sub-recipient*	*Third-Party Cash to Sub-recipient*	
Water Research Foundation		n/a	n/a	n/a	n/a	n/a
Sub-recipient (including subcontract contributions)	n/a	325,000	n/a	108,310	n/a	n/a
Third Parties NWRI	n/a	n/a		n/a		20,000
Santa Clara Valley Water District (SCVWD)	n/a	n/a		n/a		105,000
Ventura Water	n/a	n/a	100,000	n/a		27,000
City of Peoria, AZ	n/a	n/a		n/a		9,000
West Basin Municipal Water District	n/a	n/a		n/a		10,000
Orange County Water District	n/a	n/a		n/a		5,000
Denver Water	n/a	n/a		n/a		5,000
Clean Water Services (Oregon)	n/a	n/a		n/a		0
City of San Diego	n/a	n/a		n/a		0
Upper Occoquan Services District	n/a	n/a		n/a		0
City of Santa Rosa	n/a	n/a		n/a		0
City of Austin	n/a	n/a		n/a		9,000
SFPUC	n/a	n/a		n/a		5,000
	n/a	n/a		n/a		
	n/a	n/a		n/a		
	n/a	n/a		n/a		
	n/a	n/a		n/a		
	n/a	n/a		n/a		
	n/a	n/a		n/a		
	n/a	n/a		n/a		
Subtotal	*0*	* *325,000*	*100,000*	*108,310*	*0*	*195,000*
Total Award, Cost Share, and Third-Party Non-Cash In Kind	* 425,000			108,310		195,000
Total Project Value	728,310					

* 325,000 shown includes LADWP's full two year funding commitment.

Form ver. 2012.05

Contribution Sources

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536

OK
OK

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

		Total	Award	Cost Share
A	Key Personnel	19,214	16,332	2,882
B	Other Personnel	38,603	32,812	5,791
	Total Direct Labor and Fringe Benefits	*57,817*	*49,144*	*8,673*
C	Equipment Rental	32,000	24,000	8,000
	Special Equipment	0	0	0
D	Materials and Supplies	0	0	0
E	Travel	3,000	3,000	0
F	Subcontracts	345,643	264,933	80,710
G	Other Direct Costs	22,000	22,000	0
	Total Direct Costs	*460,460*	*363,077*	*97,383*
H	Indirect Costs	72,851	61,923	10,928
I	Fee	0	0	0
J	Surveys	0	0	0
	Total Direct and Indirect Costs	***533,311***	***425,000***	***108,311***
	Third-Party Non-Cash In Kind	**195,000**	n/a	n/a
	Total Project Value	**728,311**		

Water Research Foundation
Research Project Budget

* Required fields are highlighted in yellow.

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536

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

Name	Project Role	Number of Hours	Direct Hourly Rate	% Time Allocated to Project	Subtotal Direct Labor	Fringe Benefit % of Direct Labor	Subtotal Fringe Benefits	Total	Award	Cost Share
Andrew Salveson	Principal Investigator	183.00	70.00	5.0%	12,809	50.00%	6,405	19,214	16,332	2,882
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
		Total Key Personnel			12,809		6,405	19,214	16,332	2,882

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

Name/Position	Project Role	Number of Hours	Direct Hourly Rate	% Time Allocated to Project	Subtotal Direct Labor	Fringe Benefit % of Direct Labor	Subtotal Fringe Benefits	Total	Award	Cost Share
Eva Steinle-Darling	Public Health Criteria/Bench-Scale Testing and Analysis	272.00	40.65	7.5%	11,058	50.00%	5,529	16,586	14,098	2,488
Greg Pope	Blending Water Quality Issues	252.50	47.59	6.9%	12,017	50.00%	6,009	18,026	15,322	2,704
Guy Carpenter	Technical Advisor	38.00	70.00	1.0%	2,660	50.00%	1,330	3,990	3,392	599
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
		Total Other Personnel			25,735		12,868	38,603	32,812	5,791

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

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536

C. Equipment Rental and Special Equipment Purchase

Equipment Rental (*List items and dollar amount for each item exceeding $1,000*)	Total	Award	Cost Share
UF Toray HF-2020 membrane pilot	12,000	12,000	0
RO pilot	20,000	12,000	8,000
			0
			0
			0
Total Equipment Rental	**32,000**	**24,000**	**8,000**

Special Equipment Purchase (*List items and dollar amount for each item exceeding $5,000*)	Total	Award	Cost Share
			0
			0
			0
			0
			0
Total Special Equipment Purchase	**0**	**0**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536

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

E. Travel	Total	Award	Cost Share
Travel for Pilot Training (Ventura Water)	1,000	1,000	0
Travel for Sampling Assitance (Ventura Water)	1,000	1,000	0
Travel for Training/Sampling Assistance (Santa Clara Valley Water District)	200	200	0
Travel to attend project meeting in Las Vegas - travel from Oakland to Las Vegas (PI - Andrew Salveson)	800	800	0
			0
			0
			0
			0
Total Travel	**3,000**	**3,000**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536

F. Subcontracts	Total	Award	Cost Share
Baribeau Environmental Engineering	14,080	12,672	1,408
Virginia Tech	102,165	102,165	0
Trussel Technologies	43,022	38,720	4,302
Southern Nevada Water Authority (SNWA)	186,376	111,376	75,000
			0
			0
			0
			0
Total Subcontracts	**345,643**	**264,933**	**80,710**

G. Other Direct Costs	Total	Award	Cost Share
Purchase of various parts for pilot mobilization (e.g., flow meter, valves, and piping)	4,500	4,500	0
Purchase of 1 gpm Trojan UV reactor for AOP testing	4,500	4,500	0
UF Toray HF-2020 membrane pilot shipping	5,000	5,000	0
RO Pilot Shipping	3,000	3,000	0
Sample Shipping	5,000	5,000	0
			0
			0
			0
Total Other Direct Costs	**22,000**	**22,000**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Carollo Engineers
PI Name: Andrew Salveson
Project Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities
Preparation/Revision Date: 1/14/2014
RFP # (if applicable): 4536

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

Cost Category	Rate %	Base $	Total	Award	Cost Share
A. Key Personnel	126%	19,319	24,342	20,691	3,651
B. Other Personnel	126%	38,499	48,509	41,232	7,276
			0		0
			0		0
			0		0
		Total Indirect Costs	**72,851**	**61,923**	**10,928**

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

J. Survey	Total	Award	Cost Share
			0
			0
			0
			0
			0
			0
Total Survey Costs	**0**	**0**	**0**

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Exhibit B
Project 04536

Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

TASK	DUE DATE
Begin Project	October 1, 2014
Scope of Work	November 1, 2014
Sub-recipient presents Proof of Insurance(s) or Certificate of Self Insurance & Worker's Compensation Insurance	November 1, 2014
Periodic Report 1 – electronic copy	January 1, 2015
Periodic Invoice 1	January 1, 2015
Periodic Report 2 (incl. Technical Summary & Web Update) - electronic copy	April 1, 2015
Periodic Invoice 2 – electronic copy	April 1, 2015
Periodic Report 3 – electronic copy	July 1, 2015
Periodic Invoice 3– electronic copy	July 1, 2015
Periodic Report 4 (incl. Technical Summary & Web Update) – electronic copy	October 1, 2015
Periodic Invoice 4	October 1, 2015
Periodic Report 5 – electronic copy	December 1, 2015
Periodic Invoice 5	December 1, 2015
Draft Report – electronic copy and one hardcopy	March 1, 2016
Draft Invoice	March 1, 2016
Final Report – electronic copy and one hardcopy	June 1, 2016
Letters of Confirmation from participating utilities	June 1, 2016
Complete & Submit Exhibit E – Assignment of Copyright	June 1, 2016
Final Invoice & Final Compensation	June 1, 2016
Project End & Foundation Publication Date	March 1, 2017

Note: Please submit one electronic copy of each Periodic Report. And submit one electronic copy for Draft & Final Report and hardcopy in *MSWord format*. For each report an invoice must be submitted for payment using Exhibit D – printed on your company letterhead.

Foundation Key Contacts:

Project Management

- John Y. Whitler, Research Manager, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: (303) 347-6105, and Email: jwhitler@WaterRF.org.

Contract Administration

- Peggy Falor, Manager Contracts and Project Administration, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: (303) 734-3424, and Email: pfalor@WaterRF.org.
- Monica Morgan, Project Coordinator, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: (303) 734-3475, and Email: mmorgan@WaterRF.org.

Sub-recipient Key Contacts:

Principal Investigator and Authorized Representative

- Andrew Salveson, Associate Vice President, Carollo Engineers, Inc., 2700 Ygnacio Valley Rd., Suite 300, Walnut Creek, CA 94598, Phone: (925) 977-3060, and Email: asalveson@carollo.com.

Accounting Contact (Project Funds disbursements will be mailed to the care of this contact)

- Jane M. Anderson, Senior Billing Administrator, Carollo Engineers, Inc., 4600 E. Washington St. Suite 500, Phoenix AZ 85034, Phone: (602) 263-9500, and Email: jmanderson@carollo.com.

Co-Principal Investigators:

- Shane Trussell, Ph.D., P.E., Vice President, Trussell Technologies, 6540 Lusk Blvd., Suite C175, San Diego, CA 92121, Phone: (858) 458-1030, and Email: shane.trussell@trusselltech.com.
- Marc Edwards, Ph.D., Professor, Virginia Polytechnic Institute and State University, Department of Civil Engineering, 407 Durham Hall, Blacksburg, VA 24061, Phone: (540) 231-7236, and Email: edwardsm@vt.edu.

Partner Contact:

- Julie Minton, Director Research Programs, WateReuse Research Foundation, 1199 N. Fairfax St., Ste. 410, Alexandria, VA 22314, Phone: (703) 548-0880, Ext. 108, and Email: . .

Co-funder Contacts:

- Paula Kehoe, San Francisco Public Utilities, 525 Golden Gate Ave., 10th Floor, San Francisco, CA 94102, Phone: (415) 554-0792, and Email: pkehoe@sfwater.org
- Angela O'Brien, Zone 7 Water Agency, 601 E. Vallecitos Rd., Livermore, CA 94550, Phone: (925) 454-5748, and Email: aobrien@zone7wwater.com.
- Jeff Quimby, Contra Costa Water District, P.O. Box H20, Concord, CA 94524, Phone: (925) 688-8310, and Email: jquimby@ccwater.com.
- Mikel Halliwell, Alameda County Water District, 43885 South Grimmer Blvd., Fremont, CA 94538, Phone: (510) 668-4412, and Email: mikel.halliwell@acwd.com
- Linda Hu, East Bay Municipal Utility, 375 11th St., MS 407, Oakland, CA 94607, Phone: (510) 287-1691, and Email: lhu@ebmud.com.

- Evelyn Cortez-Davis, Los Angeles Department of Water & Power, 111 N. Hope St., Room 1460, Los Angeles, CA 90012, Phone: (213) 367-2360, and Email: evelyn.cortez-davis@ladwp.com.
- Shana Epstein, Ventura Water, 336 Sanjon Rd., Ventura, CA 93001, Phone: (805) 652-4518, and Email: sepstein@venturawater.net.

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

BUDGET SUMMARY

Exhibit C
Project 04536

Contractor: Carollo Engineers, Inc.
2700 Ygnacio Valley Rd., Suite 300
Walnut Creek, CA 94598

Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

This PFA shall be effective from **10/01/2014** and shall end on **03/01/2017** detailed in Exhibit B. The Foundation shall not have any obligation for payment of invoices for costs incurred by the Sub-recipient after the foregoing end date.

The Foundation and the Co-funders agree to provide aggregate Project Funds to the Sub-recipient in an amount not to exceed Three Hundred Ninety Five Thousand US dollars ($395,000.00) for the completion of this PFA. The Foundation Contribution and the Co-funders Contribution are as detailed below. The Foundation Contribution and other participant's contributions are as detailed below. The Sub-recipient agrees to contribute One Hundred Eight Thousand three Hundred Ten US dollars ($108,310.00) in Cost Share and One Hundred Ninety Five Thousand US dollars ($195,000.00) in in-kind contributions as detailed below. The total budget for the Project is Six Hundred Ninety Eight Thousand Three Hundred Ten US dollars ($698,310.00).

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

- Jane M. Anderson, Senior Billing Administrator, Carollo Engineers, Inc., 4600 E. Washington St. Suite 500, Phoenix AZ 85034, Phone: (602) 263-9500, and Email: jmanderson@carollo.dom.

ORGANIZATION	Award Amount	Cost Share	In-Kind Amount
Participants			
WaterReuse Research Foundation	$0.00	$0.00	$0.00
Co-funders			
San Francisco Public Utilities	$15,000.00	$0.00	$5,000.00
Zone 7 Water Agency	$10,000.00	$0.00	$0.00
Contra Costa Water District	$15,000.00	$0.00	$0.00
Alameda County Water District	$15,000.00	$0.00	$0.00
East Bay Municipal Utility	$15,000.00	$0.00	$0.00
Los Angeles Department of Water & Power	$30,000.00*	$0.00	$0.00
Ventura Water	$100,000.00	$0.00	$27,000.00
Participants			
NWRI	$0.00	$0.00	$20,000.00
Santa Clara Valley Water District	$0.00	$0.00	$105,000.00
West Basin Municipal Water	$0.00	$0.00	$10,000.00

Exhibit C Continued
Project 04536

ORGANIZATION	Award Amount	Cost Share	In-Kind Amount
Orange County Water District	$0.00	$0.00	$5,000.00
Denver Water	$0.00	$0.00	$5,000.00
Clean Water Services (Oregon)	$0.00	$0.00	$0.00
City of San Diego	$0.00	$0.00	$0.00
Southern Nevada Water Authority	$0.00	$75,000.00	$0.00
Austin Water Utility	$0.00	$0.00	$9,000.00
City of Peoria	$0.00	$0.00	$9,000.00
City of Oxnard	$0.00	$0.00	$0.00
City of Santa Rosa	$0.00	$0.00	$0.00
Norman Water Department	$0.00	$0.00	$0.00
Upper Occoquan Services District	$0.00	$0.00	$0.00
Baribeau Environmental Engineering	$0.00	$1,408.00	$0.00
Co-PIs			
Trussell Technologies, Inc.	$0.00	$4,302.00	$0.00
Virginia Polytechnic Institute	$0.00	$0.00	$0.00
Sub-recipient			
Carollo Engineers, Inc.	$0.00	$27,600.00	$0.00
Water Research Foundation	$195,000.00	$0.00	$0.00
Totals	**$395,000.00**	**$108,310.00**	**$195,000.00**
Total Project Budget $698,310.00			

Note – All Co-funders shown were contracted through separate Letters of Agreement. LADWP funding commitment will be split between two years @ $30,000.00 each year.

Project Award Funds: not to exceed $395,000.00
10% of Project Funds advanced on or following Effective Date: $39,500.00
Amount due upon the Foundation's acceptance of Draft Report: $39,500.00
Amount due upon the Foundation's acceptance of the Final Report and final invoice: $39,500.00

Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

Exhibit D – Invoice Form

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

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

Exhibit E
Project 04536

Title: Blending Requirements for Water from Direct Potable Reuse Treatment Facilities

Assignment of Interest in Copyrighted Works

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

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

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

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

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

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

State of _____ }
} ss
County of _____ }

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

_____
Notary Public Comm'n. Exp.

TASK ORDER NO. 1

CAROLLO ENGINEERS, INC.

AND
SOUTHERN NEVADA WATER AUTHORITY
CONSULTANT

This Task Order is issued by the ENGINEER and accepted by the CONSULTANT pursuant to the mutual promises, covenants and conditions contained in the Agreement between the above named parties dated the _____ day of _____, 20__, in connection with:

Water Research Foundation Project #4536:
Blending Requirements for Water From Direct Potable Reuse Treatment Facilities

PURPOSE

Task Order #1 is intended to cover CONSULTANT's time and expenses to support Task 2 (providing utility perspective and water quality data), Task 3 (performing detailed water quality analysis, bench-top water treatment simulations, and operation of premise plumbing rigs), and Task 4 (reporting of results done by CONSULTANT and review of overall results and deliverables). Details of the CONSULTANT's work are further specified in the Water Research Foundation (WaterRF) Funding Agreement entitled "Blending Requirements for Water From Direct Potable Reuse Treatment Facilities" (project number 4536) up to a maximum fee of $111,376. The WaterRF Funding Agreement is attached for reference. The CONSULTANT's Project Manager, Eric Dickenson (hereinafter "Project Manager"), will oversee bench- and pilot-scale tests and analytical work (Task 3). Southern Nevada Water Authority will provide as in-kind the use of advanced treatment pilot skids (ozone and biological filtration) to the WaterRF 4536 project.

TIME OF PERFORMANCE

The work for this project is scheduled to take place between November 20, 2014 and March 1, 2017.

EFFECTIVE DATE

This Task Order No. 1 is effective as of the _____ day of _____, 20__.

IN WITNESS WHEREOF, duly authorized representatives of the ENGINEER and of the CONSULTANT have executed this Task Order No.1 evidencing its issuance by ENGINEER and acceptance by CONSULTANT.

CAROLLO ENGINEERS, INC.

By: _____
[Title]

By: _____
[Title]

CONSULTANT

Accepted this _____ day of _____, 20___

By: _____
John J. Entsminger, General Manager

APPROVED AS TO FORM:

By: _____
Laura Ellen Browning, Deputy Counsel

PROGRESS BILLING

Please submit invoice in one pdf format to: accountspayable@carollo.com

Carollo Engineers, Inc.

Southern Nevada Water Authority
(SUBCONTRACTOR)

If mailing the invoice, please send to:

4600 E. Washington Street, Suite 500
(Address)

P.O. Box 99954
(Address)

Phoenix, AZ 85034
(City, State, Zip)

Las Vegas, NV 89193-9954
(City, State, Zip)

702-856-3668
(Phone)

Sent by: _____

Date: _____

Attn: Accounts Payable

Subject: _____

Carollo Project Number 9589A00

Professional Services for the Period Ending _____

Task Summary	Current Period	Previous Billings	Job to Date	Contract Limits	% of Budget
	$	$	$	$	%
Total Amounts					

Prior Billings Not Paid $ _____

Progress Percent Complete (based on completed work) _____ %

NOTE: Attach SUBCONSULTANT's Current Period Invoice

SUBCONSULTANT BILLING INSTRUCTIONS

Note: SUBCONSULTANT invoices come in a wide variety of formats. Very few offer job-to-date information that indicates progress of the job in relation to contract authorizations.

The attached Progress Billing cover sheet has been designed to remedy the problem and provide the needed information in a consistent manner. The SUBCONSULTANT's invoice should be prepared in the normal manner then attached to the Progress Billing cover sheet.

When the Project is being started, the Project Manager needs to fill in some of the information on this form and provide it to the SUBCONSULTANT for their use in preparing the monthly billing to Carollo Engineers.

Address:	**Do not edit the mailing address – it is the centralized address for Concur billings.**
Subject:	Fill in the name of the Project
Carollo Project Number:	Fill in
Description:	This section is for recording the amounts and hours. Sometimes breakdowns of the consultant's charges will be needed. Usually it will be derived from the Scope of Services. The Project Manager should list the names of the items to be listed separately. The breakdown of the Contract limit should be completed in the "Contract Limits" column. If no breakdown is required, type in "total contract" in the description column and fill in the Contract Limit.

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Agreement	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors approve and authorize the General Manager to sign an agreement between the Water Research Foundation and the Authority for the "Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration" study, authorize the Authority to contribute $304,000 in cost-share services as its co-participant portion, and accept funds in an amount not to exceed $350,000.	

Fiscal Impact:
If the above recommendation is approved, the Authority will contribute $304,000 in cost-share services. The Water Research Foundation will contribute an amount not to exceed $350,000 in monetary funds and other Project participants will contribute $114,975 of cost-share and $148,712 of in-kind services for a total Project value of $917,687, which includes the Authority's contribution.

Background:
The Water Research Foundation (WaterRF) has utilized the Authority's expertise on numerous occasions to participate in various studies to improve many aspects of water quality. The Authority's Water Quality Research and Development (R&D) Division has comprehensive expertise in the study of chemical contaminants and pilot- and full-scale filtration processes. Recognizing this, the WaterRF has selected the R&D Division as the Principal Investigator to conduct solicited research on the "Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration" study (Project).

The overarching goal of the Project is to provide guidance and assist water utilities in achieving maximum simultaneous removal of multiple chemical contaminants using biofiltration in a drinking water system without compromising the existing objectives of the filtration process. The effective removal of individual classes of some chemical contaminants can be achieved by biofiltration. However, biofiltration performance for simultaneously removing multiple classes of chemical contaminants is not well established, therefore further research is required.

If approved, the Authority would participate as Co-Principal Investigator while leading the Project, enlisting the assistance of additional Co-Principal Investigators and other participants to complete the research. This Project directly complements the mission of developing solutions that will ensure adequate high quality future water supplies for the Las Vegas Valley.

AGENDA ITEM # 5

The $350,000 provided by the WaterRF would cover all direct costs incurred by the Authority and for subcontract work provided by the Co-Principal Investigators. The Authority's cost-share primarily includes the value of existing equipment use, as well as some labor and analytical costs.

This agreement is being entered into pursuant to Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:KPF:DJR:ED:jf
Attachments

DISCLOSURE OF OWNERSHIP/PRINCIPALS

Business Entity Type Water Research Foundation						
☐ Sole Proprietorship	☐ Partnership	☐ Limited Liability Company	☐ Corporation	☐ Trust	☒ Non-Profit Organization	☐ Other
Business Designation Group						
☐ MBE	☐ WBE	☐ SBE	☐ PBE	☐	☐	
Minority Business Enterprise	Women-Owned Business Enterprise	Small Business Enterprise	Physically Challenged Business Enterprise			

Corporate/Business Entity Name:			
(Include d.b.a., if applicable)	Water Research Foundation		
Street Address:	6666 W. Quincy Ave	**Website:**	www.waterrf.org
City, State and Zip Code:	Denver, CO 80235	**POC Name and Email:**	Peggy Falor pfalor@waterrf.org
Telephone No:	303-734-3424	**Fax No:**	
Local Street Address:	same as above	**Website:**	
City, State and Zip Code:	↓	**Local Fax No:**	303-730-0851
Local Telephone No:	↓	**Local POC Name Email:**	
Number of Clark County, Nevada Residents Employed:			

All entities, with the exception of publicly-traded and non-profit organizations, must list the names of individuals holding more than five percent (5%) ownership or financial interest in the business entity appearing before the SNWA Board of Directors.

Publicly-traded entities and non-profit organizations shall list all Corporate Officers and Directors in lieu of disclosing the names of individuals with ownership or financial interest. The disclosure requirement, as applied to land-use applications, extends to the applicant and the landowner(s).

Entities include all business associations organized under or governed by Title 7 of the Nevada Revised Statutes, including but not limited to private corporations, close corporations, foreign corporations, limited liability companies, partnerships, limited partnerships, and professional corporations.

Full Name	Title	% Owned (Not required for Publicly Traded Corporations/Non-profit organizations)

This section is not required for publicly-traded corporations. N/A

1. Are any individual members, partners, owners or principals, involved in the business entity, an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☑ No (If yes, please note that SNWA employee(s), or appointed/elected official(s) may not perform any work on professional service contracts, or other contracts, which are not subject to competitive bid.)

2. Do any individual members, partners, owners or principals have a spouse, registered domestic partner, child, parent, in-law or brother/sister, half-brother/half-sister, grandchild, grandparent, related to an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☑ No (If yes, please complete the Disclosure of Relationship form on Page 2. If no, please print N/A on Page 2.)

I certify under penalty of perjury, that all of the information provided herein is current, complete, and accurate. I also understand that the SNWA will not take action on land-use approvals, contract approvals, land sales, leases or exchanges without the completed disclosure form.

Peggy Falor
Signature

Peggy Falor
Print Name

Manager- Contracts & Proj. Admin
Title

9/17/2014
Date

For projects 4558 & 4559

DISCLOSURE OF RELATIONSHIP

List any disclosures below:
(Mark N/A, if not applicable.)

NAME OF BUSINESS OWNER/PRINCIPAL	NAME OF SNWA EMPLOYEE OR OFFICIAL AND JOB TITLE	RELATIONSHIP TO SNWA EMPLOYEE OR OFFICIAL	SNWA EMPLOYEE'S/OFFICIAL'S DEPARTMENT
n/a	n/a	n/a	n/a

"Consanguinity" is a relationship by blood. "Affinity" is a relationship by marriage.

"To the second degree of consanguinity" applies to the candidate's first and second degree of blood relatives as follows:

- Spouse – Registered Domestic Partners – Children – Parents – In-laws (first degree)
- Brothers/Sisters – Half-Brothers/Half-Sisters – Grandchildren – Grandparents – In-laws (second degree)

For SNWA Use Only:

If any Disclosure of Relationship is noted above, please complete the following:

N/A ☐ Yes ☐ No Is the SNWA employee(s) noted above involved in the contracting/selection process for this particular agenda item?

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in any way with the business in performance of the contract?

Notes/Comments:
No LVVWD or SNWA employees were noted.

Signature

Eric Dickenson, Acting for
Print Name David J. Rexing
Authorized Department Representative

Project Funding Agreement 04559

This Project Funding Agreement (hereafter "PFA") is entered into on _____, 20__, (the "Effective Date") by and among the Water Research Foundation (the "Foundation"), a Delaware non-profit corporation whose principal place of business is located at 6666 W. Quincy Ave., Denver, Colorado 80235, and Southern Nevada Water Authority ("Sub-recipient"), whose principal place of business is located at 1299 Burkholder Blvd, Henderson, Nevada 89015.

The Foundation has selected said Sub-recipient to receive a research and development grant as more specifically detailed in this PFA. The parties mutually agree as follows:

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

A. "Cost Share" the portion of allowable costs that the sub-recipient, subcontractor or third-party participant contributes toward completing the Foundation project. Cost share includes any non-federal cash and non-cash contributions from the sub-recipient and subcontractors, and non-federal cash contributions from participants. All Cost Share must meet Code of Federal Regulations (CFR) requirements in 2 CFR Part 215.23 or the requirements of OMB Circular A-102.24 as applicable.

B. "Foundation Award" is that portion of the Project Funds which the Foundation has agreed to contribute to fund the Project under this PFA, as detailed in Exhibit C.

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

D. "PAC" is the Project Advisory Committee that consists of independent volunteers selected by the Foundation and Co-funders to provide technical review, assistance, and/or expertise related to the Project. The number of volunteers to serve on the PAC will be determined by the Foundation.

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

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

G. "Project Funds" is the aggregate maximum amount of cash award which the Foundation agrees to provide to Sub-recipient to fund its performance of the Project pursuant to this PFA.

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

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

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

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

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

II. GENERAL OBLIGATIONS OF THE PARTIES

A. The Sub-recipient.

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

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

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

4. Focus Area Annual Research Summit

Projects that are funded with the Foundation's Focus Area funds are required to participate in the Focus Area Annual Research Summit. The Summit brings together focus area Technical Advisory Committee (TAC) members, Focus Area Council (FAC) members, and project PIs on an annual basis to review the technical progress and results of projects funded within an individual focus area. The summits may also include researchers for projects that are related to the Focus Area, but not funded by Focus Area funds. Focus area research summits are held on an annual basis via web conference and are usually held in the fall or winter. PIs for projects funded under a particular focus area will be required to present project information at the Focus Area Annual Research Summit every year. Researchers should include time and resources in the proposal budget to cover the creation and presentation of a 15-30 minute presentation, to be given via webcast, on an annual basis for the duration of the project period.

B. The Foundation. The Foundation will disburse the Project Funds to the Sub-recipient as detailed in this PFA and Exhibit C. The Foundation's disbursement of the Project Funds may further be subject to the Foundation's receipt of its own funding from appropriate sources.

III. DISBURSEMENT OF PROJECT FUNDS

A. Advance Payment. All payments of the Project Funds will be disbursed by the Foundation directly to the Sub-recipient. The amount of Project Funds was determined on the basis of the budget submitted by the Sub-recipient, and set forth in Exhibit C. The Project Funds is a "not to exceed" amount and no payments in excess of such amount are authorized or required. Following the Effective Date the Foundation will advance to the Sub-recipient 10% of the Project Funds. All subsequent disbursements of the Project Funds shall be governed by the requirements described in Section III.B below and in Exhibit C.

B. Invoicing and Payments.

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

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

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

(a) The ten percent (10%) advance payment must be shown on all invoices, including the final invoice, as an advance payment received. Subject to the hold back provision below, invoices will be paid to the extent actual costs incurred exceed the advance payment.

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

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

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

IV. COMPLIANCE MONITORING

A. Financial Management System. The Sub-recipient shall maintain an accounting system and accurate and complete accounting records that, at a minimum but without limitation, allow for the identification, tracking, and verification of costs, expenses, Cost Share, in-kind contributions, invoiced items, and funding received, all in a manner that is segregated and allocable solely to performance of the Project. All costs incurred must be supported by original *or true and correct copies of* receipts and be made available to the Foundation upon request.

B. Cost Principles. The Sub-recipient represents and warrants that the budget disclosures included in the Project Proposal and presented to the Foundation was prepared by Sub-recipient in full compliance with the cost principles governing determination of reimbursable costs and expenses in Sub-recipient's type of organization. Sub-recipient shall throughout the Project, and in the preparation of every invoice, report, and maintenance of its accounting system, remain in compliance with the cost principles by which it is governed. It shall be Sub-recipient's obligation to determine and comply with its governing cost principles.

- State, local or Indian tribal government, 2 CFR 225.
- Non-profit Organization (NPO), 2 CFR 230.
- Institution of Higher Education, 2 CFR 220.
- Hospitals, 45 CFR 74 Appendix E.
- Commercial (For Profit) and selected Non-Profit Organizations 48 CFR 31.2

C. Indirect Costs and Allocation of Costs:

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

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

E. Audit and Monitoring.

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

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

3. Any deficiencies or non-compliance in Sub-recipient's systems, procedures, record keeping, finances, and performance of other obligations under this PFA discovered in the audit, review or monitoring process, or discovered otherwise, may, at the Foundation's option, require Sub-recipient to take corrective action that has been detailed by the Sub-recipient and approved by the Foundation for the Sub-recipient to remedy the deficiency or noncompliance, or may result in the Foundation exercising its termination rights under Section VII below.

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

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

V. PROCUREMENT STANDARDS

A. Procurement Standards. It is an express requirement under the Proposal Guidelines and this PFA that the Sub-recipient remain in compliance with the U.S. Federal standards for procurement as are outlined in the U.S. Federal Uniform Administrative Requirements applicable to Sub-recipient's organization type. These standards govern procedures for procurement of supplies, equipment, and other services for which cost is incurred in whole or in part under this PFA. These standards include but are not limited to the following:

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

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

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

VI. IP RIGHTS AND PUBLICATION

A. Work Product.

1. The Foundation shall own all worldwide copyrights in all the Work Product, including the Scope of Work, all Periodic Reports, all Draft Reports, the Final Report, and all drafts of these works and reports. Sub-recipient shall and hereby does assign exclusively to the Foundation all right, title, and interest in and to the Work Product and the copyrights embodied therein. The Sub-recipient may use without restrictions all data from the Work Product such as innovations, creations, processes, designs, methods, formulas, plans, technical data and specifications.

2. *The Sub-recipient hereby agrees to provide to the Foundation copies of any publication or presentation of any Foundation owned Intellectual Property approved for publication/presentation upon request of such publication or presentation.*

3. The Foundation will provide the Sub-recipient with five (5) hardcopies of the Final Report and a PDF. If the Final Report is published in a PDF format only, the Sub-recipient will receive the Final Report in that format.

4. The Foundation hereby grants the Sub-recipient a royalty free, perpetual, irrevocable, world-wide, nonexclusive license, without the requirement for any accounting, to utilize Foundation's Intellectual Property solely for educational purposes.

B. Inventions and Patents.

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

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

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

4. All IP rights that were owned and developed by the Sub-recipient or third parties prior to the Effective Date and outside the scope of the Project (collectively, "Preexisting IP"), and which the Sub-recipient will use in the performance of the Project, or incorporate in whole or in part into any Deliverables, has been fully disclosed and identified by the Sub-recipient in the Project Proposal. The Sub-recipient represents and warrants that all Preexisting IP is used with full authorization and permission from its respective owner, and copies of such permissions and licenses shall be provided to the Foundation by the Effective Date. The Sub-recipient shall obtain all appropriate permissions on the Foundation's behalf to the extent necessary to enable the Foundation to exercise its ownership and publication rights in the Work Product, including the Final Report, such right shall be transferable, sublicenseable, and shall not be subject to any payment or other obligation on the part of the Foundation. Such agreements to procure rights for the Foundation shall be subject to the Foundation's prior approval, in its sole discretion.

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

C. Publication. As the owner of Work Product, all rights to publish, distribute, publicly perform, and publicly present the Reports belong solely to the Foundation. Sub-recipient may publish or present based on the Work Product, in whole or in part. All copies of or presentations based on the Work Product shall furthermore conspicuously display the following notice:

Source: Author, Title of Foundation Work

Copyright [year of publication],
Water Research Foundation. Reproduced with permission.

D. Acknowledgement. Any public presentation or publication by the Sub-recipients, including a student writing a thesis, dissertation, or report, based on the Inventions or any portion of the Work Product, if permitted by the Foundation, shall include a statement substantially as follows: *Southern Nevada Water Authority gratefully acknowledges that the Water Research Foundation are funders of certain technical information upon which this publication [manuscript] [presentation] is based. Southern Nevada Water Authority thanks the Water Research Foundation, for their financial, technical, and administrative assistance in funding the project through which this information was discovered.*"

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

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

VII. TERM AND TERMINATION

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

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

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

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

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

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

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

VIII. DISPUTE RESOLUTION

A. In the event of the Sub-recipient's performance, or other acts or omissions in performing the Project or under this PFA, Foundation's final determination, following reasonable consultation with the PAC, shall govern.

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

IX. STANDARD TERMS AND CONDITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

solely to the Sub-recipient for payment and enforcement of its rights under its agreement with the Sub-recipient.

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

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

M. Foundation Right of Approval. The Foundation shall have the right, in their sole discretion, to refuse to permit any employee of the Sub-recipient, or employee of an approved agent, assignee, or subcontractor of the Sub-recipient, to be located at a Foundation work location, or to provide services to the Foundation pursuant to this PFA.

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

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

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

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

R. Applicable Law/Venue. *Except as stated in the following sentence, the parties elect to remain silent on applicable law and venue with regard to actions against Sub-recipient which silence is not be construed as an agreement that one party's State law applies or is more appropriate for*

venue. If legal action is taken against Sub-recipient, to the extent that the law applied conflicts with the protections afforded to Sub-recipient by the Nevada Revised Statutes 41.0305 through 41.039, inclusive, Nevada law shall apply. Any action, including, without limitation, any claim or other complaint, against the Water Research Foundation, however, must be brought in U.S. Federal District Court. The terms of this paragraph will survive the termination of this PFA.

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

T. Relationship. The parties are independent contractors, and no agency, employer-employee, partnership, or joint venture relationship is intended or created by this PFA. No party shall have any right or authority to assume or create any obligation, commitment or responsibility for or on behalf of the others except as the other may expressly authorize in writing. No party shall be eligible to participate in another's benefit program. Sub-recipient shall be solely responsible for the performance and compensation of its employees, for withholding taxes and providing unemployment and other benefits.

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

Water Research Foundation

By: Robert C. Renner, P.E., B.C.E.E.
Title: Executive Director

P Falor

Date: 10/21/2014

pf

Southern Nevada Water Authority

By: John J. Entsminger
Title: General Manager

Date: _____

Water Research Foundation

For: Hsiao-wen Chen
By: Hsiao-wen Chen, Ph.D.
Title: Research Manager

Date: 21 Oct 2014

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

Southern Nevada Water Authority

By: Eric Dickenson, Ph.D.
Title: Principal Investigator

Date: _____

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

Southern Nevada Water Authority

APPROVED AS TO FORM

By: Laura Ellen Browning
Title: Deputy Counsel

Signature Page Instructions

1. Review document and have a duly authorized representative and the Principal Investigator sign this page.
2. Only this signature page is required to be returned back to the Foundation.
3. Please **Email** a scanned PDF of the executed signature page to the following:
   a. Peggy Falor at pfalor@WaterRF.org
4. Do not return the entire agreement, only the signature page.
5. Please return no later than **ten (10) calendar days** from receipt.

The Foundation will email a PDF of this fully executed agreement to you for your files.

Exhibit A
Project 04559

Title: Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration

Project proposal, & all subsequent correspondence.

Research Proposal

Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration

(RFP 4559)

Submitted to:

Water Research Foundation
6666 West Quincy Avenue
Denver, Colorado 80235

Submitted by:

University of Colorado Boulder

SOUTHERN NEVADA WATER AUTHORITY

AMERICAN WATER

carollo
Engineers...Working Wonders With Water™

Date: June, 5 2014

Proposal Cover Worksheet

RFP # 4559

Title: Simultaneous Removal of Multiple Chemical Contaminants using Bioflitration

Organization: *(Legal name as it should appear in the contract)*

Organization: Southern Nevada Water Authority

Complete Address *(No P.O. Boxes Please)*: 1299, Burkholder Blvd., Henderson, NV 89015

Personnel: *(Separately upload CV or brief resume for PI, Co-PIs and other key research team members)*

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

Name: Eric Dickenson, Ph.D.

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Organization	City/State/Country
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City of Moline	Moline/IL/United States
Clark County Water Reclamation District	Las Vegas/NV/United States
City of Houston	Houston/TX/United States
Greenville Utilities Commission	Greenville/NC/United States
Upper Occoquan Service Authority	Centreville/VA/United States
Trussell Technologies, Inc.	Pasadena/CA/United States

Project Period: 01/01/2015 - 07/01/2017

Project Abstract

Project objectives: The overarching objective of the proposed research is to assist water utilities in achieving maximum simultaneous removal of multiple chemical contaminants using biofiltration without compromising the existing objectives of the filtration process. The specific research objectives targeted at achieving this project goal are: (1) perform a state-of-knowledge review of chemical contaminant removal by biofiltration, (2) develop appropriate indicator chemicals for use in the evaluation of biofilter performance for a wide spectrum of chemical contaminants, (3) evaluate the effect of filter media type (i.e., exhausted GAC vs. anthracite) and empty bed contact time (EBCT), (4) evaluate the effect of operational parameters, such as short-term effects of chlorinated backwashing and changes in loading rates, (5) investigate the impact of upstream processes, such as oxidation and coagulation, on the biofiltration performance for multiple contaminants, (6) identify if biofiltration performance is compromised during short-term chemical spiking events, (7) evaluate the simultaneous removal capabilities for 3+ year old biologically-active carbon filters at full-scale, (8) recommend post or pretreatment strategies to increase the removal of chemical contaminants that are resistant to biodegradation, and (9) develop a guidance tool that will provide assistance to water utilities in achieving maximum simultaneous removal of multiple chemical contaminants using biofiltration without compromising the existing water quality objectives.

Technical approach: The technical approach for the proposed work comprises of 6 research tasks from which the final guidance document will be generated. In Task 1, data from unpublished and published literature will be assembled to review likely chemical contaminants present in biofilters and assess biofiltration performance for removing these contaminants. In Task 2 indicator chemicals will be selected that appropriately represent groupings of contaminants (based on biodegradability characteristics) that can be monitored to assess biofiltration performance for a wide spectrum of chemical contaminants. For Task 3 the impact of media type, EBCT, chlorinated backwashing, upstream processes, and chemical spiking events, will be assessed for multiple chemical contaminants in three biofiltration pilot-scale studies (operated at least six months each) located at the City of Houston (one pilot) and Southern Nevada (two pilots). For Task 4 several full-scale plants using biologically-active carbon (3+ years old) will be evaluated for their ability to remove multiple chemical contaminants from four different surface waters. In Task 5, the guidance tool will consist of the development of a Guidance Manual, which will comprise of information and performance data gathered during the literature/field review, pilot testing, and full-scale evaluations. This manual will be used to identify key design and operational parameters that influence the simultaneous removal of multiple contaminants and it will recommend approaches for treatment optimization even for contaminants that are resistant to biodegradation. Also, a multi-contaminant removal matrix will be developed that provides a visual snapshot of anticipated multi-contaminant removal ranges for various sets of operating and design conditions. Finally, the results generated from Tasks 1 to 5 will be compiled in the final report in Task 6.

Anticipated results and benefits: The results from the proposed work will include biofiltration performance data for multiple chemical contaminants from literature review, pilot and full-scale evaluations. The Guidance Manual and tool will provide guidance to water utilities on biofiltration treatment optimization for the simultaneous removal of multi-contaminants by identifying key design and operational variables that can impact biofiltration performance in treatment systems.

Project team and budget: The project team consists of Dr. Eric Dickenson [Southern Nevada Water Authority (SNWA), Principal Investigator (PI)], and Co-PIs (Co-Principal Investigators), Dr. Eric Wert (SNWA), Dr. Scott Summers (University of Colorado), Dr. Jess Brown (Carollo Engineers, Inc.), and Dr. Orren Schneider (American Water). The participating utilities are Clark County Water Reclamation District, NV, Philadelphia Water Department, PA, City of Moline, IL, City of Houston, TX, and Greenville Utilities Commission, NC, Upper Occoquan Service Authority, VA, and Trussell Technologies, Inc., CA.

SNWA is the principal applicant and is requesting $350,000 from the WaterRF for this project. Cost-share contribution from our project team and participating utilities total $567,687 resulting in a total budget of $917,687.

Project Description

1.1 Introduction

Biological filtration (biofiltration) while established in Europe, has recently become a viable, low-cost technology for removing biodegradable contaminants from drinking water, and improving biostability in water distribution systems in North America (Reungoat et al., 2011). Biofiltration is primarily used in many North American utilities to produce biologically stable water especially after ozonation, with low turbidity (i.e., water that does not support the growth of microorganisms to a significant extent) (Huck et al., 2000), but several factors such as: minimization of chlorine application to meet increasingly stringent maximum contaminant levels (MCLs) for disinfection by products (DBPs), increasing chemical costs, and perceptions of sustainability by the drinking water community, has provoked strong interests in biofiltration processes for removing chemical contaminants from drinking water (Kohl & Dixon, 2012). Research studies (Elhadi et al., 2006; McDowall et al., 2007b; Rittmann et al., 1995; Westerhoff et al., 2005b) have shown biological filtration to be an effective removal technology for 2-methylisoborneol (MIB) and range of anthropogenic trace organic contaminants in drinking water (Hedegaard & Albrechtsen, 2014; Meffe et al., 2010; Snyder et al., 2007; Zearley & Summers, 2012). Granular media filters become biological when there is no disinfectant residual in the filter effluent allowing for the media to be colonized by naturally occurring microorganisms in the source water. Growth and maintenance of the attached microorganisms in the biological filter (biofilter) are supported by the biodegradation of the primary substrate which in most drinking water biofilters is the biodegradable fraction of the dissolved organic matter (DOM) (Servais et al., 2005). The trace organic contaminant concentrations are not high enough to sustain biological processes of the microorganisms alone and are biodegraded by secondary utilization mechanisms (secondary substrate or cometabolism) (Rittmann & McCarty, 2001; Stratton et al., 1983). Microorganisms may not initially have the capability to biodegrade a compound but can acclimate over the course of days to months to biodegrade a compound (Alexander, 1999). Possible explanations for an acclimation period in biofilters include the proliferation of small microbial populations or genetic adaptation within the microbial population through mutations or transfer of genetic information (Alexander, 1999; Rittmann & McCarty, 2001).

Numerous studies including Water Research Foundation projects and a growing body of literature (Chaudhary et al., 2003; Gerrity et al., 2011; Matamoros et al., 2012; Reungoat et al., 2011; Zearley & Summers, 2012) have been dedicated to biofiltration. Specifically, some current and past Water Research Foundation projects focused on biofiltration include: (1) a monitoring and control tool box for biological filtration (project 4231) (Evans et al., 2013), (2) optimizing filtration in biological filters (project 252) (Huck et al., 2000), (3) occurrence, impacts, and removal of manganese in biofiltration processes (project 4021) (Kohl & Dixon, 2012), (4) engineered biofiltration for enhanced hydraulic and water treatment performance (project 4215) (Lauderdale et al., 2011), (5) ozone-enhanced biofiltration for geosmin and MIB removal (project 2775) (Westerhoff et al., 2005a), (6) an operational definition of biostability for drinking water (ongoing project 4312), and (7) optimizing biofiltration for various source water quality conditions (ongoing project 4555). From these studies, it is evident that the role of biofiltration in water treatment has expanded beyond the reduction of biodegradable organic matter (BOM) in water, and turbidity control to include, the removal of many chemical contaminants such as, pharmaceutical and personal care products (PPCPs), taste and odor causing compounds (MIB) and geosmin), DBPs, and inorganic contaminants (e.g., manganese, iron, and ammonia) from water. ***Since many water utilities already operate conventional filters with granular media, converting the filters to biological mode can extend the bed-life of the filters to meet their water quality objectives without additional capital investments (e.g., post-filter adsorbers). Moreover, many water utilities are increasingly faced with the challenge of dwindling water supplies and a strong push for potable water reuse. Improving the performance of biofiltration for simultaneously removing multiple chemical contaminants without minimizing its current water quality objectives will be critical to expanding the source waters available to such utilities.***

The process of biofiltration as illustrated in Figure 1 typically involves filtration through a granular media (e.g., sand, anthracite, and/or activated carbon) with no oxidant residual, followed by

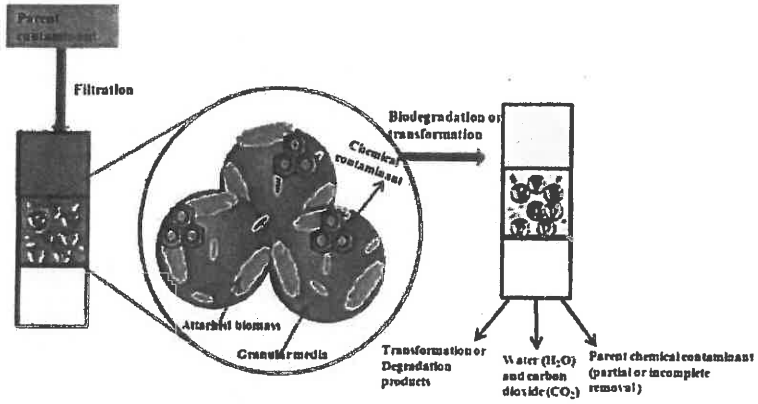


Figure 1 Schematic illustration of biological filtration

bacterial growth of biomass on the media that is actively able to degrade or transform chemical contaminants and, the degradation or transformation of chemical contaminants into their intermediates or end products through oxidation and reduction reactions (Zhu et al., 2010). Common oxidants (electron acceptors) used for microbial metabolic and/or growth processes include oxygen, nitrate, perchlorate, sulfate, or iron, while, the reductants (electron donors) can be organic matter, trace organic compounds, ammonia, or arsenic (Zhu et al., 2010). The efficacy of biofiltration in removing most contaminants will depend on biofilter design characteristics and operational parameters, such as media type (e.g., sand, anthracite, and activated carbon), empty bed contact time (EBCT), hydraulic loading rates (HLR) and pretreatment processes (e.g., pre-oxidation). Previous studies (Chaudhary et al., 2003; Gerrity et al., 2011; Reungoat et al., 2011; Zearley & Summers, 2012) have investigated the effect of several of these variables on the removal of various chemical contaminants by biofilters. Data from these studies have been summarized in Table 1 and will be discussed in greater detail in the following sections.

1.2 Overview of biofiltration performance for the removal of chemical contaminants

1.2.1 Inorganic contaminants

Classical inorganic contaminants such as ammonia (NH_3-N), manganese (Mn), iron (Fe), and phosphate (PO_4^{3-}) associated with biological growth in drinking, and waste water systems have been successfully removed by biofiltration (Table 1).

1.2.1.1 Metals: According to a previous WaterRF study (Kohl & Dixon, 2012), metal species such as soluble Mn(II) can be effectively metabolized, and oxidized to manganese dioxide [Mn(IV)] by Mn-oxidizing microorganisms in biofilms. The resulting biogenic Mn-oxides are suggested to be relatively stable, highly reactive, and may facilitate other redox reactions such as, microbial respiration, sorption of other metal species, and degradation of organic chemicals. ***Similar to Mn, Arsenic [As(III)] and iron [Fe(II)] are metal species that can be sorbed and oxidized into their oxide forms on biologically active media***. But, the removal of these elements has been found (Kohl & Dixon, 2012; Pokhrel et al., 2005) to be impacted by some design and operational parameters. Pre-ozonation of influent water at full-scale testing for instance, was reported to increase the removal of both As (III) and Fe(II) on biologically activated carbon (BAC) to about 100 % (Pokhrel et al., 2005). Also, a strong correlation was observed between increasing Mn loading rate (0.05 to 0.4 mg Mn/m^2 min) in influent water and Mn removal on BAC-sand filter media (Kohl & Dixon, 2012).

1.2.1.2 Non-metals: Biological treatment can also be used to reduce inorganic non-metals, e.g., ammonia in water. Although NH_3-N in drinking water does not directly pose a health concern, it can promote nitrification conditions and biofilm growth in the distribution system (Lytle et al., 2013). *Nitrosomonas* is the genus of bacteria that oxidizes NH_3-N to nitrite (NO_2^-) which is subsequently converted to nitrate (NO_3^-) by *Nitrospira*. Unlike *Nitrospira*, the presence of inorganic phosphorus is a requirement for cellular metabolism and ATP (Adenosine triphosphate) generation in *Nitrosomonas*.

Table 1. Summary of biofiltration performance and operational parameters for various chemical contaminants

Contaminants	Removal performance	Biofilter design and operational characteristics				
		Media type	EBCT	Length of run	Hydraulic loading rate	Pre-treatment
Organic contaminants						
Pharmaceutical and personal care products						
17beta-Estradiol (Gerrity et al., 2011)	89 to 95 % removed	BAC	22 min	39 hrs	1799gal/ft^2.day	NA
Diazepam (Gerrity et al., 2011)	96 % removed	BAC	30 min	4 months	1799gal/ft^2.day	Primary , secondary treatment, RAS, ozonation
Diclofenac (Gerrity et al., 2011)	99 % removed	BAC	30 min	4 months	1799gal/ft^2.day	Primary , secondary treatment, RAS, ozonation
Sulfamethazine (Lee et al., 2012)	No removal	Anthracite	20 min	3 weeks	1767 gal/ft^2/day	Ozonation
Sucralose (Lee et al., 2012)	No removal	Anthracite	20 min	3 weeks	1767 gal/ft^2/day	Ozonation
Naproxen (Zearley & Summers, 2012)	72%	Sand	8 min	1 year	1 gal/ft^2.min	Ozonation and dechlorination
Acetaminophen (Zearley & Summers, 2012)	79 % removed	Sand	16 min	1 year	1 gal/ft^2.min	Ozonation and dechlorination
Plasticizer						
Bisphenol A (Zearley & Summers, 2012)	64 % removed	Sand	8 min	1 year	1 gal/ft^2.min	Ozonation
Pesticides						
Aldicarb (Zearley & Summers, 2012)	72 % removed	Sand	16 min	1 year	1 gal/ft^2.min	Ozonation
Diazinon (Hollender et al., 2009)	less than 8% removed	Sand	3 to 10 min	1 year	1 gal/ft^2.min	Ozonation
Acetochlor (Zearley & Summers, 2012)	17 % removed	Sand	16 min	1 year	1 gal/ft^2.min	Ozonation
Chlorpyrifos (Zearley & Summers, 2012)	63 % removed	Sand	8 min	1 year	1 gal/ft^2.min	Ozonation

Contaminants	Removal performance	Biofilter design and operational characteristics				
		Media type	EBCT	Length of run	Hydraulic loading rate	Pre-treatment
Atrazine (Bonné et al., 2002)	80 % removed	BAC	20 min	4 years	NA	Ozonation, hardness removal
Taste and odor compounds						
Geosmin (Elhadi et al., 2004)	87 % removed	BAC	4 min	55 days	NA	Added ozonation products
2- Methyl isoborneol (Elhadi et al., 2004)	19 % removed	BAC	4 min	11 days	NA	Added ozonation products
Disinfection by products						
Formaldehyde (DiGiano et al., 2001)	66 % removed	Anthracite	5 min	4 days	NA	Ozonation
N-nitrosodimethylamine (Farré et al., 2011)	78 % removed	BAC	60 min	1.3 years	471.21 gal/ft^2.day	Ozonation
Dichloromethane (Gasperi et al., 2010)	51 to 80% removed	Biostyrene	NA	9 months	NA	Primary treatment
Natural organic matter						
Biodegradable organic matter (Wert et al., 2008)	60%	Sand and anthracite	~ 3 to 10 min	24 weeks	2 - 6 gpm/sf	Ozonation
Dissolved organic carbon (Black & Bérubé, 2014)	50 % reduction	Exhausted GAC	20 min	7 days	NA	Ozonation
		Inorganic contaminants				
Metals						
Iron (Lytle et al., 2013)	99%	Gravel	34 min	NA	0.5 – 2.2 gpm/sq ft	Ozonation
Manganese (Kohl & Dixon, 2012)	100 %	GAC and sand	NA	NA	NA	NA
Non-metals						
NH_3-N (Lytle et al., 2013)	~ 50 % removed	Gravel	~ 9 min	1.2 years	0.5 – 2.2 gpm/sq ft	No pretreatment
Total nitrogen (Cao et al., 2014)	40 to 70% removed	Quartz sand	NA	120 days	2 m^3/m^{2}h	Activated sludge innoculation

However, both microorganisms require aeration (up to saturation level) as a requirement for biological nitrification (Lytle et al., 2013). Ozonation has been reported to achieve saturated dissolved oxygen levels that exceed the stoichiometric oxygen requirement for nitrification (4.5 mg O_2/mg NH_3-N) and could enhance the biological removal of NH_3-N (Wert et al., 2008). The effect of hydraulic loading rate (HLR) on NH_3-N removal has been found to vary. For instance, a change in HLR (from 4 to 2 gpm/sq ft and 1.1 to 2.2 m^3/m^2h, respectively) of NH_3-N-bearing water did not significantly impact nitrogen balances on either biologically activated gravel (Lytle et al., 2013) or quartz sand media (Cao et al., 2014). Conversely, nitrification performance was reportedly reduced by 60 % in anthracite-sand pilot-biofilters at a higher HLR (6 gpm/sf) than a lower one (2 gpm/sf), and increasing EBCT in the biofilters did not impact nitrification (Wert et al., 2008).

1.2.2 Monitoring approach for inorganic contaminants: Changes in alkalinity and/or dissolved oxygen (DO) are directly related to nitrification and can be used as a monitoring tool to directly measure the removal, and conversion of NH_3-N to NO_2^- and NO_3^-. Accordingly, decreasing oxygen levels and alkalinity are indicative of increased removal of NH_3-N and conversion to NO_3^-. The uptake of Mn(II), As(III) is characterized by the formation or precipitation of their oxide forms so, dissolved oxygen levels can also be used to track their removal by biologically activated media. In-line DO measurements or DO probes can be used to determine the amount of dissolved oxygen (before and after biofiltration) in the biofilters. In addition, the concentration and removal efficiencies of Mn(II), Fe(II), and As(III) in grab samples (pre- and post-biofiltration) from the biofilters can be determined using inductively coupled plasma mass spectrometry (ICP-MS). Measurements of NH_3-N, NO_2^- and NO_3^- in grab samples from biofilters can effectively monitor the conversion of ammonia to nitrite and nitrate and determine the amount of ammonia removed during biofiltration. For this proposed study, direct measurements of Mn(II), Fe(II), total N, and NH_3-N will be conducted using grab samples (before and after biofiltration) from pilot and full-scale biofilters to assess their removal efficiencies.

1.2.3 Organic contaminants

Organic contaminants in biofilters are primarily biodegraded by two catalytic processes: metabolism and cometabolism. Figure 2 is a representation of these two processes. Labile organic matter are mineralized as primary substrates for microbial growth in metabolism (Benner et al., 2013). Cometabolized compounds are biodegraded as secondary substrates by nonspecific enzymes generated from primary substrate metabolism (Zearley & Summers, 2012). In general, when a substrate concentration falls below its minimum concentration to sustain bacterial growth, it can be biodegraded as a secondary substrate through the use of the more plentiful primary substrate (Rittman et al., 1995). Organic pollutants in wastewater typically include, pharmaceutical and personal care products (PPCPs), pesticides, natural organic matter (NOM), taste and odor compounds, and flame retardants. Biodegradation of these contaminants can involve enzymatic reactions that are specific to their

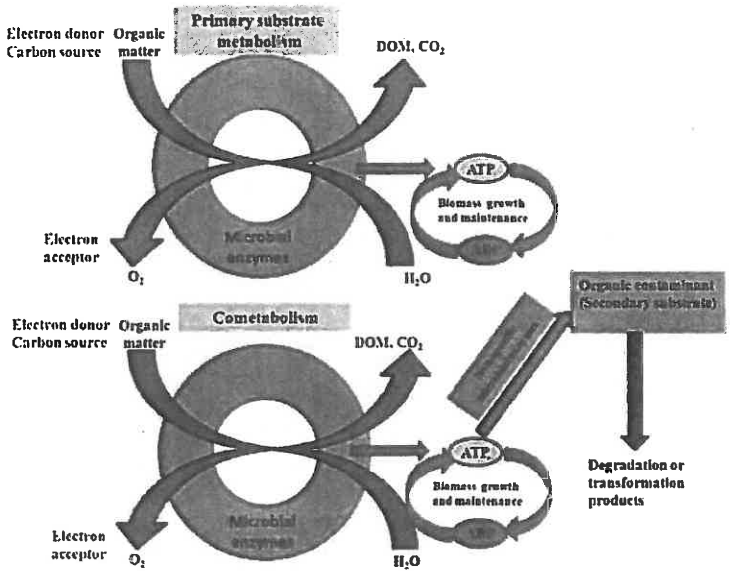


Figure 2 Biodegradation mechanisms for organic contaminants

chemical structures, and the degree of biodegradability will vary among individual and specific groups of compounds.

1.2.3.1 Taste and odor compounds: Geosmin and MIB in drinking water can occur at very low concentrations (less than 100 ng/L) that do not support microbial growth in biofilters, yet are still problematic. However, MIB and Geosmin can be metabolized as secondary substrates by some bacterial enzymes in the presence of biodegradable organic matter (primary substrates) (Rittman et al., 1995). Sand, granular activated carbon (GAC) or anthracite can serve as support for microbes that degrade MIB and Geosmin but, higher biomass density has been reported for GAC than sand and anthracite because of its high surface area, and macropores that retain organic matter long enough to promote slow bacterial degradation (Kalkan et al., 2011; Wang et al., 1995). MIB and Geosmin are proposed to be primarily degraded by the bacteria genus, *Pseudomonas* (Westerhoff et al., 2005a) and the degradation of MIB and Geosmin can be impacted by biofilter operation and design characteristics. For example, a previous WaterRF study (Westerhoff et al., 2005a) reported higher MIB removal (50 to 90 %) in GAC-sand than anthracite-sand pilot biofilters. In addition, using an EBCT of 3 min achieved slightly better MIB removal than an EBCT of 2 min for both GAC-sand and anthracite-sand biofilters. Pre-ozonation of influent water in GAC-sand biofilters was also reported to enhance MIB biodegradation up to 14 %. In general, Geosmin is suggested to be better biodegraded than MIB (Ndiongue et al., 2006; Nerenberg et al., 2000). Similar to MIB however, increasing EBCT from 5 to 7.5 min in a pilot GAC-sand biofilter increased Geosmin removal from 38 % to 78 % (Ndiongue et al., 2006). Besides media type and EBCT, acclimation of microorganisms can promote the removal of both Geosmin and MIB. A 26-year old sand biofilter with well-established biofilm for instance, could remove Geosmin and MIB to below detection limit compared to an un-established biofilter which removed 60 % Geosmin and 40 % of MIB, after 154 days of operation (McDowall et al., 2007a). The impact of episodic occurrences of trace organic contaminants on their removal by drinking water biofilters with sand media was also evaluated by McDowall et al. (2007a). The removal of naturally occurring algal metabolite 2-methylisoborneol (MIB) and the herbicide 2,4-dichlorphenoxyacetic acid (2,4-D) by seven biofilters with empty bed contact times (EBCT) of 8.7 min was presented under a range of intermittent exposure conditions with continuous presence of dissolved organic matter (DOM). Under constant exposure conditions over seven months, high average removal levels, about 70%, for both MIB and 2,4-D were found and much of the variability in removal over this time could be explained by EBCT changes using a pseudo-first order model. Adapted microorganisms in drinking water biofilters retained the capacity to biodegrade MIB and 2,4-D after non-exposure periods up to 5 months. However, after 9 months of non-exposure, MIB and 2,4-D removals were significantly lower than the control biofilter, although the biofilter began to re-acclimate to these trace organic contaminants.

1.2.3.2 Pharmaceutical and Personal care products (PPCPs): PPCPs can potentially be metabolized as either primary or secondary substrate. However, at low environmentally relevant concentrations, PPCPs are likely degraded as secondary substrates by cometabolism (Onesios et al., 2009). The biofiltration performance among different classes of PPCPs varies widely. Among the class of antibacterial agents for example, triclosan was reported to be more readily biodegraded than triclocarban in an aerobic soil biofilter due to the presence of hydroxyl groups in its structure (Ying et al., 2007). Design and operational parameters will also impact the removal of PPCPs, e.g., longer EBCT (15.8 min) was reported to enhance the removal of pharmaceuticals: acetaminophen, carbamazepine, ibuprofen, naproxen and sulfamethoxazole than a lower one (7.9 min) (Zearley & Summers, 2012). Reducing EBCT from 120 to 30 min also reduced the removal of gabapentin from 95 to 52 % (Reungoat et al., 2011). Previous studies (Smith & Aubin, 1994; Ying et al., 2007; Zearley & Summers, 2012) have also found that microbes may experience an initial lag phase before acclimating or adapting to biofilter conditions. At an EBCT of 7.5 min for instance, naproxen removal increased up to 70 % until 150 days when steady state or acclimation was reached (Zearley & Summers, 2012). Further, during the start-up of a biofilter, various microbial groups may not be adjusted or acclimated to operational conditions in the biofilter so, fluctuations in

external parameters such as HLR, EBCT, pH and temperature could easily impact the biological removal of PPCPs. Sudden spikes (from 2.5 to 122 L h^{-1}/m^2) in HLR and PPCP-influent water concentration (mimicking stormwater concentrations) in a biofilter however, did not impact biological degradation of several PPCPs including triclosan, triclosan-methyl and 7-Acetyl-1,1,3,4,4,6-hexa-methyltetrahydronaphthalene (Bester & Schafer, 2009). Pre-ozonation of influent water can oxidize PPCPs to by-products that can be readily degraded by microbes in biofilters than their parent compounds (Reungoat et al., 2011). Accordingly, the combination of ozonation and biofiltration removed 15 to 20 % more PPCP-derived DOC (dissolved organic carbon) than ozonation alone (Reungoat et al., 2011).

1.2.3.3 Organic matter and disinfection by-products: Organic matter (OM) in raw source water is the primary precursor of disinfection by-products (DBP) such as trihalomethanes (THMs), haloacetic acids (HAAs) and *N*-nitrosodimethylamine (NDMA) in drinking water (Liu & Li, 2010). Microbial activity does play a significant role in the degradation or transformation of DBP, DBP precursors, and OM (Chen et al., 2009; Krasner et al., 2009). But, biofiltration performance for DBPs and OM will differ among various water qualities. For example, DBPFP (DBP formation potential) of humic-like organic matter in water may not be amenable to biological degradation compared to the more biodegradable tannic acid-DBPFP (Liu & Li, 2010). Also, the reduction of HAA formation potentials (HAAFPs) was strongly correlated to microbial activity, and the temperature of the test water favored the removal of HAAFPs than THMFPs (Kim & Kang, 2008). Assimilable organic carbon (AOC) which can serve as primary substrates may be present in some source waters but, pre-oxidation, e.g., pre-chlorination and pre-ozonation has been proposed to increase AOC concentrations in biofilters. NDMA precursors however, were suggested (Farre et al., 2011) to be successfully degraded as a co-metabolites in biologically active carbon filters without pre-oxidation. Besides pre-oxidation of source water, other biofilter design and operation conditions can also impact biofiltration performance for DBP removal. Higher THM precursor removals were observed in GAC/sand filters compared to anthracite/sand filters due to higher biological activity (Westerhoff et al., 2005a). Figure 3 also illustrates the impact of EBCT and HLR on the biological removal of dissolved organic carbon (DOC). Longer EBCTs in the range of up to 20 min has been shown by others (Fonseca et al., 2001; Huck et al., 2000; Wang et al., 1995) has been to enhance the removal of dissolved organic carbon. In this study, there was no significant change in biofiltration performance for DOC removal with different loading rates; 1.5 m/h and 5 m/h (0.6 to 2 gpm/ft^2) in Figure 3.

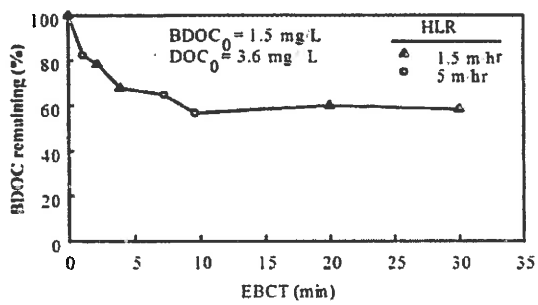


Figure 3 Impact of hydraulic loading rate and EBCT on biological removal of dissolved organic carbon (Wang et al., 1995).

1.2.3.4 Pesticides, flame retardants and plasticizers: Enhanced removal (up to 3 times more) of pesticides such as atrazine, metribuzin, chloradizon, bentazon and metoalchlor in a pilot BAC-filter than fresh GAC-filter is indicative that pesticides can be biologically degraded (Van der Aa et al., 2012). Though no optimal EBCT could be determined by Van der Aa et al. (2012) for these pesticides in BAC biofilters, a longer EBCT of 15.8 min achieved higher removal of the pesticides, aldicarb (72 %) and diazinon (40 %) than a low EBCT of 7.8 min in sand biofilters (Zearley & Summers, 2012). On the other hand, low EBCT was more favorable for atrazine removal in the sand biofilters (Zearley & Summers, 2012) and pre-ozonation was also reported to increase atrazine removal up to 92 % in BAC-filters (Gerrity et al., 2011). For plasticizers, e.g., bisphenol A, longer EBCT (15.8 min) was more favorable than a shorter one of 7.8 min (Zearley & Summers, 2012). Pre-denitrification and increased HLR (from 1.1 to 2.2 m^3/m^2 h) in a sand-biofilter also enhanced the removal of di-(2-ethylhexyl) phthalate (DEHP)

from 48 % to 82 % (Cao et al., 2014). Though, the correlation between pre-denitrification and DEHP could not be established, increased HLR or higher water flow velocity was proposed to accelerate mass transfer in the biofilter thus, improving the substrate utilization rate (Pujol et al., 1998). Flame retardants such as tris-(2 -chloropropyl)-phosphate (TCPP) are recalcitrant to biodegradation and TCPP has been used as a biological marker for compounds that are recalcitrant to biosorption or biodegradation in biofilters (Bester & Schafer, 2009). Still, 64 % of TCPP was eliminated (Table 1) in a biologically active soil filter and a spike in HLR (from 2.5 and 122 L h^{-1}/m^2) did not significantly impact the removal of TCPP (Bester & Schafer, 2009).

1.2.3.5 Turbidity (particulate matter): ***The primary objective of filtration is to remove pathogenic microorganisms and non-microbial turbidity that interferes with the production of pathogen free water. It is of paramount importance that the use of biologically active filters does not impede the achievement of this primary objective.*** Turbidity is not necessarily a contaminant but suspended solids in the form of silt and clay; inorganic and organic impurities can pose a disinfection demand by shielding microorganisms within the biofilter. Thus, turbidity removal is essential. Upstream processes such as coagulation, flocculation, and sedimentation are typically used to decrease particle loading rate to biofilters and increase biofilter run times. As a rule of thumb, turbidity in water treatment systems is removed to below 0.1 NTU (Huck et al., 2000). Since, turbidity is removed by filtration, the filter media type (e.g., sand vs. carbon) will likely influence the degree to which turbidity is removed than any other design or operational parameters. For instance, there was no obvious difference in effluent turbidities from different water qualities using pre-chlorinated, chlorinated or non-chlorinated waters for backwashing in pilot anthracite/sand biofilters (Goldgrabe et al., 1993). Previous studies (Krasner et al., 1993; LeChavallier et al., 1992) also found that the removal efficiency for turbidity by biologically activated GAC/sand and anthracite/sand pilot filters was about the same, 0.2 NTU. Particulate matter in biofilters can build up over time leading to clogging and headloss in the filter. Appropriate backwashing protocols however, can achieve uniform hydraulic conditions, and minimize excessive build-up of biofilm in the biofilters (Huck et al., 2000).

1. Objectives

Based on the background provided in the previous section, the effective removal of individual classes of some chemical contaminants can be achieved by biofiltration. But, biofiltration performance for simultaneously removing multiple classes of chemical contaminants (including inorganic and organic contaminants) is not well established. Also, depending on the influent water quality, the effect of several design and operational parameters has been found to vary across different classes of contaminants. In particular, the effect of changes in EBCT, influent concentration (e.g., during spike events), media type, and upstream process (e.g., pre-oxidation) on biological filtration performance can be important and require further research to understand their impact on biological removal of multiple chemical contaminants from various water qualities ***during pilot- and full-scale applications***. ***The overarching goal of the proposed work is to provide guidance and assist water utilities in achieving maximum simultaneous removal of multiple chemical contaminants using biofiltration without compromising the existing objectives of the filtration process.***

This study will specifically:

- Perform a state-of-knowledge review of chemical contaminant removal by biofiltration.
- Develop appropriate indicator chemicals for use in the evaluation of biofilter performance for a wide spectrum of chemical contaminants.
- Evaluate the effect of filter media type (i.e., exhausted GAC vs. anthracite) and EBCT on the biofiltration performance for simultaneously removing multiple chemical contaminants.
- Evaluate the effect of operational parameters, such as short-term effects of backwashing and changes in loading rates, on the performance of biofilter for simultaneously removing multiple chemical contaminants.

- Identify the impact of events of high concentration spikes of select chemical contaminants in the source water.
- Investigate the effect of upstream processes, e.g., pre-oxidation, on the performance of biofilter for simultaneously removing multiple chemical contaminants.
- Evaluate the long-term (3+ years) simultaneous removal capabilities for biologically-active carbon filters at full-scale sites.
- Recommend strategies to increase the removal of chemical contaminants that are resistant to biodegradation.
- Develop a guidance tool that will assist water utilities in achieving maximum simultaneous removal of multiple chemical contaminants using biofiltration without compromising the existing objectives of the filtration process.

Table 2. Categorization of organic contaminants based on relative percent removals and removal rates in various biological treatment systems.

Reference	Zearley and Summers (2012)	Salveson et al. (2012)	Drewes and Dickenson (2011)
Biological Treatment System	Drinking Water Biofilters	Wastewater Activated Sludge Systems	Potable Soil Aquifer Treatment
Micropollutant	Removal (%)	k (L/g^d)	Removal (%)
Rapid Removal			
2,4–D	68 ± 11	N/A	N/A
Acetaminophen	59 ± 11	N/A	N/A
Atenolol	N/A	>10	N/A
Bisphenol A	64 ± 29 [d]	>10	N/A
Caffeine	67 ± 18	>10	>99
Gemfibrozil	70 ± 7	0.1-10	>90
Ibuprofen	95 ± 3.3 [d]	>10	25-90
MIB	93 ± 1.3	N/A	N/A
Naproxen	72 ± 2	>10	25-90
Triclosan	90 ± 0 [d]	>10	>90
Trimethoprim	83 ± 13	0.1-10	>90
Moderate Removal			
Cotinine	23 ± 21	N/A	N/A
DEET	N/A	0.1-10	25-90
Diazinon	12 ± 12	N/A	N/A
Erythromycin	15 ± 27	N/A	N/A
Iopromide	13 ± 18	N/A	25-90
Sulfamethoxazole	2.4 ± 4.1	0.1-10	25-90
Poor Removal			
Carbamazepine	0.5 ± 1.1	<0.1	<25
Primidone	N/A	<0.1	25-90
Sucralose	N/A	<0.1	N/A
TCEP	N/A	<0.1	25-90
Triclocarban	N/A	<0.1	N/A

2. Research approach

In order to achieve the stated objectives for this proposed study, the research approach will be organized into six tasks from which the final deliverables will be generated. The tasks proposed for this study are summarized in Table 3 and will be expounded on in greater detail in the following sections. In several of the tasks we will be using data from indirect potable reuse systems at which the concentrations

of many compounds of emerging concern (CECs) are the highest and provide an endmember for evaluating biofiltration performance.

Table 3 Research approach for proposed study

Tasks		Lead/Support
Task 1	Review the performance of biofilters for removing multiple chemical contaminants	CU/SNWA
Task 2	Develop appropriate indicator compounds/chemicals that represent certain classes/categories to assess biofiltration performance.	CU/SNWA
Task 3	Systematic evaluation of biofiltration performance at pilot-scale.	SNWA/Carollo/CU
Subtask 3.1	Development of biomass and acclimation	
Subtask 3.2	Evaluate the effect of filter media type and EBCT	
Subtask 3.3	Evaluate the effect of operational parameters	
Subtask 3.4	Evaluate the impact of high concentration spikes of select contaminants	
Subtask 3.5	Evaluate the impact of upstream treatment processes	
Task 4	Evaluation of biofiltration performance at full-scale	American Water/Carollo SNWA
Task 5	Develop a Guidance Toolbox for the Simultaneous Removal of multiple chemical contaminants	Carollo/SNWA/CU/ American Water
Subtask 5.1	Guidance Manual	
Subtask 5.2	Multi-Contaminant Removal Matrix	
Task 6	Project report	SNWA/Carollo/CU/ American Water

Task 1: Review the performance of biofilters for removing multiple chemical contaminants

The goal of Task 1 is to systematically evaluate the efficacy of biofiltration in removing a range of chemical compounds from drinking water sources. Our approach for Task 1 will be to assemble data on biofiltration removal efficiencies for various contaminants from published peer-reviewed literature, previous WaterRF reports and unpublished data from existing pilot and full-scale biofilters from participating water utilities. There is a growing interest in using biofiltration for the removal of CECs from drinking water sources. This study will obtain data from ongoing indirect potable reuse projects, where the CEC concentrations are the highest that have already evaluated the simultaneous CEC removal in full- or pilot-scale biofiltration systems. For example, the Upper Occoquan Service Authority is participating (see support letter) in this study and will share their knowledge and CEC removal data by dual media biofiltration. Likewise, Trussell Technologies, Inc. (see support letters) will provide CEC removal data that they have collected in two separate BAC pilot-scale potable reuse studies located at the City of San Diego and Los Angeles County Sanitation District. Also, simultaneous CEC removal data will be acquired from other full-scale potable reuse systems that practice BAC, such as Gwinnet County, GA, El Paso, TX and Aurora Water, CO (based on verbal communications). The compiled data will be reviewed to identify likely CECs targeted by biofiltration, important operational and design parameters along with other factors that can impact the removal performance of biofilters for specific classes of chemical contaminants (similar to Table 1). Members of our team have been working on biofilter research and application for more than 25 years. Collectively the team has extensively evaluated biofilter performance for NOM, EfOM, ozonation byproducts, MIB and Geosmin, CECs, NH_3, and Mn under drinking water and/or water reuse scenarios in North America and in Europe, and thus, have access to unpublished data from many utilities.

Task 2: Develop appropriate indicator compounds/chemicals that represent certain classes/categories to assess biofiltration performance

The proposed approach for investigating the biological removal of multiple chemical contaminants, particularly organic contaminants, in this work will involve identifying indicator compounds to monitor the biodegradation or biotransformation performance as a whole in pilot and full-scale biofilters. This has been a proven tool and is being adopted particularly in potable reuse treatment systems when a wide universe of contaminants needs to be considered (Dickenson et al., 2009). An indicator compound is an individual chemical occurring at a quantifiable level, which represents certain physicochemical and/or biodegradable characteristics of a family of trace organic constituents that provides a conservative assessment of removal (Drewes & Dickenson, 2011). Previously, indicator compounds for monitoring CECs in biofilters were categorized according to the relative rates of removal or percent removals (Table 2). Interestingly, though Table 2 shows removal data from different biological systems, drinking water biofilter, activated-sludge, soil aquifer treatment; several organic contaminants fall within similar performance treatment categories. For this proposed work, our project team will build upon Dr. Summer's earlier work in which more than 25 CECs were systematically evaluated (Zearley & Summers, 2012), and refine and identify appropriate categorization and biodegradable indicator compounds. Specifically, compounds will be categorized based on their chemical functionalities and biodegradability characteristics (Spencer et al., 2013). Table 4 categorizes contaminants based on the likelihood of certain structural moieties that may serve as initial attack sites for compounds undergoing biotransformation (Salveson et al., 2012). Some compounds are not likely to undergo biotransformation due to the lack of sites easily amenable to biochemical reactions.

Table 4. Categorization of the biotransformation of organic contaminants as a function of reactive structural moieties.

Biotransformation likely compound	Type	Biotransformation likely compound	Type	Biotransformation unlikely	Type
Acid		**Ether**		**Halogenated**	
Ibuprofen	*aliphatic*	Fluoxetine	*aromatic*	TCEP	*phosphate ester*
Naproxen	*aliphatic*			TCPP	*phosphate ester*
Gemfibrozil	*aliphatic*	**Nitrile**		Triclocarban	*aromatic amide*
		Cimetidine		Sucralose	*cycloalkane alcohol*
Carbonyl					
Benzophenone	*aliphatic*	**Heterocyclic N Ring**			
		Caffeine	*2 N; 5 ring*	**Non Halogenated**	
Alcohol		Trimethoprim	*2 N; 6 ring*	Primidone	*amide ring*
Bisphenol A	*aromatic*			Meprobamate	*carbamate*
BHA	*aromatic*	**Sulfonamide**		Carbamazepine	*anzepine amide*
Triclosan	*aromatic*	Sulfamethoxazole	*aromatic*		
Amide		**Amine**			
DEET	*aliphatic*	Diphenhydramine	*aliphatic*		
Acetaminophen	*aromatic*				
Atenolol	*aliphatic*				

The biotransformation and biodegradation potential of the compounds in this work will be confirmed by the Minnesota Biodegradation Prediction Pathway model (Ellis et al., 2008; Loonen et al., 1999), which will also provide an understanding of biodegradation pathways for CECs in biofilters. The outcome of this task is to identify indicator compounds that appropriately represent similar chemistries (e.g., aliphatic, aromatic, and ester compounds) of other CECs and can be used to monitor performance of a biofilter.

Task 3: Systematic Evaluation of Biofiltration Performance at Pilot-Scale

Task 3 and its subtasks will focus on evaluating biofiltration performance at three different and existing pilot biofilters that are described in the following sections. Pilot studies will be performed at the City of Houston's (CoH) East Water Purification Plant, Southern Nevada Water Authority's Alfred Merritt Smith (AMS) water treatment plant located in Boulder City, NV and at Clark County Water Reclamation District (CCWRD) water reclamation plant located in Las Vegas, NV. Table 5 summarizes the number of pilot columns that will operated in parallel at each site and the chemical contaminants that will be evaluated for each site and Table 6 provides the ambient source water quality. If concentrations are too low some chemicals that are affordable will be continuously spiked, which is doable at pilot-scale.

In the operation of all of the pilot plant biofilters turbidity will be closely monitored and the impact of all design and operation variables will be assessed.

Table 5. Chemical contaminants that will be evaluated for each pilot study.

Pilot Site	# Pilot Columns	TOC/ AOC	THM/HAA precursors	N-DBP precursors	T&O	Mn	Fe	NH_3	NDMA	PPCP	Steroidal Hormone	PFAAs
CoH	4	✓	✓	✓	✓	✓	-	✓	-	✓	-	-
SNWA	2	✓	✓	-	✓	✓	-	-	-	✓	-	-
CCWRD	3	✓	-	✓		✓	✓	-	✓	✓	✓	✓

Table 6. Ambient water quality for the source waters for the pilot system.

		City of Houston		SNWA-AMS	CCWRD
Analyte	Units	Lake Houston	Trinity River	Lake Mead	TTWW
TOC	mg/L	9.2	6.3	2.5-2.9	7
Temperature	°C	11-30	12-30	13-19	19-30
pH		7.6	7.9	7.8-8.4	3.7-7.2
Turbidity	NTU	22	25	1	1-3
Manganese	µg/L	33	8.6	<5	12
Ammonia	mg/L	0.23	--	<0.02	--
Fe	mg/L	<0.1	--	<0.1	0.58
MIB	ng/L	13	--	--	--
Geosmin	ng/L	6	--	--	--

TTWW: Tertiary-treated wastewater

City of Houston (CoH)

Four existing parallel pilot filters operated at the CoH's East Water Purification Plant (EWPP) located in Houston, TX, will be used for biofiltration testing (Figure 4). The pilot plant has the capability to receive water from two sources, the Trinity River via the Coastal Water Authority pipeline and Lake Houston via a canal. Water quality concerns at CoH are MIB, geosmin, manganese, ammonia and NDMA precursors. The source waters are known to be impacted by upstream wastewater effluents and likely contain wastewater-derived TOrCs, such as PPCPs. If ambient PPCPs are too low, affordable, low level (ng/L) indicator CEC will be spiked prior to the pilot ozone/biofiltration processes. Raw water is pumped into two holding tanks and can be blended in proportions to match the full-scale plant. The pilot plant includes two identical trains. Each train is equipped with rapid mix, flocculation, and sedimentation basins containing plate settlers. Ozone may or may not be applied to the settled water to simulate intermediate ozonation prior to filtration. Prechlorination will also be evaluated. The treated water is then

filtered through four constant-rate, dual media filters (two filters per train). The filter columns can be backwashed with air scour and non-chlorinated or chlorinated water for backwashing. City of Houston owns the ozone and biofilter skids and will provide the skids and maintenance supplies and operational consumables as in-kind to the project.

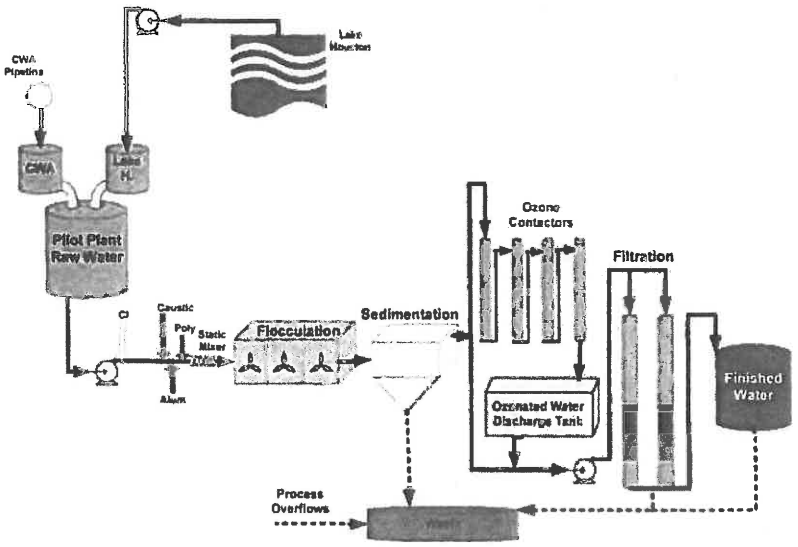


Figure 3 Schematic representation of Pilot biofiltration unit at City of Houston (COH)

Southern Nevada Water Authority (SNWA)

Two existing parallel pilot filters (~2 gpm each) operated at the SNWA owned Alfred Merritt Smith (AMS) water treatment plant located in Boulder City, NV, will be used for the biofiltration testing. As illustrated in Figure 5, the pilot is fed with raw Colorado River Water (CRW). The CRW has some presence of wastewater-derived contaminants, but their concentrations are low. Therefore, the team proposes to continuously spike indicator CECs identified in Task 2 into the influent water of the pilot biofilters. We are able to do this on site where the effluent of the pilots will be discharged into the local septic system. The proposed list of spiked compounds is shown in Table 7 and they were selected based on their likely occurrence and wide range of properties, but the list will likely be modified based on Task 2 results. It was determined that it would not be costly to spike these target constituents, many at low ng/L levels, on a continuous basis for six months. The pilot uses air scouring and non-chlorinated or chlorinated water for

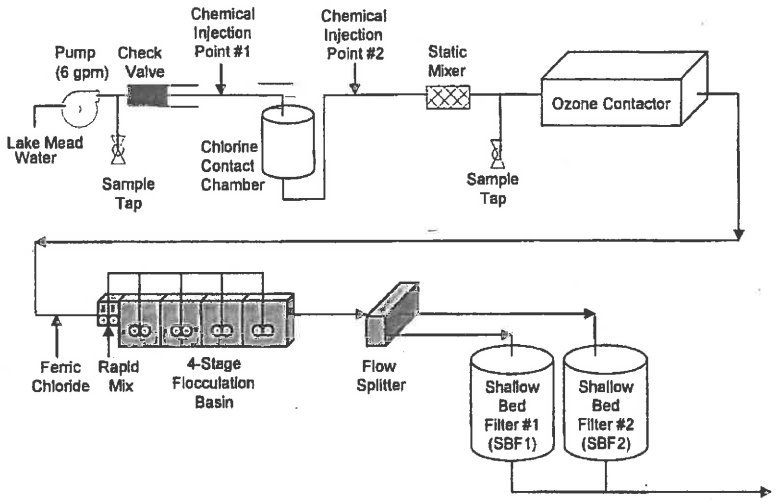


Figure 4 Schematic representation of biofiltration process at AMS

backwashing. In-line turbidimeters will be used to monitor turbidity. SNWA owns the ozone and biofilter skids and will provide the skids and maintenance supplies and operational consumables as in-kind to the project.

Table 7. Analytes that will be spiked prior to the pilot biofilters at SNWA AMS treatment plant

Analyte	Concentration, C_0	Units	Analyte	Concentration, C_0	Units
Ammonia	0.5	mg/L	gemfibrozil	100	ng/L
Mn	0.2	mg/L	ibuprofen	100	ng/L
acetaminophen	100	ng/L	naproxen	100	ng/L
atenolol	100	ng/L	NDMA	10	ng/L
atrazine	100	ng/L	PFOA	100	ng/L
bisphenol A	100	ng/L	sucralose	100	ng/L
caffeine	100	ng/L	sulfamethoxazole	100	ng/L
DEET	100	ng/L	testosterone	100	ng/L
Estrone	100	ng/L	trimethoprim	100	ng/L
ethynylestradiol	100	ng/L	triclocarban	100	ng/L

SNWA-Clark County Water Reclamation District

Three existing parallel pilot filters (~2 gpm each) operated at Clark County Water Reclamation District (CCWRD) water reclamation plant located in Las Vegas, NV, will be also used for the biofiltration testing (Figure 6). The pilot biofilters at CCWRD are currently operated by SNWA for an ongoing WateReuse Research Foundation (WRRF) potable reuse project that is evaluating the ability of biofiltration to remove NDMA directly. SNWA owns the ozone and biofilter skids and will provide the skids and maintenance supplies and operational consumables as in-kind to the project. By the time that this proposed project is to begin and the WRRF project is finished, the biofilters will have been operated continuously for one year with the same media and will have been well characterized and acclimated. These pilots are fed ozonated tertiary treated reclaimed water with a turbidity of 1-3 NTU. A 10-gpm ozone pilot (low dose: 0.3 mg-O_3:mg-DOC) is used to treat tertiary treated wastewater resulting from a full-scale operation on site. This is not a typical drinking water source, however it is believed that the source of many of the target CECs in drinking water sources is derived from wastewater (WW) effluent discharges, and this scenario provides a worst case in regards to impacted source water. There are many drinking water sources which have very high fractions of WW contributions. The South Platte River (CO) downstream of the City of Denver's WW discharge, serves as the drinking water source for several utilities and can be more that 70% WW effluent. The same is true for Boulder Creek (CO), downstream of the City of Boulder's WW discharge. There are several source waters on the east coast, which have similar WW contributions (e.g., Passaic River (NJ)).

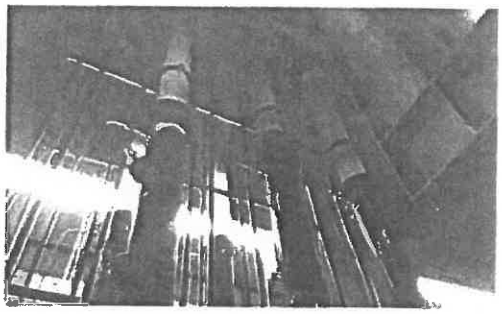


Figure 5 Pilot biofilters at Clark County Water Reclamtion District (CCWRD)

The water quality of the CCWRD is convenient in that it contains many of our target contaminants that are already present in appreciable ambient levels (Table 8) and can be evaluated simultaneously without the need to spike in numerous compounds. The compounds reported in Table 8 are compounds that likely occur in drinking water sources, if they are impacted by wastewater effluents. Contaminants that are known to occur will be monitored including, organic carbon, manganese, iron,

DBP precursors, trace organic chemicals, such as pharmaceuticals, personal care products, NDMA, pesticides, flame retardants, perfluoroalkyl acids, and steroidal hormones.

Table 8. Typical influent water quality to the pilot biofilters at CCWRD

Analyte	Result (ng/L)	Analyte	Result (ng/L)
NDMA	10	Dilantin	63
PFPnA	13	Diuron	6.3
PFHxA	9.6	Erythromycin	50
PFHpA	1.9	Fluoxetine	39
PFOA	7.3	Gemfibrozil	50
PFNA	3.4	Iohexal	1600
PFDA	1.5	Lidocaine	240
PFBS	6.0	Lincomycin	25
PFHxS	1.3	Lopressor	210
PFOS	4.0	Meprobamate	280
1,7-Dimethylxanthine	28	Nifedipine	23
4-nonylphenol	620	Primidone	120
Acesulfame	2100	Simazine	5.3
Albuterol	200	Sucralose	37000
Amoxicillin	440	Sulfamethoxazole	390
Atenolol	180	TCEP	20
Caffeine	54	TCPP	340
Carbamazepine	170	TDCPP	1300
Carisoprodol	150	Theobromine	54
Cimetidine	540	Theophylline	87
Cotinine	57	Triclosan	34
DEET	520	Triclocarban	100
Dehydronifedipine	300	Trimethoprim	20
DIA	12		

Subtask 3.1: Development of Biomass and Acclimation

The biofilters at the three pilot locations will be operated at least for 6 months in order to allow acclimation to occur (Zearley & Summers, 2012). Total organic carbon (TOC), assimilable organic carbon (AOC) and ATP measurements of the biomass media in the columns (CCWRD pilot) and filter effluents (AMS and City of Henderson) will be monitored during start-up and throughout the study. Acclimation to carbon and AOC is expected to be reached within 1-3 months after start-up. The performance of chemical contaminant removal will be monitored during the start-up phase to assess acclimation degree for respective chemical contaminants. During this phase the pilots will be operated with constant EBCT and hydraulic loading rates and filter run time and turbidity will be monitored.

Subtask 3.2: Evaluate the Effect of Filter Media Type and EBCT

Subtask 3.2 will determine the effects of filter media type and/or EBCT for the three pilot studies (Table 9). Anthracite versus exhausted GAC will be evaluated. GAC with minimal adsorption capacity is critical to the successful evaluation of GAC. A very common mistake is to attribute removal to bioprocesses when the adsorption capacity of the GAC is not exhausted, so we propose to use GAC that has been in service for 5+ years. This GAC will be obtained from one of the American Water plants that currently employ BAC. Note, the indicator chemical Triclocarban present in the SNWA AMS and CCWRD studies will be used to indicate whether the adsorption capacity of the media has been exhausted as this chemical has high sorption propensity and is recalcitrant to biodegradation. Anthracite and exhausted GAC will be compared for the SNWA, AMS and CCWRD sites, where EBCT and hydraulic loading rates are kept the same. EBCT will be evaluated at the City of Houston and CCWRD sites, where 5 versus 10 minutes and 10 and 20 minutes will be compared, respectively (Table 9). The performance of

steady-state chemical contaminant removal will be monitored after acclimation for that particular contaminant has been achieved.

Table 9. Design and operating parameters for pilot-scale biofilters.

Biofilter Parameters	units	Filter #1	Filter #2	Filter #3	Filter #4
		City of Houston			
Media Type		GAC	GAC	GAC	GAC
Filter Age	Yr	10+	10+	10+	10+
EBCT	Min	5	5	10	10
HLR	GPM/ft^2	5	5	5	5
		Southern Nevada Water Authority - AMS			
Media Type		Anthracite	GAC	-	-
Filter Age	Yr	0	10+	-	-
EBCT	Min	10	10	-	-
HLR	GPM/ft^2	2	2		-
		Southern Nevada Water Authority - CCWRD			
Media Type		Anthracite	GAC	GAC	-
Filter Age	Yr	1	10+	10+	-
EBCT	Min	10	10	20	-
HLR	GPM/ft^2	5	5	5	-

Subtask 3.3: Evaluate the Effect of Operational Parameters

Subtask 3.3 will determine the impact of periodic chlorinated backwashing and daily changes in loading rates on the immediate removal for chemical contaminants. The impact chlorinated backwashing will be evaluated at the SNWA AMS or CCWRD pilots. During regular operation, non-chlorinated backwashing will be employed. Chlorinated backwashing events will be employed for each column for a given pilot system. Chemical contaminant removal performance will be monitored before and after the back washing event. Samples will be collected after the event until steady-state removal is achieved again. This sampling regime will be performed at least twice (duplication) for sequential chlorinated backwashing events. The outcome of this test will reveal, if the biofilters are able to perform as well after a chlorination backwashing event. This testing will be performed towards the tail end of the pilot study, and will be the last parameter evaluated, since the chlorination may deactivate the biomass in the filter.

Filters can experience daily fluctuations in flow and loading rates. For example, during the day low loading rates of 2 gpm/ft^2 and high loading rates of 6 gpm/ft^2 may be applied. The impact of daily variable loading rates will be applied at the SNWA AMS or CCWRD pilots. The columns will be operated at a loading rate of 2 gpm/ft^2 during the day (12-hour period) and at a loading rate of 6 gpm/ft^2 during the night. The biofiltration performance for chemical contaminant removal will be monitored during these two different loading rate scenarios. This test evaluation will be performed at least three times for replication. The outcome of this test will reveal, if daily changes in loading rates affect biofiltration removal performance.

Subtask 3.4: Evaluate the Impact of High Concentration Events of Select Contaminants

Subtask 3.4 will evaluate the impact of high concentration spikes on biofiltration performance. Challenge tests will be evaluated at the SNWA AMS and CoH pilots towards the end of six months of operation. At SNWA AMS pilot, the challenge tests will involve elevating the concentration of indicator CECs from 100 to 1000 ng/L before biofiltration, which simulates higher wastewater effluent impacted source water. In addition, elevated levels of taste and odor compounds, MIB and/or Geosmin (~20 ng/L), will be spiked before biofiltration to simulate a sudden algal event. These challenge tests will be performed continuously up to a week. Similar challenge testing will be performed at the CoH pilot, where the following challenge tests will be evaluated: Mn (~20 ug/L to 200 ug/L), NH_3 (0.3 to 0.6 mg/L) and MIB and/or geosmin (20 ng/L). The biofiltration performance for chemical contaminant removal will be

compared between before and during spiking events. The outcome of this test will reveal, if biofiltration is still effective at removing the contaminants at higher concentration levels.

Subtask 3.5: Evaluate the Impact of Upstream Treatment Processes

Subtask 3.5 will evaluate the impact of intermediate ozonation (before filtration), coagulation and/or prechlorination upon biofiltration performance. It is known that ozone has the ability to reduce the levels of some CECs, but it could enhance biofiltration performance for the removal of only partially reduced chemicals or those not affected during ozone treatment. Coagulation has the ability impact the concentration and type of TOC exposed to downstream biofilters, which may have an impact on biofiltration CEC removal performance. Also, in pre-chlorination, chlorine would be consumed by GAC and thus biomass will still have to develop, but the impact on biofilter performance is not known. Many plants have GAC filter caps and still practice pre-chlorination. One of these upstream processes will be evaluated at the CoH pilot. The performance of the biofilter columns will be compared to see if upstream processes impact biofiltration performance. In particular the degradation of preformed HAAs will be monitored, as they are known to be biodegradable.

Task 4: Evaluation of biofiltration performance at full-scale

The long-term (3+ years) simultaneous removal capabilities for biologically-active carbon will be assessed for several full-scale sites. American Water will lead an investigation on evaluating biofiltration performance at a few full-scale sites. American Water operates over 30 full-scale surface water treatment plants that utilize GAC in the filters. Typically, these plants replace the media in their filters every 3-4 years. Recently, the company moved towards a model where GAC media is replaced less frequently, or not at all. Previous research examining the impacts of replacing GAC at American Water has shown that, while replacing media improves organics removal, it also has some deleterious effects (e.g., shorter filter runs, higher headloss, loss of manganese removal capability, etc.) for a period of up to ten months (Schneider, 2013). ***What is less apparent when media is replaced is how the long-term simultaneous removal capabilities of biologically active carbon are impacted.*** For this task, we propose to evaluate two full-scale plants having biologically active GAC. The plants are located on the Mississippi River (Davenport, IA and Moline, IL) and on the Delaware River (Delran, NJ). Both of these rivers have wastewater discharges upstream of the plants (Minneapolis/St. Paul, MN and Trenton, NJ) as well as river traffic and other industries. Thus, these plants are concerned with a wide range of organic contaminants including bulk TOC/DBP precursors, taste and odor compounds (T & O), PPCPs, and perfluorinated compounds. Also, these two plants will be compared against conventional filters on the same source water: the Mississippi River (Moline, IL) and the Delaware River (Baxter WTP, Philadelphia, PA). Table 10 is a summary of the characteristics (design and operational characteristics) of the full-scale biofilters and the existing chemicals of concern in these systems. For these systems (Table 10), we propose to collect raw and filtered water (from exhausted GAC media) for two consecutive quarters that preferably includes algal event(s). The parameters to be monitored and measured by the SNWA laboratory and the monitoring frequency for the samples collected are included in Table 7.

In addition to these plants, we propose to examine several other American Water plants that utilize GAC and leave the media in place for at least several years. One of the main factors driving GAC media replacement at American Water plants in Illinois and Indiana is the presence of Atrazine in the raw water during springtime. Typically, the pesticide is land applied by farmers during the growing season (April through June) and, following rainfall, the Atrazine runs off into surface water bodies and arrives at the plant. At present, the plants replace their media every three years. For this task, we propose to monitor one of two locations – Peoria or Alton, Illinois (Table 10). The monitoring will consist of measuring the Atrazine concentrations in the plant influent and effluent from two filters (measured by American Water) to track whether biological activity on the media can degrade adsorbed Atrazine to regenerate some adsorption sites (De Souza et al., 1995; Sinclair & Lee, 1992; Van der Aa et al., 2012). Separate media samples will also be analyzed by American Water for biomass (as measured by ATP concentrations). Results will be reported as mass of Atrazine per unit mass of media (dry weight). The Peoria plant operates using bituminous GAC in all of their filters and replaces the media every four years. Media is

scheduled to be replaced in two of the filters in autumn 2014, but the media in several of the filters will be at least 3 years old at that time. In addition to Atrazine, Peoria is concerned with taste and odor compounds, which will be monitored and measured by American Water. The Alton plant has bituminous GAC in all but one of their filters. The last filter contains wood-based GAC that was installed in summer 2013 at the same time the one of the bituminous GAC filters was replaced. As with Peoria, both Atrazine and taste and odor compounds are of concern to Alton.

For Task 4, simultaneous removal biofilter performance will also be evaluated at full-scale at a plant operated by the Greenville Utilities Commission (GUC) in North Carolina. This investigation will be led by Carollo Engineers Inc. GUC operates 7 dual conventional media filters (6 of which contain anthracite/sand, and 1 GAC/sand media). The plant is fed pre- and intermediate-ozonated and chlorinated Tar River water. Since September 2010 however, chlorine was turned off the top of the GAC filter allowing this filter to be converted to biological mode. The Greenville plant typically has issues with Mn, DBPs, and sometimes T&O. Carollo Engineers and GUC plan to evaluate the impact of biofiltration performance on simultaneous Mn, DBP precursor, and T&O removal in the BAC filter and compare its removal efficiency to the conventional filters. This testing and associated analytical work will be performed as in-kind to the project.

In the operation of all full-scale biofilters turbidity will be closely monitored and the impact of all design and operation variables will be assessed.

Proposed Water Quality Monitoring Schedule

Where otherwise noted, samples will be collected for the biofilter influent and the effluents for each filter. SNWA will be leading the laboratory analysis and the analytical methods for the proposed work are discussed in detail in the QA/QC section. The monitoring parameters and their frequency are reported in Table 11. Pilot-scale studies will have an approximate duration of six months each and full-scale evaluation will be evaluated over the course of 6 months to a year.

Excess turbidity in biofilters can impact water quality and may be indicative of a buildup of excessive biofilm. Hence, turbidity can be used as an effective monitoring tool to assess biofiltration performance. Measuring turbidity with in-line turbidimeters will (1) ensure that effluent water is compliant with turbidity regulations, (2) help identify filter run times, and (3) reveal hydraulic anomalies within the biofilters. For the proposed study, backwashing of pilot and full-scale biofilters will be performed to reduce turbidity without compromising microbial growth in biofilters. In-line turbidimeters will be used to ensure that the removal of multiple chemical contaminants by established biofilm does not compromise turbidity control in both pilot and full-scale biofilters.

Biological degradation of OM will consume DO thus; DO will be used as an indirect indicator to monitor biological activity in biofilters such as change in BOM loading, and biofilter hydraulics. Further, biotransformation or biodegradation of organic contaminants in some instances will yield TOC and AOC, which will be used to monitor biodegradation of organic contaminants. AOC, TOC, and UV_{254} will be analyzed in grab samples (before and after biofiltration) from full-scale and pilot biofilters using TOC analysis, ultraviolet spectroscopy and fluorescence techniques. In addition, NDMA, NDMA formation potential (NDMAFP), THM/HAA (for prechlorinated systems), and THM/HAA formation in grab samples will be conducted to monitor biotransformation or biodegradation of DBP. Other organic compounds such as taste and odor compounds, PPCPs and perfluoroalkyl compounds (PFCs) spiked into some of the pilot biofilters where appropriate will be analyzed using indicator compounds that best represent their biodegradability. The SNWA laboratory performs a method on a suite of indicator TOrC (~20 compounds; PPCPs, atrazine, TCEP), that represent compounds that commonly occur in wastewater effluents and a wide range of chemical/structural properties. This list of compounds is presented in the QA/QC section. As a result of Task 2, a few additional indicator chemicals for biodegradability characteristics may be added to this LC-MS/MS indicator list. A more comprehensive list of trace organic analytes (~92 chemicals) will be also performed by Eurofins Eaton Analytical (presented in the QA/QC section). Yeast estrogen screening assays will also be conducted by SNWA to assess potential estrogenic activity and specifically monitor the removal of endocrine disrupting compounds.

Table 10 Full-scale biofilter characteristics and existing chemicals of concern

Plant	Utility	Source	Media	Media depth	Pretreatment	Backwash Type	Backwash frequency	Primary Concern	Secondary Concerns
Davenport, IA	Iowa American	Mississippi River	GAC/sand	30" GAC/ 12" sand	KMnO4/PAC (as needed), Polyaluminum sulfate, Superpulsators	Chlorinated	100 hours	T&O	PPCPs, DBP precursors,
Moline, IL	Moline Water Dept.	Mississippi River	Sand/Anthracite	14" anthracite/ 12" sand	KMnO4, Chloramines, Ferric chloride, lime, clarification, CO_2, PO_4, Fluoride	Chloraminated	60 hours	T&O	PPCPs, DBP precursors,
Delaware River Regional WTP	NJ American	Delaware River	GAC/sand	60" GAC/ 6" sand	Ozone, ferric chloride, Superpulsators	Chlorinated	60 hours	DBP precursors	T&O, PFCs, PPCPs,
Baxter WTP	NJ American	Delaware River	Anthracite/ sand	21" anthracite/ 9" sand	Chlorine, ferric chloride, lime, clarification	Chlorinated	72 hours		
Alton, IL	Illinois American	Mississippi River	Bituminous GAC/sand	40" GAC/ 12" sand	KMnO4, chloramines, alum, polymers, Superpulsators	Chlorinated	100-120 hours	Atrazine	T&O, DBP precursors
Peoria, IL	Illinois American	Illinois River	Bituminous GAC/sand wood-based GAC/sand	30" GAC/ 13.5" sand	KMnO4, aluminum chlorohydrate, polymers clarification	Chlorinated	60 - 80 hours	Atrazine	T&O, DBP precursors
Greenville, NC	Greenville Utilities Commission	Tar River	GAC/sand	NA	Ozone	NA	NA	Mn and DBP precursors	T&O

Table 11. Parameters for monitoring biofiltration performance

Parameters	Pilot: CoH	Pilot: SNWA-AMS	Pilot: CCWRD	Full-Scale
Temperature, turbidity	daily	daily	daily	daily
pH, dissolved oxygen	weekly	weekly	weekly	weekly
Nutrients: ammonia, nitrate, phosphate	2×/month	2×/month	2×/month	2×
DOC/TDN/UV/fluorescence	2×/month	2×/month	2×/month	2×
ATP: aqueous	2×/month	2×/month	2×/month	2×
ATP: solid	-	-	1×/month	2×
Alkalinity	monthly	monthly	monthly	2×
Assimilable organic carbon	1×/month	1×/month	1×/month	2×
Metals (i.e., Mn, Fe, Ca, K, Na, Mg, other trace metals)	2×/month	2×/month	2×/month	2×
NDMA Formation Potential	4×	4×	4×	2×
THM/HAA Formation Potential	4×	4×	4×	2×
Indicator TOrC (PPCP/atrazine/ flame retardant)	4×	4×	4×	2×
Comprehensive TOrC (PPCP/ Pesticides/flame retardants)	2×	-	2×	-
Steroidal Hormones	-	4×	4×	-
NDMA	-	4×	4×	-
Perfluoroalkyl acids	1×	4×	4×	2×
MIB and Geosmin	1×/month	1×/month	-	2×
YES Assay (estrogenicity)	2×	2×	2×	2×

Task 5: Develop a Guidance Toolbox for the Simultaneous Removal of CECs

The goal of this task is to create resources that can be used to inform decisions related to the implementation, design, operation, maintenance, and monitoring of biofiltration systems for the simultaneous removal multiple contaminants, including CECs. Two deliverables will be developed during this task: 1) a Biofiltration Multi-Contaminant Removal Guidance Manual, and 2) a companion Multi-Contaminant Removal Matrix.

Subtask 5.1: Guidance Manual

The Guidance Manual will comprise information and performance data gathered during the literature/field review, pilot testing, and full-scale evaluations. It will identify key design and operational parameters that influence the simultaneous removal of multiple contaminants and will recommend approaches for treatment optimization. It will recommend strategies to increase the removal of chemical contaminants that are also resistant to biodegradation. In addition, it will also include suggestions for appropriate direct and surrogate monitoring of multi-contaminant removal performance. The Guidance Manual will provide a resource to all utilities currently operating or considering the operation of biological filters with a multi-contaminant treatment objective. A working outline for the Manual is provided on the next page:

1. Introduction
    - Guidance Manual Objectives and Organization
2. Background Information
    - Overview of commonly coexisting contaminants and their concentrations in drinking water sources
    - Technologies/treatment trains used for simultaneous removal of multiple contaminants
        - Pretreatment: oxidation, coagulation/filtration, sedimentation, PAC
        - Post treatment: GAC, membranes, oxidation (chlorine/ozone), blending
    - Overview of the use of biofiltration for simultaneous removal of co-contaminants
3. Design considerations for simultaneous removal of contaminants
    - Hydraulic, oxidant, filter media, filter bed, backwash system designs
4. Optimizing performance for the simultaneous removal of multiple contaminants
    - Coagulation, pH adjustment, pre-oxidation, nutrient addition, backwash protocol
6. Monitoring
    - In-line parameters, grab-sample parameters, and performance indicator multiple contaminants and surrogates for in-line monitoring
7. References
8. Case Studies
9. FAQs and Troubleshooting

Subtask 5.2: Multi-Contaminant Removal Matrix

A multi-contaminant removal matrix will be developed that provides a snapshot of anticipated multi-contaminant removal ranges given various sets of operating and design conditions. The impact of various operating and design variables on multi-contaminant removal will be displayed visually, and the matrix will provide a utility with an approximate viability assessment of multi-contaminant removal for their system. Table 12 presents an example matrix, which will be updated and expanded based on information collected during Tasks 1 through 4.

Table 12 Example matrix representing expected contaminant removal given the biofilter influent characteristics and operating parameters.

Media Type	Media Age	EBCT	HLR	TOC (mg/L)	Temp (°C)	Contaminant A Removal Ranges	Contaminant B Removal Ranges	Contaminant C Removal Ranges

Evaluation Criteria

The proposed project will address several key knowledge gaps by achieving the specific objectives previously outlined in the Project Description. Specific criteria to evaluate and assess the success of the project objectives are provided in Table 13.

Table 133. Evaluation criteria to assess success in addressing key project objectives

Project objective	Criteria to Assess Success of Project Objectives
1. **Perform a state-of-knowledge review of chemical contaminant removal by biofiltration.**	• Assemble data on biofiltration removal efficiencies for various chemical contaminants in Task 1. • Input data into Task 5 evaluation matrices.
2. **Develop appropriate indicator chemicals for use in the evaluation of biofilter performance for a wide spectrum of chemical contaminants.**	• Identify indicator compounds that can appropriately represent biofiltration performance of specific chemical contaminants based on their chemistries in Task 2.
3. **Evaluate the effect of filter media type (i.e., exhausted GAC vs. anthracite) and EBCT on the biofiltration performance for simultaneously removing multiple chemical contaminants.**	• Evaluate biofilter performance at removing multiple contaminants from CoH, AMS and CCWRD water as a function of media type (exhausted GAC vs. anthracite) in subtask 3.2.
4. **Evaluate the effect of operational parameters, such as short-term effects of backwashing and changes in loading rates, on the performance of biofilter for simultaneously removing multiple chemical contaminants.**	• Evaluate impact of changes in hydraulic loading rate and chlorinated backwashing on biofiltration performance at removing multiple chemical contaminants from AMS or CCWRD water in subtask 3.3.
5. **Identify the impact of high concentration spike of select chemical contaminants in the source water.**	• Assess biofilter performance at removing MIB and geosmin from water during a simulated algal bloom event at AMS Pilot in subtask 3.4. • Investigate biofilter performance at removing Mn from water during Mn spike testing at CoH pilot in subtask 3.4.
6. **Investigate the effect of upstream processes, e.g., pre-oxidation, on the performance of biofilter for simultaneously removing multiple chemical contaminants.**	• Evaluate the impact of pre-chlorination, pre-ozonation and/or coagulation processes upstream of the CoH pilot biofilters, on the removal of multiple chemical contaminants from water in subtask 3.5.
7. **Evaluate the long-term (3+ years) simultaneous removal capabilities for biologically-active carbon filters at full-scale sites.**	• Assess long-term (3+ years) simultaneous removal of multiple chemical contaminants from water at several American Water full-scale plants in Task 4.
8. **Recommend strategies to increase the removal of chemical contaminants that are resistant to biodegradation.**	• Recommend pre or post-biofiltration operations (e.g., membrane filtration, GAC, and chlorine/ozone) in Task 5 and its subtasks to enhance the removal of multiple chemical contaminants.
9. **Develop a guidance tool that will provide guidance and assist water utilities in achieving maximum simultaneous removal of multiple chemical contaminants using biofiltration without compromising the existing objectives of the filtration process.**	• Develop biofiltration multi-contaminant removal guidance manual and a companion multi-contaminant removal matrix tool in Task 5.

Applications Potential

Biofiltration technology has become a viable, low-cost alternative for removing multiple chemical contaminants from drinking water. Since most water utilities already employ one or more filter media in their conventional filtration processes, converting these filters to biological mode is a practical and cost-effective approach for treating multi-contaminants and expanding source waters available to such utilities. The overall goal of the proposed work is to provide a guidance document to assist water utilities in achieving maximum simultaneous removal of multiple chemical contaminants using biofiltration without compromising existing water quality objectives (i.e., producing biologically stable water with low turbidity). In this work, Task 1 will review data (published and unpublished) from peer-reviewed journals, WaterRF reports and participating utilities on biofilter performance at removing multiple chemical contaminants. Data assembled from this Task will inform water utilities with or without existing biofiltration units of likely chemicals of emerging concern (CECs) targeted by biofiltration and the potential of this technology to reduce CECs in their water treatment systems. In addition, indicator CECs that can appropriately represent and monitor biofilter performance at removing chemical contaminants with similar chemistries will be identified in Task 2.

The focus of Task 3 will be to systematically evaluate the removal of multiple chemical contaminants in biofilters at City of Houston (TX) and two SNWA (NV) operated pilot plants at Clark County Water Reclamation District (CCWRD) and Alfred Merritt Smith (AMS). The performance data from the biofilters will identify key design and operational parameters, e.g., media type, EBCT (empty bed contact time), etc., that can impact the simultaneous removal of multi-contaminants in biofilters. Data generated in Task 3 and its subtasks will provide practical design and operational directives for water treatment operators and managers to optimize the performance of biofilters in their treatment systems.

Another aspect of the proposed work will be to evaluate the removal of multi-contaminants at full-scale systems consisting of biologically-active carbon that are 3+ years old. Specifically, the seasonal (April through June) impacts of pesticide (atrazine) and taste and odor compounds at Peoria or Alton plants will be monitored to assess if the concentrations of these chemicals decline over time in the biofilters. The research findings from Task 4 will particularly benefit water utilities with agriculturally impacted waste-waters by examining the impacts of agricultural activities on biofilter performance at removing agro-CECs.

Based on the work completed in Tasks 1 through 4, Task 5 will place the research results in the context by developing a multi-contaminant removal matrix that will provide a snap shot of anticipated multi-contaminant removal ranges given various sets of operating and design conditions. A visual display of multi-contaminant removal as a function of various operating and design variables will provide each utility with a viability assessment of the potential efficacy of biofiltration at removing multi-contaminants in their treatment systems. The final report compiled in Task 6 will be a guidance document with critically-needed information for utilities currently operating biofilters or considering the operation of biofilters to optimize the treatment performance of biofilters at simultaneously removing multi-contaminants without minimizing their existing water quality objectives.

Quality Assurance/Quality Control

The Project Team has successfully used the following project management QA/QC procedures for many grant-funded research activities. Specific laboratory QA/QC procedures are provided in the subsequent section.

Project Management QA/QC Approach

Project Monitoring and Oversight. All Project Team deliverables (whether draft or final) will undergo a formal review process led by Dr. Eric Dickenson (SNWA, Project Manager, Water Quality Research and Development) prior to submittal to the PAC and WaterRF. Dr. Dickenson will be involved in and informed about the project from conception through completion. The lead researchers and QA/QC personnel assigned to the proposed project team have experience in terms of study design, data collection and processing, water quality, and regulatory compliance. Peer review, both with partner utilities and the PAC, throughout the course of the study will ensure a clearly focused technical direction that is consistent with objectives of the study.

Maintenance and Storage of Data. The Project Team exercises great care in maintaining the integrity of data collected and confidentiality of data sources during the course of research. SNWA uses internal network storage that is backed-up on defined time intervals to protect and chronicle data collection efforts. Electronic document and data control procedures ensure that the team knows and has access to the array of electronic files that are developed during the course of a study. Efficient data storage, together with inter-, outer-, and intra-network communications permit cost efficiencies while maintaining quality management standards among all of our offices.

Progress Reports and Briefings. An important part of the QA/QC process will be the delivery of progress reports and discussion briefings with the PAC and WaterRF. Feedback received from these interactions will ensure that the study is progressing as planned and will provide opportunities to identify problem areas and solutions. The team members encourage frequent communication during the course of the project and believe that collaboration with the PAC and WaterRF is essential to meeting the study objectives and defining project success.

Communication and Planning. To achieve and maintain effective communication, the individuals who wrote this proposal will be directly involved with project implementation. Dr. Dickenson, as PI and Dr. Eric Wert, Dr. Scott Summers, Dr. Jess Brown, and Dr. Orren Schneider, as co-PIs, will be intimately involved in all phases of project implementation: conceptualization and planning, administration, methodology development, data development and assessment, research, writing and editing. More specifically to this effort, additional communication and planning procedures will be as follows:

- Preparation of detailed plans for overall project deliverables and individual tasks. These plans are routinely reviewed and refined by the PIs;
- Maintenance of state-of-the-art research tools to ensure in-depth familiarity with the relevant literature and developments in the field;
- A systematic documentation and project tracking system with a standard filing system for all project-related documents and materials;
- Utilizing reviewers to ensure final reports are comprehensible to non-technical readers;
- Frequent Project Team meetings, including conference calls, to ensure all team members are up to date on project developments, challenges, and utility and Foundation needs;

- Utilization of web-based applications and meeting tools as well as phone calls and site visits (as needed) for information communication and collection between Project Team Members, technical advisors, WaterRF, and participating utilities;
- Internal data review by a senior staff person to ensure reliability of the source, as well as accuracy and appropriate use of the data;
- Open communications with the PAC in which the Project Team actively solicits input and feedback concerning scope, methods, data sources, and/or preliminary findings; and
- Quarterly progress reports identifying progress to date with all deliverables, challenges encountered, how such challenges were addressed, and planned activities for the next quarter.

Laboratory QA/QC Procedures

Water quality data obtained and used in this project will be supplied by Southern Nevada Water Authority, American Water, and additional participating utilities, all of which have strict QA/QC procedures with respect to both data and laboratory analyses. The analytical and QA/QC procedures that will be followed by SNWA are provided in detail below. Principal Investigator Dr. Eric Dickenson and Principal Research Chemist Brett Vanderford will regularly assess the QA/QC laboratory results to ensure compliance with the stated objectives.

Sample Analysis

Standardized and approved analytical methods (i.e., U.S. EPA, Standard Methods) to monitor regulated contaminants and water quality will be used throughout this project. For CEC, PFAA, and NDMA analysis, peer-reviewed published methods developed by the project team will be used (Benotti et al. 2009, Vanderford et al., 2003, Vanderford and Snyder, 2006, Appleman et al. 2014, Holady et al., 2012). The methods used for project water quality parameters are reported in Table 1. CEC analytes to be measured by the SNWA and Eurofins Laboratories are presented in Tables 2 and 3, respectively, along with their method reporting limits. For NOM characterization, methods developed and published by the research team will be utilized (McKnight et al. 2001). Chloramine and chlorine FP testing will follow the methods presented by Gerecke and Sedlak (2003) and SM 5710B, respectively. The E-screen assay will be performed as previously published by the research team (Snyder et al., 2008). In the case of emerging contaminants, field and laboratory blanks are of great importance, and this team has over a decade of experience with these challenging analyses. The QA program at SNWA is based upon the requirements of ANSI/ASQC E4, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs."

The accuracy of each microcontaminant analysis will be determined by measuring spike recoveries in the matrix of interest. The relative errors will be calculated and will be considered acceptable if they fall within the control limits determined for the particular test. In general, a test will not be deemed useful if its precision or accuracy is found to be equal to or greater than 20% of the highest value observed. Wherever possible, external performance standards will also be run. This serves as a measure of accuracy both for the analysis and for standard preparation. Results are presented in routine project meetings, where any analytical problems are discussed. Further, these data will be provided to the PAC in all periodic reports for review and feedback.

All sampling will be performed using Nitrile gloves to prevent accidental contamination with EDCs and PPCPs contained in such ubiquitous items as soap (triclosan), sunscreen (oxybenzone), and tobacco products (nicotine). All samples to be analyzed for selected EDCs and pharmaceuticals will be collected in specially cleaned and silanized glass amber vials or bottles complete with Teflon-lined caps to ensure sample integrity. In addition, a concerted effort will be made to keep bottle headspace to a minimum. We have previously established a holding time of no greater than two weeks, though this will be less for NOM analyses. If additional compounds are added to the target compound suite, a new holding

study will be undertaken to ensure that the additional compounds are also stable for two weeks. All samples destined for microcontaminant analysis will be preserved by adding 0.1 % sodium azide, then kept refrigerated at 4°C until sample extraction has taken place. Each sample event will include quality control samples including at least one blank (trip and/or equipment blank) and one duplicate.

Table 1 Methods for water quality parameters.

Water Quality Parameter	Laboratory	Methods
pH	SNWA	SM 4500H+ B
Alkalinity	SNWA	SM 2320 B
TOC	SNWA	SM 5310 B
Turbidity	SNWA	SM 2130 B
Anions (nitrate, phosphate, nitrite)	SNWA	EPA 300.0
Ammonia	SNWA	SM 4500-NH3 G
UV Absorbance	SNWA	SM 5910 B
Fluorescence	SNWA	McKnight et al. 2001
ATP	SNWA	LUMINULTRA test kit
AOC	SNWA	SM 9217B
Cations (Mn, Fe, Ca, K, Na, Mg), Trace Metals	SNWA	EPA 200.7
NDMA	SNWA	Holady et al. 2012
THMs/HAAs	SNWA	EPA 524.3, 552.2
Indicator CEC (PPCP, atrazine, sucralose, flame retardant)	SNWA	LC MS/MS; Vanderford et al. 2006
Atrazine	American Water	LC MS/MS
Comprehensive CEC (PPCPs/pesticides/sweetners/flame retardents)	Eurofins	LC MS/MS
Steroidal hormones	SNWA	LC MS/MS; Benotti et al. 2009
Perfluoroalkyl acids	SNWA	LC MS/MS; Appleman et al. 2014
MIB/Geosmin	SNWA	GC MS/MS; Wert et al. 2014
MIB/Geosmin	American Water	EPA 6040D
YES Assay	SNWA	Snyder et al., 2008

Table 2 Analyte List for SWNA Method for CECs

Analyte	MRLs, ng/L	Analyte	MRLs, ng/L
Acetaminophen	5.0	PFBA	5.0
Atenolol	1.0	PFPnA	2.0
Atrazine	1.0	PFHxA	0.50
Bisphenol A	5.0	PFHpA	0.50
Caffeine	5.0	PFOA	5.0
Carbamazepine	0.5	PFNA	0.50
DEET	1.0	PFDA	0.50
Fluoxetine	0.50	PFUdA	0.50
Gemfibrozil	0.25	PFDoA	0.25
Ibuprofen	1.0	PFBS	0.25
Meprobamate	0.25	PFHxS	0.25
Naproxen	0.50	PFOS	0.25
Phenytoin	1.00	PFDS	0.10
Primidone	0.50		
Sucralose	25	Testosterone	0.50
Sulfamethoxazole	0.25	Progesterone	0.50

TCEP	10	Estrone	0.20
Triclocarban	2.0	Estradiol	0.50
Triclosan	1.0	Ethynylestradiol	1.0
Trimethoprim	0.25		

Table 3 Analyte List for Eurofins Method for CECs

Analyte	MRL, ng/L	Analyte	MRL, ng/L
1,7-Dimethylxanthine	10	Ibuprofen	10
2,4-D	5	Iohexal	10
4-nonylphenol	100	Iopromide	5
4-tert-Octylphenol	50	Isobutylparaben	5
Acesulfame-K	20	Isoproturon	100
Acetaminophen	5	Ketoprofen	5
Albuterol	5	Ketorolac	5
Amoxicillin	20	Lidocaine	5
Andorostenedione	5	Lincomycin	10
Atenolol	5	Linuron	5
Atrazine	5	Lopressor	20
Azithromycin	20	Meclofenamic Acid	5
Bendroflumethiazide	5	Meprobamate	5
Bezafibrate	5	Metazachlor	5
BPA	10	Methylparaben	20
Bromacil	5	Metolachlor	5
Butalbital	5	Naproxen	10
Butylparaben	5	Nifedipine	20
Caffeine	5	Norethisterone	5
Carbadox	5	Oxolinic acid	10
Carbamazepine	5	Pentoxifylline	5
Carisoprodol	5	Phenazone	5
Chloramphenicol	10	Primidone	5
Chloridazon	5	Progesterone	5
Chlorotoluron	5	Propazine	5
Cimetidine	5	Propylparaben	5
Clofibric Acid	5	Quinoline	5
Cotinine	10	Simazine	5
Cyanazine	5	Sucralose	100
DACT	5	Sulfachloropyridazine	5
DEA	5	Sulfadiazine	5
DEET	10	Sulfadimethoxine	5
Dehydronifedipine	5	Sulfamerazine	5
DIA	5	Sulfamethazine	5
Diazepam	5	Sulfamethizole	5
Diclofenac	5	Sulfamethoxazole	5
Dilantin	20	Sulfathiazole	5
Diuron	5	TCEP	10
Erythromycin	10	TCPP	100
Estradiol	5	TDCPP	100
Estrone	5	Testosterone	5

Ethinyl Estradiol - 17 alpha	5	Theobromine	10
Ethylparaben	20	Theophylline	20
Flumeqine	10	Triclosan	10
Fluoxetine	10	Trimethoprim	5
Gemfibrozil	5	Warfarin	5

All samples (both quality control and field samples) will be spiked with a series of stable isotopically labeled surrogate standards to monitor the efficiency of the extraction procedures. These surrogates will be selected to mimic the target analytes as closely as possible to ensure meaningful conclusions from their performance. Quantitation will be performed using isotope dilution.

Each instrument involved in the project will be required to have a well-maintained logbook documenting instrument performance and maintenance. This logbook will contain information relevant to the project and will document any applicable changes to instrument hardware, performance, calibration, routine maintenance, and any other items deemed necessary. Before the start of qualitative analysis, each instrument will have the following items calculated and/or defined for each applicable analyte: instrument detection limit (IDL), method detection limit (MDL), practical quantitation limit (PQL) (also known as the MRL), and initial calibration. The IDL is a measure of the lowest detectable amount of an analyte that can be distinguished from a blank by an instrument. It will be defined as the amount determined by multiplying by three the standard deviation obtained for the analysis of a standard solution at a concentration three to five times the desired IDL on three nonconsecutive days with seven consecutive measurements per day. The MDL is the concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Unlike the IDL, it represents the entire process of analysis, including extraction/preparation and instrumental detection. It will be defined as the amount determined by multiplying the standard deviation of multiple replicate analyses by the appropriate t-statistic. The analyte concentration used to determine the MDL should be approximately the value of the expected MDL. The PQL is generally defined as 5 times the MDL and is considered to be the lowest practical level from which data can be reported. Any concentration measured that is below the PQL will not be considered reliable and will be reported as non-detectable (ND). We generally use the PQL as the lowest concentration analytical standard in the calibration curve.

Measurements that fall between the MRL and the highest calibration standard will be reported. Otherwise, samples will be diluted and reanalyzed. Water quality parameter values will be reported as non-detect if a response value is less than one-third that of the MRL. Method blanks, and stability standards will be analyzed along with sample sequence (after every ~10-20 samples) and they must also have responses less than one-third that of the MRL as applicable. Fortified blanks in ultrapure water will be used for every sample sequence for verification of calibration and recovery. Analytical replicates (10%) will be used to confirm reproducibility. 10% duplicate samples will be collected for field samples.

Management Plan

The management team for the proposed work is comprised of experienced professionals, academics and consultants from SNWA, Carollo Engineers Inc., University of Colorado, and American Water (Figure 6.1). Our team members are experts in the field of biofiltration, and are collectively capable of achieving and exceeding the objectives stated by the RFP. Our project members have also authored or co-authored peer-reviewed journal articles and WaterRF reports on biofiltration and have unique capabilities in:

- Operating pilot- and full-scale biofilters to remove multiple chemical contaminants using various filter media.
- Identifying surrogate parameters and indicator compounds that can appropriately represent specific classes of compounds and assess biofiltration performance of chemical contaminants with similar chemistries.
- Assessing the impact of upstream processes (e.g., pre-ozonation), influent concentration (e.g., during spike events), design and operational parameters on biofilter performance at removing multi-contaminants.

These abilities are invaluable for assessing the simultaneous removal of multiple chemical contaminants by biofilters and optimizing biofiltration treatment processes in water treatment systems.

The Principal Investigator (PI) for this project is Dr. Eric Dickenson, Project Manager, Applied Research and Development with the SNWA. Dr. Dickenson has more than 14 years of experience in drinking water and water reuse treatment of traditional and emerging contaminants. Dr. Dickenson has also served as PI or Co-PI (Co-Principal Investigator) for numerous successful research projects funded by NSF, USEPA, USDA, WaterRF, WRRF, and WERF. In particular, Dr. Dickenson is currently involved with the WateReuse Research biofiltration project (WateReuse-13-10) where he serves as Co-PI in this on-going study to investigate the removal of disinfection by-products by various filter media in pilot-scale biofilters. He provides significant management expertise of multi-disciplinary teams and has an excellent track record for the successful completion of projects, on budget and time. Dr. Dickenson will be directly involved in overseeing the completion of Tasks 1 through 6 as well as the subtasks under these Tasks. Besides, providing overall leadership to the project team, he will be the point of contact for the participating utilities and organizations and will keep the WaterRF abreast of the project status through electronic, phone communication and WaterRF reports as required by the WaterRF. Dr. Dickenson will also oversee the project progress by scheduling monthly conference calls, monitoring the project budget and research activities to ensure that the project proceeds according to the timed schedule. Dr Eric Dickenson will be assisted in his leadership role by Dr. Eric Wert from SNWA who is a Co-PI for the proposed work. Dr. Wert has authored and co-authored peer-reviewed journal articles on biofiltration and has over 14 years of experience in the design, and implementation of water quality and treatment research projects at pilot and full-scale. Dr. Wert will be directly responsible for overseeing the operation of the pilot biofilter at Alfred Merritt Smith (AMS) in Subtask 3.1. The SNWA team also comprises of Dr. Mandu Inyang, a post-doctoral researcher who will be involved in the operation of the pilot biofilters and sampling protocols at the Clark County Water Reclamation District (CCWRD) and AMS. Mr. Brett Vanderford is the Principal Research Chemist at SNWA and he will manage and oversee the analytical work and measurements of the CECs (chemicals of emerging concern) investigated in this work. A Pilot Plant Specialist and Graduate Intern will also be involved in the operation and sampling protocols for the pilot biofilters at AMS and CCWRD.

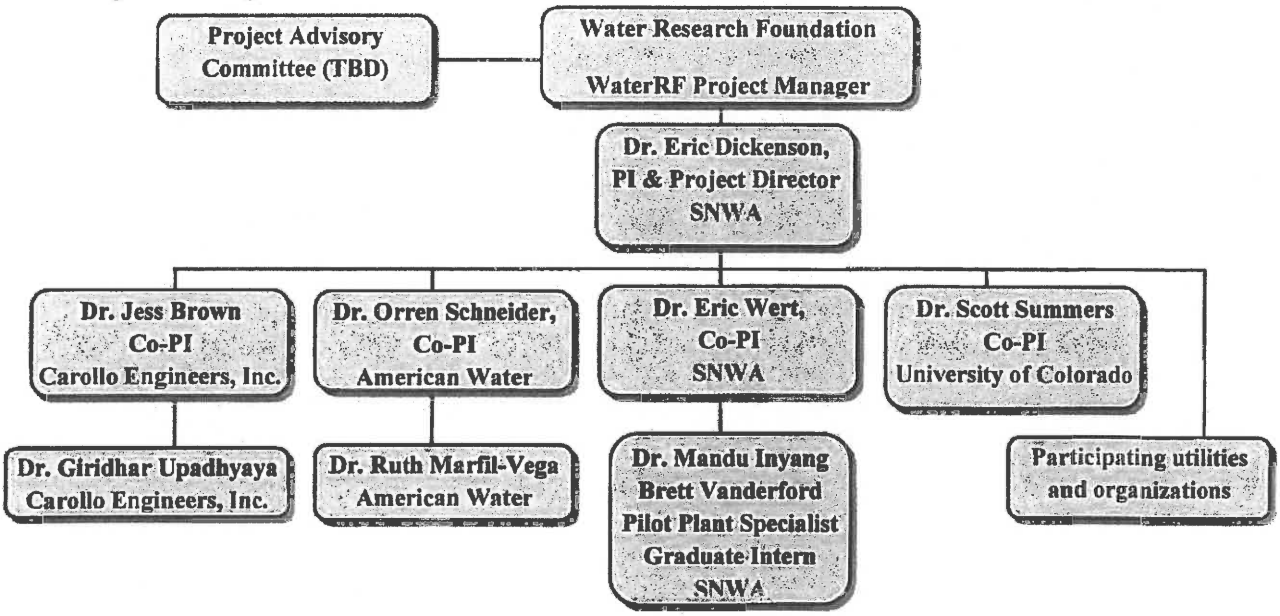
Dr. Scott Summers, University of Colorado is a Co-PI for the proposed work and he will oversee Tasks 1 and 2. Dr. Summers is a renowned expert in biofiltration technology and he has authored peer-

reviewed journal articles and WaterRF reports on the subject of biofiltration. In addition to reviewing and assessing biofilter performance for removing multiple contaminants in Task 1, Dr. Summers will lead the investigation in identifying indicator CECs that can appropriately represent and assess biodegradation performance of multi-contaminants with similar chemistries.

The team at American Water will lead the investigation on the removal of multiple CECs in the full-scale pilot biofilters in Task 4 and also assist in the development of the multi-contaminant matrix tool for assessing biofiltration performance in Task 5. Dr. Orren Schneider is a Co-PI for the proposed work and he will directly manage and oversee the operation of the full-scale biofilters at the different full-scale plants. Dr. Schneider has served as Co-PI or PI on funded research projects worth over $2M. He also has 20 years of expertise in the evaluation, design and optimization of pilot and full-scale treatment operations for advanced coagulation, clarification, filtration, disinfection and membrane technologies. For the proposed work, Dr. Schneider will be supported by Dr. Ruth Marfil-Vega, an environmental scientist with 10 years' experience in sampling and monitoring CECs such as trace organics, heavy metals, and pharmaceutical and personal care products.

Finally, Dr. Jess Brown, Carollo Engineers, P.C. will lead and oversee the: pilot work at the City of Houston in Task 3, full-scale work at Greenville Utilities Commission in Task 4, and Task 5 and its subtasks. Dr. Jess Brown will be primarily responsible for developing the multi-contaminant matrix tool in Task 5 that will provide information and guidance on the simultaneous removal of multiple CECs as a function of water quality, upstream processes, biofilter operational and design conditions. Dr. Brown is an expert in biological filtration of drinking water with 15 years expertise in pilot- and full-scale studies covering conventional and advanced treatment processes for wastewater and drinking water. He is also an expert in water quality testing and treatment process optimization. Dr. Giridhar Upadhyaya is an environmental engineer with Carollo Engineer, Inc. with 20 years' experience in water treatment. He will be assisting Dr. Brown in completing Tasks 3, 4, and 5.

Figure 6.1 Organizational Chart



Communication Plan

The end product of this study is a guidance document that will assist water utilities currently operating biofilters or considering the operation of biofilters, to simultaneously remove multiple chemical contaminants without minimizing their water quality objectives, e.g., turbidity control. This guidance document will be a valuable resource for water utilities operating conventional filters (with granular media) that want to maximize their treatment performance without additional capital investment. The guidance manual will also be a useful tool to provide a snap-shot of multi-contaminant removal ranges for biofilters as a function of water quality, temperature, upstream processes, design and operational parameters in treatment systems. Delivering the results from the proposed study in a timely manner is therefore crucial for reducing chemical contaminants in public drinking water supplies and also providing water treatment operators a viability assessment of biofilter performance at multi-contaminant removal in their systems. Our project team is committed to frequently communicate the results from this study to various groups including WaterRF subscribers.

The final WaterRF report generated from the proposed work will be a resource tool that can be used to inform decisions related to the implementation, design, operation, and monitoring of biofiltration systems for simultaneous removal of multiple chemical contaminants. Specifically, performance data gathered from field and literature review, pilot-testing, and full-scale evaluations in this work will be used to recommend approaches (e.g., design and operation considerations, backwashing protocol, upstream and post-biofilter treatment processes) for optimizing biofilter treatment operations in water utilities. This report will in addition, provide useful suggestions for direct and surrogate monitoring of multi-contaminant removal performance using in-line, grab-sample and surrogate parameters.

Interim deliverables such as website updates, presentations at water quality conferences, webcasts and peer-reviewed journal articles from the proposed work will be released prior to the dissemination of the final WaterRF report. Information on our research findings will be posted twice a year on the WaterRF website via their communication portals. These short-term deliverables may prove useful to other ongoing research projects on biofiltration. Our results will also be communicated to water professionals by presenting our findings at local and national water quality conferences such as the AWWA annual conferences (both ACE and WQTC). The PI will further present research findings at the Focus Area Annual Research Summit on an annual Basis. Two webcasts are proposed to be broadcasted to share results from this study to other WaterRF stakeholders and subscribers. At least two journal articles are anticipated to be developed from the research results and will be written in a timely manner to communicate project findings with other scientific researchers in the hopes of advancing the scientific communities' understanding of biofiltration. The final report will be available upon completion via an electronic file, easily accessible to subscribers and other members of the drinking water community.

Throughout the duration of the project and at its closure, there will be ample opportunities to disseminate the latest results and to communicate with a wide range of targeted audiences - subscribers, water quality researchers, regulatory agencies, and persons involved with other WaterRF projects (both to avoid overlap as well as to build on current knowledge).

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Licenses and Inventions

This research is not likely to produce inventions, new products, or processes. The research team members do not own or control any pre-existing patents or patent applications related to the proposed research.

Budget Narrative

The Southern Nevada Water Authority (SNWA) is proposing to complete this project in 30 months (2.5 years). The total project budget of $917,687, including in-kind contributions, will be expended within the contract period.

Primary Contractor Budget Justification – Southern Nevada Water Authority

SNWA will provide management leadership to the project and perform the majority of analytical work for pilot- and full-scale testing for the project. The cost to WaterRF for SNWA's time will be $148,481, with in-kind (cost-share) provided by SNWA, of $304,000, for a total of $452,481.

Salaries and Wages: The salary rates of employees participating in the project are established by the Southern Nevada Water Authority and their Board of Directors.

PI Dr. Eric Dickenson will dedicate 160 hours of time to this project managing and overseeing the research tasks of the project. Mr. Brett Vanderford will oversee analytical measurements with a total of 40 hours. Dr. Eric Wert, Co-PI will dedicate 60 hours of his time to overseeing the pilot-scale biofilter operation at SNWA. Remaining labor for the pilot-scale work will be highly skilled and provided by a Pilot Plant Specialist, (120 hours total), Dr. Mandu Inyang, a Postdoctoral Researcher, (250 hours total) and a Graduate Intern (1000 hours total). Estimated salary and wages for SNWA amount to $51,095 ($13,637 as in-kind).

Fringe Benefits: A fringe benefit rate of 40% is added to the salaried labor budget for SNWA, contributing $11,638 ($3,693 as in-kind) to the budget. The rate for fringe benefits is established by the Southern Nevada Water Authority. The graduate intern does not have overhead applied.

Equipment Rental: None expected. Two pilot plant systems will be provided to the project by SNWA as in-kind (valued at $250,000) to the project.

Materials and Supplies: The labor and nonlabor costs of analytical samples outlined in the scope of this proposal will be $94,700 of which an additional $36,673 will be provided as a cost-share. A budget of $4,000 is proposed for miscellaneous pilot equipment supplies.

Travel: A travel budget of $4,375 is provided in the SNWA subcontract for the PI communications of project findings at conferences and project meetings.

Other Direct Costs: None expected.

Indirect Costs: None expected.

Subcontracts: Southern Nevada Water Authority will enter into a subcontract with Carollo Engineers, Inc. ($76,300), American Water ($60,000), and Colorado University ($65,219) to share in all tasks associated with this project.

Subcontractor Budget Justification – University of Colorado.

1. Foundation Share

Salaries and Wages:
Dr. R. Scott Summers (PI), ($6,252) will devote 20 percent of his time in each summer month to this project. He will coordinate the project and supervise the research activities from the CU side. He will participate in bi-weekly research project meetings and oversee project activities, data analysis and interpretation.

Graduate Research Assistant (GRA), ($24,013) will devote 50 percent of his/her time over 12 months to participate in tasks 1, 2 and 5.

Fringe Benefits:
Summers (27.5%) $1,751.
GRA (7.9%) $1,993.

Indirect Costs: The current on-campus indirect cost rate is 52.50% of total direct costs excluding tuition ($17,855). This rate has been negotiated with the HHS.

Travel: none

Other Direct Costs: University of Colorado tuition remission ($13,356)

Sub-Contractor Budget Justification – Carollo Engineers, Inc.

Salaries and Wages: Salary rates for the non-federal employees (Dr. Jess Brown, Dr. Greg Pope, Dr. Giridhar Upadhyaya, and the TBD intern) are established in conjunction with their employer, Carollo Engineers, Inc. Indirect costs of 126% are included in the hourly rates budget for each of these researchers. A 0% wage increase has been incorporated for each staff person for each year of the project. Over the 2.5-year (30 month) project, Dr. Brown will devote 1% of his time to planning and directing research activities, as well as monitoring the project budget and preparing project reports for submission to the Foundation. Dr. Pope will devote 3% of his time to oversee and support pilot testing with the city of Houston. Dr. Upadhyaya will devote 3% of his time to lead the development of the guidance manual and assist with reporting activities. An intern will devote 75% of his/her time to the daily operation of the Houston pilot trains during Subtask 3.3.

Fringe Benefits: For Carollo personnel, fringe benefits are 50% of direct labor.

Equipment Rental: No equipment rentals are expected as part of this proposal.

Shipping: $2,000 in sample shipping costs (Houston to SNWA) has been included in the Houston pilot testing budget

Travel: $4,500 in travel costs have been included for travel to and from the Houston piloting site for the intern and for Dr. Pope over the ~6-month pilot testing period.

Sub-Contractor Budget Justification – American Water.

American Water costs for this project will be $154,975. These include $60,000 of Foundation awards funding and in-kind contributions from American Water of $99,975.

Co-PIs: Dr. Orren Schneider will function as Co-PI for the project. Dr. Schneider will also lead the full-scale plant evaluation task and be involved with the development of guidance documents. Dr. Marfil-Vega will conduct the analyses of sorbed and dissolved contaminants as part of the full-scale plant evaluations. Approximately 10 percent of Dr. Schneider's time and 15% of Dr. Marfil-Vega's time will be devoted to the project. All of their direct labor will be in the form of Foundation Award funds.

Salaries and Wages: The salary rates of American Water employees are based on salaries as of June 2014. Foundation funds will be used to support the wages of Dr. Schneider and Dr. Marfil-Vega. The direct wage support of American Water personnel will encompass approximately $38,250.

Fringe Benefits: The fringe benefits for full-time American Water personnel are calculated at 50% of the direct wages. The fringe benefits for Dr. Schneider and Dr. Marfil-Vega, will serve as part of our in-kind contribution and account for approximately $19,125.

Overhead: All overhead costs for all American Water employees will be shown as in-kind contributions for the project. This overhead is calculated at a rate of 80% of direct labor and amounts to approximately $30,600.

Equipment Rental: None.

Materials and Supplies: None

Travel: Travel for one PAC meeting for Drs. Schneider and Marfil-Vega is assumed. These costs (approximately $1,750) will be part of American Water's portion of the award.

Other Direct Costs:
We have budgeted $2,000 for monthly sample shipping of water and media during the full-scale comparison of sorbed and dissolved constituents at either the Alton or Peoria, IL plant. These funds will be supported by the Foundation as part of the award.

Analyses of taste and odor compounds at the Alton or Peoria plants will be conducted by American Water's Central Laboratory in Belleville, IL on a per sample basis. We have budgeted $13,000 for these tests.

The majority of American Water's in-kind contribution will be in the form of the value of the data provided for the project. In addition to the Peoria or Alton WTPs, we will be providing data from the Delaware River Regional Water Treatment Plant in Delran, NJ and the East River Station in Davenport, IL. These data will include historical records of plant performance and records for organics removal (tastes and odors, DBPs, CECs, etc.). These data are valued at $50,000.

Schedule

The proposed research is designed for 2.5 years (30 months). The actual launch date will depend on successful completion of contract negotiations, but it is anticipated for January 2015 and the project is expected to be finished in July 2017. The Table below illustrates the proposed research, broken into project tasks. The scope of work (SOW) is due by the end of the first month and a PAC meeting is expected to occur during month 2.

Research Work Plan and Schedule

Tasks	Year 1												Year 2																	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
SOW																														
Task 1																														
Task 2																														
Task 3																														
Task 4																														
Task 5																														
Reports		P		Q			Q			Q			Q			Q			Q			Q					D			F

SOW: Scope of Work, Q: Quarterly Report, P: PAC Meeting, D: Draft Final Report, F: Final report

Task 1: Review the performance of biofilters for removing multiple chemical contaminants
Task 2: Develop appropriate indicator compounds/chemicals that represent certain classes/categories to assess biofiltration performance.
Task 3: Systematic evaluation of biofiltration performance at pilot-scale.
Task 4: Evaluation of biofiltration performance at full-scale.
Task 5: Develop a Guidance Toolbox for the simultaneous removal of multiple chemical contaminants

Current and Pending Form

Investigator: Eric Dickenson

Other agencies to which this proposal has been/will be submitted: None

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Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Integration of Filtration and Advanced Oxidation

Source of Support: U.S. EPA

Total Award Amount: $499,778 Total Award Period Covered: 09/2012-01/2016

Location of Project: Clarkson University/Southern Nevada Water Authority

Person-Months Per Year Committed to the Project: 0.25

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Controlling Nitrosamines and Other Trace Organic Contaminants

Source of Support: WateReuse Research Foudnation

Total Award Amount: $1,460,606 Total Award Period Covered: 09/2013-09/2015

Location of Project: Southern Nevada Water Authority

Person-Months Per Year Committed to the Project: 1.0

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Evaluation of Strategies for Managing CECs

Source of Support: Water Research Foundation

Total Award Amount: $693,966 Total Award Period Covered: 10/2013-10/2015

Location of Project: Carollo Engineers, Univ. of Arizona, Tech. Univ. Munich, SNWA

Person-Months Per Year Committed to the Project: 0.5

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Evaluating Fate Mechanisms for Contaminants of Concern in BNR

Source of Support: Water Environment Research Foundation

Total Award Amount: $174,717 Total Award Period Covered: 04/2014-04/2016

Location of Project: University of Cincinnati/Southern Nevada Water Authority

Person-Months Per Year Committed to the Project: 0.5

☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Testing Water Quality in a Municipal Wastewater Effluent Treated

Source of Support: Texas Water Development Board

Total Award Amount: $477,111 Total Award Period Covered: 05/2014-11/2015

Location of Project: Big Springs, Texas

Person-Months Per Year Committed to the Project: 0.2

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Blending Requirements for Water from Direct Potable Reuse

Source of Support: Water Research Foundation

Total Award Amount: $714,310 Total Award Period Covered: 06/2014-06/2016

Location of Project: Carollo Engineers/Southern Nevada Water Authority

Person-Months Per Year Committed to the Project: 0.25

☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Major Sources of Nitrosamine Precursors in Raw Waters

Source of Support: Water Research Foundation

Total Award Amount: $380,000 Total Award Period Covered: 08/2014-08/2016

Location of Project: Stanford University/Clemson University/SNWA

Person-Months Per Year Committed to the Project: 1.0

☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Bench-Scale Evaluation of Alternative Cr(VI) Removal Options for

Source of Support: Water Research Foundation

Total Award Amount: $250,000 Total Award Period Covered: 10/2014-10/2016

Location of Project: Southern Nevada Water Authority

Person-Months Per Year Committed to the Project: 1.0

Current and Pending Form

This form must be completed for the Principal Investigator and for each Co-Principal Investigator.
Failure to provide this information may result in disqualification of your proposal.

Investigator: Eric Wert

Other agencies to which this proposal has been/will be submitted:

Support: ☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Effect of Ozone Dissolution Methods on Bromate Formation, Disinfection Credit, and Operating Cost

Source of Support: Water Research Foundation - Tailored Collaboartion Proposal

Total Award Amount: $327,000 Total Award Period Covered: Pending

Location of Project: Las Vegas, NV

Person-Months Per Year Committed to the Project: 2.4

Support: ☐ Current ☐ Pending ☑ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Optimizing Biofiltration for Various Source Water Quality Conditions

Source of Support: Water Research Foundation

Total Award Amount: $350,000 Total Award Period Covered: Pending

Location of Project: Pending

Person-Months Per Year Committed to the Project: Pending

Support: ☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Major Sources of Nitrosamine Precursors from Raw Waters and Distribution Systems

Source of Support: Water Research Foundation - Tailored Collaboration

Total Award Amount: $363,800 Total Award Period Covered: Pending

Location of Project: Las Vegas, NV

Person-Months Per Year Committed to the Project: 0.3

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Form

This form must be completed for the Principal Investigator and for each Co-Principal Investigator.
Failure to provide this information may result in disqualification of your proposal.

Investigator: R. Scott Summers

Other agencies to which this proposal has been/will be submitted: None

---

Support: ☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Simultaneous Removal of Multiple Chemical Contaminants using

Source of Support: Water RF

Total Award Amount: $350,000 Total Award Period Covered: 6/1/10-12/31/12

Location of Project: University of Colorado

Person-Months Per Year Committed to the Project: 0.5

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Solar-Biochar Toilet

Source of Support: Bill & Melinda Gates Foundation

Total Award Amount: $1,500,000 Total Award Period Covered: 9/1/12- 12/30/14

Location of Project: University of Colorado

Person-Months Per Year Committed to the Project: 0.5

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Henry's Law and Freundlich Adsorption Constants for VOCs

Source of Support: Water RF

Total Award Amount: $100,000 Total Award Period Covered: 1/1/13 - 12/31/1

Location of Project: NC State University

Person-Months Per Year Committed to the Project: 0.5

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: REMOVAL OF VOLATILE ORGANIC CONTAMINANTS (VOCS) FROM

Source of Support: Water RF

Total Award Amount: $50,000 Total Award Period Covered: 8/1/13- 12/15/14

Location of Project: University of Colorado

Person-Months Per Year Committed to the Project: 0.25

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Form

Investigator: R. Scott Summers

Other agencies to which this proposal has been/will be submitted: None

Support: ☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: NATIONAL CENTER FOR INNOVATION IN SMALL DRINKING WATER

Source of Support: USEPA

Total Award Amount: $1,400,000 Total Award Period Covered: 6/1/14-5/31/15

Location of Project: University of Colorado

Person-Months Per Year Committed to the Project: 1.0

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Form

This form must be completed for the Principal Investigator and for each Co-Principal Investigator. Failure to provide this information may result in disqualification of your proposal.

Investigator: Jess Brown

Other agencies to which this proposal has been/will be submitted:

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Conversion of Conventional Filters to Biofilters

Source of Support: Water Research Foundation

Total Award Amount: $445,234 Total Award Period Covered: Fall 2013-Spring 2015

Location of Project: Denver, CO

Person-Months Per Year Committed to the Project: 0.8

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Removal of nitrate/DBCP using 2-stage fixed-bed biotreatment

Source of Support: Cucamonga Valley Water District

Total Award Amount: $167,300 Total Award Period Covered: Fall 2013-Fall 2014

Location of Project: Rancho Cucamonga, CA

Person-Months Per Year Committed to the Project: 0.5

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Removal of nitrate/TCE/TCE using 2-stage fixed-bed biotreatment

Source of Support: Chino Basin Desalter Authority

Total Award Amount: $702,400 Total Award Period Covered: Spring 2014-Spring 2015

Location of Project: Chino, CA

Person-Months Per Year Committed to the Project: 1.5

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Development of a Biofiltration Knowledge Base

Source of Support: Water Research Foundation

Total Award Amount: $449,942 Total Award Period Covered: Spring 2013-Spring 2015

Location of Project: Denver, CO

Person-Months Per Year Committed to the Project: 0.5

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Full-Scale Demonstration of Engineered Biofiltration and Development of a Biofiltration Performance-Tracking Tool

Source of Support: Water Research Foundation

Total Award Amount: $502,338 Total Award Period Covered: Summer 2013-Fall 2015

Location of Project: Tampa, FL

Person-Months Per Year Committed to the Project: 0.5

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Form

This form must be completed for the Principal Investigator and for each Co-Principal Investigator. Failure to provide this information may result in disqualification of your proposal.

Investigator: Orren Schneider, Ph.D., P.E.

Other agencies to which this proposal has been/will be submitted: None

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Support: ☐ Current ☑ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Simultaneous Removal of Multiple Chemical Contaminants by Biofiltration (this project)

Source of Support: Water Research Foundation

Total Award Amount: $350,000 Total Award Period Covered: 2014-2016

Location of Project: Mt. Laurel, NJ

Person-Months Per Year Committed to the Project: 0.6

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: An Operational Definition of Biostability in Drinking Water

Source of Support: Water Research Foundation

Total Award Amount: $300,000 Total Award Period Covered: 2011-8/2014

Location of Project: Mt. Laurel, NJ

Person-Months Per Year Committed to the Project: 1.8

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Use of Heated Metal Oxide Particles (HMOPS) as Adsorbents for Membrane Fouling Reduction in Water Reuse/Desalination Applications

Source of Support: WaterReuse Research Foundation

Total Award Amount: $270,000 Total Award Period Covered: 9/14-12/16

Location of Project: Mt. Laurel, NJ

Person-Months Per Year Committed to the Project: 1.2

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Case Studies to Identify Occurrence, Accuracy and Causative Factors of Reverse Flow

Source of Support: Water Research Foundation

Total Award Amount: $265,000 Total Award Period Covered: 2012-12/2014

Location of Project: Mt. Laurel, NJ

Person-Months Per Year Committed to the Project: 3

Support: ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support*

Project/Proposal Title: Converting Conventional Filters to Biofilters

Source of Support: Water Research Foundation

Total Award Amount: $250,000 Total Award Period Covered: 2013-2015

Location of Project: Mt. Laurel, NJ

Person-Months Per Year Committed to the Project: 3 months

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
USE ADDITIONAL SHEETS AS NECESSARY

Third Party Contribution Letters of Commitment

Letters of commitment:

Southern Nevada Water Authority	Boulder city, NV
Clark County Water Reclamation District	Las Vegas, NV
Carollo Engineers, Inc.	Fountain Valley, CA
American Water	Vorhees, NJ
Philadelphia Water Department	Philadelphia, PA
City of Moline	Moline, IL
City of Houston	Houston, TX
Greenville Utilities Commission	Greenville, NC
Upper Occoquan Service Authority	Centreville, VA
Trussell Technologies, Inc.	Pasadena, CA

SOUTHERN NEVADA WATER AUTHORITY
SOUTHERN NEVADA WATER SYSTEM
River Mountains Water Treatment Facility
1299 Burkholder Boulevard • Henderson, NV 89015
MAILING ADDRESS: P.O. Box 99954 • Las Vegas, NV 89193-9954
(702) 856-3500 • snwa.com

June 3, 2014

Eric Dickenson. Project Manager
Research and Development
Southern Nevada Water Authority
P.O. Box 99954
Las Vegas, Nevada 89193

RE: Letter of participation support for Water Research Foundation RFP 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

Dear Dr. Dickenson:

The Southern Nevada Water Authority (SNWA) would be pleased to participate on the proposed study in response to the Water Research Foundation RFP entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". SNWA will serve as Principal Investigator and perform pilot-scale testing and the majority of the analytical component of the project.

SNWA has extensive experience performing pilot-scale filtration testing and will provide the use of our pilot-scale equipment as in-kind: 10 gpm ozone skid and two 6-gpm filter skids that contain three and two parallel filters, respectively. The value of these skids and associated equipment amount to over $250,000. The ozone pilot skid and one filter skid will be operated by SNWA staff at Clark County Water Reclamation District's water reclamation plant and the second filter skid will be operated at SNWA's Alfred Merritt Smith water treatment plant. SNWA will provide power for this filter pilot and full-scale ozonated Colorado River/Lake Mead water as feed water to the filter pilot. SNWA will provide as in-kind analytical services up to the amount of $54,000; labor and nonlabor costs associated with bulk and trace organic analysis (e.g., TOC, EDCs, PPCPs, PFCs, NDMA).

Please contact me at (702) 856-3664 if you have any questions or comments.

Sincerely,

David J. Rexing
SNWA W.Q. R&D Manager
P.O. Box 99954 M/S 1970
Las Vegas, NV 89193-9954
702.856.3664 T
702.856.3647 F
D.Rexing@SNWA.com

cc. David L. Johnson, Southern Nevada Water Authority, Deputy General Manager Eng./Ops.

Clark County
Water Reclamation
DISTRICT

Wednesday, June 04, 2014

Eric Dickenson, Ph.D.
Southern Nevada Water Authority
River Mountains Water Treatment Facility
1299 Burkholder Blvd.
Henderson, NV 89015

RE: Letter of participation support for Water Research Foundation RFP 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

Dear Dr. Dickenson:

The Clark County Water Reclamation District (CCWRD) would be pleased to cooperate and collaborate with the Southern Nevada Water Authority (SNWA) on the proposed study in response to the Water Research Foundation RFP entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

CCWRD will provide access to our main Facility in Las Vegas, NV to SNWA staff for the operation of an existing pilot-scale ozone and biofiltration pilot system. CCWRD will provide space and power for the safe operation of the pilot processes and will supply tertiary treated reclaimed water as feed water to the processes. Additionally, CCWRD will provide routine general water quality and operational data from the full-scale operation in support of the project. CCWRD provides these in-kind services up to the amount of $25,000.

CCWRD reserves the right that our participation is kept anonymous in reports, journal publications and presentations as a result of this project. Out participation is contingent on the premise that we will receive a copy of all reports and presentations that result from the project.

We look forward to working with your team on this important research topic. If you have any questions, please feel free to contact me at 702-668-8455 or e-mail at dfischer@cleanwaterteam.com .

Sincerely,

06-04-14

Daniel C. Fischer
CCWRD Deputy General Manager

Cc: LeAnna Risso; Jeff Mills; Doug Drury, Ph.D.

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5857 East Flamingo Road, Las Vegas, Nevada 89122 (702) 668-8888, (800) 782-4324
cleanwaterteam.com

carollo

Engineers...Working Wonders With Water™

June 4, 2014

Dr. Eric Dickenson
Project Manager
Water Quality Research and Development
Southern Nevada Water Authority

RE: Letter of in-kind support for Water Research Foundation Project 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration"

Dear Dr. Dickenson,

Carollo Engineers is committed to supporting the aforementioned Water Research Foundation project to advance the understanding of removing multiple contaminants simultaneously through biofiltration. To support this project we will provide an in-kind contribution of $15,000 and request funding of $76,300 as detailed in the budget justification. Our in-kind contribution will be in the form of labor to help complete the City of Houston pilot testing and lead the development of the guidance manual. Carollo Engineers is excited about participating in this important research.

Sincerely,

Jess Brown, Ph.D., P.E. (FL)
Vice President
R&D Practice Director

AMERICAN WATER

Mark LeChevallier
1025 Laurel Oak Rd
Voorhees, NJ 08043

P 856.727.6106
F 856.727.6198

5/28/14

Water Research Foundation
6666 W. Quincy Ave
Denver, CO 80235

Re: Water Research Foundation proposal 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration"

To whom it may concern:

American Water is pleased to confirm its commitment to provide an in-kind contribution of $99,975 to the project entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". The in-kind contribution will take the form of fringe benefits and overhead for the work performed as part of this project as well as water quality data and design information from our participating treatment plants in Davenport, IA, Delran, NJ, and Peoria and Alton, IL.

Please feel free to contact me if you require any additional information.

Sincerely,

Mark Le Chevallier

Mark W. LeChevallier, Ph.D.
Director, Innovation and Environmental Stewardship

Philadelphia
PWD
Water Department

The ARAMARK Tower
1101 Market Street
Philadelphia, Pennsylvania 19107-2994

HOWARD M. NEUKRUG, P.E.
Commissioner

May 19, 2014

Dr. Eric Dickenson
Water Quality Research and Development
Southern Nevada Water Authority
100 City Parkway, Suite 700
Henderson, NV 89015

RE: Letter of participation support for Water Research Foundation RFP 4559, "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration"

Dear Dr. Dickenson,

The Philadelphia Water Department (PWD) has committed to participating in your proposed study, in response to the Water Research Foundation RFP 4559 entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". PWD is interested in understanding the efficacy of removing multiple chemical contaminants using biofiltration without compromising our existing filtration objectives. This study will provide valuable understanding of the potential application of biofiltration to our system. We estimate to provide an in-kind contribution of $5,612 for the following activities:

- Provide data of existing trace organic contaminants, chemical contaminants, and associated water quality analysis results
- Collect and ship full scale samples to the project team laboratories for further analyses
- Identify system specific issues to support assessment of biofiltration implementation
- Review and provide feedback on the analysis results of operations and water quality

PWD understands that our participation in this project could be for a duration of 12 to 24 months. The Philadelphia Water Department reserves the right to keep our participation anonymous in reports, journal publications, and presentations as a result of this project. We understand that, by signing this letter, we are free to pledge support to other teams competing for this research endeavor. All communication will be kept confidential.

The Philadelphia Water Department is pleased to support this research project and looks forward to working with your team. If I can be of further assistance, please contact me at (215)685-6112, email chris.crockett@phila.gov or contact Ya-Chi Tsao at 215-685-6269, email ya-chi.tsao@phila.gov.

Sincerely,

Christopher Crockett, Ph.D., P.E.
Deputy Commissioner of Planning and Environmental Services
Philadelphia Water Department

CITY OF
MOLINE
ILLINOIS

DEPARTMENT OF PUBLIC WORKS

WATER DIVISION

30 18th Street
Moline, IL 61265
(309) 524-2300
FAX (309) 524-2314

WATER POLLUTION CONTROL DIVISION

SOUTH PLANT
2800 48th Avenue
Moline, IL 61265
(309) 524-2325
FAX (309) 524-2327

NORTH PLANT
007 1st Avenue
Moline, IL 61265
(309) 524-2335
FAX (309) 524-2336

SEWER MAINTENANCE
015 1st Avenue
Moline, IL 61265
(309) 524-2340
FAX (309) 524-2336

WEB SITE
http://www.moline.il.us

May 16, 2014

RE: Letter of participation support for Water Research Foundation RFP 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

Dear Dr. Dickenson:

The Moline Water Division would be pleased to participate in your proposed study in response to the Water Research Foundation RFP entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". Biological filtration is increasingly being used as a low-cost, treatment technology by many North American water utilities to minimize turbidity and enhance the removal of chemical contaminants in drinking water. We are interested in maximizing the removal of multiple chemical contaminants by biofiltration and still meeting our filtration objectives (e.g., maintaining turbidity control). We believe that this project will provide valuable insight to our water treatment facility operators and managers.

We are willing to provide staff time in identifying issues that are specific to our system in the implementation and operation of biofilters. We will provide, if available, chemical contaminant and routine water quality data and collect and ship water for water quality analysis to the project team laboratories. We will provide additional staff time, as needed, to review and provide feedback on the analysis results. The Moline Water Division reserves the right that our participation is kept anonymous in reports, journal publications and presentations as a result of this project. We understand that by signing this letter we are free to pledge support to other teams competing for this research endeavor but will keep all communication confidential.

We estimate the value of our support at approximately $5,000 as in-kind contributions in the way of our staff time in providing data for existing trace organic contaminants and associated water quality analysis and collecting and shipping of full-scale biofiltration samples. Please contact Greg Swanson at (309) 524-2301 if you have any questions or comments. We sincerely look forward to working with your team on this important research topic.

Best Regards,

Gregory A. Swanson
Utilities General Manager
City of Moline
30 – 18th Street, Moline IL 61265
gswanson@moline.il.us

CITY OF HOUSTON

Department of Public Works & Engineering

Annise D. Parker

Mayor

Daniel W. Krueger, P.E., Director
P.O. Box 1562
Houston, Texas 77251-1562

T. 832 395-2500
www.houstontx.gov

June 3, 2014

RE: Letter of participation support for Water Research Foundation RFP 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

Dear Dr. Dickenson:

The City of Houston Department of Public Works and Engineering Department (City) would be pleased to participate in your proposed study in response to the Water Research Foundation RFP entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". Biological filtration is increasingly being used as a low-cost, treatment technology by many North American water utilities to minimize turbidity and enhance the removal of chemical contaminants in drinking water. We believe that this project will provide valuable insight to our water treatment facility operators and managers. As an in-kind contribution to this project, we are offering the use of our state-of-the-art water treatment pilot plant (2 full treatment trains, each with 2 parallel filter columns) for a ~6-month pilot study using biofiltration to treat Lake Houston water. This pilot system has a value of over $1M, and the in-kind contribution associated with the 6-month use of the pilot is approximately $100,000 when compared to the cost of renting equivalent equipment. We also estimate providing an in-kind contribution of $6,000 associated with approximately 120 hours of staff time to assist with setting up and maintaining operation of the pilot.

The City reserves the right to require that our participation is kept anonymous in reports, journal publications and presentations as a result of this project. We understand that by signing this letter we are free to pledge support to other teams competing for this research endeavor but will keep all communication confidential.

The City is pleased to support this research. Please contact me if you have any questions. We sincerely look forward to working with your team on this important research topic.

Best Regards,

Yvonne W. Forrest
Senior Assistant Director
Drinking Water Operations
City of Houston Department of Public Works
Email: Yvonne.Forrest@houstontx.gov
Phone: (832) 395-2847

Council Members: Brenda Stardig Jerry Davis Ellen R. Cohen Dwight A. Boykins Dave Martin Richard Nguyen Oliver Pennington Edward Gonzalez Robert Gallegos Mike Laster Larry V. Green Stephen C. Costello David W. Robinson Michael Kubosh C.O. "Brad" Bradford Jack Christie
Controller: Ronald C. Green

Greenville Utilities

May 27, 2014

RE: Letter of participation support for Water Research Foundation RFP 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

Dear Dr. Dickenson:

Greenville Utilities Commission would be pleased to participate in your proposed study in response to the Water Research Foundation RFP entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". Biological filtration is increasingly being used as a low-cost, treatment technology by many North American water utilities to minimize turbidity and enhance the removal of chemical contaminants in drinking water. We are interested in maximizing the removal of multiple chemical contaminants by biofiltration and still meeting our filtration objectives (e.g., maintaining turbidity control). We believe that this project will provide valuable insight to our water treatment facility operators and managers.

We are willing to provide staff time in identifying issues that are specific to our system in the implementation and operation of biofilters. We will provide, if available, chemical contaminant and routine water quality data and collect and ship water for water quality analysis to the project team laboratories. We will provide additional staff time, as needed, to review and provide feedback on the analysis results. Greenville Utilities Commission reserves the right that our participation is kept anonymous in reports, journal publications and presentations as a result of this project. We understand that by signing this letter we are free to pledge support to other teams competing for this research endeavor but will keep all communication confidential.

We estimate the value of our support at approximately $5,000 as in-kind contributions in the way of our staff time in providing data for existing trace organic contaminants and associated water quality analysis and collecting and shipping of full-scale biofiltration samples. Please contact Randy Emory at (252) 551-1554 if you have any questions or comments. We sincerely look forward to working with your team on this important research topic.

Best Regards,

Randall D. Emory, P.E.
Director of Water Resources
Greenville Utilities Commission
emoryrd@guc.com

www.guc.com

Your Local Advantage

Upper Occoquan Service Authority

Leader in Water Reclamation and Reuse

14631 COMPTON ROAD, CENTREVILLE, VIRGINIA 20121-2506 (703) 830-2200

Charles P. Boepple
Executive Director

Michael D. Reach
Deputy Executive Director

June 2, 2014

Eric Dickenson, Ph.D.
Project Manager
Water Quality Research and Development
Southern Nevada Water Authority
P.O. Box 99954
Las Vegas, NV 89193-9954

RE: Letter of participation support for Water Research Foundation RFP 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

Dear Dr. Dickenson:

The Upper Occoquan Service Authority (UOSA) would be pleased to participate in your proposed study in response to the Water Research Foundation RFP entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". Biological filtration is increasingly being used as a low-cost, treatment technology to minimize turbidity and enhance the removal of chemical contaminants. UOSA is keenly interested in this subject.

We are willing to provide staff time in identifying issues that are specific to our full-scale system in the implementation and operation of our biofilters. UOSA will provide, if available, chemical contaminant, routine water quality data and operational data associated with our biofiltration (multi-media) and biological activated carbon treatment processes in our advanced water treatment systems. We will provide additional staff time, as needed, to review and provide feedback on the data provided.

UOSA is also agreeable to providing water samples for analysis by the team's research lab provided that UOSA gets the analytical results of any such testing that occurs on the samples UOSA provides.

UOSA reserves the right that our participation is kept anonymous in reports, journal publications and presentations as a result of this project.

UOSA estimates the value of its support at approximately $2,500 as in-kind contributions in the way of our staff time in providing the requested data. Please contact Bob Angelotti by phone at (703) 830-2200 ext. 1286 or via email at bob.angelotti@uosa.org if you have any questions or comments. We sincerely look forward to working with your team on this important research topic.

Sincerely,

Charles P. Boepple
Executive Director

Trussell
TECHNOLOGIES INC

June 4, 2014

RE: Letter of participation support for Water Research Foundation RFP 4559 "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration".

Dear Dr. Dickenson:

Trussell Technologies, Inc. would be pleased to participate in your proposed study in response to the Water Research Foundation RFP entitled "Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration". Biological filtration is increasingly being used as a low-cost, treatment technology to minimize turbidity and enhance the removal of chemical contaminants.

We have experience in operating pilot-scale biologically-active filters for two California potable reuse projects in affiliation with the City of San Diego and Los Angeles County Sanitation District. We are willing to provide staff time in identifying issues that are specific to the operation of biofilters and share chemical contaminant data, routine water quality data and operational data associated with the biofiltration processes. We will provide additional staff time, as needed, to review and provide feedback on the data provided.

We estimate the value of our support at approximately $5,000 as in-kind contributions in the way of our staff time in providing the requested data. Please contact Fred Gerringer at (626) 486-0560 x106 if you have any questions or comments. We sincerely look forward to working with your team on this important research topic.

Best Regards,

R. Shane Trussell, Ph.D., P.E., BCEE
President
Trussell Technologies, Inc.
380 Stevens Avenue, Suite 308
Solana Beach, CA 92075
(858) 458-1030 x103
shanet@trusselltech.com

Water Research Foundation
Research Project Budget

Download instructions for budget preparation at http://www.waterrf.org/funding/Pages/proposal-guidelines.aspx

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

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

Sub-recipient (organization name): Southern Nevada Water Authority
PI Name: Eric Dickenson
Project Title: Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration
Preparation/Revision Date:
RFP # (if applicable): 4559

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

Sources of Award, Cost Share, and Non-Cash In-Kind Contributions (Insert rows to list more third parties.)		Award			Cost Share		Third-Party Non-Cash In Kind
		Foundation Funds	*Sub-recipient*	*Third-Party Cash to Foundation*	*Sub-recipient*	*Third-Party Cash to Sub-recipient*	
Water Research Foundation		350,000	n/a	n/a	n/a	n/a	n/a
Sub-recipient (including subcontract contributions)		n/a		n/a	418,975	n/a	n/a
Third Parties	Clark County Water Reclamation District	n/a	n/a		n/a		25,000
	Philadelphia Water Department						5,612
	City of Moline						5,000
	City of Houston	n/a	n/a		n/a		100,600
	Greenville Utilities Commission	n/a	n/a		n/a		5,000
	Upper Occoquan Service Authority	n/a	n/a		n/a		2,500
	Trussell Technologies, Inc.	n/a	n/a		n/a		5,000
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
		n/a	n/a		n/a		
	Subtotal	***350,000***	***0***	***0***	***418,975***	***0***	***148,712***
Total Award, Cost Share, and Third-Party Non-Cash In Kind		**350,000**			**418,975**		**148,712**
Total Project Value		**917,687**					

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Southern Nevada Water Authority
PI Name: Eric Dickenson
Project Title: Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration
Preparation/Revision Date: 1/0/1900
RFP # (if applicable): 4559

OK
OK

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

		Total	Award	Cost Share
A	Key Personnel	17,375	13,199	4,176
B	Other Personnel	45,358	32,208	13,150
	Total Direct Labor and Fringe Benefits	*62,733*	*45,407*	*17,326*
C	Equipment Rental	250,000	0	250,000
	Special Equipment	0	0	0
D	Materials and Supplies	4,000	4,000	0
E	Travel	4,375	4,375	0
F	Subcontracts	316,494	201,519	114,975
G	Other Direct Costs	131,373	94,700	36,673
	Total Direct Costs	*768,975*	*350,001*	*418,974*
H	Indirect Costs	0	0	0
I	Fee	0	0	0
J	Surveys	0	0	0
	Total Direct and Indirect Costs	***768,975***	***350,001***	***418,974***
	Third-Party Non-Cash In Kind	148,712	n/a	n/a
	Total Project Value	**917,687**		

Water Research Foundation
Research Project Budget

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

Sub-recipient (organization name): Southern Nevada Water Authority
PI Name: Eric Dickenson
Project Title: Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration
Preparation/Revision Date: Preparation/Revision Date
RFP # (if applicable): 4559

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

Name	Project Role	Number of Hours	Direct Hourly Rate	% Time Allocated to Project	Subtotal Direct Labor	Fringe Benefit % of Direct Labor	Subtotal Fringe Benefits	Total	Award	Cost Share
Eric Dickenson	Principal Investigator	160.00	54.73	3.8%	8,757	40.00%	3,503	12,260	11,493	766
Eric Wert	Co-Principal Investigator	60.00	60.90	1.4%	3,654	40.00%	1,462	5,116	1,706	3,410
					0		0	0		0
					0		0	0		0
					0		0	0		0
				Total Key Personnel	12,411		4,964	17,375	13,199	4,176

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

Name/Position	Project Role	Number of Hours	Direct Hourly Rate	% Time Allocated to Project	Subtotal Direct Labor	Fringe Benefit % of Direct Labor	Subtotal Fringe Benefits	Total	Award	Cost Share
Brett Vanderford	Principal Research Chemist	40.00	63.35	1.0%	2,534	40.00%	1,014	3,548	3,548	0
Mandu Inyang	Postdoctoral Researcher	250.00	35.00	6.0%	8,750	40.00%	3,500	12,250	9,800	2,450
	Pilot Plant Specialist	120.00	45.00	2.9%	5,400	40.00%	2,160	7,560	1,260	6,300
	Graduate Intern	1,000.00	22.00	24.0%	22,000		0	22,000	17,600	4,400
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
					0		0	0		0
				Total Other Personnel	38,684		6,674	45,358	32,208	13,150

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

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Southern Nevada Water Authority
PI Name: Eric Dickenson
Project Title: Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration
Preparation/Revision Date: Preparation/Revision Date
RFP # (if applicable): 4559

C. Equipment Rental and Special Equipment Purchase

Equipment Rental (*List items and dollar amount for each item exceeding $1,000*)	Total	Award	Cost Share
Pilot Plant Skids	250,000	0	250,000
			0
			0
			0
			0
Total Equipment Rental	**250,000**	**0**	**250,000**

Special Equipment Purchase (*List items and dollar amount for each item exceeding $5,000*)	Total	Award	Cost Share
			0
			0
			0
			0
			0
Total Special Equipment Purchase	**0**	**0**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Southern Nevada Water Authority
PI Name: Eric Dickenson
Project Title: Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration
Preparation/Revision Date: Preparation/Revision Date
RFP # (if applicable): 4559

D. Materials and Supplies	Total	Award	Cost Share
Pilot Equipment Supplies	4,000	4,000	0
			0
			0
			0
			0
			0
			0
			0
Total Materials and Supplies	**4,000**	**4,000**	**0**

E. Travel	Total	Award	Cost Share
Meetings/Conferences	4,375	4,375	0
			0
			0
			0
			0
			0
			0
			0
Total Travel	**4,375**	**4,375**	**0**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Southern Nevada Water Authority
PI Name: Eric Dickenson
Project Title: Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration
Preparation/Revision Date: Preparation/Revision Date
RFP # (if applicable): 4559

F. Subcontracts	Total	Award	Cost Share
Carollo Engineers	91,300	76,300	15,000
American Water	159,975	60,000	99,975
University of Colorado Boulder	65,219	65,219	0
			0
			0
			0
			0
			0
Total Subcontracts	**316,494**	**201,519**	**114,975**

G. Other Direct Costs	Total	Award	Cost Share
Analytical Costs	131,373	94,700	36,673
			0
			0
			0
			0
			0
			0
			0
Total Other Direct Costs	**131,373**	**94,700**	**36,673**

Water Research Foundation
Research Project Budget

Sub-recipient (organization name): Southern Nevada Water Authority
PI Name: Eric Dickenson
Project Title: Simultaneous Removal of Multiple Chemical Contaminants using Biofiltration
Preparation/Revision Date: Preparation/Revision Date
RFP # (if applicable): 4559

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

Cost Category	Rate %	Base $	Total	Award	Cost Share
			0		0
			0		0
			0		0
			0		0
			0		0
		Total Indirect Costs	0	0	0

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

J. Survey	Total	Award	Cost Share
			0
			0
			0
			0
			0
			0
Total Survey Costs	0	0	0

Water Research Foundation
advancing the science of water

Project 4559
Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration

Comments on Proposal

1. Table 9 (Design and operating parameters for pilot-scale biofilters) for subtask 3.2 (Evaluate the Effect of Filter Media Type and EBCT) shows that the hydraulic loading rates to be evaluated are 2 and 5 gpm/ft^2. It is recommended that when examining biofiltration design conditions, the project team evaluate filtration rates higher than 5 gpm/sf^2. Many facilities are looking at operating at much higher filtration rates (even up to 10 gpm/sf^2). It would be good to see if through this project, the team could develop a general good practice limit.

To evaluate the impact of HLR at >5 gpm/ft^2 we would need at least two filters in parallel at different HLRs. The team does not currently have the resources to accommodate such a testing plan.

2. For clarification, can a chart be developed combining the information in Table 3 (Research approach for proposed study), that in the text in the management plan, and Figure 6.1 (Organizational Chart) to illustrate the role/responsibilities of each project team member mentioned in the management plan?

Please see below the requested chart.

3. Milwaukee Water Works, WI, was listed as a utility volunteer in the RFP. Is it possible to include it in the project?

The team proposes to contact Milwaukee Water Works to discuss their interests in this project and explore possible opportunities for them to participate in this project.

Tasks	Description	Lead/Support	Team Members Lead/Support(s)
Tasks 1-6	Project management and oversight	Southern Nevada Water Authority	**Dr. Eric Dickenson, PI**
Task 1	Perform comprehensive review of biofilter performance for removing multiple chemical contaminants	University of Colorado	**Dr. Summers, CoPI** Graduate Student
Task 2	Develop appropriate indicator compounds/chemicals that represent certain classes/categories to assess biofiltration performance.	University of Colorado	**Dr. Summers, CoPI** Graduate Student
Task 3	Systematic evaluation of biofiltration performance at pilot-scale		
Responsibilities:	Evaluate biofiltration performance at City of Houston pilot facility Evaluate biofiltration performance at SNWA: Alfred Merritt Smith and Clark County Water Reclamation District pilot facilities	Carollo Engineers Southern Nevada Water Authority	**Dr. Jess Brown, CoPI** Dr. Giridhar Upadhyaya **Dr. Eric Wert, CoPI** Dr. Mandu Inyang Pilot Plant Specialist Graduate Intern
Task 4	Evaluation of biofiltration performance at full-scale		
Responsibilities:	Evaluate biofilter performance at American Water full scale facilities Evaluate biofilter performance at Greenville Utilities Commission	American Water Carollo Engineers	**Dr. Schneider, CoPI** Dr. Ruth Marfil-Vega **Dr. Jess Brown, CoPI** Dr. Giridhar Upadhyaya
Task 5	Develop a Guidance Toolbox for the Simultaneous Removal of multiple chemical contaminants	Carollo Engineers American Water	**Dr. Jess Brown, CoPI** Dr. Giridhar Upadhyaya Dr. Schneider, CoPI
Task 6	Project Report	Southern Nevada Water Authority University of Colorado Carollo Engineers American Water	**Dr. Eric Dickenson, PI** Dr. Eric Wert, CoPI Dr. Scott Summers, CoPI Dr. Jess Brown, CoPI Dr. Schneider, CoPI
Project Analytical Work	Measurement of chemical contaminants	Southern Nevada Water Authority American Water	**Brett Vanderford** **Dr. Ruth Marfil-Vega**

Exhibit B
Project 04559

Title: Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration

TASK	**DUE DATE**
Begin Project	January 1, 2015
Scope of Work	February 1,2015
Sub-recipient presents Proof of Insurance(s) or Certificate of Self Insurance & Worker's Compensation Insurance	February 1, 2015
Periodic Report 1 – electronic copy	April 1, 2015
Periodic Invoice 1	April 1, 2015
Periodic Report 2 (incl. Technical Summary & Web Update) - electronic copy	July 1, 2015
Periodic Invoice 2 – electronic copy	July 1, 2015
Periodic Report 3 – electronic copy	October 1, 2015
Periodic Invoice 3– electronic copy	October 1, 2015
Periodic Report 4 (incl. Technical Summary & Web Update) – electronic copy	January 1, 2016
Periodic Invoice 4	January 1, 2016
Periodic Report 5 – electronic copy	April 1, 2016
Periodic Invoice 5	April 1, 2016
Periodic Report 6 (incl. Technical Summary & Web Update) – electronic copy	July 1, 2016
Periodic Invoice 6	July 1,2016
Periodic Report 7 – electronic copy	October 1, 2016
Periodic Invoice 7	October 1, 2016
Draft Report – Guidance Toolbox – electronic copy and one hardcopy	January 1, 2017
Draft Report Invoice	January 1, 2017
Final Report – Guidance Toolbox – electronic copy and one hardcopy	June 1, 2017
Letters of Confirmation from participating utilities	June 1, 2017
Complete & Submit Exhibit E – Assignment of Copyright	June 1, 2017
Final Invoice & Final Compensation	June 1, 2017
Project End & Foundation Publication Date	January 1, 2018

Note: Please submit one electronic copy of each Periodic Report. And submit one electronic copy for Draft & Final Report and hardcopy in *MSWord format.* For each report an invoice must be submitted for payment using Exhibit D – printed on your company letterhead.

Foundation Key Contacts:

Project Management

- Hsiao-wen Chen, Research Manager, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: 303-347-6103, and Email: hchen@WaterRF.org.

Contract Administration

- Peggy Falor, Manager Contracts and Project Administration, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: (303) 734-3424, and Email: pfalor@WaterRF.org.
- Monica Morgan, Project Coordinator, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: 303-734-3475, and Email: mmorgan@WaterRF.org.

Sub-recipient Key Contacts:

Principal Investigator/Authorized Representative

- Eric Dickenson, R&D Project Manager, Southern Nevada Water Authority, PO Box 99954, Las Vegas, NV 89153-9954, Phone: 702-856-3668, and Email: eric.dickenson@snwa.com.

Accounting Contact (Project Funds disbursements will be mailed to the care of this contact)

- Jennifer Fuel, Administrative Secretary, PO Box 99954, Las Vegas, NV 89153-9954, Phone: 702-856-3665, and Email: Jennifer.Fuel@lvvwd.com.

Co-Principal Investigator:

- Eric Wert, Southern Nevada Water Authority, PO Box 99954, Las Vegas, NV 89153-9954, Phone: 702-856-3669, and Email: eric.wert@lvvwd.com.
- R. Scott Summers, University of Colorado at Boulder, Civil, Environmental & Architectural Engineering Department, Boulder, CO 80309-0428, Phone: 303-492-6644, and Email: r.summers@colorado.edu.
- Orren Schneider, American Water, 3906 Church Rd., Voorhees, NJ 08054, Phone: 856-727-6132, and Email: orren.schneider@amwater.com.
- Jess Brown, Carollo Engineers, 10540 Talbert, Ste. 200 E, Fountain, CA 92708, Phone: 714-593-5236, and Email: jbrown@carollo.com.

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

BUDGET SUMMARY

Exhibit C
Project 04559

Contractor: Southern Nevada Water Authority
1299 Burkholder Blvd.
Henderson, NV 89015

This PFA shall be effective from **01/01/2015** and shall end on **01/01/2018** detailed in Exhibit B. The Foundation shall not have any obligation for payment of invoices for costs incurred by the Sub-recipient after the foregoing end date.

The Foundation agrees to provide aggregate Project Funds to the Sub-recipient in an amount not to exceed Three Hundred Fifty Thousand US dollars ($350,000.00) for the completion of this PFA. The Foundation Contribution and other participant's contributions are as detailed below. The Sub-recipient agrees to contribute Four Hundred Eighteen Thousand Nine Hundred Seventy Five US dollars ($418,975.00) in Cost Share and One Hundred Forty Eight Thousand Seven Hundred Twelve US dollars ($148,712.00) in in-kind contributions as detailed below. The total budget for the Project is Nine Hundred Seventeen Thousand Six Hundred Eighty Seven US dollars ($917,687.00).

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

- Jennifer Fuel, Administrative Secretary, PO Box 99954, Las Vegas, NV 89153-9954, Phone: 702-856-3665, and Email: Jennifer.Fuel@lvvwd.com.

ORGANIZATION	Award Amount	Cost Share	In-Kind Amount
Participants			
Philadelphia Water Department	$0.00	$0.00	$5,612.00
City of Houston, Department of Public Works & Engineering	$0.00	$0.00	$100,600.00
Greenville Utilities Commission	$0.00	$0.00	$5,000.00
Trussell Technologies, Inc.	$0.00	$0.00	$5,000.00
City of Moline Water Department	$0.00	$0.00	$5,000.00
Upper Occoquan Service Authority	$0.00	$0.00	$2,500.00
Clark County Water Reclamation	$0.00	$0.00	$25,000.00
Co-PIs			
Southern Nevada Water Authority	$0.00	$0.00	$0.00
University of Colorado at Boulder	$0.00	$0.00	$0.00
American Water	$0.00	$99,975.00	$0.00
Carollo Engineers	$0.00	$15,000.00	$0.00
Sub-recipient			
Southern Nevada Water Authority	$0.00	$304,000,00	$0.00
Water Research Foundation	$350,000.00	$0.00	$0.00
Total Project Budget $917,687.00	**$350,000.00**	**$418,975.00**	**$148,712.00**

Project Award Funds: not to exceed $350,000.00
10% of Project Funds advanced on or following Effective Date: $35,000.00
Amount due upon the Foundation's acceptance of Draft Report: $35,000.00
Amount due upon the Foundation's acceptance of the Final Report and final invoice: $35,000.00

Exhibit D
Project 04559

Title: Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration

Exhibit D – Invoice Form

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

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

Exhibit E
Project 04559

Title: Simultaneous Removal of Multiple Chemical Contaminants Using Biofiltration

Assignment of Interest in Copyrighted Works

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

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

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

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

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

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

State of _____ }
} ss
County of _____ }

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

_____
Notary Public Comm'n. Exp.

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Agreement	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors approve and authorize the General Manager to sign an agreement between Hazen and Sawyer, P.C., and the Authority for the "GAC Control of Regulated and Emerging Disinfection Byproducts of Health Concern" study, and accept funds in an amount not to exceed $60,000 for this research work.	

Fiscal Impact:
If the above recommendation is approved, funds in an amount not to exceed $60,000 will be accepted by the Authority.

Background:
With the U.S. EPA considering future disinfection byproduct (DBP) rules, there is an urgent need to investigate the implications of current treatment strategies such as granular activated carbon (GAC) use and disinfectant choice on regulated and emerging DBPs. The issue of chlorinated DBPs is of particular interest to the Authority as its drinking water systems utilize chlorine as a secondary disinfectant.

The Authority has worked closely and successfully with Hazen and Sawyer, P.C. (Hazen and Sawyer), and the Water Research Foundation (WaterRF) on several disinfection byproduct related research projects. Due to that effective relationship, Hazen and Sawyer has requested the Authority's Water Quality Research and Development (R&D) Division to participate as Co-Principal Investigator and perform pilot-scale testing and disinfection byproduct analytical work for the WaterRF Study #4560, "GAC Control of Regulated and Emerging DBPs of Health Concern," awarded to Hazen and Sawyer.

If approved, the attached agreement provides for the Authority to receive $60,000 from Hazen and Sawyer to conduct pilot-scale testing and disinfection byproduct analytical work for this study. The Authority is also a participant in this study, providing additional in-kind services, which consists of equipment use and analytical costs. This research directly complements the mission of developing solutions that will ensure adequate high quality future water supplies for the Las Vegas Valley. The mission necessitates continued research to better understand treatment strategies to curb both regulated and emerging DBPs. This study will provide the most comprehensive assessment to-date regarding whether GAC treatment can be used to control regulated and emerging DBPs in finished drinking water.

This agreement is being entered into pursuant to Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:KPF:DJR:ED:jf
Attachments

AGENDA ITEM # 6

DISCLOSURE OF OWNERSHIP/PRINCIPALS

Business Entity Type						
☐ Sole Proprietorship	☐ Partnership	☐ Limited Liability Company	☐ Corporation	☐ Trust	☐ Non-Profit Organization	☒ Other: P.C.

Business Designation Group					
☐ MBE	☐ WBE	☐ SBE	☐ PBE	☐	☐
Minority Business Enterprise	Women-Owned Business Enterprise	Small Business Enterprise	Physically Challenged Business Enterprise		

Corporate/Business Entity Name:	Hazen and Sawyer, P.C. (Professional Corporation)	
(Include d.b.a., if applicable)	N/A	
Street Address:	4011 Westchase Blvd, Suite 500	**Website:** www.hazenandsawyer.com
City, State and Zip Code:	Raleigh, NC 27607	**POC Name and Email: Benjamin D. Stanford** **bstanford@hazenandsawyer.com**
Telephone No:	(919) 833-7152	**Fax No: (919) 833-1828**
Local Street Address:	N/A	**Website: N/A**
City, State and Zip Code:	N/A	**Local Fax No: N/A**
Local Telephone No:	N/A	**Local POC Name Email: N/A**
Number of Clark County, Nevada Residents Employed: Zero (0)		

All entities, with the exception of publicly-traded and non-profit organizations, must list the names of individuals holding more than five percent (5%) ownership or financial interest in the business entity appearing before the SNWA Board of Directors.

Publicly-traded entities and non-profit organizations shall list all Corporate Officers and Directors in lieu of disclosing the names of individuals with ownership or financial interest. The disclosure requirement, as applied to land-use applications, extends to the applicant and the landowner(s).

Entities include all business associations organized under or governed by Title 7 of the Nevada Revised Statutes, including but not limited to private corporations, close corporations, foreign corporations, limited liability companies, partnerships, limited partnerships, and professional corporations.

Full Name	Title	% Owned (Not required for Publicly Traded Corporations/Non-profit organizations)
N/A	N/A	N/A

This section is not required for publicly-traded corporations.

1. Are any individual members, partners, owners or principals, involved in the business entity, an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please note that SNWA employee(s), or appointed/elected official(s) may not perform any work on professional service contracts, or other contracts, which are not subject to competitive bid.)

2. Do any individual members, partners, owners or principals have a spouse, registered domestic partner, child, parent, in-law or brother/sister, half-brother/half-sister, grandchild, grandparent, related to an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please complete the Disclosure of Relationship form on Page 2. If no, please print N/A on Page 2.)

I certify under penalty of perjury, that all of the information provided herein is current, complete, and accurate. I also understand that the SNWA will not take action on land-use approvals, contract approvals, land sales, leases or exchanges without the completed disclosure form.

Benjamin D. Stanford

Signature

Benjamin D. Stanford

Print Name

Director of Applied Research

Title

10/22/2014

Date

Revised 3/1/11

DISCLOSURE OF RELATIONSHIP

List any disclosures below:
(Mark N/A, if not applicable.)

NAME OF BUSINESS OWNER/PRINCIPAL	NAME OF SNWA EMPLOYEE OR OFFICIAL AND JOB TITLE	RELATIONSHIP TO SNWA EMPLOYEE OR OFFICIAL	SNWA EMPLOYEE'S/OFFICIAL'S DEPARTMENT

"Consanguinity" is a relationship by blood. "Affinity" is a relationship by marriage.

"To the second degree of consanguinity" applies to the candidate's first and second degree of blood relatives as follows:

- Spouse – Registered Domestic Partners – Children – Parents – In-laws (first degree)
- Brothers/Sisters – Half-Brothers/Half-Sisters – Grandchildren – Grandparents – In-laws (second degree)

For SNWA Use Only:

If any Disclosure of Relationship is noted above, please complete the following:

N/A

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in the contracting/selection process for this particular agenda item?

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in any way with the business in performance of the contract?

Notes/Comments:
No LVVWD or SNWA employees were noted.

Signature

Eric Wert, Acting for
Print Name David J. Rexing
Authorized Department Representative

H&S CLIENT: ***Water Research Foundation*** ***HAZEN AND SAWYER, P.C.***
PROJECT: ***GAC Control of Regulated and Emerging DBPs of Health Concern*** ***JOB NO.: 32329-000***

SUBCONTRACT AGREEMENT FOR SERVICES

This Agreement dated _____, 20___ is made and entered into between:

Hazen and Sawyer, P.C. (hereinafter ***"H&S"***)
4011 WestChase Blvd., Suite 500
Raleigh, NC 27607

and

Southern Nevada Water Authority (hereinafter ***"CONSULTANT"***)
River Mountains Water Treatment Facility
P.O. Box 99954
Las Vegas, NV 89193-9954

WHEREAS, **H&S** *is performing services for its client, Water Research Foundation (hereinafter "***H&S CLIENT***") on the project known as* GAC Control of Regulated and Emerging DBPs of Health Concern.

(hereinafter "***PROJECT***"); and

WHEREAS, ***H&S*** requests ***CONSULTANT's*** services in connection with the ***PROJECT***;

NOW THEREFORE, in consideration of the mutual promises herein contained, ***H&S*** and ***CONSULTANT*** agree as follows:

Art. 1. THE SUBCONTRACT DOCUMENTS

1.1 Included Documents. The Subcontract Documents consist of: (1) this Agreement, including Schedule A (Scope of Services) and Schedule B (Compensation) attached hereto; and (2) the agreement entered into between ***H&S*** and ***H&S CLIENT***, including all contract documents enumerated therein, (hereinafter "***H&S CLIENT AGREEMENT***"). These form the Subcontract and are as fully a part of the Subcontract as if attached to this Agreement or repeated herein. To the extent that the provisions of the ***H&S CLIENT AGREEMENT*** are applicable to ***CONSULTANT's*** services and scope of work under this Agreement, ***CONSULTANT*** shall assume toward ***H&S*** all obligations and responsibilities that ***H&S***, under such documents, assumes toward ***H&S CLIENT***. ***H&S*** shall have the benefit of all rights, remedies and redress against ***CONSULTANT*** that ***H&S CLIENT***, under such documents, has against ***H&S***, insofar as applicable to this Agreement. ***CONSULTANT*** acknowledges that it has read and reviewed the ***H&S CLIENT AGREEMENT*** and is aware of the obligations and responsibilities set forth therein.

§1.2 Entire Agreement. The Subcontract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations or agreements, either written or oral.

1.3 Modification. Unless otherwise provided for herein, no amendments, changes, alterations, or modifications of this agreement shall be effective unless in writing and executed by ***CONSULTANT*** and ***H&S***.

1.4 Conflicting Terms. In the event of a conflict between the terms of this Agreement and the ***H&S CLIENT AGREEMENT***, this Agreement shall be controlling.

Art. 2. SCOPE OF SERVICES

2.1 Under this Agreement, ***CONSULTANT*** shall furnish the services set forth in attached Schedule A. Such services shall be performed by individuals as employees of ***CONSULTANT***, an independent contractor, and not as employees of ***H&S***.

2.2 QUALITY CONTROL PLAN

2.2.1 As part of its Services, ***CONSULTANT*** shall develop, implement and maintain a Quality Control Plan ("QC Plan") as part of ***CONSULTANT's*** overall quality assurance policy to provide the requisite services in accordance with the applicable standard of care.

Art. 3. DURATION OF AGREEMENT

This Agreement shall commence upon execution and terminate either: (1) upon the satisfactory completion of ***CONSULTANT's*** scope of services set forth in Schedule A; or (2) as set forth in Article 9 below.

Art. 4. PAYMENT AND BILLING

4.1 Payment Amount(s). As compensation for the services to be performed by ***CONSULTANT***, ***H&S*** shall pay ***CONSULTANT*** the amount(s) set forth in Schedule B, attached hereto. The method of compensation, *i.e.*, lump sum or not-to-exceed, shall be set forth in Schedule B. ***H&S*** agrees only to be liable for payment to ***CONSULTANT*** for the ***CONSULTANT's*** proper performance of services, as provided for in Schedule B.

4.2 Invoicing & Documentation. ***CONSULTANT*** shall keep accurate back-up documentation of the time expended in executing its scope of work. Payment for services performed by ***CONSULTANT*** shall be based upon ***CONSULTANT's*** satisfactory completion of services as properly invoiced and documented by ***CONSULTANT***. ***CONSULTANT's*** invoices and documentation shall be subject to verification by ***H&S*** prior to payment. Invoices submitted by ***CONSULTANT***, at a minimum, shall:

(a) accurately describe the services rendered during the invoice period, including employee names, rates, hours and respective dates of performance and any reports submitted or percent of work completed during the invoice period, as determined by ***H&S***;

(b) identify any other authorized expenses incurred hereunder; and

(c) make reference to this Agreement and Job No. 32329-000, and otherwise identify the invoice in such manner as ***H&S*** may reasonably require.

All invoices and billing documentation shall be sent to ***H&S*** at the following address:

Hazen and Sawyer, P.C.
Attention: Ben Stanford, Ph.D.
4011 Westchase Blvd, Suite 500
Raleigh, NC 27607

4.3 Maximum H&S Obligation. ***CONSULTANT*** shall not take any action hereunder which could cause the amount for which ***H&S*** would be obligated to ***CONSULTANT*** to exceed a total amount of $60,000. For not-to-exceed Agreements, as opposed to lump-sum or fixed-price Agreements, ***CONSULTANT*** shall advise ***H&S*** in writing when costs incurred under this Agreement are equal to seventy-five percent (75%) of the aforementioned sum. Notwithstanding any other provisions of this Agreement, ***H&S*** shall not be obligated to pay to ***CONSULTANT*** any amount in excess of the aforementioned sum; provided however, that this sum may be increased from time-to-time by ***H&S*** in writing.

4.4 Payments will be made to ***CONSULTANT*** within fourteen (14) days after receipt by ***H&S*** of payment from the ***H&S CLIENT*** based upon the quarterly invoice submitted for the project. ***H&S's*** receipt of payment from the ***H&S CLIENT*** shall be an express and absolute condition precedent to any duty or obligation of H&S to make payment to ***CONSULTANT*** for any invoice for payment or request for compensation.

4.5 ***CONSULTANT*** is entitled to a 10% pre-payment of project funds according to the provisions of the ***H&S CLIENT AGREEMENT***, which will be made available to the ***CONSULTANT*** within fourteen (14) days of receipt from the ***H&S CLIENT***. The ***H&S CLIENT AGREEMENT***, stipulates that 20% of the ***CONSULTANT*** budget will be withheld and dispersed upon submission of the Draft Final Report (10%) and the Final Report (10%) to the ***CLIENT.***

4.6 Payment Conditioned on Proof of Insurance. Payment will not be made to the ***CONSULTANT*** unless its current insurance statement has been submitted to ***H&S***. The insurance certificate shall be submitted to ***H&S*** with the executed Agreement.

Art. 5. DATA AND INFORMATION

CONSULTANT agrees that all data and information (including without limitation, computer software, computer databases, computer software documentation, specifications, designs, drawings, reports, blueprints and the like) generated in the performance of this Agreement and data and information which are specified to be delivered or which are, in fact, delivered pursuant to this Agreement shall be governed by all provisions stated in the ***H&S CLIENT AGREEMENT***. ***CONSULTANT*** shall deliver all data and information to ***H&S*** upon request and, in any event, upon the completion of all work hereunder or the termination or expiration hereof, whichever shall first occur, and shall be fully responsible for the care and protection thereof until such delivery. Except as otherwise provided in this Agreement, said documents shall be delivered to ***H&S*** without additional cost to ***H&S***. ***H&S*** may withhold payments then due to ***CONSULTANT*** until ***CONSULTANT*** complies with the provisions of this paragraph.

Art. 6. SUBCONTRACTING

Performance of this Agreement shall not be subcontracted in whole or in part without the prior written consent of ***H&S***. In the event ***H&S*** consents to such subcontract, ***CONSULTANT*** shall remain bound by the terms of this Agreement until the satisfactory completion of all work hereunder or the termination or expiration hereof, whichever shall first occur. A separate Notice to Proceed from ***H&S*** is required prior to initiation of any services subcontracted by ***CONSULTANT*** or as otherwise required by Schedule A.

Art. 7. CONFLICTS OF INTEREST

7.1 Neither ***CONSULTANT*** nor its employees shall have or hold any continuing or frequently recurring employment or contractual relationship that is substantially antagonistic or incompatible with ***CONSULTANT's*** loyal and conscientious exercise of judgment related to its performance under this Agreement.

7.2 ***CONSULTANT*** agrees that none of its officers or employees shall, during the duration of this Agreement, serve as an expert witness against ***H&S*** or against ***H&S CLIENT*** in any legal or administrative proceeding in which he or she is not a party, unless compelled by court process, nor shall such persons give sworn testimony or issue a report or writing, as an expression of his or her expert opinion, which is adverse or prejudicial to the interests of ***H&S*** or of ***H&S CLIENT*** for the work performed under this Agreement or in connection with any such pending or threatened legal or administrative proceeding. The limitations of this section shall not preclude such persons from representing themselves in any action or in any administrative or legal proceeding.

7.3 In the event ***CONSULTANT*** is permitted to utilize subcontractors to perform any services required by this Agreement, ***CONSULTANT*** agrees to prohibit such subcontractors, by written contract, from having any conflicts within the meaning of this Article 7.

Art. 8. SUSPENSION OF SERVICES

H&S may suspend, delay or interrupt ***CONSULTANT's*** services, or any portion thereof, for a period of 90 days or less at any time and without cause upon written notice to ***CONSULTANT***. ***CONSULTANT*** shall resume such services upon receipt of a written notice of resumption from ***H&S***. ***CONSULTANT*** may be allowed an increase in fee or an extension of time, or both, if ***CONSULTANT*** makes a claim that is approved by ***H&S*** as provided by Article 10.

Art. 9. TERMINATION

9.1 Termination for Cause. ***H&S*** may terminate this Agreement at any time by giving ***CONSULTANT*** three (3) days written notice if ***CONSULTANT*** fails to perform its obligations under this Agreement and fails to cure within such three (3) day period. In the event of such termination for cause, ***H&S*** shall be entitled to pursue, against ***CONSULTANT***, any and all legal remedies available to it under the terms of this Agreement.

9.2 Termination for Convenience. ***H&S*** may terminate this Agreement at any time with or without cause upon at least three (3) days written notice to ***CONSULTANT***. In the event of such a termination for convenience, provided ***CONSULTANT*** is not in default of its obligations pursuant to this Agreement, ***CONSULTANT*** will be paid for that portion of the work satisfactorily completed prior to termination.

9.3 Conversion to Termination for Convenience. In the event any termination for cause is later determined to have been improper, such terminationshall be automatically converted to a termination for convenience under this Article and the ***CONSULTANT*** shall be strictly limited to the compensation provided for in Article 9.2 above.

Art. 10. CHANGES IN THE SERVICES

10.1 Written Change Order. ***H&S*** may, at any time, by written order to ***CONSULTANT***, issue additional instructions, require additional services, issue revisions or direct the omission of services within the general scope of this Agreement, including those that are a result of additions, deletions or revisions to the ***H&S CLIENT AGREEMENT***.

10.2 Equitable Adjustment. If such changes cause an increase or decrease in the ***CONSULTANT's*** cost of, or time required for, performance of any services under this Agreement, an equitable adjustment may be made in price and/or time of performance, provided that any claim for an adjustment must be made in strict accordance with the terms of the ***H&S CLIENT AGREEMENT***. If the ***H&S CLIENT AGREEMENT*** requires ***H&S*** to take some act or make some submission with respect to any request for adjustment of compensation and/or time within a specified time frame or limit, ***CONSULTANT*** shall strictly observe those time frames or limits so as to permit ***H&S*** a reasonable opportunity to comply with the ***H&S CLIENT AGREEMENT***. In the event the ***H&S CLIENT AGREEMENT*** fails to address a time frame or limit in which to submit a claim for adjustment, ***CONSULTANT*** shall submit

such claim in writing within thirty (30) days of receipt of said written order. ***CONSULTANT's*** failure to strictly comply with the foregoing shall result in a complete waiver and release of any claim it may have for such adjustment.

Art. 11. NOTICES

All notices or orders provided for in this Agreement shall be in writing and shall be deemed to be given to:

H&S if mailed by certified or registered mail, postage prepaid to:
Hazen and Sawyer, P.C.,
Attention: Ben Stanford; or

CONSULTANT if mailed by certified or registered mail, postage prepaid to
Southern Nevada Water Authority,
Attention: Dr. Eric Dickenson
PO Box 99954
Las Vegas, NV 89193-9954

Art. 12. CLAIMS AND DISPUTES

12.1 Applicable Law. This Agreement shall be interpreted and construed in accordance with the laws of the State of Nevada.

12.2 Attorney's Fees. In any action brought to enforce its rights under this Agreement, the prevailing party shall be entitled to recover its reasonable attorney's fees, costs and disbursements incurred only to the extent same is provided for in the ***H&S CLIENT AGREEMENT***; otherwise, each party shall bear its own fees and costs.

12.3 Dispute Resolution Procedure. Any claims or disputes and any action involving the enforcement or interpretation of any rights hereunder shall be submitted to the jurisdiction of the courts of the State of Nevada.

Art. 13. INSURANCE

13.1 Consultant's Coverage. ***CONSULTANT*** shall, at its own expense, purchase and maintain, in a company or companies lawfully authorized to do business in the State and in companies satisfactory to ***H&S***, insurance coverage as specified in this Insurance Article herein. Such insurance shall be maintained until four (4) years after substantial completion of construction (or termination of the contract if construction is not involved) and will protect ***H&S*** and ***CONSULTANT*** from claims set forth below which may arise out of or result from ***CONSULTANT's*** operations under this Agreement and for which ***H&S*** may be liable, whether such operations be by ***CONSULTANT*** or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable.

13.2. Minimum Coverage. ***CONSULTANT*** shall maintain at a minimum the following insurance policies and coverage with carriers authorized to cover risks and licensed to underwrite policies in the State and having a Best's rating of AVII or higher:

(a) Worker's Compensation as required by all applicable state and federal laws.

(b) Employer's Liability with limits of $500,000 each accident, $500,000 Disease (each employee) and $500,000 Disease (policy limit).

(c) Comprehensive General Liability with minimum limits of $1,000,000 per occurrence $1,000,000 aggregate.

(d) Professional Liability with limits of not less than $5,000,000, per claim and in the aggregate, insuring the professional liability of ***CONSULTANT***.

(e) Business Auto Insurance for all owned, hired, non-owned and Employers' non-ownership vehicles with minimum limits of $1,000,000 combined single limit.

13.3 Subcontractor Coverage. In addition to the requirements set forth in Article 6 above, ***CONSULTANT*** shall not subcontract any part of this Agreement without assuming absolute responsibility for requiring the same insurance as that set forth in this Article from its subcontractors and/or subconsultants.

13.4 Cancellation, Renewal or Modification. Each insurance policy required by this Agreement shall contain a provision that coverage afforded under the policy will not be canceled, non-renewed, materially changed or allowed to expire until at least thirty (30) days prior written notice has been given to ***H&S*** or, in the event of non-payment, ten (10) days prior written notice. The cancellation provision in the policy shall be modified to read as follows:

> Should any of the above policies described herein be canceled, non-renewed or materially changed (materially changed defined as a reduction in the policy limit by endorsement during the policy period) before the expiration date thereof, the insurer shall give thirty (30) days written notice to the certificate holder named hereon.

13.5 Failure to Maintain Insurance. In the event ***CONSULTANT*** fails to maintain any of the insurance required under this Agreement, it shall constitute a material breach of this Agreement. ***H&S*** may, at its option, purchase such coverage for the project and charge the cost thereof to ***CONSULTANT***, plus all incidental expenses and damages arising therefrom. The provisions of this paragraph shall not bar ***H&S*** from exercising any other remedies available to it under the terms of this Agreement, including, without limitation, the remedies referenced in Article 9 above.

13.6 No Limitation of Liability. Compliance with the foregoing insurance requirements shall not relieve ***CONSULTANT*** from liability under any portion of this Agreement, or otherwise act as a limitation of ***CONSULTANT's*** liability.

Art. 14. CLIENT LIMITATION OF LIABILITY

14.1 To the fullest extent permitted by law, the ***CLIENT*** shall have no liability or obligation the ***CONSULTANT***, and the ***CONSULTANT*** will look solely to ***H&S*** for payment and enforcement of its rights under its agreement with ***H&S***.

Art. 15. PERFORMANCE STANDARDS

15.1 The standard of care for all professional services provided by ***CONSULTANT*** shall be the standard of care set forth in the ***H&S CLIENT AGREEMENT***. If not set forth in the ***H&S CLIENT AGREEMENT***, ***CONSULTANT*** shall perform all professional services with the care and skill ordinarily exercised by members of the same profession currently practicing in the United States, on projects of similar size and complexity at the time the services are performed.

15.2 ***CONSULTANT*** represents that all persons delivering the services required by this Agreement have the knowledge and skills, either by training, experience, education, or a combination thereof, to adequately and competently perform the duties, obligations, and services set forth in the Scope of Services and to provide and perform such services to ***H&S's*** satisfaction for the agreed compensation. ***CONSULTANT*** agrees that it will employ the current state-of-the-art in performing its services and shall provide additional services needed to correct its deficiencies at no additional cost to ***H&S***.

Art. 16. RECORDS

16.1 ***H&S***, ***H&S CLIENT***, and, if the services to be performed hereunder relate to a state or federal government contract, the Comptroller General of the United States and the department or agency of the government having cognizance over said prime Contract, and any of their duly authorized representatives, shall have access to and the right to examine any directly pertinent books, documents, papers and records of ***CONSULTANT*** involving transactions related to this Agreement.

16.2 ***CONSULTANT*** shall grant access to such records for the time period which ***H&S*** is required to grant access to ***H&S CLIENT*** pursuant to the terms of the ***H&S CLIENT AGREEMENT***. If the ***H&S CLIENT AGREEMENT*** is silent as to the matter, ***CONSULTANT*** shall grant access to such records until the expiration of three years after final payment under this Agreement.

16.3 ***CONSULTANT*** warrants that its accounting books and records are kept on a job cost basis in accordance with generally accepted accounting practices and that its overall accounting system is sufficient to sustain an audit by local, state or federal audit agencies. ***CONSULTANT*** agrees that should a local, state or federal audit disallow ***CONSULTANT's*** costs based on inadequate or insufficient records, ***CONSULTANT*** will reimburse ***H&S*** all such costs disallowed.

Art. 17. AUDIT RIGHT AND RETENTION OF RECORDS

17.1 ***H&S*** shall have the right to audit the books and records of ***CONSULTANT***. ***CONSULTANT*** shall keep such records and accounts as may be necessary in order to record complete and correct entries related to the Project.

17.2 ***CONSULTANT*** shall preserve and make available, at reasonable times for examination and audit by ***H&S*** all financial records, supporting documents, statistical records, and any other documents pertinent to this Agreement for the time period which ***H&S*** is required to preserve and make available such records to ***H&S CLIENT*** pursuant to the terms of the ***H&S CLIENT AGREEMENT***. If the ***H&S CLIENT AGREEMENT*** is silent as to the matter, ***CONSULTANT*** shall preserve and make available such records until the expiration of three years after final payment under this Agreement.

17.3 If any audit has been initiated and audit findings have not been resolved at the end of the applicable time period, the books and records shall be retained until resolution of the audit findings. If the any public records request act is determined by ***H&S*** to be applicable to ***CONSULTANT***'s records, ***CONSULTANT*** shall comply with all requirements thereof; however, no confidentiality or nondisclosure requirement of either federal or state law shall be violated by ***CONSULTANT***. Incomplete or incorrect entries in such books and records shall be a basis for ***H&S***'s disallowance of any payment upon entries.

Art. 18. GRATUITIES PROHIBITED

CONSULTANT warrants that neither it nor any of its employees, agents or representatives has offered or given any gratuities to ***H&S***'s employees, agents, or representatives with a view toward securing this Agreement or securing favorable treatment with respect thereto.

Art. 19. SUCCESSORS AND ASSIGNEES

This Agreement is to be binding on the heirs, successors and assignees of the parties hereto but is not to be assigned by either party without first obtaining the written consent of the other.

Art. 20. WAIVER OF BREACH AND MATERIALITY

Failure by ***H&S*** to enforce any provision of this Agreement shall not be deemed a waiver of such provision or modification of this Agreement. A waiver of any breach of a provision of this Agreement shall not be deemed a waiver of any subsequent breach and shall not be construed to be a modification of the terms of this Agreement. ***H&S*** and ***CONSULTANT*** agree that each requirement, duty, and obligation set forth herein is substantial and important to the formation of this Agreement and, therefore, is a material term hereof.

Art. 21. PERMITS, LICENSES, NOTICES AND COMPLIANCE WITH LAWS

22.1 ***CONSULTANT*** shall give notices and comply with applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities bearing on performance of the services of this Agreement. The ***CONSULTANT*** shall secure and pay for permits, fees, licenses and inspections by government agencies necessary for proper execution and completion of the services of this Agreement.

22.2 ***CONSULTANT*** shall comply with federal, state and local tax laws, social security acts, unemployment compensation acts and worker's compensation acts insofar as applicable to the performance of services under this Agreement.

22.3 ***CONSULTANT*** shall not unlawfully discriminate against any person in its operations and activities in its use or expenditure of the funds or any portion of the funds provided by this Agreement and shall affirmatively comply with all applicable provisions of the American with Disabilities Act (ADA) in the course of providing any services funded in whole or in part by ***H&S***, including Titles I and II of the ADA (regarding nondiscrimination on the basis of disability), and all applicable regulations, guidelines, and standards.

22.4 ***CONSULTANT's*** decisions regarding the delivery of services under this Agreement shall be made without regard to or consideration of race, age, religion, color, gender, sexual orientation, national origin, marital status, physical or mental disability, political affiliation, or any other factor which cannot be lawfully or appropriately used as a basis for service delivery.

22.5 ***CONSULTANT*** shall comply with Title I of the Americans with Disabilities Act regarding nondiscrimination on the basis of disability in employment and further shall not discriminate against any employee or applicant for employment because of race, age, religion, color, gender, sexual orientation, national origin, marital status, political affiliation, or physical or mental disability. In addition, ***CONSULTANT*** shall take affirmative steps to ensure nondiscrimination in employment against disabled persons. Such actions shall include, but not be limited to, the following: employment, upgrading, demotion, transfer, recruitment or recruitment advertising, layoff, termination, rates of pay, other forms of compensation, terms and conditions of employment, training (including apprenticeship), and accessibility.

22.6 ***CONSULTANT*** shall take affirmative action to ensure that applicants are employed and employees are treated without regard to race, age, religion, color, gender, sexual orientation, national origin, marital status, political affiliation, or physical or mental disability during employment. Such actions shall include, but not be limited to, the following: employment, upgrading, demotion, transfer, recruitment or recruitment advertising, layoff, termination, rates of pay, other forms of compensation, terms and conditions of employment, training (including apprenticeship) and accessibility.

Art. 22. SEVERANCE

In the event this Agreement or a portion of this Agreement is found by a court of competent jurisdiction to be invalid, the remaining provisions shall continue to be effective unless ***H&S*** elects to terminate this Agreement. The election to terminate this Agreement based upon this provision shall be made within seven (7) days after the finding by the court becomes final.

Art. 23. JOINT PREPARATION

Preparation of this Agreement has been a joint effort of ***H&S*** and ***CONSULTANT*** and the resulting document shall not, solely as a matter of judicial construction, be construed more severely against one of the parties than any other.

Art. 24. PRIORITY OF PROVISIONS

If there is a conflict or inconsistency between any term, statement, requirement, or provision of any exhibit attached hereto, any document or events referred to herein, or any document incorporated into this Agreement by reference and a term, statement, requirement, or provision of this Agreement, the term, statement, requirement, or provision contained in Articles 1 through 27 of this Agreement shall prevail and be given effect.

Art. 25. COMMUNICATIONS

All communications and correspondence between ***CONSULTANT*** and ***H&S CLIENT*** shall be through ***H&S***.

Art. 26. PROJECT SPECIFIC TERMS

The following additional Project specific terms and conditions are:

___None _____

_____

Art. 27. COUNTERPARTS

This Agreement may be executed in two (2) counterparts, each of which shall be deemed to be an original.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the date first above written.

Southern Nevada Water Authority	**HAZEN AND SAWYER, P.C.**
By: _____ John J. Entsminger	By: _____ Mark Bishop
Title: General Manager	Title: Vice President
By: _____ Laura Browning	By: _____ Alan Stone
Title: Project Attorney	Title: Vice President

Small Disadvantaged Business	No Yes or No
Small Business	No Yes or No
Employer Identification No. *	88-0278492

* *This is the identifying number required to be used in federal income tax and employment tax returns.*

SCHEDULE A

SCOPE OF SERVICES

Southern Nevada Water Authority

GAC Control of Regulated and Emerging DBPs of Health Concern

The scope of work to be provided by ***CONSULTANT*** includes professional services for the elements listed below.

Scope of Work Document for SNWA as prepared by Hazen and Sawyer

SNWA will be responsible for operating and conducting pilot-scale column tests located at Clark County Water Reclamation District as part of Task 2.1. SNWA Staff will be responsible for documenting and writing all results for Task 2.1 for quarterly reports and for the final report. Also, SNWA will be responsible performing analytical analysis (i.e., nitrosamines and amine assay) on project samples. It is expected that SNWA staff will travel to a conference and/or team meetings for the project. SNWA Staff will be responsible for writing sections of the Final Report relevant to Tasks 2.1 and any analytical testing conducted by SNWA that are associated with the other remaining tasks.

TIME OF COMPLETION

The scope of work will be completed by the ***CONSULTANT*** within twenty seven (27) months of the project starting date listed in the ***H&S CLIENT AGREEMENT.***

SCHEDULE B

COMPENSATION

Southern Nevada Water Authority

GAC Control of Regulated and Emerging DBPs of Health Concern

H&S shall pay ***CONSULTANT*** as full compensation for the services identified under Schedule A the amount(s) listed below. Compensation shall be on a not to exceed basis in the amount of $60,000.00. In addition, ***CONSULTANT*** shall be responsible for documenting the $80,000 of additional in-kind cost from SNWA in the form of analytical costs, in-kind use of the AOP Pilot Skid, and/or of in-kind use of the Column Pilot Skid.

BACKUP DOCUMENTATION

Project Funding Agreement 04560 between the Water Research Foundation and Hazen and Sawyer.

SNWA is a subcontractor to this agreement and we will have an executed copy before the Board meeting.

Project Funding Agreement 04560

This Project Funding Agreement (hereafter "PFA") is entered into on _____, 20__, (the "Effective Date") by and among the Water Research Foundation (the "Foundation"), a Delaware non-profit corporation whose principal place of business is located at 6666 W. Quincy Ave., Denver, Colorado 80235, and Hazen and Sawyer, P.C. ("Sub-recipient"), a New York corporation whose principal place of business is located at 498 Seventh Avenue, New York, NY 10018.

The Foundation has selected said Sub-recipient to receive a research and development grant as more specifically detailed in this PFA. The parties mutually agree as follows:

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

A. "Cost Share" is goods or services provided in kind by the Sub-recipient, and key personnel identified in the budget submittal, the value of which is dictated by the cost principles that are applicable by the providing organization's cognizant agency.

B. "Foundation Contribution" is that portion of the Project Funds which the Foundation has agreed to contribute to fund the Project under this PFA, as detailed in Exhibit C.

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

D. "PAC" is the Project Advisory Committee that consists of independent volunteers selected by the Foundation and Co-funders to provide technical review, assistance, and/or expertise related to the Project. The number of volunteers to serve on the PAC will be determined by the Foundation.

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

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

G. "Project Funds" is the aggregate maximum amount of cash award which the Foundation agrees to provide to Sub-recipient to fund its performance of the Project pursuant to this PFA.

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

I. "Proposal Guidelines" is the Foundation's written guidelines, currently maintained at

http://www.waterrf.org/funding/ProposalDocuments/GuidelinesForFocusAreaProgramProposals.pdf

in which the procedures, criteria and requirements for eligibility, proposal, performance, administration, reporting, and other matters governing the proposal of and performance of a Project are set forth. The Proposal Guidelines were provided to the Sub-recipient prior to its submission of a Project Proposal, and its terms and requirements are incorporated in this PFA by this reference. The terms "Deliverable", "Periodic Report", "Draft Report", and "Final Report" appearing in this PFA shall have the definitions, and be governed by the requirements applicable thereto, as set forth in the Proposal Guidelines.

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

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

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

II. GENERAL OBLIGATIONS OF THE PARTIES

A. The Sub-recipient.

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

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

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

4. Focus Area Annual Research Summit

   Projects that are funded with the Foundation's Focus Area funds are required to participate in the Focus Area Annual Research Summit. The Summit brings together focus area Technical Advisory Committee (TAC) members, Focus Area Council (FAC) members, and project PIs on an annual basis to review the technical progress and results of projects funded within an

individual focus area. The summits may also include researchers for projects that are related to the Focus Area, but not funded by Focus Area funds. Focus area research summits are held on an annual basis via web conference and are usually held in the fall or winter. PIs for projects funded under a particular focus area will be required to present project information at the Focus Area Annual Research Summit every year. Researchers should include time and resources in the proposal budget to cover the creation and presentation of a 15-30 minute presentation, to be given via webcast, on an annual basis for the duration of the project period.

B. The Foundation. The Foundation will disburse the Project Funds to the Sub-recipient as detailed in this PFA and Exhibit C. The Foundation's disbursement of the Project Funds may further be subject to the Foundation's receipt of its own funding from appropriate sources.

III. DISBURSEMENT OF PROJECT FUNDS

A. Advance Payment. All payments of the Project Funds will be disbursed by the Foundation directly to the Sub-recipient. The Project Funds was determined on the basis of the budget submitted by the Sub-recipient, and set forth in Exhibit C. The Project Funds is a "not to exceed" amount and no payments in excess of such amount are authorized or required. Following the Effective Date the Foundation will advance to the Sub-recipient 10% of the Project Funds. All subsequent disbursements of the Project Funds shall be governed by the requirements described in Section III.B below and in Exhibit C.

B. Invoicing and Payments.

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

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

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

   (a) The ten percent (10%) advance payment must be shown on all invoices, including the final invoice, as an advance payment received. Subject to the hold back provision below, invoices will be paid to the extent actual costs incurred exceed the advance payment.

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

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

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

IV. COMPLIANCE MONITORING

A. Financial Management System. The Sub-recipient shall maintain an accounting system and accurate and complete accounting records that, at a minimum but without limitation, allow for the identification, tracking, and verification of costs, expenses, Cost Share, in-kind contributions, invoiced items, and funding received, all in a manner that is segregated and allocable solely to performance of the Project. All costs incurred must be supported by original receipts and be made available to the Foundation upon request.

B. Cost Principles. The Sub-recipient represents and warrants that the budget disclosures included in the Project Proposal and presented to the Foundation was prepared by Sub-recipient in full compliance with the cost principles governing determination of reimbursable costs and expenses in Sub-recipient's type of organization. Sub-recipient shall throughout the Project, and in the preparation of every invoice, report, and maintenance of its accounting system, remain in compliance with the cost principles by which it is governed. It shall be Sub-recipient's obligation to determine and comply with its governing cost principles.

- State, local or Indian tribal government, 2 CFR 225
- Non-profit Organization (NPO), 2 CFR 230.
- Institution of Higher Education, 2 CFR 220.
- Hospitals, 45 CFR 74 Appendix E.
- Commercial (For Profit) and selected Non-Profit Organizations. 48 CFR 31.2

C. Indirect Costs and Allocation of Costs:

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

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

E. Audit and Monitoring.

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

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

3. Any deficiencies or non-compliance in Sub-recipient's systems, procedures, record keeping, finances, and performance of other obligations under this PFA discovered in the audit, review or monitoring process, or discovered otherwise, may, at the Foundation's option, require Sub-recipient to take corrective action that has been detailed by the Sub-recipient and approved by the Foundation for the Sub-recipient to remedy the deficiency or noncompliance, or may result in the Foundation exercising its termination rights under Section VII below.

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

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

V. PROCUREMENT STANDARDS

A. Procurement Standards. It is an express requirement under the Proposal Guidelines and this PFA that the Sub-recipient remain in compliance with the U.S. Federal standards for procurement as are outlined in the U.S. Federal Uniform Administrative Requirements applicable to Sub-recipient's

organization type. These standards govern procedures for procurement of supplies, equipment, and other services for which cost is incurred in whole or in part under this PFA. These standards include but are not limited to the following:

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

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

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

VI. IP RIGHTS AND PUBLICATION

A. Work Product.

1. The Foundation shall own all worldwide copyrights in all the Work Product including the Scope of Work, all Periodic Reports, all Draft Reports, the Final Report, and all drafts of these works and reports. Sub-recipient shall and hereby does assign exclusively to the Foundation all right, title, and interest in and to the Work Product and the copyrights embodied therein. The Sub-recipient may use without restrictions all data from the Work Product such as innovations, creations, processes, designs, methods, formulas, plans, technical data, and specifications.

2. The Sub-recipient represents, warrants and covenants that it has required and will continue to require all Subcontractors and other third parties that contribute in whole or in part to the Work Product to assign all copyrights therein exclusively to the Foundation. The Sub-recipient has acquired and shall acquire broad permission(s) to incorporate any third-party copyrighted materials into the Work Product, and to authorize the Foundation to modify, copy, distribute, publish, publicly present, publicly display, and create derivative works based thereon in connection with its exercise of ownership rights in the Work Product. The Sub-recipient shall utilize the Foundation's form located at http://waterrf.org/thefoundation/legal/Pages/MaterialUsePermissionRequest.aspx for securing the foregoing required permission for the Foundation. The Sub-recipient shall provide full ownership and license information for any such material, and the Foundation agrees to include appropriate third party copyright acknowledgements in the impacted Work Product.

3. The Foundation will provide the Sub-recipient with five (5) hardcopies of the Final Report and a PDF. The Final Report may be published in a PDF format only. The Sub-recipient will receive the Final Report in that format. The Work Product may not be copied, published, adapted, posted on an intranet or website, or disclosed in any manner by the Sub-recipient, any Subcontractor or other third party except with the Foundation's prior written approval.

4. The Foundation hereby grants the Sub-recipient a royalty free, perpetual, irrevocable, world-wide, nonexclusive license, without the requirement for any accounting, to utilize Foundation's Intellectual Property solely for educational purposes.

B. Inventions and Patents.

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

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

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

4. Background Intellectual Property. *This PFA shall not be construed as implying that either party hereto shall have the right or license (express or implied) to use background Intellectual Property of the other in connection with this Project except as otherwise provided hereunder or required by Federal government regulations. Background Intellectual Property includes property and the legal right therein of either party developed before or independent of this PFA or the Project including inventions, patent applications, patents, copyrights, trademarks, mask works, trade secrets, know-how and any information embodying proprietary data such as technical data and computer software.*

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

C. Publication. As the owner of Work Product, all rights to publish, distribute, publicly perform, and publicly present the Reports belong solely to the Foundation. Sub-recipient may publish or present based on the Work Product, in whole or in part, and only with the prior written permission of the Foundation, which may be withheld or conditioned at the Foundation's sole discretion. Any such request for permission from the Foundation must be made to the Foundation at least three (3) weeks prior to the requesting party's proposed date of publication or presentation based on any

portion of the Final Report, and the request must be accompanied by copies of the proposed publication or presentation material. The Sub-recipient may in no event publish or present based on or exercise any other copyrights with respect to the Interim Reports or the Draft Report. All copies of or presentations based on the Work Product authorized to be made by the Foundation shall furthermore conspicuously display the following notice:

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

D. *Acknowledgement. Any public presentation or publication by the Sub-recipient, including a student writing a thesis, dissertation, presentation, or report, based on the Inventions or any portion of the Work Product, shall include a statement substantially as follows: "Hazen and Sawyer, P.C. [or other entity] acknowledges that the Water Research Foundation are funders of certain technical information upon which this publication [manuscript] [presentation] is based. Hazen and Sawyer, P.C. [or other entity] thanks the Water Research Foundation, for their financial, technical, and administrative assistance in funding the project through which this information was discovered."*

E. *Disclaimer. Any publication and presentation by Sub-recipient or students utilizing any portion of the Work Product shall include the following disclaimer: The comments and views detailed herein do not necessarily reflect the views of the Water Research Foundation, its officers, directors, affiliates or agents.*

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

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

VII. TERM AND TERMINATION

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

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

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

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

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

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

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

VIII. STANDARD TERMS AND CONDITIONS

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

B. Quality Assurance. The Sub-recipient shall use its best efforts to ensure that all data and test results developed during the course of this PFA and included, or relied upon, in the Work Product are accurate to the best of its knowledge, information, and belief. In the event the Sub-recipient obtains any data, test results, information derived from such data or test results, or other information to be included in the Project from water utilities or any Subcontractor, the Sub-recipient will utilize reasonable and customary efforts to ensure the accuracy of the information obtained.

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

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

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

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

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

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

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

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

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

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

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

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

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

L. Severability. The provisions of this PFA shall be severable, and the invalidity, illegality or unenforceability of any provision of this PFA shall not affect the validity or enforceability of any other provisions. If any provision of this PFA is found to be invalid, illegal, or unenforceable,

such provision shall be modified to the extent necessary to render it enforceable, and as modified, this PFA shall remain in full force and effect.

M. Foundation Right of Approval. The Foundation shall have the right, in their sole discretion, to refuse to permit any employee of the Sub-recipient, or employee of an approved agent, assignee, or subcontractor of the Sub-recipient, to be located at a Foundation work location, or to provide services to the Foundation pursuant to this PFA.

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

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

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

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

R. Limitation of Liability. IN NO EVENT SHALL *EITHER PARTY* OR ANY OF *THEIR* OFFICERS, DIRECTORS, EMPLOYEES, AFFILIATES, AGENTS OR REPRESENTATIVES BE LIABLE TO ANY OTHER PARTY, OR ANY THIRD PARTY FOR ANY SPECIAL, INDIRECT, INCIDENTAL, EXEMPLARY OR CONSEQUENTIAL DAMAGES OR LOSS OF GOODWILL OR EXPECTED PROFITS OR REVENUES, IN ANY WAY RELATING TO THIS PFA, INCLUDING, WITHOUT LIMITATION, THE FAILURE OF ESSENTIAL PURPOSE, EVEN IF IT HAS BEEN NOTIFIED OF THE POSSIBILITY OR LIKELIHOOD OF SUCH DAMAGES OCCURRING, AND WHETHER SUCH LIABILITY IS BASED ON CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY, STATUTE, PRODUCTS LIABILITY OR OTHERWISE. IN NO EVENT SHALL THE *PARTY'S* LIABILITY HEREUNDER EXCEED THEIR RESPECTIVE CONTRIBUTION ALREADY MADE UNDER THIS PFA.

S. *Applicable Law/Venue. The parties elect to remain silent on applicable law and venue with regard to actions against Sub-recipient which silence is not be construed as an agreement that one party's State law applies or is more appropriate for venue. Any action, including, without limitation, any claim or other complaint, against the Water Research Foundation, however, must*

be brought in U.S. Federal District Court. The terms of this paragraph will survive the termination of this PFA.

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

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

THE REMAINDER OF THIS PAGE IS INTENTIONALLY LEFT BLANK

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

Water Research Foundation

By: Robert C. Renner, P.E., B.C.E.E.
Title: Executive Director

Date: _____

Hazen and Sawyer, P.C.

By: _____
Title: _____

Date: _____

Water Research Foundation

By: Djanette Khiari, Ph.D.
Title: Research Manager

Date: _____

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

Hazen and Sawyer, P.C.

By: Benjamin Stanford, Ph.D.
Title: Principal Investigator

Date: _____

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

Signature Page Instructions

1. Review document and have a duly authorized representative sign this page.
2. Only this signature page is required to be returned back to the Foundation.
3. Please return the executed signature page using **one** of the choices below:
   a. **Email** a scanned PDF to pfalor@WaterRF.org or,
   b. **Fax** a copy back to Peggy Falor at (303) 730-0851 or,
   c. **Mail** a copy back to Peggy Falor at Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, phone: (303) 734-3424
4. Do not return the entire agreement, only this signature page.
5. Please return no later than **ten (10) business days** from receipt.
6. The Foundation will email a PDF of this fully executed agreement to you for your files.

Exhibit A
Project 04560

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

Title: GAC Control of Regulated and Emerging DBPs of Health Concern

Project proposal and all subsequent correspondence.

Exhibit B
Project 04560

Title: GAC Control of Regulated and Emerging DBPs of Health Concern

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

TASK	DUE
Begin Project	Start date
Scope of Work	30 days after start date
Sub-recipient presents Proof of Insurance(s) or Certificate of Self Insurance & Worker's Compensation Insurance	30 days after start date
Periodic Report 1 – electronic copy	3 months after start date
Periodic Invoice 1	3 months after start date
Periodic Report 2 (incl. Technical Summary & Web Update) - electronic copy	6 months after start date
Periodic Invoice 2 – electronic copy	6 months after start date
Periodic Report 3 – electronic copy	9 months after start date
Periodic Invoice 3– electronic copy	9 months after start date
Periodic Report 4 (incl. Technical Summary & Web Update) – electronic copy	12 months after start date
Periodic Invoice 4	12 months after start date
Periodic Report 5 – electronic copy	15 months after start date
Periodic Invoice 5	15 months after start date
Periodic Report 6 (incl. Technical Summary & Web Update) – electronic copy	18 months after start date
Periodic Invoice 6	18 months after start date
Periodic Report 7 – electronic copy	21 months after start date
Periodic Invoice 7	21 months after start date
Periodic Report 8 (incl. Technical Summary & Web Update) – electronic copy	24 months after start date
Periodic Invoice 8	24 months after start date
Draft Report – electronic copy and one hardcopy	27 months after start date
Draft Invoice	27 months after start date
Final Report – electronic copy and one hardcopy	5 months after draft report
Letters of Confirmation from participating utilities	5 months after draft report
Complete & Submit Exhibit E – Assignment of Copyright	5 months after draft report
Final Invoice & Final Compensation	5 months after draft report
Project End & Foundation Publication Date	12 months after draft report

Note: Please submit one electronic copy of each Periodic Report, Draft & Final Report in MSWord format. For each report an invoice must be submitted for payment using Exhibit D – printed on your company letterhead.

Foundation Key Contacts:

Project Management

- Djanette Khiari, Research Manager, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: (303) 734-3478, and Email: dkhiari@WaterRF.org.

Contract Administration

- Peggy Falor, Manager – Contracts and Project Administration, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: (303) 734-3424, and Email: pfalor@WaterRF.org.
- Valerie Roundy, Project Coordinator, Water Research Foundation, 6666 W. Quincy Ave., Denver, CO 80235, Phone: (303) 347-6124, and Email: vroundy@WaterRF.org.

Sub-recipient Key Contacts:

Principal Investigator/Authorized Representative

- Benjamin D. Stanford, Ph.D., Director of Applied Research, Hazen and Sawyer, P.C., 4011 Westchase Blvd., Suite 500, Raleigh, NC 27607, Phone: (919) 863-1027, and Email: bstanford@hazendandsawyer.com.

Accounting Contact (Project Funds disbursements will be mailed to the care of this contact)

- William Crayon, Comptroller, Hazen and Sawyer, P.C., 498 Seventh Ave., 11th Floor, New York, New York 10018, Phone: (212) 539-7077, and Email: wcrayon@hazenandsawyer.com.

Administrative Contact

- William Crayon, Comptroller, Hazen and Sawyer, P.C., 498 Seventh Ave., 11th Floor, New York, New York 10018, Phone: (212) 539-7077, and Email: wcrayon@hazenandsawyer.com.

Co-Principal Investigator:

- Detlef Knappe, Ph.D., Professor, North Carolina State University, 2501 Stinson Drive, Department of CC&EE, Campus Box 7908, Raleigh, NC 27695, Phone: 919-515-8791, and Email: knappe@ncsu.edu.
- R. Scott Summers, Ph.D., Professor of Engineering, University of Colorado, Boulder, ECES 108. CEAE Department-CB0428, University of Colorado Boulder, Boulder, CO 80309, Phone: 303-482-6644, and Email: r.summers@colorado.edu.
- Susan Richardson, Ph.D., Arthur Sease Williams Professor of Chemistry, University of South Carolina, Department of Chemistry and Biochemistry, JM Palms Center for Graduate Science Research, 631 Sumter St., Columbia, SC 29208, Phone: 807-777-6932, and Email: Richardson.susan@sc.edu.
- Eric Dickenson, Ph.D., Project Manager, Southern Nevada Water Authority, River Mountain Water Treatment Facility, PO Box 99954, Las Vegas, NV 89193, Phone: 702-856-3668, and Email: eric.dickenson@snwa.com.

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

BUDGET SUMMARY

Exhibit C
Project 04560

Contractor: Hazen & Sawyer, P.C.
498 Seventh Avenue
New York, NY 10018

Title: GAC Control of Regulated and Emerging DBPs of Health Concern

This PFA shall be effective from <start date> and shall end on <end date> detailed in Exhibit B. The Foundation shall have any obligation for payment of invoices for costs incurred by the Sub-recipient after the foregoing end date.

The Foundation agrees to provide aggregate Project Funds to the Sub-recipient in an amount not to exceed Four Hundred Thousand US dollars ($400,000.00) for the completion of this PFA. The Sub-recipient agrees to contribute Sixty Nine Thousand Three Hundred Forty Five US dollars ($69,345.00) in Cost Share and Two Hundred Twenty Eight Thousand Three Hundred Sixty Four US dollars ($228,364.00) in in-kind contributions as detailed below. The total budget for the Project is Six Hundred Ninety Seven Thousand Seven Hundred Nine US dollars ($697,709.00).

Payments to the Sub-recipient will be issued to the Sub-recipient organization and mailed to the address shown in the first paragraph of this funding agreement and shown above.

ORGANIZATION	Award Amount	Cost Share	In-Kind Amount
Project Participants			
Northern Kentucky Water District	$0.00	$0.00	$5,000.00
American Water	$0.00	$0.00	$10,000.00
Mohawk Valley Water Authority	$0.00	$15,000.00	$15,000.00
Cobb County Water System	$0.00	$15,000.00	$10,000.00
Southern Nevada Water Authority	$0.00	$0.00	$80,000.00
City of Phoenix Water Services Department	$0.00	$0.00	$10,000.00
City of Scottsdale – Water Resources Dept.	$0.00	$0.00	$20,000.00
City of Greensboro	$0.00	$10,000.00	$10,000.00
North Carolina State University	$0.00	$0.00	$23,364.00
University of South Carolina	$0.00	$0.00	$20,000.00
Clark County Water Reclamation District	$0.00	$0.00	$25,000.00
Co-PI			
North Carolina State University	$0.00	$0.00	$0.00
University of Colorado at Boulder	$0.00	$0.00	$0.00
University of South Carolina	$0.00	$0.00	$0.00

ORGANIZATION	Award Amount	Cost Share	In-Kind Amount
Southern Nevada Water Authority	$0.00	$0.00	$0.00
Partner			
American Water Works Association	$35,000	$0.00	$0.00
Sub-recipient			
Hazen and Sawyer, P.C.	$0.00	$29,345.00	$0.00
Water Research Foundation	$365,000.00	$0.00	$0.00
TOTALS	**$400,000.00**	**$69,345.00**	**$228,364.00**
Total Project Budget $697,709.00			

Project Award Funds: not to exceed $400,000.00
10% of Project Funds advanced on or following Effective Date: $40,000.00
Amount due upon the Foundation's acceptance of Draft Report and Invoice: $40,000.00
Amount due upon the Foundation's acceptance of the Final Report and final invoice: $40,000.00

Title: GAC Control of Regulated and Emerging DBPs of Health Concern

Exhibit D – Invoice Form

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

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

Exhibit E
Project 04560

Title: GAC Control of Regulated and Emerging DBPs of Health Concern

Assignment of Interest in Copyrighted Works

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

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

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

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

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

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

State of _____ }
} ss
County of _____ }

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

_____
Notary Public Comm'n. Exp.

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Agreement	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors approve and authorize the General Manager to sign a cooperative agreement between the Nevada Division of Forestry and the Authority to conduct inmate conservation camp work detail services for the period from December 10, 2014, through November 30, 2016, for an amount not to exceed $200,000.	

Fiscal Impact:
If the above recommendation is approved, the Authority will be reimbursed for work completed on the Las Vegas Wash through grant funding provided to the Authority by the U.S. Bureau of Reclamation. For work on locations other than the Wash, funds in an amount of $30,000 have been included in the approved Authority budget.

Background:
Since September 2000, the Board of Directors has approved four agreements with the State of Nevada, Division of Forestry (NDF) for inmate conservation work detail services at the Las Vegas Wash (Wash). The most recent agreement provided services through October 31, 2014.

The NDF conservation camps have been a vital source for labor to support stabilization and enhancement efforts at the Wash for the past 14 years. If approved, this cooperative agreement (Agreement) will allow the Authority to continue restoration efforts for the Wash and other Authority properties within Clark County. Tasks to be performed under this Agreement include site maintenance, planting native species, harvesting native species, tamarisk removal, and site cleanup activities. This Agreement will provide for the continued use of an inexpensive labor force for management of the Wash and the mechanism to allow the work detail services to occur at other Authority properties.

This cooperative agreement is being entered into pursuant to NRS 277.180 and Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:ZLM:LML:KKC:NR:pe
Attachment

AGENDA ITEM # 7

NEVADA DIVISION OF FORESTRY

CONSERVATION CAMP PROGRAM

FORESTRY WORK PROJECT AGREEMENT FOR COOPERATORS

Project # 320051

This Agreement is entered into this _____ day of _____, 2014 by and between the Nevada Division of Forestry, hereinafter called NDF, and the Southern Nevada Water Authority, a political subdivision of the State of Nevada, hereinafter called the Cooperator.

WHEREAS Legislative policy in NRS 209.461 requires each offender to participate in employment and/or vocational training in the community and:

WHEREAS NDF provides a work program of employment for offenders in the conservation camp system for the purpose of promoting and encouraging public conservation projects pursuant to NRS 209.132 and NRS 209.461 and:

WHEREAS the parties to this Agreement seek to accomplish a public conservation project more fully described below.

NOW, THEREFORE the parties agree as follows:

COOPERATOR agrees to reimburse NDF for labor and equipment furnished on an as-needed basis for work on the project as described in Attachment 1, the Nevada Division of Forestry Conservation Camp Project Plan and Agreement and Attachment 2, the Financial Estimate. NDF agrees to provide the labor and equipment as described in Attachments 1 and 2, only as requested and approved by the Cooperator. Cooperator will reimburse NDF for the work performed at the contracted daily rate described in Attachment 2, but in no event will the total amount reimbursed by Cooperator under this Agreement exceed $200,000. Attachments 1 & 2 are incorporated herein as though set forth in full. NDF will bill the Cooperator on a monthly basis for actual costs accrued based upon the rates in Attachment 2. Payment is due within thirty (30) days after Cooperator's receipt of the billing statement. Accounts sixty (60) days in arrears will be assessed at a rate of 1.5% per month until the account is paid in full. In case suit shall be brought by either party for collection of payments due the State of Nevada under the provisions of this Agreement or to enforce any of the terms or conditions of this Agreement, the prevailing party shall be allowed to recover reasonable attorneys' fees and costs of suit.

TERM: This Agreement shall terminate upon the completion of the project described herein or by the date of 30 November 2016, whichever is earlier. The term of this Agreement may be extended by NDF due to lack of manpower as a result of Department of Corrections' action in

filling the conservation camps with suitable inmates. Either party may terminate this work Agreement upon five (5) days written notice to the other party.

NDF, by and through this Agreement, neither expressly nor impliedly warranties or guarantees the project work as the workmanship or conformity with plans, specifications, or other information not made available to NDF nor expressly made a part of this Agreement. NDF agrees to use its best efforts to complete this work Agreement in a timely manner. Should NDF fail to complete the job the contract price will be prorated to reflect value of services completed.

To the extent permitted by Nevada law, Cooperator shall indemnify, hold harmless and defend, not excluding the State's right to participate, the State from and against all liability, claims, actions, damages, losses, and expenses, including without limitation, reasonable attorney's fees and costs, arising out of any alleged negligent or willful acts or omissions of Cooperator, its officers, employees and agents pursuant to this Agreement.

The Nevada Department of Corrections (NDOC), as custodian of offenders under Nevada law, retains the right to review each proposed work project for security reasons and may modify or otherwise attach conditions to this Agreement in accordance with their regulations and policies. Inmate labor is the ultimate responsibility of NDOC; therefore, the offenders are not employees of Cooperator or NDF. NDF does provide workman's SIIS insurance for each inmate working under the terms of this Agreement.

This Agreement represents the entire Agreement between the parties and may not be amended except in writing and signed by both parties. Security conditions, if any, by the Department of Corrections may be conveyed orally to the parties at the time work is anticipated to commence at the project.

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COOPERATIVE AGREEMENT "FORESTRY WORK PROJECT AGREEMENT FOR COOPERATORS" BETWEEN THE NEVADA DIVISION OF FORESTRY, CONSERVATION CAMP PROGRAM, AND THE SOUTHERN NEVADA WATER AUTHORITY

This Agreement shall be construed and interpreted according to the laws of the State of Nevada.

NEVADA DIVISION OF FORESTRY

Jon Shogren, Southern Section Chief

COOPERATOR

John J. Entsminger, General Manager

Southern Nevada Water Authority
1001 South Valley View Blvd.
Las Vegas, Nevada 89153
Address

702-258-3100
Phone Number

88-6000363
Tax ID Number

Approved as to Form:

Dana R. Walsh
Deputy Counsel

ATTACHMENT 1

NEVADA DIVISION OF FORESTRY
CONSERVATION CAMP PROJECT PLAN AND AGREEMENT

Date: 8/12/2014

Camp: Jean, Three Lake Valley Conservation Camp

PROJECT: Southern Nevada Water Authority-Las Vegas	
LOCATION: Las Vegas	**COUNTY: Clark**
COOPERATOR: Southern Nevada Water Authority	**AGENCY: Community**
PROJECT AGENT: Nick Rice	**PHONE: (702) 858-2781, (702) 822-3316**
PURPOSE OF PROJECT: Tamarisk Removal/re-vegetation	
PROPOSED STARTING DATE: 30 November 2014	**ESTIMATED WORKING DAYS:**
SCHEDULED STARTING DATE:	**CREW ASSIGNED PROJECT:**

PROJECT DESCRIPTION:

1. **Crew will cut Tamarisk and stack slash.**
2. **Crew will spray cut stumps with herbicide within 20 minutes of cutting.**
3. **Crew will harvest and plant indigenous plant species.**
4. **Crew will wear required PPE including hardhats, eye protection and chaps for leg protection.**
5. **Crew will complete project safely utilizing safe work practices while operating hand and power tools.**
6. **Crew will help install jute logs.**
7. **Crew will perform general site clean-up.**
8. **Crews will support implementation of approved burn plans.**
9. **Crews will perform planting of plants.**
10. **Crew will perform weeding of project site.**
11. **Crews will use best management practices to avoid the ignition of wildfire.**

MATERIALS REQUIRED FROM COOPERATOR:

1. Herbicide approved for site and species.
2. All specialized herbicide spray equipment and safety equipment.
3. Trash dumpster.
4. Hip Wading boots.
5. Plant material.

TECHNICAL PLANS REQUIRED: Yes for application of any herbicide written plan will have to be done prior to the application of chemical (herbicide) and approved by the State Forester.

ATTACHMENT 2

FINANCIAL ESTIMATE

CONTRACTED DAILY RATE

Crew Supervisor	Crewman	Days/Hours	Cost/Day	Total
1	12	1	$1000.00	**$1000.00**

EQUIPMENT INCLUDED

Type	Cost	Estimated Miles/ Hours	Total
Crew Truck Daily Rate	**$0**		
Crew Truck Mileage (included up to 100 miles per day)	**$0**	**100**	
Chipper			

Total Contracted Daily Rate	**$1000.00**

MISCELLANEOUS ITEMS:

Description	Cost	Miscellaneous Miles/ Hours	Total
Crew Truck Mileage	$3.81 per mile	Only if exceed 100 miles per day	0
Chipper	$266.47	1	0

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Agreement	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager Engineering/Operations	
Recommendations: That the Board of Directors approve and authorize the General Manager to sign a funding contribution agreement between the Nevada Division of Water Resources and the Authority for surface and groundwater data collection services within Nevada to be performed by the U.S. Geological Survey for an amount not to exceed $200,695.	

Fiscal Impact:
The required $200,695 is available in the Authority's Capital Budget.

Background:
Since 2006, the Authority has participated in a cooperative program with the Nevada Division of Water Resources (NDWR) and the U.S. Geological Survey (USGS) to fund a surface water and groundwater monitoring program in southern and eastern Nevada. The total annual cost of the program is $568,456, of which the USGS and NDWR will collectively contribute $367,761. The Authority would contribute the remaining $200,695.

The program includes three elements:

1. Eastern and southern Nevada Surface Water Data Network ($102,600) for operating and maintaining stream flow gages and monitoring spring discharge in southern and eastern Nevada;

2. Eastern and southern Nevada Groundwater Data Network ($59,895) for monitoring groundwater in the Las Vegas Valley and regional carbonate-rock province; and

3. Eastern and southern Nevada high altitude precipitation measurements ($38,200) for collecting volumetric precipitation measurements from mountains located in southern and eastern Nevada.

If approved, the program provided for in this agreement partially fulfills the Authority's hydrological monitoring requirements associated with groundwater permits issued by the Nevada State Engineer and requirements set forth in the U.S. Department of the Interior and Authority stipulated agreements.

This agreement is being entered into pursuant to NRS 277.180 and Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:ZLM:AB:JPP:GMK:lmv:nsh
Attachments

AGENDA ITEM # 8

BRIAN SANDOVAL
Governor

STATE OF NEVADA

LEO DROZDOFF
Director

JASON KING, P.E.
State Engineer

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES
901 South Stewart Street, Suite 2002
Carson City, Nevada 89701-5250
(775) 684-2800 • Fax (775) 684-2811
http://water.nv.gov

FUNDING CONTRIBUTION AGREEMENT FOR HYDROLOGIC STUDIES IN EASTERN AND SOUTHERN NEVADA

The Southern Nevada Water Authority (SNWA) agrees to contribute funding to the Nevada State Engineer (NSE) for Federal Fiscal Year 2015 for continuation of hydrologic studies in eastern and southern Nevada with work to be performed by the U.S. Geological Survey (USGS).

SNWA agrees to contribute a portion of the total actual USGS cost of hydrologic work as described in the letter to the NSE dated August 25, 2014 from John Sciacca, Director of the USGS Nevada Water Science Center. It is understood that the total cost of the project for the period October 1, 2014 through September 30, 2015 is $568,456. SNWA's share is $200,695, or such lesser amount as determined by reducing SNWA's share by the sum contributed by any other participant from the State of Nevada. The specified amount will be paid to the NSE for use in performing, or having performed said studies, with payments to be made promptly after receipt of the NSE's billing.

The hydrologic work is to be performed as a cooperative effort between the USGS, the NSE and SNWA to further understand the hydrology and water resources of eastern and southern Nevada.

NEVADA STATE ENGINEER

By: _____

Title: State Engineer

Date: 9/2/14

SOUTHERN NEVADA WATER AUTHORITY

By: _____

Title: John J. Entsminger
General Manager

Date: _____

Southern Nevada Water Authority
Approved as to form:
By Dana Walsh Date 10-7-14

BRIAN SANDOVAL
Governor

STATE OF NEVADA

LEO DROZDOFF
Director

JASON KING, P.E.
State Engineer

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES
901 South Stewart Street, Suite 2002
Carson City, Nevada 89701-5250
(775) 684-2800 • Fax (775) 684-2811
http://water.nv.gov

September 2, 2014

Mr. Gavin Kistinger, Hydrologist
Southern Nevada Water Authority
Water & Environmental Resources Department
Water Resources Division
P.O. Box 99956
Las Vegas, Nevada 89113

RE: HYDROLOGIC STUDIES IN SOUTHERN AND EASTERN NEVADA

Dear Mr. Kistinger:

Please find enclosed the Contribution Funding Agreement for the subject program with work to be performed by the U.S. Geological Survey. Three original copies of this agreement for the federal fiscal year 2015 are enclosed with this letter, one for your records and two to be returned to this office for processing. Please return the signed funding agreements at your earliest possible convenience.

The enclosed agreement includes by reference a letter that summarizes your share of the costs for the subject program. You will be billed later for your share by the Nevada Department of Conservation and Natural Resources. If you have any questions please contact Matt Dillon at (775) 684-2856.

Sincerely,

Jason King, P.E.
State Engineer

JK:md

cc: Andrew Burns, SNWA Division Manager
John Guillory, NDWR

United States Department of the Interior

U.S. GEOLOGICAL SURVEY

PACIFIC REGION
NEVADA WATER SCIENCE CENTER
2730 N. Deer Run Road
Carson City, Nevada 89701
Phone: 775-887-7600; Fax: 775-887-7629
Website: http://www.usgs.gov/

August 25, 2014

Jason King, State Engineer
Nevada Division of Water Resources
901 South Stewart Street, Suite 2002
Carson City, Nevada 89701

Dear Mr. King:

The Nevada Water Science Center (NVWSC) thanks you for your continued support of the surface-water (SW) and groundwater (GW) monitoring program conducted cooperatively between the U.S. Geological Survey (USGS) and the Nevada Division of Water Resources (NDWR). This program is conducted using pass-through funding from Southern Nevada Water Authority (AUTHORITY) in the eastern and southern part of Nevada.

The total cost for continued operation and maintenance (O&M) will be $568,456 for the period of performance October 1, 2014 – September 30, 2015. NDWR's portion of the funds to support the cooperative program is $113,313 and the AUTHORITY's portion of the funds is $200,695. Pending availability of Cooperative Water Program Funds, the USGS contribution will be $254,448.

The following table lists the contributions from NDWR, AUTHORITY, and USGS for Federal fiscal year 2015. A more detailed description of the funding is provided on Enclosures 1 and 2.

USGS Project No.	Program Element	Estimated Funding Structure			Total Funds
		NDWR	AUTHORITY	USGS**	
NV-00190	Eastern and Southern Nevada SW (Enclosure 1)	$49,038	$102,600	$132,146	$283,784
NV-00290	Eastern and Southern Nevada GW (Enclosure 2)	$64,275	$98,095	$122,302	$284,672
	GRAND TOTAL	**$113,313**	**$200,695**	**$254,448**	**$568,456**

** *USGS funds are subject to availability of FY 2015 Federal matching funds.*

The objectives of this study are to:

1. Establish, operate, and maintain hydrologic monitoring networks;
2. Maintain a data base of collected hydrologic data;
3. Collect long-term hydrologic data within the carbonate-rock province study area;
4. Obtain new or refined hydrologic information that would advance the level of knowledge on how the carbonate-rock province study area hydrologically functions;
5. Maintain a cooperative working relationship with all organizations that manage and/or monitor surface-water in southern Nevada;
6. Provide quality assurance and quality control protocols for hydrologic data collection by all involved agencies;
7. Disseminate collected data in a timely manner.

If you approve of this work and the funding required, please sign the attached JFA and return it to Helen Houston at NVFinance@usgs.gov so we may provide your agency with uninterrupted, continuous data. Funds are not required at this time. A signed agreement is not a bill, only an agreement to pay for the work that will be done.

If you have questions please refer to the contact list on Enclosure 3.

Sincerely,

John Sciacca, Director
USGS Nevada Water Science Center

Enclosures

cc: B. Rinne, J. Johnson, G. Kistinger, SNWA
M. Poff, S. Berris, USGS, NVWSC
GS-W-NV Finance

Enclosure 1

Summary of Cooperative Surface-Water Program for Federal Fiscal Year 2015

Program Elements

A. Operation of Surface-Water Gaging Stations

The current work-plan calls for site operation and maintenance of surface-water gaging stations at two diversions, eight springs and five streams; monitored during FY 2015.

The operation & maintenance costs include maintaining the stream-gaging equipment, providing real-time telemetry and display of hydrologic data on USGS web page, making scheduled water discharge measurements, reduction and analysis of stage data, verification and development of stage/discharge relationships (ratings), computation of daily stream-flow, and data publication costs. Sites are generally visited on a 6-week basis, but may require more frequent visits if problems occur.

Provisional data from sites with data collection platforms (DCP), will be available on NWISWeb at http://waterdata.usgs.gov/nv/nwis/rt. All data will be compiled, reviewed, quality-assured, finalized and disseminated in the annual publication, "U.S. Geological Survey Water-Resources Data--Nevada."

Operation of Continuous Surface-Water Gaging Stations at:

Site Name	Type
1. Corn Creek Spring near Las Vegas	Spring
2. White River near Red Mountain near Preston	Stream
3. Big Springs Creek North Channel near Baker	Stream
4. Big Springs Creek South Channel near Baker	Stream
5. Cleve Creek near Ely	Stream
6. Steptoe Creek near Ely, NV	Stream
7. Preston Big Spring near Preston, NV	Spring
8. Crystal Springs near Hiko, NV	Spring
9. Crystal Springs Diversion near Hiko, NV	Diversion
10. Ash Springs Creek below Hwy. 93 at Ash Springs, NV	Spring
11. Ash Springs Creek Diversion	Diversion
12. NDW-Hot Creek Spring	Spring
13. Geyser Spring	Spring
14. Stump Spring near Pahrump, NV	Spring
15. Grapevine Spring and precipitation near Pahrump, NV	Spring/Precipitation

B. Biannual collection of discharge

Miscellaneous measurements collected on a biannual basis, at twenty springs in Moapa, Railroad, and Meadow Valleys, are planned for May and September, 2015. Panaca Spring will only be measured on an annual frequency because of operational constraints. Included in this activity are data reduction, dissemination and quality assurance of measurements.

Provisional water-level data will be supplied to cooperators quarterly within four weeks of data collection. All data will be compiled, reviewed, quality-assured, finalized and disseminated in the annual publication, "U.S. Geological Survey Water-Resources Data--Nevada."

Biannual discrete spring measurements of discharge at:

Site Name	Valley
a. Moorman Spring	White River
b. Lund Spring	White River
c. Cold Spring	White River
d. Nicholas Spring	White River
e. Arnoldson Spring	White River
f. Flag Spring 1	White River
g. Flag Spring 2	White River
h. Flag Spring 3	White River
i. Butterfield Spring	White River
j. Baldwin Flume	Moapa
k. Muddy River 10	Moapa
l. Muddy River 11	Moapa
m. Muddy River 12	Moapa
n. Muddy River 13	Moapa
o. Warm Springs East	Moapa
p. Muddy River 15	Moapa
q. Muddy River 16	Moapa
r. Muddy River 19	Moapa
s. Muddy River 20	Moapa
t. Panaca Spring (annual)	Meadow

Cost Structure of Programs A and B:

Station Number	Program Element	NDWR Funds	AUTHORITY Funds	USGS Funds*	Total Funds
	Program Element A.				
09419625	Corn Creek Spring near Las Vegas	$0	$10,800	$8,135	$18,935
09415460	White River near Red Mountain near Preston	$0	$10,800	$8,135	$18,935
102432241	Big Springs Creek North Channel near Baker, Nv	$0	$10,800	$8,135	$18,935
10243224	Big Springs Creek South Channel near Baker, Nv	$0	$10,800	$8,135	$18,935
10243700	Cleve Creek nr. Ely, NV	$10,800	$0	$8,135	$18,935
10244950	Steptoe Creek nr. Ely, NV	$9,850	$0	$7,419	$17,269
09415510	Preston Big Spring nr. Preston, NV	$10,800	$0	$8,135	$18,935
09415590	Crystal Springs nr Hiko, NV	$0	$10,800	$8,135	$18,935
09415589	Crystal Springs Diversion nr Hiko, NV	$0	$10,800	$8,135	$18,935
09415645	Ash Springs Crk Below Diversion at Hwy. 93 at Ash Springs, NV	$0	$10,800	$8,135	$18,935
094156395	Ash springs Diversion Ditch blw Hwy 93 at Ash Springs, NV	$0	$10,800	$8,135	$18,935
09415558	Hot Creek nr Sunnyside, NV	$0	$10,800	$8,135	$18,935
10245100	Geyser Creek at Springs Orifice nr Minerva, NV	$5,400	$5,400	$8,135	$18,935
	Stump Spring nr Pahrump, NV	$0	$0	$8,135	$8,135
	Grapevine Spring and precipitation nr Pahrump, NV	$0	$0	$9,792	$9,792
	Program Element B.				
	Misc. Spring Measurements	$12,188	$0	$9,180	$21,368
	TOTAL	$49,038	$102,600	$132,146	$283,784

** USGS funds are subject to availability of FY 2015 Cooperative Water Program funds*

Enclosure 2

Summary of Cooperative Groundwater Program for Federal Fiscal Year 2015

Program Elements

A. Operation of water level monitoring stations

The current work-plan calls for site operation and maintenance of continuous water level monitoring stations in eight wells completed in basin-fill and seven wells completed in carbonate rock; monitored during FY 2015. Of these sites nine wells are in the Carbonate-Rock Province, and six wells are in Las Vegas Valley.

The operation & maintenance costs include maintaining the water level monitoring equipment, making scheduled water level measurements with calibrated measuring tapes, reduction and analysis of water level data, quality assurance (including calibration) of field equipment, computation of daily water level, and data publication costs. Sites are generally visited on a 6-8 week basis, but may require more frequent visits if problems occur.

Provisional data from sites with data collection platforms (DCP) will be available on NWISWeb at http://waterdata.usgs.gov/nv/nwis/rt. All data will be compiled, reviewed, quality-assured, finalized and disseminated in the annual publication, "U.S. Geological Survey Water-Resources Data--Nevada."

Operation of water level monitoring stations at:

	Station Name	Local Well Number	Aquifer	Depth	DCP
1.	CNLV Regional Park 1	212 S19 E61 21DDB 1	fill[1]	1300'	No
2.	CNLV Deer Springs	212 S19 E61 19BC1	fill	650'	No
3.	CNLV Allen & Lone Mtn	212 S19 E61 32CC1	fill	650'	No
4.	CNLV Diana Terrace	212 S20 E61 13ABDB1	fill	1230'	No
5.	CNLV Wilshire	212 S20 E62 05CAAA1	fill	1000'	No
6.	Maude Fitzpatrick	212 S22 E61 04BCB 1	fill	355'	No
7.	USBLM SHV-1	217 S16 E63 09DDAB1	carb[2]	920'	Yes
8.	CE-DT-4 (MX-4)	210 S13 E63 23DDDC1	carb	669'	Yes
9.	CSV-2 well	219 S13 E65 28DAC1	carb	478'	Yes
10.	USGS-MX (Delamar Well)	182 S06 E63 12AD 1	fill	1195'	Yes
11.	USGS-MX (S. Dry Lake)	181 S03 E64 12AC 1	fill	1000'	Yes
12.	USGS-MX (N. Dry Lake)	181 N03 E63 27CAA 1	carb	2395'	Yes
13.	USGS MX Coal Valley Well	172 N03E5910BD1	carb	1837'	Yes
14.	USGS-MX Steptoe Valley Well	179 N12 E63 12AB1	carb	640'	Yes
15.	Creech New Field Well	161 16S 56E 03CC	carb	560'	Yes

[1]*fill = Basin fill aquifer*
[2]*carb = Regional Paleozoic carbonate aquifer*

B. Quarterly collection of water levels in the Carbonate-Rock Province

Miscellaneous water level measurements collected on a quarterly basis, from wells in the Carbonate Rock Province, are planned for FY 2015. Included in this activity are data reduction, dissemination and quality assurance of measurements. Frequency of data collection will be fixed, and will occur in December 2014, March 2015, June 2015, and September 2015.

Provisional water level data will be supplied to cooperators quarterly within four weeks of data collection. All data will be compiled, reviewed, quality-assured, finalized and disseminated in the annual publication, "U.S. Geological Survey Water-Resources Data--Nevada."

Water levels measured by the Southern Nevada Water Authority will be provided to USGS at the same schedule as when these data are provided to the State of Nevada.

Quarterly collection of water levels in the Carbonate-Rock Province at:

	Agency Site ID	Local Number	Name	Aquifer	Depth
1.	380652116200901	156 N03 E50 13CA 1	USGS-MX (Revielle Valley)	fill[1]	682'
2.	382901116125201	156 N07 E51 10AD 1	USGS-MX (Hot Creek 1)	fill	480'
3.	380906116050502	173B N03 E52 02DA 2	USGS-MX (S. R&R Valley)	fill	495'
4.	384338115283601	173B N10 E58 17CAAB1	USGS-MX (N. R&R Valley)	fill	581'
5.	384920115343001	173B N11 E57 09CDB 1	USBLM - Ball Creek Well 1	fill	186'
6.	393624115244601	175 N20 E58 14BDAB1	------	fill	135'
7.	393510115274801	175 N20 E58 20DBDA1	USBLM	fill	233'
8.	393425115215301	175 N20 E59 30DADA1	------	fill	unknown
9.	394418115250301	175 N22 E58 34AADA1	175 Big Tank Well	fill	unknown
10.	394340115252501	175 N22 E58 34DC 1	USGS-MX	fill	150'

[1]*fill = Basin fill aquifer*

C. Biannual high altitude precipitation measurements

Collecting biannual, volumetric measurements from eleven high-altitude precipitation stations is planned for FY 2015. This activity includes data reduction, dissemination, and quality assurance of measurements. Frequency of site visits and data collection will be fixed and will occur in October 2014 and June 2015. Starting in FY 2015, pressure sensors will be installed in each station to collect time series precipitation data on an hourly basis. Time series will be provided to the Authority with minimal processing and will not be input to the USGS NWIS database for computation or publication.

Provisional precipitation data will be supplied to cooperators quarterly within four weeks of data collection. All data will be compiled, reviewed, quality-assured, finalized and disseminated in the annual publication, "U.S. Geological Survey Water-Resources Data--Nevada."

Should data collection in any of the above noted elements be interrupted or data collection incomplete, USGS will inform the cooperators as soon as possible upon learning of the interruption.

Biannual high altitude precipitation measurements at:

	Latitude	Longitude	Elevation	Name
1.	391913	1141431	9300'	Unnamed Peak NW of Mt. Moriah
2.	381438	1142333	9200'	Mt. Wilson
3.	363500	1151443	9600'	Sheep Peak
4.	355641	1152946	8080'	Potosi Peak
5.	372035	1144329	7891'	S. Delamar Mtns
6.	373107	1144333	7867'	S. of Chokecherry Peak
7.	375337	1143438	9375'	Highland Peak
8.	373915	1152328	8640'	Mt. Irish
9.	361738	1154042	10104'	Mt. Charleston
10.	381157	1153731	9,100'	Quinn Canyon Range
11.	380025	1162738	9,100'	Kawich Range

Eight precipitation stations were discontinued FY15by agreement between the Southern Nevada Water Authority and USGS.

Cost Structure of Programs A, B and C:

Program Element	NDWR Funds	AUTORITY Funds	USGS Funds*	Total Funds
Program Element A.				
CNLV Regional Park 1	$7,200	$0	$5,423	$12,623
CNLV Deer Springs	$7,200	$0	$5,423	$12,623
CNLV Allen & Lone Mtn	$7,200	$0	$5,423	$12,623
CNLV Diana Terrace	$7,200	$0	$5,423	$12,623
CNLV Wilshire	$7,200	$0	$5,423	$12,623
Maude Fitzpatrick	$7,200	$0	$5,423	$12,623
USBLM SHV-1	$0	$8,150	$6,139	$14,289
CE-DT-4 (MX-4)	$0	$8,150	$6,139	$14,289
CSV-2 well	$0	$8,150	$6,139	$14,289
USGS-MX (Delamar Well)	$0	$8,150	$6,139	$14,289
USGS-MX (N. Dry Lake)	$0	$8,150	$6,139	$14,289
USGS-MX (S. Dry Lake)	$0	$8,150	$6,139	$14,289
USGS MX Coal Valley Well	$8,150	$0	$6,139	$14,289
USGS-MX Steptoe Valley Well	$8,150	$0	$6,139	$14,289
Creech Near Field Well		$8,150	$6,139	$14,289
Total	$59,500	$57,050	$87,789	$204,339
Program Element B.				
Quarterly Water Levels in Carbonate Rock Prov.	$4,775	$2,825	$5,725	$13,325
Program Element C.				
Biannual High Altitude Precip. Measurements	$0	$38,200	$28,788	$67,008
TOTAL	$64,275	$98,075	$122,302	$284,672

** USGS funds are subject to availability of FY 2015 Cooperative Water Program funds.*

Enclosure 3

JFA#:15WSNV00300_00

USGS Nevada Water Science Center
2730 N. Deer Run Road
Carson City, NV 89701
Phone: 775-887-7600
Fax: 775-887-7629
DUNS: 178930541

Nevada Division of Water Resources
901 S. Stewart Street, Suite 2001
Carson City, NV 89701
Phone: 775-687-4380
FAX: 775-687-6972
TID: 88-6000022

Technical Contact
Megan Poff; Steven Berris
Phone: 702 564-4526; 775-887-7693
mpoff@usgs.gov; snberris@usgs.gov

Technical Contact
Matt Dillon, Associate Engineer
Phone: 775-684-2856
mdillon@water.nv.gov

Executive Contact
John Sciacca, Director
Phone: 775-887-7650
jsciacca@usgs.gov

Executive Contact
Jason King, State Engineer
Phone: 775-684-2861

Billing Contact
Helen Houston, Budget Analyst
Carson City, NV 89701
Phone 775-887-7605
NVFinance@usgs.gov

Billing Contact
Rosa Mayhall, Fiscal Services
Phone: 775-684-2880
rmayhall@water.nv.gov

Any updates to contact information can be submitted to Helen Houston at NVfinance@usgs.gov.

Form 9-1366
(Oct. 2005)

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

JOINT FUNDING AGREEMENT

Customer #:	6000000345
Agreement #:	15WSNV00300
Project #:	
TIN #:	88-6000022
Fixed Cost Agreement	YES

FOR

WATER RESOURCES INVESTIGATIONS

THIS AGREEMENT is entered into as of the, 25 day of August, 2014 by the U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the Nevada Division of Water Resources (NDWR). , party of the second part.

1. The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation of the surface-water (SW) and ground-water (GW) monitoring program herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50; and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) includes In-Kind Services in the amount of $0.00 .

   (a) by the party of the first part during the period

Amount	Date	to	Date
$254,448.00	October 1, 2014		September 30, 2015

   (b) by the party of the second part during the period

Amount	Date	to	Date
$314,008.00	October 1, 2014		September 30, 2015

   DUNS: 618881197

   (c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

   (d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

9-1366 (Continuation) Customer #: 6000000345 Agreement #: 15WSNV00300

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.

9. USGS will issue billings utilizing Department of the Interior Bill for Collection (form DI-1040). Billing documents are to be rendered quarterly. Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof, that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983).

U.S. Geological Survey United States Department of the Interior **USGS Point of Contact**		Nevada Division of Water Resources **Customer Point of Contact**	
Name:	Steve Berris	Name:	Matt Dillon
Address:	2730 N. Deer Run Road Carson City, NV 89701	Address:	901 South Stewart Street . Suite 2001 Carson City, NV 89701
Telephone:	(775) 887-7693	Telephone:	(775) 684-2856
Email:	snberris@usgs.gov	Email:	mdillion@water.nv.us

Signatures and Date

Signature:	Date:	Signature:	Date:
Name: John Sciacca		Name: Jason King	
Title: Director		Title: State Engineer	
Signature:	Date:	Signature:	Date:
Name:		Name:	
Title:		Title:	
Signature:	Date:	Signature:	Date:
Name:		Name:	
Title:		Title:	

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Agreement	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors approve and authorize the General Manager to sign an agreement between Spring Valley Associates, LLC, and the Authority for professional staffing services for the Authority's Northern Resources properties, for an amount not to exceed $975,000 annually for a three-year term, with an option to extend for another three-year term.	

Fiscal Impact:
Ranch operations are funded by the Authority's Operating Budget. There is no fiscal impact to the current fiscal budget if this agreement is approved. In fiscal year 2015/2016 the total not-to-exceed amount will increase to $975,000. Revenue from agricultural and livestock operations offset direct operating expenses.

Background:
On April 12, 2007, the Authority entered into an agreement with Spring Valley Associates, LLC, for the operation and maintenance of the Authority's Northern Resources properties and grazing allotments located in White Pine and Lincoln Counties. On December 18, 2008, the Board of Directors approved Amendment No. 1 to increase the total not-to-exceed amount of the initial agreement due to additional costs for the rehabilitation of the Northern Resources properties. On December 17, 2009, the Board approved Amendment No. 2 to change the contract year to a calendar year basis. On June 21, 2012, the Board approved Amendment No. 3, which increased the total not-to-exceed amount due to expansions in alfalfa and harvestable hay acreage and increased costs to manage 90,000 acres of ranch property that were previously managed by another contractor. The current agreement will expire on December 31, 2014.

If approved, the attached agreement requests an increase in the annual not-to-exceed amount from $850,000 to $975,000. This increase is necessary to facilitate the continued growth in ranch operations including increases in livestock populations and harvestable acreage, as well as the accompanying increases in labor costs for managing this growth.

This agreement is being entered into pursuant to NRS 332.115(1)(b) and Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:ZLM:BJP:nsh
Attachments

AGENDA ITEM # 9

DISCLOSURE OF OWNERSHIP/PRINCIPALS

Business Entity Type						
☐ Sole Proprietorship	☐ Partnership	☒ Limited Liability Company	☐ Corporation	☐ Trust	☐ Non-Profit Organization	☐ Other

Business Designation Group					
☐ MBE	☒ WBE	☐ SBE	☐ PBE	☐ ESB	☐
Minority Business Enterprise	Women-Owned Business Enterprise	Small Business Enterprise	Physically Challenged Business Enterprise	Emerging Small Business	

Corporate/Business Entity Name:			
(Include d.b.a., if applicable)	Spring Valley Associates, LLC		
Street Address:	PO Box 150083	**Website:**	
City, State and Zip Code:	Ely, NV 89315	**POC Name and Email:**	
Telephone No:	435-855-2122	**Fax No:**	435-855-2122
Local Street Address:		**Website:**	
City, State and Zip Code:		**Local Fax No:**	
Local Telephone No:		**Local POC Name Email:**	
Number of Clark County, Nevada Residents Employed:	Ø		

All entities, with the exception of publicly-traded and non-profit organizations, must list the names of individuals, either directly or indirectly, holding more than five percent (5%) ownership or financial interest in the business entity appearing before the SNWA Board of Directors.

Publicly-traded entities and non-profit organizations shall list all Corporate Officers and Directors in lieu of disclosing the names of individuals with ownership or financial interest. The disclosure requirement, as applied to land-use applications, extends to the applicant and the landowner(s).

Entities include all business associations organized under or governed by Title 7 of the Nevada Revised Statutes, including but not limited to private corporations, close corporations, foreign corporations, limited liability companies, partnerships, limited partnerships, and professional corporations.

Full Name	Title	% Owned (Not required for Publicly Traded Corporations/Non-profit organizations)
Kerri Wright	Manager	100%

This section is not required for publicly-traded corporations.

1. Are any individual members, partners, owners or principals, involved in the business entity, an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please note that SNWA employee(s), or appointed/elected official(s) may not perform any work on professional service contracts, or other contracts, which are not subject to competitive bid.)

2. Do any individual members, partners, owners or principals have a spouse, registered domestic partner, child, parent, in-law or brother/sister, half-brother/half-sister, grandchild, grandparent, related to an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please complete the Disclosure of Relationship form on Page 2. If no, please print N/A on Page 2.)

I certify under penalty of perjury, that all of the information provided herein is current, complete, and accurate. I also understand that the SNWA will not take action on land-use approvals, contract approvals, land sales, leases or exchanges without the completed disclosure form.

Kerri Wright
Signature

Kerri Wright
Print Name

Manager
Title

10/27/2014
Date

DISCLOSURE OF RELATIONSHIP

List any disclosures below:
(Mark N/A, if not applicable.)

NAME OF BUSINESS OWNER/PRINCIPAL	NAME OF SNWA EMPLOYEE OR OFFICIAL AND JOB TITLE	RELATIONSHIP TO SNWA EMPLOYEE OR OFFICIAL	SNWA EMPLOYEE'S/OFFICIAL'S DEPARTMENT
N/A			

"Consanguinity" is a relationship by blood. "Affinity" is a relationship by marriage.

"To the second degree of consanguinity" applies to the candidate's first and second degree of blood relatives as follows:

- Spouse – Registered Domestic Partners – Children – Parents – In-laws (first degree)
- Brothers/Sisters – Half-Brothers/Half-Sisters – Grandchildren – Grandparents – In-laws (second degree)

For SNWA Use Only:

If no Disclosure or Relationship is noted above or if the section is marked N/A, please check this box:

☒ No Disclosure

If any Disclosure of Relationship is noted above, please complete the following:

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in the contracting/selection process for this particular agenda item?

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in any way with the business in performance of the contract?

Notes/Comments:

Signature

David L. Johnson

Print Name
Authorized Department Representative

AGREEMENT TO PROVIDE PROFESSIONAL SERVICES

This Agreement is made and entered into this _____ day of November, 2014, by and between SPRING VALLEY ASSOCIATES, LLC, a Utah limited liability company, hereinafter called "SVA," and the SOUTHERN NEVADA WATER AUTHORITY, a political subdivision of the State of Nevada, hereinafter called the "AUTHORITY." SVA and the AUTHORITY are sometimes hereinafter referred to individually as "Party" and collectively as the "Parties." The term "AUTHORITY" also refers to staff of the AUTHORITY acting within their designated authority and duties.

WITNESSETH:

WHEREAS, the AUTHORITY owns and operates several ranches comprised of approximately 24,000 acres in White Pine County and Lincoln County, Nevada. The ranches are currently operated to produce alfalfa, hay, and forage for cattle and sheep. Additionally, the AUTHORITY holds grazing permits that allow it to graze cattle and sheep on approximately 933,000 acres of federal land;

WHEREAS, the AUTHORITY staffs its ranch operations using a mix of AUTHORITY employees and non-AUTHORITY staff. The nature of ranching operations requires the availability of workers on a temporary or seasonal basis, as well as full-time specialists in agricultural operations who are employed by a staffing company;

WHEREAS, the AUTHORITY desires to obtain professional staffing services for its ranch operations as more specifically described herein;

WHEREAS, SVA has been providing ranch staffing services since 2007 and is properly qualified and desires to provide the professional services required by the AUTHORITY; and

WHEREAS, the AUTHORITY, in reliance on SVA's representations and proposals, agrees to retain SVA, and SVA agrees to furnish professional services to the AUTHORITY, on the terms and conditions hereinafter set forth.

NOW, THEREFORE, in consideration of the promises and mutual covenants contained herein, the Parties hereto agree as follows:

1. SCOPE OF SERVICES:

(a) SVA shall provide staffing services to the AUTHORITY, as further described in this Agreement, hereinafter referred to as "Services" or "Work."

(b) All Services performed shall be subject to the cost ceiling contained in Paragraph 4 hereof and subject to the AUTHORITY's directions respecting priorities. SVA will furnish professional Services in the amount necessary to complete promptly and effectively the Work assigned under this Agreement. All of the Services shall be performed by SVA or an approved subcontractor.

(c) In performing Services under this Agreement, SVA shall observe and abide by the terms and conditions of all applicable laws, regulations, ordinances, or rules of the United States, of the State of Nevada, of any political subdivision thereof, and of any other duly constituted public authority or agency. SVA shall be responsible for obtaining any license, permit or other approval as required by law or otherwise, arising out of the Services to be performed hereunder.

(d) SVA has, or will secure at its own expense, the qualified personnel required to perform the Services assigned under this Agreement. Such personnel shall not also be employed by the AUTHORITY.

2. PERIOD OF PERFORMANCE:

This Agreement shall become effective as of the date it is fully executed by both Parties and, unless terminated in accordance with the terms of this Agreement, shall remain in effect for three (3) years. The AUTHORITY, in its sole discretion, may extend this Agreement for a second 3-year term by giving written notice to SVA thirty (30) days before the Agreement expires.

3. COMPENSATION:

(a) In consideration for completion of all duties and responsibilities under this Agreement, the AUTHORITY agrees to pay SVA for Work completed.

(b) SVA shall provide itemized monthly invoices for Services performed during the previous month. Invoices are to be submitted to the AUTHORITY in accordance with the Notice provisions of the Agreement and must reference the name and date of the Agreement. A copy of any invoice received from subcontractors used by SVA shall be included.

(c) SVA shall be compensated for Work performed pursuant to this Agreement on a cost-plus-fixed-fee basis. The total yearly costs reimbursed under this Agreement shall not exceed the amount set forth in Paragraph 4, inclusive of the fixed management fee paid to SVA. Costs to be reimbursed pursuant to this Agreement shall be only the following:

i. Labor costs for SVA full-time employees

ii. Labor costs for SVA part-time, temporary and/or seasonal employees

iii. Labor costs for H-2A temporary agricultural workers

iv. Necessary insurance

v. Travel and associated daily subsistence expenses for H-2A temporary agricultural workers, as required by federal regulations

vi. Meals and communications expenses for H-2A temporary agricultural workers, as required by federal regulations

vii. Utilities for SVA employees and H-2A temporary agricultural workers housed in AUTHORITY-owned facilities

viii. General and administrative expenses

(collectively hereinafter referred to as "Cost" or "Costs")

(d) The fixed management fee paid to SVA shall not exceed forty thousand dollars ($40,000) annually. The fixed management fee compensates SVA for the professional services provided pursuant to this Agreement, such as payroll processing; recruitment of SVA employees and temporary workers; H-2A program compliance; coordinating travel arrangements for H-2A temporary agricultural workers; budgeting and reporting as requested by the AUTHORITY; and administrative functions related to insurance and licensing processing for SVA employees and temporary workers.

(e) Payment shall be made by the AUTHORITY based on the monthly submission of bills by SVA which will include a detailed description of the Cost and be supported with accompanying invoices, bills, wage statements, etc., or other documentation as required by the AUTHORITY's Ranch & Resource Manager, signed by SVA and warranted as true and correct. Payment by the AUTHORITY will include an amount equal to the described Cost for reimbursable expenses plus the prorated monthly portion of the fixed management fee, which is equal to three thousand three hundred thirty-three dollars and thirty-three cents ($3,333.33).

4. <u>LIMITATION ON COSTS:</u>

The total cost of Services provided and Costs reimbursed under this Agreement shall not

exceed nine hundred seventy-five thousand dollars ($975,000) per contract year.

5. TRUTH-IN-NEGOTIATION CERTIFICATION:

Signing of this Agreement by SVA shall constitute a truth-in-negotiation certification by SVA that wage rates and other factual unit costs supporting the compensation of this Agreement are accurate, complete, and current at the time of execution of this Agreement. The original Agreement price and any additions thereto shall be adjusted to exclude any significant sums by which the AUTHORITY determines the Agreement price was increased due to inaccurate, incomplete, or noncurrent wage rates and other factual unit costs. All such Agreement adjustments shall be made within one (1) year following the end of the term of this Agreement.

6. INDEPENDENT CONTRACTOR:

The relationship of SVA to the AUTHORITY hereunder shall be that of an independent contractor and not an agent or employee. SVA shall have complete control over its employees and the method of performing its Work under this Agreement. No permitted or required approval by the AUTHORITY of personnel, costs, documents or Services of SVA shall be construed as making the AUTHORITY responsible for the manner in which SVA performs its Services or for any acts, errors or omissions of SVA. Such approvals are intended only to give the AUTHORITY the right to satisfy itself with the quality of Work performed by SVA.

7. JOINT VENTURE:

Nothing herein shall be construed to imply a joint venture or principal and agent relationship between the AUTHORITY and SVA, and neither Party shall have any right, power or authority to create any obligation, expressed or implied, on behalf of the other.

8. EMPLOYEES:

SVA will have in its employ at all times a sufficient number of capable employees, as SVA employees and not AUTHORITY employees, to enable it to properly, adequately, safely, and economically perform Work as assigned. All matters pertaining to the SVA employees' hiring, supervision, compensation, promotion, and discharge are SVA's responsibility. SVA will coordinate with the AUTHORITY's Ranch & Resources Manager, Ranch Assistant Manager, Agriculture Foreman, or other AUTHORITY managers, as appropriate, to provide guidance on day-to-day tasks for SVA employees. SVA will fully comply with all applicable state and federal laws, ordinances, and regulations, including but not limited to, workers' compensation, employee safety, social security, federal tax withholding, unemployment insurance, hours of labor, wages, working conditions, and other employee/employer related subjects.

9. HOUSING:

When available, the AUTHORITY will provide housing located on AUTHORITY-owned properties for certain SVA employees at no cost to SVA or the SVA employees. The AUTHORITY will also provide housing for H-2A temporary agricultural workers at no cost to the workers or SVA. For those SVA employees that live in AUTHORITY-owned housing, then either: (1) SVA will be responsible for providing, or causing to be provided, insurance for the SVA employees' personal belongings, or (2) those SVA employees that live in AUTHORITY-owned housing will be personally responsible for providing their own insurance to cover their personal belongings. In the event that neither SVA nor its employees can obtain or refuse to obtain such insurance, SVA will require those employees to issue a signed release to the AUTHORITY waiving any and all claims against the AUTHORITY related to their personal belongings. The AUTHORITY will not reimburse SVA employees for housing costs.

10. INVITEES:

SVA will not allow any for-profit activities to be conducted on AUTHORITY properties that would involve invitees, including but not limited to, seminars, campouts, recreation activities, or operation of the AUTHORITY properties as a bed-and-breakfast.

11. WORKER SAFETY AND HEALTH PROGRAM:

(a) Necessary vehicles, equipment, and tools will be provided by the AUTHORITY, will be maintained by the AUTHORITY, and shall remain property of the AUTHORITY while in use by SVA. SVA will be responsible for providing safety and operation training for the vehicles, equipment, and tools provided by the AUTHORITY.

(b) SVA shall implement a Worker Safety and Health Program that conforms to all federal, state, and local safety and health requirements and will appoint a dedicated safety representative to administer the program. SVA shall conduct New Employee Orientation that meets Nevada's Workplace Safety Rights and Responsibilities requirements and maintain the appropriate documentation. SVA shall maintain employee training records and make them available to the AUTHORITY upon request.

(c) SVA will ensure vehicles, equipment and tools are in a safe working condition by conducting pre-use and serviceability inspections and will notify the AUTHORITY's Ranch & Resource Manager of any issues identified. Unserviceable vehicles, equipment and tools will not be used until repaired or replaced. SVA will only allow workers to operate or use vehicles, equipment and tools for which they have received proper training. SVA will immediately notify the AUTHORITY's Ranch & Resource Manager of identified hazards associated with facilities, equipment, tools, or ongoing activities.

(d) SVA will not make modifications to AUTHORITY-owned vehicles, equipment, or tools and will not use these items to perform tasks for which they were not designed.

(e) SVA shall promptly notify the AUTHORITY's Ranch & Resource Manager of injuries and illnesses related to its employees.

(f) SVA shall provide to the AUTHORITY copies of injury and illness logs monthly and the OSHA 300 Summary annually.

12. INTERPRETATION:

The Parties agree that neither Party shall be deemed the drafter of this Agreement and, in the event this Agreement is ever construed by a court of law or equity, such court shall not construe this Agreement or any provision hereof against either Party as drafter of this Agreement.

13. CONFLICT OF INTEREST:

During the course of performance of this Agreement, SVA will not contract with any client whose interest is adverse to or would require SVA to take a position contrary to that of the Las Vegas Valley Water District and/or the AUTHORITY.

14. PROHIBITION AGAINST COMMISSION FOR OBTAINING AGREEMENT:

SVA warrants that no person or company has been employed or retained to solicit or secure this Agreement upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, except bona fide employees; nor has SVA paid or agreed to pay any person, company, corporation, individual or firm other than a partner or bona fide employee, any fee, commission, contribution, donation, percentage, gift, or any other consideration, contingent upon or resulting from award of this Agreement. For any breach or violation of this warranty, the AUTHORITY shall have the right to terminate this Agreement without liability, or at its discretion,

to deduct from the contract price, or otherwise recover, the full amount of such fee, commission, percentage, gift or consideration and any other damages.

15. PROHIBITION AGAINST INTEREST BY GOVERNMENT EMPLOYEES:

(a) No officer, employee or member of the governing body of the AUTHORITY shall (1) participate in any decision relating to this Agreement which affects his or her personal interest or the interest of any corporation, partnership, or association in which he or she is, directly or indirectly, interested or (2) have any interest, direct or indirect, in this Agreement or the proceeds thereof.

(b) SVA represents that it presently has no interest and shall not acquire any interest, direct or indirect, which would conflict in any manner or degree with the performance of Services required to be performed under this Agreement. SVA further covenants that in the performance of said Services, no person having any such interest shall be employed.

(c) No member of, delegate to, or officer or employee of the legislative, executive or judicial branches of the government of the United States, of the State of Nevada or any of its political subdivisions shall be entitled to any share or part hereof or to any benefit to arise therefrom.

16. INDEMNIFICATION:

SVA shall indemnify, hold harmless, and defend without cost to the AUTHORITY, its Board of Directors and its officers, agents, and employees, against any and all losses, claims, costs, damages, actions, proceedings, and liability arising out of, resulting from, or in any way incidental to SVA's provision of Services or Work under this Agreement. This indemnification includes, but is not limited to, claims for or by reason of any death or deaths of, or any physical injury or injuries to,

any person or persons or damage to real or personal property of any kind whatsoever, whether the person(s) or property of SVA, its agents, or subcontractors, or of third parties; harassment or discrimination or any theory of joint or dual employment by SVA's employees, agents, or subcontractors, arising out of the Services or Work under this Agreement; negligence, whether active, passive or contributory, of the AUTHORITY, and its officers, employees or agents; or infringement on any U.S. patent (issued as of the Effective Date) or any copyright or trademark.

17. INSURANCE:

(a) General:

i. SVA shall not commence any Work under this Agreement until SVA obtains, at its own expense, all insurance as required in this section; however, failure to obtain all insurance shall not relieve SVA of its obligations under this Agreement. The types of insurance to be obtained by SVA are Workers' Compensation, Employers' Liability, Automobile Liability, and Commercial General Liability as outlined in the following portions of this section.

ii. The Workers' Compensation, Employers' Liability, and Automobile Liability insurance shall be maintained in force for the full term of the Agreement.

iii. These insurance provisions are in addition and cumulative to any other right of indemnification or contribution that the AUTHORITY may have in law, in equity, or otherwise and shall survive the termination of this Agreement.

iv. Nothing contained in these insurance requirements is to be construed as limiting the extent of SVA's total responsibility for payment of claims arising in whole or in part from the actions of a third party when such actions might be taken as a result of SVA's operations under this Agreement.

v. At the time of executing this Agreement and before commencement of the Work, SVA shall have delivered to the AUTHORITY certificates of insurance and endorsements that attest to the fact that SVA has obtained the insurance as specified in this Agreement.

(b) Other Insurance:

i. All insurance provided by SVA shall be considered primary with respect to the AUTHORITY's insurance, and any similar insurance maintained by the AUTHORITY shall be considered excess and non-contributory.

ii. SVA's Workers' Compensation insurance shall be written with a property and casualty insurance company admitted to do business in the State of Nevada and rated A- or better and Class V or higher of financial size category in the current issue of Best's Key Rating Guide.

iii. SVA's Automobile Liability and Commercial General Liability insurance shall be written with property and casualty insurance companies admitted to do business in the State of Nevada and rated A- or better and Class VIII or higher of financial size category in the current issue of Best's Key Rating Guide.

iv. In the event any of SVA's insurance companies are not admitted to write business in the State of Nevada, then SVA will furnish evidence of insurance with insurance companies that are rated A- or better and Class IX or higher of financial size category in the current issue of Best's Key Rating Guide for each coverage written with a non-admitted carrier.

v. The Certificate of Insurance and related endorsements must be satisfactory to the AUTHORITY as to form and content and must comply with all

insurance requirements as set forth herein, or the certificate and endorsements may be rejected and thereby, at the option of the AUTHORITY, render this Agreement cancelable.

vi. All endorsements are to be dated, reflect the name of the insurance company, the type of insurance, and the policy number; be executed by a duly authorized representative of the insurance company; and be attached to the certificate.

vii. The full legal operating names of SVA and insurance carrier shall be properly shown where applicable.

viii. The cancellation section of the certificate is to be amended to provide thirty (30) days written notice of cancellation and initialed by the Agent.

ix. By endorsement (I.S.O. Forms CG 20 10 07 04 and CA 20 48 02 99, or equivalent), the AUTHORITY shall be included as an additional insured under the Commercial General Liability and Automobile Liability insurance policies as to bodily injury, sickness, disease, or death, personal injury, damage to or destruction of the property or persons which may arise out of or in connection with activities under the Agreement. SVA's insurance shall be primary with respect to the additional insureds; any insurance coverage maintained by the AUTHORITY shall be in excess of SVA's insurance and non-contributing.

x. By endorsement (I.S.O. Form CG 24 04 10 93 or its equivalent), SVA's Commercial General Liability, Automobile Liability and Workers' Compensation Insurance carriers shall waive their transfer rights of recovery (Waiver of Subrogation) against the AUTHORITY, its members and affiliated companies,

successors or assignees, including their directors, officers, and employees individually and collectively.

xi. The additional insured and waiver of subrogation endorsements shall read as follows:

> *The Southern Nevada Water Authority, its members, and affiliated companies, successors, or assigns, including their directors, officers, and employees individually and collectively, when acting within the scope of their employment.*

xii. If SVA fails to procure and/or maintain insurance set forth herein, in addition to other rights or remedies, the AUTHORITY shall have the right, if the AUTHORITY so chooses, to procure and/or maintain the said insurance for and in the name of SVA with the AUTHORITY as an Additional Insured, and SVA shall pay the cost thereof and shall furnish all necessary information to make effective and/or maintain such insurance. In the event SVA fails to pay the cost, the AUTHORITY hereby has the right to offset any premiums from the compensation set forth in this Agreement and directly pay for such coverage.

xiii. With respect to any and all insurance required under this Agreement, the deductible shall not exceed fifty thousand dollars ($50,000), unless otherwise agreed to by the AUTHORITY or the AUTHORITY'S Risk Management Division.

(c) <u>Workers' Compensation and Employers' Liability Insurance:</u>

i. SVA shall procure and maintain such insurance and see that its subcontractors purchase and maintain such insurance as is required under the Nevada Industrial Insurance Act, Nevada Revised Statutes Chapters 616 and 617, for all of

its employees working on the project to protect the AUTHORITY from any industrial insurance claims.

ii. In the event any class of employees engaged in any Work on the project relative to this Agreement is not protected under the Nevada Industrial Insurance Act, then SVA shall provide to the AUTHORITY adequate insurance coverage in a form and by an insurance carrier satisfactory to the AUTHORITY for the protection of such employees.

iii. In the event SVA is permissibly self-insured for Workers' Compensation insurance in the State of Nevada, SVA shall deliver to the AUTHORITY a copy of the Certificate of Consent to Self-Insure issued by the State of Nevada.

iv. SVA shall procure and maintain Employers' Liability Insurance with limits as set forth in Paragraph 17 (g).

(d) Commercial General Liability Insurance:

SVA shall procure and maintain Commercial General Liability insurance coverage. The coverage under this policy shall include, but not be limited to, commercial general liability, protective liability, blanket contractual liability, and broad-form property damage. The Commercial General Liability Insurance policy shall be written for limits as outlined under Paragraph 17 (g). The amount of coverage shall apply to bodily injury, sickness, disease or death, personal injury, damage to or destruction of the property of persons that may arise out of or in connection with the activities under this Agreement.

(e) Automobile Liability Insurance:

SVA shall procure and maintain, at its own expense, automobile liability insurance limits as outlined in Paragraph 17 (g), written on a combined-single-limit basis for bodily injury and property damage including all owned, leased, hired, or non-owned motorized vehicles and apparatus and shall indicate these coverages on the certificate.

(f) It is SVA's sole responsibility to ascertain that the aforementioned insurance requirements are fulfilled. In the event they are not, SVA shall not be relieved of its duty to perform, indemnify, defend, and hold harmless the AUTHORITY and all others concerned herein, nor shall the AUTHORITY and all concerned herein be liable to SVA or any others in the event SVA's insurance, as accepted by the AUTHORITY, fails to meet the full requirements herein.

(g) Insurance Limits

Value of Contract	Coverage	Limits of Liability
$100,000 to $999,999	General Liability	$1,000,000/per occurrence $2,000,000/aggregate
	Automobile Liability	$1,000,000/per occurrence
	Workers' Compensation	Statutory
	Employers' Liability	$100,000

18. TERMINATION:

The AUTHORITY's General Manager, his/her designee and/or SVA may terminate this Agreement on thirty (30) days prior written notice. In the case of termination by the AUTHORITY, the AUTHORITY shall pay SVA for all Work performed to the effective date of termination and the reasonable costs of transferring all documentation of all Work to the AUTHORITY.

19. RELEASE OF INFORMATION:

SVA shall make public information releases only as provided for and in accordance with this Agreement. Any and all other public releases of information gathered, obtained, or produced during the performance of this Agreement must be specifically approved in writing by the AUTHORITY prior to release. Such information shall include, but is not limited to, all products, intellectual property, Work Product, ideas, data, reports, background materials, and any and all other materials belonging to the AUTHORITY. Such public releases of information shall include, but are not limited to, publication in any book, newspaper, magazine, professional or academic journal, the internet, radio, television, and presentations to professional, academic, and/or other groups or conferences.

20. USE OF MATERIALS:

(a) The AUTHORITY shall make available to SVA such materials from its files as may be required by SVA in connection with its performance of Services under this Agreement. Such materials shall remain the property of the AUTHORITY while in SVA's possession.

(b) Upon termination of this Agreement, SVA shall turn over to the AUTHORITY any property of the AUTHORITY in its possession and any calculations, notes, reports, or other materials prepared by SVA in the course of performing this Agreement. Any proprietary software or other tools of SVA used to execute the Work shall remain the property of SVA.

21. RECORDS:

SVA shall retain financial and other records related to this Agreement for six (6) years after the completion or termination of this agreement, and shall make available to the AUTHORITY for

inspection, all books, records, documents, and other evidence directly pertinent to performance under this Agreement upon reasonable notice.

22. ASSIGNMENT:

SVA shall not assign or transfer its interest in this Agreement without the prior written consent of the AUTHORITY. If SVA assigns or transfers without prior written approval, the assignment or transfer shall be void, and not merely voidable.

23. MODIFICATION OF AGREEMENT:

This Agreement may not be changed or modified except by written instrument executed by both Parties or their designees.

24. SEVERABILITY:

Any provisions or portions of this Agreement prohibited as unlawful or unenforceable under any application of law of any jurisdiction shall as to such jurisdiction be ineffective without affecting other provisions of this Agreement. If the provisions of such applicable law may be waived, they are hereby waived to the end that this Agreement may be deemed to be a valid and binding Agreement enforceable in accordance with its terms.

25. NON-DISCRIMINATORY EMPLOYEE PRACTICES:

(a) SVA shall not employ discriminatory practices in the provision of Services, employment of personnel, or in any other respect on the basis of race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin.

(b) No person in the United States shall, on the grounds of race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity made possible by or resulting from this Agreement.

(c) SVA will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin. SVA shall ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin. This non-discrimination provision shall include, but not be limited to employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. SVA agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provision of this non-discrimination clause.

(d) SVA will, in all solicitations or advertisements for employees placed by or on behalf of SVA, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin.

(e) SVA will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice advising the said labor union or workers representatives of SVA's commitment under this provision and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

26. EQUAL EMPLOYMENT OPPORTUNITY:

(a) SVA and any subcontractor working under the authority of SVA, who is responsible for the selection, referral, hiring, or assignment of workers for the Services provided pursuant to this Agreement, is required to comply with all applicable provisions of

Title VII of the Civil Rights Act of 1964. This requirement includes compliance with Equal Employment Opportunity Commission regulations that prohibit discrimination based upon race, color, religion, sex, or national origin. Furthermore, SVA shall in all relevant manners comply with the Age Discrimination in Employment Act, the Civil Rights Act of 1991, the Equal Pay Act, and Title I of the Americans with Disabilities Act.

(b) SVA shall make all necessary documentation as required to comply with the Acts referred to above and shall make such documentation immediately available to the AUTHORITY upon the AUTHORITY's request. SVA is solely liable for failure to comply with this provision.

27. APPLICABLE LAW:

Nevada law shall govern the interpretation of this Agreement, without reference to its choice of law provisions.

28. VENUE:

The Parties agree that venue for any dispute arising from the terms of this Agreement shall be Clark County, Nevada.

29. ATTORNEY'S FEES:

Except as otherwise set forth in this Agreement, the Parties shall bear their own attorneys' fees and costs incurred in resolving claims, as well as in the preparation of this Agreement. In the event that any Party commences an action to enforce or interpret this Agreement, or for any other remedy based on or arising from this Agreement, the prevailing party therein shall be entitled to recover its reasonable and necessary attorneys' fees and costs incurred. For purposes of this provision, the "prevailing party" shall be that party which has been successful with regard to the main issue, even if that party did not prevail on all issues.

30. NO THIRD PARTY RIGHTS:

This Agreement is not intended by the Parties to create any right in or benefit to parties other than the AUTHORITY and SVA. This Agreement does not create any third party beneficiary rights or causes of action.

31. WAIVER:

The failure of either Party to enforce at any time, or for any period of time, the provisions hereof shall not be construed as a waiver of such provisions or of the rights of such Party to enforce each and every such provision.

32. CAPTIONS:

The captions contained in this Agreement are for reference only and in no way to be construed as part of this Agreement.

33. COUNTERPARTS:

This Agreement may be executed in any number of counterparts and by the different Parties on separate counterparts, each of which, when so executed, shall be deemed an original, and all counterparts together shall constitute one and the same instrument.

34. INTEGRATION:

This Agreement contains the entire understanding between the Parties relating to the transactions contemplated by this Agreement, notwithstanding any previous negotiations or agreements, oral or written, between the Parties with respect to all or any part of the subject matter hereof. All prior or contemporaneous agreements, understandings, representations and statements, oral or written, regarding the subject matter of this Agreement are merged in this Agreement and shall be of no further force or effect.

35. NOTICES:

Any and all notices, demands or requests required or appropriate under this Agreement (including invoices), shall be given in writing and signed by a person with authorization to bind SVA or AUTHORITY, either by personal delivery, via facsimile, via a scanned document sent via email, or by registered or certified mail, return receipt requested, addressed to the following addresses and fax numbers:

To SVA:

Spring Valley Associates, LLC
Attn: Kerri Wright
P.O. Box 150083
Ely, NV 89315
EMAIL: kwright_sva@yahoo.com

To AUTHORITY:

Southern Nevada Water Authority
Attn: Bernard Petersen
HC 10 Box 10853
Ely, NV 89301
EMAIL: bernard.petersen@snwa.com
FAX: (775) 591-0480

When notice is given by mail, it shall be deemed served three (3) business days following deposit, postage prepaid in the United States mail. When notice is given by facsimile or email transmission, it shall be deemed served upon receipt of confirmation of transmission if transmitted during normal business hours or, if not transmitted during normal business hours, on the next business day following the facsimile or email transmission.

The Parties may designate a new contact person under this provision for notices or invoices or change the address, email address or fax number identified above by notifying the other Party in writing.

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed the day and year first above written.

SPRING VALLEY ASSOCIATES LLC

By Kerri Wright
Kerri Wright
President

SOUTHERN NEVADA WATER AUTHORITY

By _____
John J. Entsminger
General Manager

Approved as to form:

Dana Walsh
Dana R. Walsh, Deputy Counsel

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Agreement	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager Engineering/Operations	
Recommendations: That the Board of Directors approve and authorize the General Manager to sign an agreement between Quantum Spatial, Inc., and the Authority for digital aerial imagery services for an amount not to exceed $130,000 for the period ending on December 31, 2015.	

Fiscal Impact:
If the above recommendation is approved, no additional funding is required. Quantum Spatial, Inc., will be assigned the funding previously approved for the Clark County Aerial Imagery Project.

Background:
On March 12, 2012, the General Manager approved a professional services agreement with Sanborn Map Company, Inc. (Sanborn), RFP 638-11, to acquire digital aerial images of the Las Vegas Valley and the Boulder City region for an amount not to exceed $70,000, with the option of a 10 percent annual increase for three additional renewals. This imagery would be utilized in support of Authority projects including the Water Smart Landscape Program. Sanborn was selected for their overall presentation and cost analysis, as well as familiarity with the Authority through previous working relationships.

On November 15, 2012, the Board of Directors approved an interlocal agreement among the City of Henderson, the City of Las Vegas, Clark County, the Regional Transportation Commission of Southern Nevada and the Clark County Water Reclamation District and the Authority, which established funding allocations for the Clark County Aerial Imagery Project to acquire imagery during 2013, 2014, and 2015 in areas of Clark County that were in addition to those areas covered by the Authority's existing agreement with Sanborn. On that same date the Board approved an amendment with Sanborn to increase the annual not to exceed amount to $130,000 to cover the areas that were in addition to the March 2012 agreement. All parties to the interlocal agreement funded this increase, which was offset in part by a grant from the U.S. Bureau of Reclamation.

During the 2013 and 2014 contract years, Sanborn was not able to meet the contractual deadlines required for the imagery, requiring RFP 638-11 to be revisited. Photo Science Geospatial Solutions (Photo Science) originally responded to RFP 638-11, was one of the finalists in the process, and was provided an agreement for on-call services to the Authority based upon its qualifications. Since RFP 638-11 closed, Photo Science merged with Quantum Spatial, Inc. (Quantum Spatial), grew its business, and is now in a position to and has agreed to provide the services at the same rate quoted by Sanborn. The Sanborn agreement will expire on December 31, 2014, and not be renewed.

AGENDA ITEM # 10

If approved, this agreement would allow Quantum Spatial to complete RFP 638-11, which would involve capturing the digital data imagery for Clark County and surrounding areas for the 2015 calendar year. The final imagery would allow the Authority to continue meeting its Clark County Aerial Imagery Project obligations. No additional funding beyond that originally anticipated would be required to complete this task.

This agreement is being entered into pursuant to NRS 332.115(1)(b) and Sections 5(p) and 6(i) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved the agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:ZLM:GAF:ch:nh
Attachments

DISCLOSURE OF OWNERSHIP/PRINCIPALS

Business Entity Type						
☐ Sole Proprietorship	☐ Partnership	☐ Limited Liability Company	☒ Corporation	☐ Trust	☐ Non-Profit Organization	☐ Other

Business Designation Group					
☐ MBE	☐ WBE	☐ SBE	☐ PBE	☐	☐
Minority Business Enterprise	Women-Owned Business Enterprise	Small Business Enterprise	Physically Challenged Business Enterprise		

Corporate/Business Entity Name:	Quantum Spatial, Inc.	
(Include d.b.a., if applicable)	N/A	
Street Address:	523 Wellington Way	**Website:** www.quantumspatial.com
City, State and Zip Code:	Lexington, KY 40503-1394	**POC Name and Email:** Jack L. Mitchell, PLS, CP jmitchell@quantumspatial.com
Telephone No:	859-277-8700	**Fax No:** 859-277-8901
Local Street Address:	N/A	**Website:** N/A
City, State and Zip Code:	N/A	**Local Fax No:** N/A
Local Telephone No:	N/A	**Local POC Name Email:** N/A
Number of Clark County, Nevada Residents Employed: N/A		

All entities, with the exception of publicly-traded and non-profit organizations, must list the names of individuals holding more than five percent (5%) ownership or financial interest in the business entity appearing before the SNWA Board of Directors.

Publicly-traded entities and non-profit organizations shall list all Corporate Officers and Directors in lieu of disclosing the names of individuals with ownership or financial interest. The disclosure requirement, as applied to land-use applications, extends to the applicant and the landowner(s).

Entities include all business associations organized under or governed by Title 7 of the Nevada Revised Statutes, including but not limited to private corporations, close corporations, foreign corporations, limited liability companies, partnerships, limited partnerships, and professional corporations.

Full Name	Title	% Owned (Not required for Publicly Traded Corporations/Non-profit organizations)
Geospatial Holdings, Inc.	N/A	100%

This section is not required for publicly-traded corporations.

1. Are any individual members, partners, owners or principals, involved in the business entity, an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please note that SNWA employee(s), or appointed/elected official(s) may not perform any work on professional service contracts, or other contracts, which are not subject to competitive bid.)

2. Do any individual members, partners, owners or principals have a spouse, registered domestic partner, child, parent, in-law or brother/sister, half-brother/half-sister, grandchild, grandparent, related to an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☒ No (If yes, please complete the Disclosure of Relationship form on Page 2. If no, please print N/A on Page 2.)

I certify under penalty of perjury, that all of the information provided herein is current, complete, and accurate. I also understand that the SNWA will not take action on land-use approvals, contract approvals, land sales, leases or exchanges without the completed disclosure form.

Rebecca J. Starr
Signature

Rebecca J. Starr
Print Name

Manager
Title

October 23, 2014
Date

DISCLOSURE OF RELATIONSHIP

List any disclosures below:
(Mark N/A, if not applicable.)

NAME OF BUSINESS OWNER/PRINCIPAL	NAME OF SNWA EMPLOYEE OR OFFICIAL AND JOB TITLE	RELATIONSHIP TO SNWA EMPLOYEE OR OFFICIAL	SNWA EMPLOYEE'S/OFFICIAL'S DEPARTMENT
N/A			

"Consanguinity" is a relationship by blood. "Affinity" is a relationship by marriage.

"To the second degree of consanguinity" applies to the candidate's first and second degree of blood relatives as follows:

- Spouse – Registered Domestic Partners – Children – Parents – In-laws (first degree)
- Brothers/Sisters – Half-Brothers/Half-Sisters – Grandchildren – Grandparents – In-laws (second degree)

For SNWA Use Only:

If any Disclosure of Relationship is noted above, please complete the following:

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in the contracting/selection process for this particular agenda item?

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in any way with the business in performance of the contract?

Notes/Comments:

Signature

Greg A. Fobbo

Print Name
Authorized Department Representative

AGREEMENT TO PROVIDE PROFESSIONAL SERVICES

This Agreement is made and entered into this _____ day of _____, 20__, by and between QUANTUM SPATIAL, INC., hereinafter called "CONSULTANT," and the SOUTHERN NEVADA WATER AUTHORITY, a political subdivision of the State of Nevada, hereinafter called the "AUTHORITY." The CONSULTANT and the AUTHORITY are sometimes hereinafter referred to individually as "Party" and collectively as the "Parties." The term "AUTHORITY" also refers to staff of the AUTHORITY acting within their designated authority and duties.

WITNESSETH:

WHEREAS, the AUTHORITY desires to obtain professional services as more specifically described herein, and

WHEREAS, the CONSULTANT is properly qualified and desires to provide the professional services required by the AUTHORITY, and

WHEREAS, the AUTHORITY, in reliance on the CONSULTANT's representations and proposals, agrees to retain the CONSULTANT, and the CONSULTANT agrees to furnish professional services to the AUTHORITY, on the terms and conditions hereinafter set forth.

NOW, THEREFORE, in consideration of the promises and mutual covenants contained herein, the Parties hereto agree as follows:

1. <u>SCOPE OF SERVICES</u>:

(a) The CONSULTANT shall provide any requested services, hereinafter referred to as "Services" or "Work," as described and within the time indicated in AUTHORITY'S Request for Proposals No. 638-11 ("RFP") and **Exhibit A**, which are attached herewith and made a part of this Agreement. **Exhibit A** consists of the CONSULTANT'S response to the

RFP (Pricing Proposal Page), dated March 15, 2012, and the Technical Specifications and Special Conditions for the Work to be completed under this Agreement. In the event of a conflict between the terms and conditions in the RFP and **Exhibit A**, the CONSULTANT shall follow the terms and conditions of **Exhibit A**. As described in **Exhibit A**, the ground control/surveying for the project area will be performed by AUTHORITY personnel.

(b) All Services performed shall be subject to the cost ceiling contained in Paragraph 4 hereof and subject to the AUTHORITY's directions respecting priorities. The CONSULTANT will furnish professional Services in the amount necessary to complete promptly and effectively the Work assigned under this Agreement. All of the Services shall be performed by the CONSULTANT or an approved subcontractor or subconsultant.

(c) In performing Services under this Agreement, the CONSULTANT shall observe and abide by the terms and conditions of all applicable laws, regulations, ordinances, or rules of the United States, of the State of Nevada, of any political subdivision thereof, and of any other duly constituted public authority or agency. The CONSULTANT shall be responsible for obtaining any license, permit or other approval as required by law or otherwise, arising out of the Services to be performed hereunder.

(d) The CONSULTANT has, or will secure at its own expense, the qualified personnel required to perform the Services assigned under this Agreement. Such personnel shall not be employed by the United States, the State of Nevada, Clark County, the AUTHORITY, or any other political subdivision of the State of Nevada.

2. PERIOD OF PERFORMANCE:

This Agreement shall become effective as of the date it is fully executed by both Parties and, unless terminated in accordance with the terms of this Agreement, shall remain in effect until all Services authorized to be performed by the AUTHORITY are completed by the CONSULTANT or terminated in accordance with this Agreement.

3. COMPENSATION:

(a) In consideration for completion of all duties and responsibilities under this Agreement, the AUTHORITY agrees to pay the CONSULTANT for deliverables accepted and/or Work completed to the AUTHORITY's satisfaction. Work pursuant to **Exhibit A** shall be approved and authorized by the AUTHORITY prior to the CONSULTANT commencing such work. Although pricing and acquisition methods shall be as described by the terms and conditions in **Exhibit A**, the Parties agree to negotiate as appropriate based upon unknown variables that could impact each task, such as significant difference in square miles than estimated, addition of additional tiles to the project, or a case where CONSULTANT is already committed to fly a specific area and could reduce mobilization costs.

(b) The CONSULTANT shall provide itemized monthly invoices for Services performed during the previous month. Invoices are to be submitted to the AUTHORITY in accordance with the Notice provisions of the Agreement and must reference the name and date of the Agreement. A copy of any invoice received from subcontractors or subconsultants used by the CONSULTANT shall be included.

(c) The AUTHORITY shall pay invoiced amounts from the CONSULTANT based on final negotiated pricing and deliverables received in compliance with the terms and conditions in **Exhibit A**, within thirty (30) calendar days after the date the invoice is received and approved by the AUTHORITY.

4. LIMITATION ON COSTS:

The total cost of Services provided under this Agreement shall not exceed one hundred thirty thousand dollars ($130,000) per contract year.

5. TRUTH-IN-NEGOTIATION CERTIFICATION:

Signing of this Agreement by CONSULTANT shall constitute a truth-in-negotiation certification by CONSULTANT that wage rates and other factual unit costs supporting the compensation of this Agreement are accurate, complete, and current at the time of execution of this Agreement. The original Agreement price and any additions thereto shall be adjusted to exclude any significant sums by which the AUTHORITY determines the Agreement price was increased due to inaccurate, incomplete, or noncurrent wage rates and other factual unit costs. All such Agreement adjustments shall be made within one (1) year following the end of the term of this Agreement.

6. INDEPENDENT CONTRACTOR:

The relationship of the CONSULTANT to the AUTHORITY hereunder shall be that of an independent contractor and not an agent or employee. The CONSULTANT shall have complete control over its employees and the method of performing its Work under this Agreement. No permitted or required approval by the AUTHORITY of personnel, costs, documents or Services of the CONSULTANT shall be construed as making the AUTHORITY responsible for the manner in which the CONSULTANT performs its Services or for any acts, errors or omissions of the

CONSULTANT. Such approvals are intended only to give the AUTHORITY the right to satisfy itself with the quality of Work performed by the CONSULTANT.

7. INTELLECTUAL PROPERTY ACKNOWLEDGMENT

In consideration of the covenants, representations and warranties set forth herein and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, CONSULTANT hereby covenants, represents and warrants the following:

(a) All content developed on behalf of the AUTHORITY, in whole or in part, solely or jointly by CONSULTANT and all of CONSULTANT's employees, associates or subcontractors assisting in creating developments and/or other work product, whether or not copyrightable or otherwise protected, including, without limitation, advertisements and marketing material ("Work Product") arising from services performed pursuant to, or arising out of the AUTHORITY's engagement of CONSULTANT, or previously conceived in anticipation of work to be performed in regard to the AUTHORITY's engagement of CONSULTANT, shall be deemed "work made for hire" as defined in the copyright laws of the United States of America (17 U.S.C. §101 et seq.) and the AUTHORITY shall own all right, title, and interest, including, without limitation, all copyrights and other intellectual property right, title, and interest ("Right") in and to the Work Product.

(b) To the extent that CONSULTANT is deemed to have or retain any Right or otherwise possess any Right in and to any Work Product, CONSULTANT hereby assigns, transfers, and conveys, all such Right to the AUTHORITY.

(c) CONSULTANT shall execute all documents and undertake all actions necessary to effect the clarification of ownership of all Work Product in and to the

AUTHORITY and to allow the AUTHORITY to apply for registrations of the Work Product, as well as maintain any registrations gained, including, without limitation, the Intellectual Property Assignment set forth in paragraph 8.

(d) CONSULTANT hereby waives and releases any claim of infringement of any Right of CONSULTANT (whether based in any intellectual property Right, other proprietary interest whatsoever, or fiduciary theory) in, to or respecting any Work Product (including, without limitation, any claim based on any CONSULTANT's rights in any Work Product which may be construed as "works of visual art" as defined in the Visual Arts Rights Act of 1990, 17 U.S.C. 106A) and shall never challenge nor dispute the AUTHORITY's Right in and to the Work Product.

8. INTELLECTUAL PROPERTY ASSIGNMENT

In consideration of the covenants, representations and warranties set forth herein and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, CONSULTANT hereby sells, conveys, transfers and assigns to the AUTHORITY all of the CONSULTANT's right, title, license and interest (including, without limitation, all intellectual property right, title, license and interest) in and to any and all ideas and content (including, without limitation, all material, information, creative works, documents, matter, text, data, graphics, computer-generated displays and interfaces, images, photographs and works of whatsoever nature, including, without limitation, all compilations of the foregoing and all results and/or derivations of the expression of the foregoing) designed, developed, or created by the CONSULTANT or otherwise arising out of the CONSULTANT's Services or Work and related content by and for the benefit of the AUTHORITY (including, without limitation, patents applications, issued patents, prototypes for

the purpose of same, and other associated derivatives) including, without limitation, all marks, all goodwill associated with such patents, marks, trade secrets, and copyrights in and to, relating to, associated with and/or arising from the Work, the right to applications, issuance, continuations, and divisionals of such patents and the right to applications, registrations, renewals, reissues, and extensions of such marks and copyrights, and the right to sue and recover for any past and/or continuing infringements or contract breaches, said rights, titles, licenses and interests to be held and enjoyed by the AUTHORITY, for the AUTHORITY's own use and benefit and for the use and benefit of the AUTHORITY's successors, assigns or other legal representatives, as fully and entirely as the same would have been held and enjoyed by the CONSULTANT if this sale, conveyance, transfer and assignment had not been made.

9. JOINT VENTURE:

Nothing herein shall be construed to imply a joint venture or principal and agent relationship between the AUTHORITY and the CONSULTANT, and neither Party shall have any right, power or authority to create any obligation, expressed or implied, on behalf of the other.

10. INTERPRETATION:

The Parties agree that neither Party shall be deemed the drafter of this Agreement and, in the event this Agreement is ever construed by a court of law or equity, such court shall not construe this Agreement or any provision hereof against either Party as drafter of this Agreement.

11. CONFLICT OF INTEREST:

During the course of performance of this Agreement, the CONSULTANT will not contract with any client whose interest is adverse to or would require the CONSULTANT to take a position contrary to that of the Las Vegas Valley Water District and/or the AUTHORITY.

12. PROHIBITION AGAINST COMMISSION FOR OBTAINING AGREEMENT:

The CONSULTANT warrants that no person or company has been employed or retained to solicit or secure this Agreement upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, except bona fide employees; nor has the CONSULTANT paid or agreed to pay any person, company, corporation, individual or firm other than a partner or bona fide employee, any fee, commission, contribution, donation, percentage, gift, or any other consideration, contingent upon or resulting from award of this Agreement. For any breach or violation of this warranty, the AUTHORITY shall have the right to terminate this Agreement without liability, or at its discretion, to deduct from the contract price, or otherwise recover, the full amount of such fee, commission, percentage, gift or consideration and any other damages.

13. PROHIBITION AGAINST INTEREST BY GOVERNMENT EMPLOYEES:

(a) No officer, employee or member of the governing body of the AUTHORITY shall (1) participate in any decision relating to this Agreement which affects his or her personal interest or the interest of any corporation, partnership, or association in which he or she is, directly or indirectly, interested or (2) have any interest, direct or indirect, in this Agreement or the proceeds thereof.

(b) The CONSULTANT represents that it presently has no interest and shall not acquire any interest, direct or indirect, which would conflict in any manner or degree with the performance of Services required to be performed under this Agreement. The CONSULTANT further covenants that in the performance of said Services, no person having any such interest shall be employed.

(c) No member of, delegate to or officer or employee of the legislative, executive or judicial branches of the government of the United States, of the State of Nevada or any of its political subdivisions shall be entitled to any share or part hereof or to any benefit to arise therefrom.

14. COMPLETENESS AND ACCURACY OF CONSULTANT'S WORK:

(a) The CONSULTANT shall be responsible for the completeness and accuracy of its research, supporting data, and any final reports or other deliverables prepared or compiled under its obligation under this Agreement and shall correct, at its expense, all errors or omissions therein which may be disclosed.

(b) The cost necessary to correct those errors attributable to the CONSULTANT and any damage incurred by the AUTHORITY as a result of additional costs caused by such errors shall be chargeable to the CONSULTANT. The fact that the AUTHORITY has accepted or approved the CONSULTANT's Work shall in no way relieve the CONSULTANT of any of its responsibilities.

15. INDEMNIFICATION:

CONSULTANT shall indemnify, hold harmless, and defend without cost to the AUTHORITY, its Board of Directors and its officers, agents, and employees, against any and all losses, claims, costs, damages, actions, proceedings, and liability arising out of, resulting from, or in any way incidental to CONSULTANT's provision of Services or Work under this Agreement. This indemnification includes, but is not limited to, claims for or by reason of any death or deaths of, or any physical injury or injuries to, any person or persons or damage to real or personal property of any kind whatsoever, whether the person(s) or property of CONSULTANT, its agents, or subconsultants,

or of third parties; harassment or discrimination or any theory of joint or dual employment by the CONSULTANT's employees, agents, subcontractors or subconsultants, arising out of the Services or Work under this Agreement; negligence, whether active, passive or contributory, of the AUTHORITY, and its officers, employees or agents; or infringement on any U.S. patent (issued as of the Effective Date) or any copyright or trademark.

16. INSURANCE:

(a) General:

1. The CONSULTANT shall not commence any Work under this Agreement until the CONSULTANT obtains, at its own expense, all insurance as required in this section; however, failure to obtain all insurance shall not relieve the CONSULTANT of the obligation to achieve the schedule milestone dates as defined herein. The types of insurance to be obtained by the CONSULTANT are Workers' Compensation, Employers' Liability, Automobile Liability, Aircraft Liability, Commercial General Liability, and Professional Liability as outlined in the following portions of this section.

2. The Workers' Compensation, Employers' Liability, and Aircraft Liability insurance will be maintained in force for the full period of the Agreement.

3. The Professional Liability insurance will be maintained in force for two years following the completion of the project.

4. These insurance provisions are in addition and cumulative to any other right of indemnification or contribution that the AUTHORITY may have in law, in equity, or otherwise and shall survive the completion of the project.

5. Nothing contained in these insurance requirements is to be construed as limiting the extent of the CONSULTANT's total responsibility for payment of claims arising in whole or in part from the actions of a third party when such actions might be taken as a result of the CONSULTANT's operations under this Agreement.

6. At the time of executing this Agreement and before commencement of the Work, the CONSULTANT shall have delivered to the AUTHORITY certificates of insurance and endorsements that attest to the fact that the CONSULTANT has obtained the insurance as specified in this Agreement.

(b) Other Insurance:

1. All insurance provided by the CONSULTANT shall be considered primary with respect to the AUTHORITY's insurance, and any similar insurance maintained by the AUTHORITY shall be considered excess and non-contributory.

2. The CONSULTANT's Workers' Compensation insurance shall be written with a property and casualty insurance company admitted to do business in the State of Nevada and rated A- or better and Class V or higher of financial size category in the current issue of Best's Key Rating Guide.

3. The CONSULTANT's Commercial General Liability, Aircraft Liability, and Professional Liability insurance shall be written with property and casualty insurance companies admitted to do business in the State of Nevada and rated A- or better and Class VIII or higher of financial size category in the current issue of Best's Key Rating Guide.

4. In the event any of the CONSULTANT's insurance companies are not admitted to write business in the state of Nevada, then the CONSULTANT will furnish evidence of insurance with insurance companies that are rated A- or better and Class IX or higher of financial size category in the current issue of Best's Key Rating Guide for each coverage written with a non-admitted carrier.

5. The Certificate of Insurance and related endorsements must be satisfactory to the AUTHORITY as to form and content and must comply with all insurance requirements as set forth herein, or the certificate and endorsements may be rejected and thereby, at the option of the AUTHORITY, render this Agreement cancelable.

6. All endorsements are to be dated, reflect the name of the insurance company, the type of insurance, and the policy number; be executed by a duly authorized representative of the insurance company; and be attached to the certificate.

7. The full legal operating names of the CONSULTANT and insurance carrier shall be properly shown where applicable.

8. The cancellation section of the certificate is to be amended to provide 30-day written notice of cancellation and initialed by the Agent.

9. By endorsement (I.S.O. Forms CG 20 10 07 04 and CA 20 48 02 99, or equivalent), the AUTHORITY shall be included as an additional insured under the Commercial General Liability and Aircraft Liability insurance policies as to bodily injury, sickness, disease, or death, personal injury, damage to or destruction of the property or persons which may arise out of or in connection with activities under the

Agreement. The CONSULTANT's insurance shall be primary with respect to the additional insureds; any insurance coverage maintained by the AUTHORITY shall be in excess of the CONSULTANT's insurance and non-contributing.

10. By endorsement (I.S.O. Form CG 24 04 10 93 or its equivalent), the CONSULTANT's Commercial General Liability, Aircraft Liability, and Workers' Compensation Insurance carriers shall waive their transfer rights of recovery (Waiver of Subrogation) against the AUTHORITY, its members and affiliated companies, successors or assignees, including their directors, officers, and employees individually and collectively.

11. The additional insured and waiver of subrogation endorsements shall read as follows:

> *The Southern Nevada Water Authority, its members, and affiliated companies, successors, or assigns, including their directors, officers, and employees individually and collectively, when acting within the scope of their employment.*

12. If the CONSULTANT fails to procure and/or maintain insurance set forth herein, in addition to other rights or remedies, the AUTHORITY shall have the right, if the AUTHORITY so chooses, to procure and/or maintain the said insurance for and in the name of the CONSULTANT with the AUTHORITY as an Additional Insured, and the CONSULTANT shall pay the cost thereof and shall furnish all necessary information to make effective and/or maintain such insurance. In the event the CONSULTANT fails to pay the cost, the AUTHORITY hereby has the right to

offset any premiums from the compensation set forth in this Agreement and directly pay for such coverage.

13. With respect to any and all insurance required under this Agreement, the deductible shall not exceed $50,000, unless otherwise agreed to by the AUTHORITY or the AUTHORITY'S Risk Management Division.

(c) Workers' Compensation and Employers' Liability Insurance:

1. The CONSULTANT shall procure and maintain such insurance and see that its subcontractors/subconsultants purchase and maintain such insurance as is required under the Nevada Industrial Insurance Act, Nevada Revised Statutes Chapters 616 and 617, for all of its employees working on the project to protect the AUTHORITY from any industrial insurance claims.

2. In the event any class of employees engaged in any Work on the project relative to this Agreement is not protected under the Nevada Industrial Insurance Act, then the CONSULTANT shall provide to the AUTHORITY adequate insurance coverage in a form and by an insurance carrier satisfactory to the AUTHORITY for the protection of such employees.

3. In the event the CONSULTANT is permissibly self-insured for Workers' Compensation insurance in the State of Nevada, the CONSULTANT shall deliver to the AUTHORITY a copy of the Certificate of Consent to Self-Insure issued by the State of Nevada.

4. The CONSULTANT shall procure and maintain Employers' Liability Insurance with limits as set forth in paragraph 16 (h).

(d) Commercial General Liability Insurance:

The CONSULTANT shall procure and maintain Commercial General Liability insurance coverage. The coverage under this policy shall include, but not be limited to, commercial general liability, protective liability, blanket contractual liability, and broad-form property damage. The Commercial General Liability Insurance policy shall be written for limits as outlined under paragraph 16 (h). The amount of coverage shall apply to bodily injury, sickness, disease or death, personal injury, damage to or destruction of the property of persons that may arise out of or in connection with the activities under this Agreement.

(e) Aircraft Liability Insurance:

The CONSULTANT shall procure and maintain, at its own expense, aircraft liability insurance limits as outlined in paragraph 16 (h). The coverage shall apply to bodily injury, death, damage to or destruction of persons which arise out of or in connection with the activities under this agreement. .

(f) Professional Liability Insurance:

The CONSULTANT shall procure and maintain Professional Liability Insurance as outlined in paragraph 16 (h). If this coverage is written on a claims-made basis, the retroactive date shall be prior to or coincident with the date of this Agreement and the certificate shall so state.

(g) It is the CONSULTANT's sole responsibility to ascertain that the aforementioned insurance requirements are fulfilled. In the event they are not, the CONSULTANT shall not be relieved of their duty to perform, indemnify, defend, and hold

harmless the AUTHORITY and all others concerned herein, nor shall the AUTHORITY and all concerned herein be liable to the CONSULTANT or any others in the event the CONSULTANT's insurance, as accepted by the AUTHORITY, fails to meet the full requirements herein.

(h) Insurance Limits

Value of Contract	Coverage	Limits of Liability
$100,000 to $999,999	Professional Liability	$500,000/per claim $1,000,000 aggregate
	General Liability	$1,000,000/per occurrence $2,000,000/aggregate
	Aircraft Liability	$5,000,000/per occurrence
	Workers' Compensation	Statutory
	Employers' Liability	$100,000

17. TERMINATION:

The AUTHORITY's General Manager, his/her designee and/or the CONSULTANT may terminate this Agreement on thirty (30) days prior written notice. In the case of termination by the AUTHORITY, the AUTHORITY shall pay the CONSULTANT for all Work performed to the effective date of termination and the reasonable costs of transferring all documentation of all Work to the AUTHORITY.

18. REVIEWS:

(a) The CONSULTANT shall submit draft reports and other materials for review by the AUTHORITY prior to the submission of a final report on materials. Due dates will be negotiated, but in every instance, earlier submittal is encouraged.

(b) The AUTHORITY will review the submittals and any pertinent attachments and mark all required changes. All reviews will be completed within ten (10) working days after receipt of the submission package, and the package will be returned to the

CONSULTANT. Corrections and changes to the submission will be made by the CONSULTANT and resubmitted to the AUTHORITY for approval within ten (10) working days after receipt. The final approval will be submitted to the CONSULTANT within five (5) working days after receipt of the corrected document and any attachments. Alternate review schedules may be negotiated by mutual agreement of the Parties.

19. RELEASE OF INFORMATION:

The CONSULTANT shall make public information releases only as provided for and in accordance with this Agreement. Any and all other public releases of information gathered, obtained, or produced during the performance of this Agreement must be specifically approved in writing by the AUTHORITY prior to release. Such information shall include, but is not limited to, all products, intellectual property, Work Product, ideas, data, reports, background materials, and any and all other materials belonging to the AUTHORITY. Such public releases of information shall include, but are not limited to, publication in any book, newspaper, magazine, professional or academic journal, the Internet, radio, television, and presentations to professional, academic, and/or other groups or conferences.

20. USE OF MATERIALS:

(a) The AUTHORITY shall make available to the CONSULTANT such materials from its files as may be required by the CONSULTANT in connection with its performance of Services under this Agreement. Such materials shall remain the property of the AUTHORITY while in the CONSULTANT's possession.

(b) Upon termination of this Agreement, the CONSULTANT shall turn over to the AUTHORITY any property of the AUTHORITY in its possession and any calculations,

notes, reports, or other materials prepared by the CONSULTANT in the course of performing this Agreement. Any proprietary software or other tools of the CONSULTANT used to execute the Work shall remain the property of the CONSULTANT.

21. RECORDS:

The CONSULTANT shall retain financial and other records related to this Agreement for six (6) years after the completion or termination of this agreement, and shall make available to the AUTHORITY for inspection, all books, records, documents, and other evidence directly pertinent to performance under this Agreement upon reasonable notice.

22. ASSIGNMENT:

The CONSULTANT shall not assign or transfer its interest in this Agreement without the prior written consent of the AUTHORITY. If CONSULTANT assigns or transfers without prior written approval, the assignment or transfer shall be void, and not merely voidable.

23. MODIFICATION OF AGREEMENT:

This Agreement may not be changed or modified except by written instrument executed by both Parties or their designees.

24. SEVERABILITY:

Any provisions or portions of this Agreement prohibited as unlawful or unenforceable under any application of law of any jurisdiction shall as to such jurisdiction be ineffective without affecting other provisions of this Agreement. If the provisions of such applicable law may be waived, they are hereby waived to the end that this Agreement may be deemed to be a valid and binding Agreement enforceable in accordance with its terms.

25. NON-DISCRIMINATORY EMPLOYEE PRACTICES:

(a) The CONSULTANT shall not employ discriminatory practices in the provision of Services, employment of personnel, or in any other respect on the basis of race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin.

(b) No person in the United States shall, on the grounds of race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity made possible by or resulting from this Agreement.

(c) The CONSULTANT will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin. The CONSULTANT shall ensure that applicants are employed, and the employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin. This non-discrimination provision shall include, but not be limited to employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. The CONSULTANT agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provision of this non-discrimination clause.

(d) The CONSULTANT will, in all solicitations or advertisements for employees placed by or on behalf of the CONSULTANT, state that all qualified applicants will receive

consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity or expression, age, disability, or national origin.

(e) The CONSULTANT will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice advising the said labor union or workers representatives of the CONSULTANT's commitment under this provision and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

26. EQUAL EMPLOYMENT OPPORTUNITY:

(a) The CONSULTANT and any subcontractor or subconsultant working under the authority of the CONSULTANT, who is responsible for the selection, referral, hiring, or assignment of workers for the Services provided pursuant to this Agreement, is required to comply with all applicable provisions of Title VII of the Civil Rights Act of 1964. This requirement includes compliance with Equal Employment Opportunity Commission regulations that prohibit discrimination based upon race, color, religion, sex, or national origin. Furthermore, the CONSULTANT shall in all relevant manners comply with the Age Discrimination in Employment Act, the Civil Rights Act of 1991, the Equal Pay Act, and Title I of the Americans with Disabilities Act.

(b) The CONSULTANT shall make all necessary documentation as required to comply with the Acts referred to above and shall make such documentation immediately available to the AUTHORITY upon the AUTHORITY's request. The CONSULTANT is solely liable for failure to comply with this provision.

27. APPLICABLE LAW:

Nevada law shall govern the interpretation of this Agreement, without reference to its choice of law provisions.

28. VENUE:

The Parties agree that venue for any dispute arising from the terms of this Agreement shall be Clark County, Nevada.

29. ATTORNEY'S FEES:

Except as otherwise set forth in this Agreement, the Parties shall bear their own attorneys' fees and costs incurred in resolving the claims, as well as on the preparation of this Agreement. In the event that any Party commences an action to enforce or interpret this Agreement, or for any other remedy based on or arising from this Agreement, the prevailing party therein shall be entitled to recover its reasonable and necessary attorneys' fees and costs incurred. For the purposes of this provision, the "prevailing party" shall be that party which has been successful with regard to the main issue, even if that Party did not prevail on all issues.

30. NO THIRD PARTY RIGHTS:

This Agreement is not intended by the Parties to create any right in or benefit to parties other than the AUTHORITY and the CONSULTANT. This Agreement does not create any third party beneficiary rights or causes of action.

31. WAIVER:

The failure of either Party to enforce at any time, or for any period of time, the provisions hereof shall not be construed as a waiver of such provisions or of the rights of such Party to enforce each and every such provision.

32. CAPTIONS:

The captions contained in this Agreement are for reference only and in no way to be construed as part of this Agreement.

33. COUNTERPARTS:

This Agreement may be executed in any number of counterparts and by the different Parties on separate counterparts, each of which, when so executed, shall be deemed an original, and all counterparts together shall constitute one and the same instrument.

34. INTEGRATION:

This Agreement, including **Exhibit A**, which incorporates by reference the contents of RFP 638-11, contains the entire understanding between the Parties relating to the transactions contemplated by this Agreement, notwithstanding any previous negotiations or agreements, oral or written, between the Parties with respect to all or any part of the subject matter hereof. All prior or contemporaneous agreements, understandings, representations and statements, oral or written, regarding the subject matter of this Agreement are merged in this Agreement and shall be of no further force or effect.

35. NOTICES:

Any and all notices, demands or requests required or appropriate under this Agreement (including invoices) shall be given in writing and signed by a person with authorization to bind the CONSULTANT or AUTHORITY, either by personal delivery, via facsimile, via a scanned document sent via email, or by registered or certified mail, return receipt requested, addressed to the following addresses and fax numbers:

To CONSULTANT:	Quantum Spatial, Inc. 523 Wellington Way Lexington, KY 40503-1394 Attention: Jack L. Mitchell CP PLS jmitchell@quantumspatial.com (859) 277-8901
To AUTHORITY:	Southern Nevada Water Authority P.O. Box 99956 Las Vegas, NV 89106 Attention: Craig A. Hale, Supervisor craig.hale@snwa.com (702) 862-3774

When notice is given by mail, it shall be deemed served three (3) business days following deposit, postage prepaid in the United States mail. When notice is given by facsimile or email transmission, it shall be deemed served upon receipt of confirmation of transmission if transmitted during normal business hours or, if not transmitted during normal business hours, on the next business day following the facsimile or email transmission.

The Parties may designate a new contact person under this provision for notices or invoices or change the address, email address or fax number identified above by notifying the other Party in writing.

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed the day and year first above written.

QUANTUM SPATIAL, INC.,

By _____ 11/6/14
Jeffrey S. Simmons — Date
Vice President

SOUTHERN NEVADA WATER AUTHORITY

By _____
John J. Entsminger — Date
General Manager

Approved as to form:

_____ for
Brian V. Chally, Director, Legal Services

EXHIBIT A

SCOPE OF SERVICES

Consultant's goal is to assist the SOUTHERN NEVADA WATER AUTHORITY with Digital Aerial Imagery requirements per Request for Proposal 638-11 Special Conditions and Technical Specifications including any modifications addressed in Addenda 1-4 included herein by reference, and the final deliverables list requested by the Authority and pricing from Consultant dated January 9, 2012.

Consultant and Authority hereby also agree that data acquisition will be performed from which a pilot shall be selected and submitted for review prior to initiating full production of the orthoimagery for the entire project. The Authority and Consultant will discuss the pilot data and agree upon an option or methodology necessary to complete the imagery deliverables and ensure adequate sidelap with respect to minimizing building lean as much as possible in accordance with the specifications outlined in the original RFP. To that end, the parties further agree that upon completion of this review and addition of any tiles final pricing will be negotiated and agreed upon but will not exceed $130,000 for the total project.

The schedule for the annual Digital Aerial Imagery project will be as follows:

- Imagery Acquisition: March 1 – April 15
- Pilot Delivery of 25 Tiles for Quality Checks: May 15
- Begin Delivery of Imagery Blocks (30-40 percent of overall imagery acquisition): June 15
- All initial Imagery Tiles delivered to SNWA: July 1
- Initial Quality Check Feedback from SNWA: July 24
- Final Acceptance of Imagery: August 15

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Extension of Insurance for the Lake Mead Intake No. 3 Project	**Director's Backup**
Petitioner: David H. Wright, Chief Financial Officer	
Recommendations: That the Board of Directors approve an agreement, in substantially the same form, retaining Marsh Risk and Insurance Services, the Authority's current insurance broker, and approve an extension of the Builders Risk Insurance and Terrorism Insurance on the Lake Mead Intake No. 3 Project.	

Fiscal Impact:
If the above recommendation is approved, there are adequate funds in the Authority budget for the builders risk insurance and terrorism insurance, for a total cost of $2,154,525.

Background:
On October 18, 2012, the Board of Directors authorized Marsh Risk and Insurance Services (Marsh) to extend the builders risk and terrorism insurance on the Lake Mead Intake No. 3 Project (Project) for the estimated construction term, in accordance with Project contract requirements. Of the $20,232,507 previously committed, only $15,536,191 was required to be expended due to the negotiation of more favorable insurance rates and reductions in scope of the construction project.

Pursuant to instruction from staff, Marsh has been negotiating an extension of the builders risk coverage with similar underwriter's terms and conditions as the expiring policy (Exhibit II). To make allowances for unforeseen situations, it is recommended coverage be placed from January 1, 2015, through February 29, 2016, and the Authority may be eligible to receive a premium refund if the actual final Project completion date is prior to February 29, 2016. Staff recommends that the builders risk insurance be purchased in accordance with Exhibit II.

Additionally, staff requested Marsh obtain proposals to extend terrorism coverage from January 1, 2015, to February 29, 2016. Exhibit III summarizes the coverage and costs for the terrorism coverage. Staff recommends that the terrorism insurance be purchased in accordance with Exhibit III.

This agreement is authorized pursuant to NRS 332.115(f) and Section 6(j) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved this agreement.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DHW:RCS:MJC:kah
Attachments

AGENDA ITEM # 11

DISCLOSURE OF OWNERSHIP/PRINCIPALS

Business Entity Type						
☐ Sole Proprietorship	☐ Partnership	☐ Limited Liability Company	X Corporation	☐ Trust	☐ Non-Profit Organization	☐ Other

Business Designation Group					
☐ MBE	☐ WBE	☐ SBE	☐ PBE	☐ ESB	☐
Minority Business Enterprise	Women-Owned Business Enterprise	Small Business Enterprise	Physically Challenged Business Enterprise	Emerging Small Business	

Corporate/Business Entity Name:	Marsh & McLennan Companies (NYSE – MMC)	
(Include d.b.a., if applicable)	Marsh Risk & Insurance Services	
Street Address:	777 South Figueroa Street	**Website: marsh.com**
City, State and Zip Code:	Los Angeles, CA. 91007	**POC Name and Email:mark.e.mcginnis@marsh.com**
Telephone No:	(213) 346-5722	**Fax No: (213) 346-5927**
Local Street Address:	7251 West Lake Mead , Suite # 400	**Website:** marsh.com
City, State and Zip Code:	Las Vegas, NV 89128	**Local Fax No: (866) 742 - 1445**
Local Telephone No:	(702) 804 - 7200	**Local POC Name Email: mark.e.mcginnis@marsh.com**
Number of Clark County, Nevada Residents Employed: 50		

All entities, with the exception of publicly-traded and non-profit organizations, must list the names of individuals, either directly or indirectly, holding more than five percent (5%) ownership or financial interest in the business entity appearing before the SNWA Board of Directors.

Publicly-traded entities and non-profit organizations shall list all Corporate Officers and Directors in lieu of disclosing the names of individuals with ownership or financial interest. The disclosure requirement, as applied to land-use applications, extends to the applicant and the landowner(s).

Entities include all business associations organized under or governed by Title 7 of the Nevada Revised Statutes, including but not limited to private corporations, close corporations, foreign corporations, limited liability companies, partnerships, limited partnerships, and professional corporations.

Full Name	Title	% Owned (Not required for Publicly Traded Corporations/Non-profit organizations)
N/A		

This section is not required for publicly-traded corporations.

1. Are any individual members, partners, owners or principals, involved in the business entity, an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☐ No (If yes, please note that SNWA employee(s), or appointed/elected official(s) may not perform any work on professional service contracts, or other contracts, which are not subject to competitive bid.)

2. Do any individual members, partners, owners or principals have a spouse, registered domestic partner, child, parent, in-law or brother/sister, half-brother/half-sister, grandchild, grandparent, related to an SNWA full-time employee(s), or appointed/elected official(s)?

   ☐ Yes ☐ No (If yes, please complete the Disclosure of Relationship form on Page 2. If no, please print N/A on Page 2.)

I certify under penalty of perjury, that all of the information provided herein is current, complete, and accurate. I also understand that the SNWA will not take action on land-use approvals, contract approvals, land sales, leases or exchanges without the completed disclosure form.

Signature	Mark McGinnis Print Name
Managing Director Title	10/28/14 Date

Revised 12/26/13

INSTRUCTIONS FOR COMPLETING THE DISCLOSURE OF OWNERSHIP/PRINCIPALS FORM

Purpose of the Form

The purpose of the Disclosure of Ownership/Principals Form is to gather ownership information pertaining to the business entity for use by the Southern Nevada Water Authority ("SNWA") in determining whether members of the Board of Directors of the SNWA should exclude themselves from voting on agenda items where they have, or may be perceived as having a conflict of interest, and to determine compliance with Nevada Revised Statute 281A.430, contracts in which a public officer or employee has interest is prohibited.

General Instructions

Completion and submission of this Form is a condition of approval or renewal of a contract or lease and/or release of monetary funding between the disclosing entity and the SNWA. Failure to submit the requested information may result in a refusal by the SNWA to enter into an agreement/contract and/or release monetary funding to such disclosing entity.

Detailed Instructions

All sections of the Disclosure of Ownership form must be completed. If not applicable, write in N/A.

Business Entity Type – Indicate if the entity is an Individual, Partnership, Limited Liability Company, Corporation, Trust, Non-profit Organization, or Other. When selecting 'Other', provide a description of the legal entity.

Non-Profit Organization (NPO) - Any non-profit corporation, group, association, or corporation duly filed and registered as required by state law.

Business Designation Group – Indicate if the entity is a Minority Owned Business Enterprise (MBE), Women-Owned Business Enterprise (WBE), Small Business Enterprise (SBE), or Physically-Challenged Business Enterprise (PBE). This may be needed in order to provide utilization statistics to the Legislative Council Bureau, and will be used only for such purpose.

- **Minority Owned Business Enterprise (MBE):**
  An independent and continuing business for profit which performs a commercially useful function and is at least 51% owned and controlled by one or more minority persons of Black American, Hispanic American, Asian-Pacific American or Native American ethnicity.
- **Women Owned Business Enterprise (WBE):**
  An independent and continuing business for profit which performs a commercially useful function and is at least 51% owned and controlled by one or more women.
- **Physically-Challenged Business Enterprise (PBE):**
  An independent and continuing business for profit which performs a commercially useful function and is at least 51% owned and controlled by one or more disabled individuals pursuant to the federal Americans with Disabilities Act.
- **Small Business Enterprise (SBE):**
  An independent and continuing business for profit which performs a commercially useful function, is not owned and controlled by individuals designated as minority, women, or physically-challenged, and where gross annual sales does not exceed $2,000,000.
- **Emerging Small Business (ESB)**
  A business that has been certified by the Nevada Office of Economic Development.

Business Name (include d.b.a., if applicable) – Enter the legal name of the business entity and enter the "Doing Business As" (d.b.a.) name, if applicable.

Corporate/Business Address, Business Telephone, Business Fax, and Email – Enter the street address, telephone and fax numbers, and email of the named business entity.

Local Business Address, Local Business Telephone, Local Business Fax, and Email – If business entity is out-of-state, but operates the business from a location in Nevada, enter the Nevada street address, telephone and fax numbers, point of contact and email of the local office. Please note that the local address must be an address from which the business is operating from that location. Please do not include a P.O. Box number, unless required by the U.S. Postal Service, or a business license hanging address.

Number of Clark County Residents employed by this firm.

List of Owners/Officers – Include the full name, title and percentage of ownership of each person who has ownership or financial interest in the business entity. If the business is a publicly-traded corporation or non-profit organization, list all Corporate Officers and Directors only.

For All Contracts – **(Not required for publicly-traded corporations)**

1) Indicate if any individual members, partners, owners or principals involved in the business entity are an SNWA full-time employee(s), or appointed/elected official(s). If yes, the following paragraph applies.

   In accordance with NRS 281A.430.1, a public officer or employee shall not bid on or enter into a contract between a government agency and any private business in which he has a significant financial interest, except as provided for in subsections 2, 3, and 4.

2) Indicate if any individual members, partners, owners or principals involved in the business entity have a second degree of consanguinity or affinity relation to an SNWA full-time employee(s), or appointed/elected official(s) (reference form on Page 2 for definition). If **YES**, complete the Disclosure of Relationship Form.

A professional service is defined as a business entity that offers business/financial consulting, legal, physician, architect, engineer or other professional services.

Signature and Print Name – Requires signature of an authorized representative and the date signed.

Disclosure of Relationship Form – If any individual members, partners, owners or principals of the business entity is presently an SNWA employee, public officer or official, or has a second degree of consanguinity or affinity relationship to an SNWA employee, public officer or official, this section must be completed in its entirety.

SNWA Lake Mead # 3 Intake Tunnel – Builders Risk and Terrorism Insurance
Amendment to the original SNWA / Marsh Client Service Agreement of November 1, 2012 to January 1, 2015 for brokering extension of coverage from January 1, 2015 thru February, 2016.

This endorsement " A " to Client Service Agreement between Southern Nevada Water Authority (SNWA) and Marsh Risk and Insurance Services for the term of November 1, 2012 to January 1, 2015 relates to the further extension of Builders Risk insurance and Terrorism insurance from January 1, 2015 to February, 2016 and potentially a few months beyond that.

Brokerage of Builders Risk insurance on the SNWA Lake Mead # 3 Intake Tunnel – London placement

It is agreed that as respects the additional extension of the Builders Risk insurance aforementioned placed in the Lloyds of London insurance market that the following is understood and agreed to when determining Marsh Risk & Insurance Services fee :

1. **Marsh will earn a fixed base fee of $200,000, regardless if the term of the Builder Risk Extension is 12 months *(shortest term currently considered) or 18 months (longest term currently considered).***

2. **The incentive bonus threshold that Marsh may earn begins at $4 million for the Builders Risk premium for a 12 month policy and $250,000 more per month of term thereafter up to 18 months. Consequently, an 18 month policy would have the incentive bonus begin at $5.5 million.**

3. **The incentive bonus would be based on Marsh earning 10% of the savings in between the threshold amount and the final premium.**
   Example:
   Threshold $ 4 mil – 12 month extension
   Extension quote - $ 3 mil
   Difference - $ 1 mil
   Marsh Bonus – 10% of $ 1 mil i.e. $ 100K

4. **The incentive bonus is capped at $200,000 for a 12 month policy and $10,000 more per month of term thereafter up to 18 months. An 18 month policy would have an incentive cap of $260,000.**

5. **The total commission will then be a minimum of $200,000 (fixed base fee), and a maximum of $400,000 under a 12 month term or $460,000 under an 18 month term.**

SNWA Lake Mead # 3 Intake Tunnel – Builders Risk and Terrorism Insurance
Amendment to the original SNWA / Marsh Client Service Agreement of November 1, 2012 to January 1, 2015 for brokering extension of coverage from January 1, 2015 thru February, 2016.

Brokerage of Terrorism insurance on the SNWA Lake Mead # 3 Intake Tunnel

It is agreed that Marsh will continue to earn commission – as before in the November 1, 2012 to January 1, 2015 term – for brokering the additional extension of the Terrorism insurance on the SNWA Lake Mead # 3 Intake Tunnel for January 1, 2015 thru February, 2016.

Agreed:

SOUTHERN NEVADA WATER AUTHORITY

John J. Entsminger, General Manager
Date:

Gregory J. Walch, General Counsel
Date:

MARSH RISK & INSURANCE CO.

Mark McGinnis, Managing Director
Date: 10/29/2014

D: SNWA –Marsh CSA – endst extend BR and Terrorism beyond 1-1-15 Fee – Commission 10-29-14

EXHIBIT II

Lake Mead Intake No. 3 Project
Builders Risk Insurance

Policy Term – Extension from January 1, 2015 to February 29, 2016

SUMS INSURED/ LIMITS:

Contract Works – items i) and ii)

Until Substantial Completion (est 10.31.15)	USD 507,244,597
Post SC to Final Completion (est 02.29.16)	USD 8,000,000

Tunnel Boring Machinery – item iii)

While tunneling (est to 02.28.15)	USD 53,000,000
Dismantling and removal (est to 05.31.15)	USD 10,000,000

Additional Limits

Consultants Fees	USD 5,000,000
Removal of Debris	USD 10,000,000
Expediting Expenses/Airfreight	USD 10,000,000
Search and Locate Costs	USD 1,000,000
Plans and Documentation	USD 500,000
Loss Mitigation Measures	USD 1,000,000
Existing Property	USD 10,000,000

All of the above Limits, are payable in addition to the Sums Insured and shall apply to each occurrence.

INTEREST INSURED:

Property Insured-

Item i) Permanent works, materials (including those supplied free to the Project by or on behalf of the Principal, provided the value is included in the Contract Works Sum Insured), Temporary Works, equipment, machinery, supplies, Camps, and all other property used for or in connection with the Project.

Item ii) Worksite areas adjacent to the property site, off-site storage areas and off-site staging areas.

Item iii) Tunnel Boring Machinery and ancillary equipment.

DEDUCTIBLES:

Earthquake	USD 1,000,000 any one occurrence
Underground works (including shafts)	USD 1,000,000 any one occurrence
Storm, Tempest, Flood, Water Damage, Subsidence, Collapse, Testing and Commissioning	USD 250,000 any one occurrence
All other losses	USD 100,000 any one occurrence
Tunnel Boring Machine	10% of loss subject to a minimum of USD 250,000 and a maximum of USD 1,000,000

EXCLUSIONS:

A.

1. Loss of Occupancy
2. Penalties or Liquidated Damages
3. Money
4. Wear and Tear
5. Aircraft or Waterborne Vessels
6. Ocean or Air Transit
7. Inventory Losses
8. War
9. Radioactive Contamination
10. Terrorism
11. Professional Consultants
12. Tunnel Works - Abandonment
13. Mechanical or Electrical Breakdown
14. Electronic Data Recognition
15. Piling Clause

B. Any loss of or damage to **Tunnel Works**, the **Insurers** will not indemnify the **Insured** for:

(a) The expenses incurred for alterations in the construction methods due to unforeseen ground conditions or obstructions;

(b) The expenses incurred for measures which become necessary to improve or stabilize ground conditions or to seal against water ingress unless necessary to reinstate indemnifiable loss or damage;
(c) The expenses incurred for removing material which has been excavated or due to overbreak in excess of the design profile and/or for refilling cavities resulting therefrom;
(d) Dewatering unless necessary to reinstate indemnifiable loss or damage;
(e) Loss or damage due to breakdown of the dewatering system if such loss or damage could have been avoided by use of standby facilities;
(f) The abandonment of tunnel boring machines;
(g) The loss of bentonite, suspensions, or any media or substance used for excavation support or as a ground-conditioning agent.

INSURANCE UNDERWRITERS:

- Munich RE
- Starr Underwriting
- Great Lakes
- SCOR
- HDI Gerling
- Zurich

EXHIBIT III

Lake Mead Intake No. 3 Project
Terrorism Policy

Policy Term – Extension from January 1, 2015 to February 29, 2016

SUMS INSURED/ LIMITS: All amounts to 100%

Contract Works – item i) and ii)

Until Substantial Completion (est 10.31.15)	USD 507,244,597
Post SC to Final Completion (est 02.29.16)	USD 8,000,000

Tunnel Boring Machinery – item iii)

While tunneling (est to 02.28.15)	USD 53,000,000
Dismantling and removal (est to 05.31.15)	USD 10,000,000

Participating Insurance Company's:
- Lexington Insurance Company
- Validus
- Catlin
- Lancashire Insurance Company Ltd.

Additional Limits

Acceleration Costs	USD 5,000,000
Consultants Fees	USD 5,000,000
Demolition and Increased Cost of Constructions	USD 75,000,000
Expediting Expenses/Airfreight	USD 50,000,000
Existing Property	USD 10,000,000
Fire Brigade Services Charges and Extinguishing Expenses	USD 10,500,000
Loss Mitigation Measures	USD 1,000,000
Loss Adjustment Expenses	USD 1,000,000
Off Site Storage	USD 50,000,000
Pollution Clean-up	USD 5,000,000
Plans and Documentation	USD 500,000
Property in Transit	USD 50,000,000
Removal of Debris	USD 10,000,000
Search and Locate Costs	USD 1,000,000
Trees and Shrubs	USD 10,500,000

All of the above Limits, are payable in addition to the Sums Insured and shall apply to each occurrence but shall not increase the Policy Limits of Liability per any occurrence or aggregate.

DEDUCTIBLES:

All Losses	USD 100,000 any one occurrence

EXCLUSIONS:

Loss of Occupancy
Penalties or Liquidated Damages
Money
Aircraft or Waterborne Vessels
Ocean or Air transit
War
Radioactive Contamination
Taken Into Use
Nuclear, Biological, Chemical, Radiological Terrorism
Hoax or Threats of Terrorism

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Water Resource Plan	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors adopt the 2009 Water Resource Plan for the 2015 calendar year.	

Fiscal Impact:
None by approval of the above recommendation.

Background:
The SNWA 1995 Amended Cooperative Agreement requires that the Authority adopt a Water Resource Plan (Plan), and thereafter review the Plan at least annually, revising when necessary. The Board of Directors first adopted the current Plan in May 2009. The Board has reviewed and adopted the Plan each year since then.

The Plan encapsulates uncertainties in current economic conditions in addition to normal Colorado River conditions and shortage scenarios. The Plan continues to demonstrate the flexibility needed to respond to conditions as they develop and to meet future demands in a timely manner.

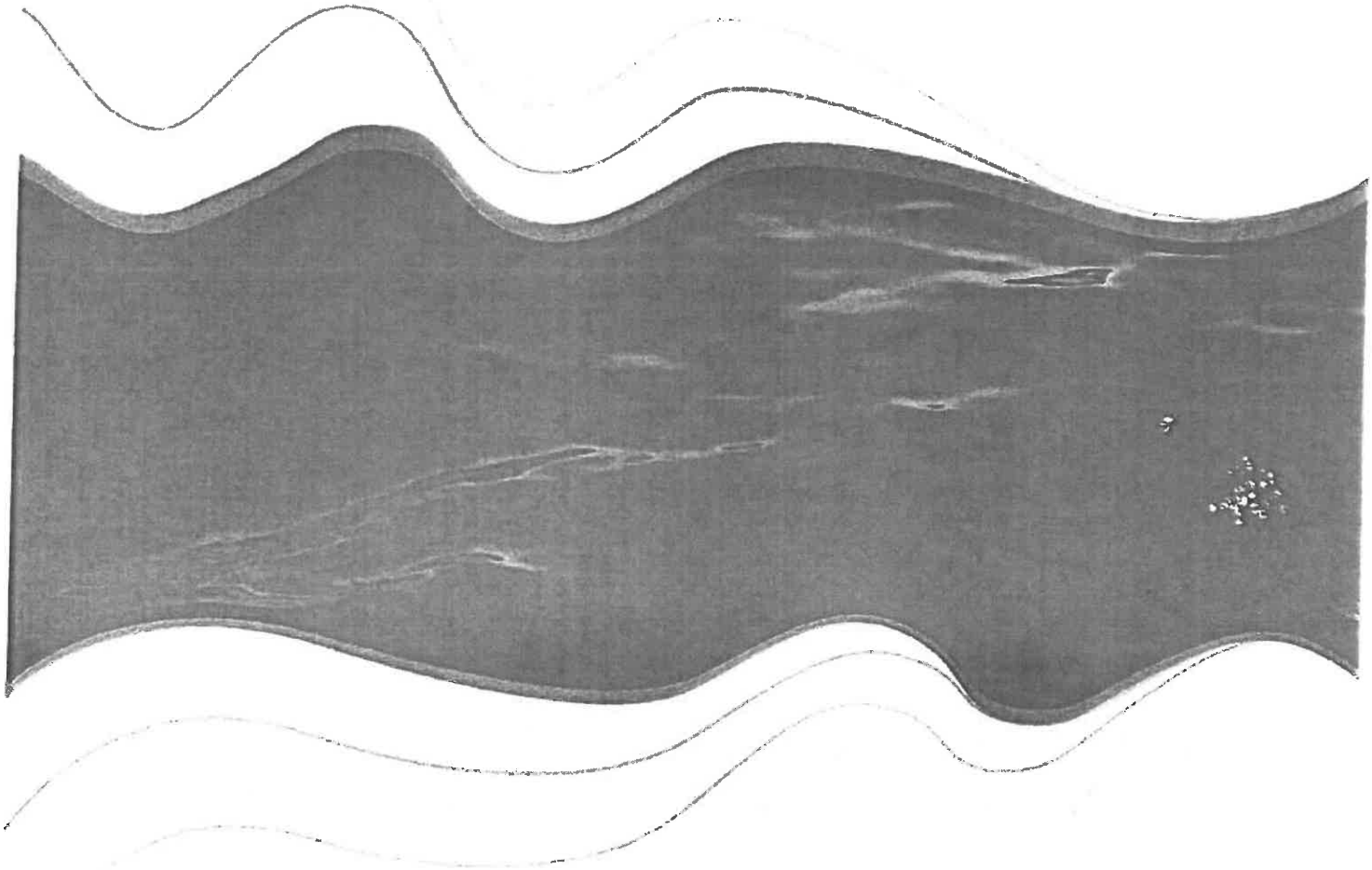
In 2012, the Authority formed the Integrated Resource Planning Advisory Committee (IRPAC) to help guide future water resource planning for southern Nevada. Throughout 2014, IRPAC has been reviewing the Authority's activities related to water resources, conservation, facilities, and water quality. Recommendations from the IRPAC process presented to the Board will be used to prepare an updated Water Resource Plan.

This action is authorized pursuant to Sections 5(j) and 8(h) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved this agenda item.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:ZLM:AB:JJ:TM:lmv:nsh
Attachment

AGENDA ITEM # 12



Water Resource Plan 09

SOUTHERN NEVADA WATER AUTHORITY

Southern Nevada Water Authority

Board of Directors

Shari Buck, Chair
City of North Las Vegas

Steven Kirk, Vice Chair
City of Henderson

Andrea Anderson
City of Boulder City

Susan Brager
Las Vegas Valley Water District

Tom Collins
Clark County Water Reclamation District

Steve Sisolak
Big Bend Water District

Lois Tarkanian
City of Las Vegas

Patricia Mulroy, General Manager

Member Managers
Elizabeth Fretwell, City of Las Vegas • Vicki Mayes, City of Boulder City
Richard Mendes, Clark County Water Reclamation District • Gregory Rose, City of North Las Vegas
Patricia Mulroy, Las Vegas Valley Water District • Virginia Valentine, Big Bend Water District
Mark Calhoun, City of Henderson

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Executive Summary

The Southern Nevada Water Authority (SNWA) was formed in 1991 by a cooperative agreement among the following agencies in Southern Nevada:

- Big Bend Water District
- City of Boulder City
- City of Henderson
- City of Las Vegas
- City of North Las Vegas
- Clark County Water Reclamation District
- Las Vegas Valley Water District

Together, these seven agencies provide water and wastewater service to nearly 2 million residents in the cities of Boulder City, Henderson, Las Vegas and North Las Vegas, and areas of unincorporated Clark County. As their wholesale water provider, the SNWA is responsible for water treatment and delivery, as well as acquiring and managing long-term water resources for Southern Nevada. Since its inception, the SNWA has worked to seek new water resources for Southern Nevada, manage existing and future water resources, construct and manage regional water facilities and promote conservation.

The SNWA prepared its first Water Resource Plan in 1996. Since then, the plan has been reviewed annually and updated as needed. The 2009 plan represents the eighth revision in 13 years. This plan provides a comprehensive overview of water resources and demands in Southern Nevada, including a history of water resources and demands in the region; an overview of the SNWA water resource portfolio; and the SNWA's approach to demand forecasting, demand management and meeting long-term resource needs, including during times of declared shortages. The plan also includes a discussion on environmental issues that will influence future resource planning in Nevada and the Colorado River Basin.

An underlying principle of the 2009 Water Resource Plan is to maximize the use of existing resources, while maintaining the flexibility to adjust planning as circumstances or conditions warrant. This approach has proved increasingly valuable as the SNWA continues to work to address unprecedented drought conditions along the Colorado River, evolving demand-forecasting scenarios, and local economic conditions.

The SNWA has worked diligently over the last decade to enhance regional conservation efforts, secure additional in-state resources, enhance the flexibility of Colorado River management, and respond to severe and sustained drought conditions in the region. The following provides an overview of recent developments that continue to influence water-planning efforts in Southern Nevada.

DROUGHT

The SNWA continues to respond to ongoing drought conditions in the Colorado River Basin. Between 1999 and 2008, the average annual inflow to the system was 66 percent of normal. As a result, the combined storage of Lake Mead and Lake Powell – the two primary reservoirs in the Colorado River system – was 52 percent of the total combined capacity in early 2009.

For the SNWA, there are two primary consequences of continued declines in Lake Mead water levels:

possible reduction of available Colorado River supplies and operating challenges associated with water intake facilities at Lake Mead. Drought conditions have required the SNWA to enact contingency plans for Lake Mead intake facilities and develop a plan for responding to severe and sustained shortage of Colorado River resources.

To this end, the SNWA Board of Directors updated its drought plan in 2009 to outline the SNWA's approach to meeting demands during declared shortages in light of new rules and agreements. The drought plan has been updated to include current conditions and incorporated as a new chapter in the 2009 Water Resource Plan.

The SNWA's new shortage response (Chapter 4) outlines several scenarios to offset drought impacts based on the severity of Colorado River conditions. These include the use of Intentionally Created Surplus (ICS), banked resources, shortage-sharing agreements and heightened conservation measures, and development of in-state groundwater resources. SNWA also continues to work with the other Colorado River Basin states to identify and explore options for long-term augmentation of Colorado River resources.

WATER CONSERVATION

Conservation is a long-standing component of the SNWA's water resource portfolio. Conservation will significantly lower projected demands during the 50-year planning horizon.

Building upon the success of its previous efforts, the SNWA Board of Directors in 2009 adopted a new conservation goal of 199 gallons per capita per day (GPCD) by 2035. Achieving this goal will reduce overall use by more than 50 GPCD and save the community approximately 276,000 acre-feet of water per year by the year 2035.

Based on the recommendation of a 2005 citizen advisory committee, the SNWA also is working with its member agencies to make major temporary drought-response measures permanent. These include, but are not limited to, landscape-development codes, assigned-watering schedules and golf course water budgets. The SNWA continues to maintain a broad mix of education and incentive programs, which is discussed further in Chapter 2.

COLORADO RIVER RESOURCES

The SNWA is actively engaged with the other Colorado River Basin states regarding Colorado River management and development guidelines.

In response to severe Colorado River Basin drought conditions, the Secretary of the Interior (Secretary), in cooperation with the seven basin states, initiated a process in 2005 to explore management options for lakes Mead and Powell. These efforts resulted in the Secretary's 2007 Record of Decision for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines).

Since that time, the SNWA has worked to maximize use of Colorado River resources, including development of Intentionally Created Surplus (ICS). To this end, the SNWA partnered with California and Arizona on funding for the Drop 2 Storage Reservoir to capture U.S. Colorado River water that would otherwise go unused in the lower basin and pass into Mexico, and began utilizing pre-compact water rights from the Muddy and Virgin rivers for use in meeting regional demands. The latter represents the first "new" permanent water supply put to use in the region since large-scale diversions of Colorado River water began in the 1950s.

IN-STATE DEVELOPMENT

In light of ongoing drought conditions in the Colorado River Basin, the SNWA continues to work through the necessary state and environmental permitting processes to develop in-state, non-Colorado River resources.

The 2009 Water Resource Plan assumes the development of 134,000 acre-feet per year (AFY) of in-state groundwater based on current permits and outstanding applications. Under normal hydrological

conditions, the SNWA is planning for use of this resource in 2020 (Figure 1); however, these resources may be needed sooner if drought conditions persist or intensify.

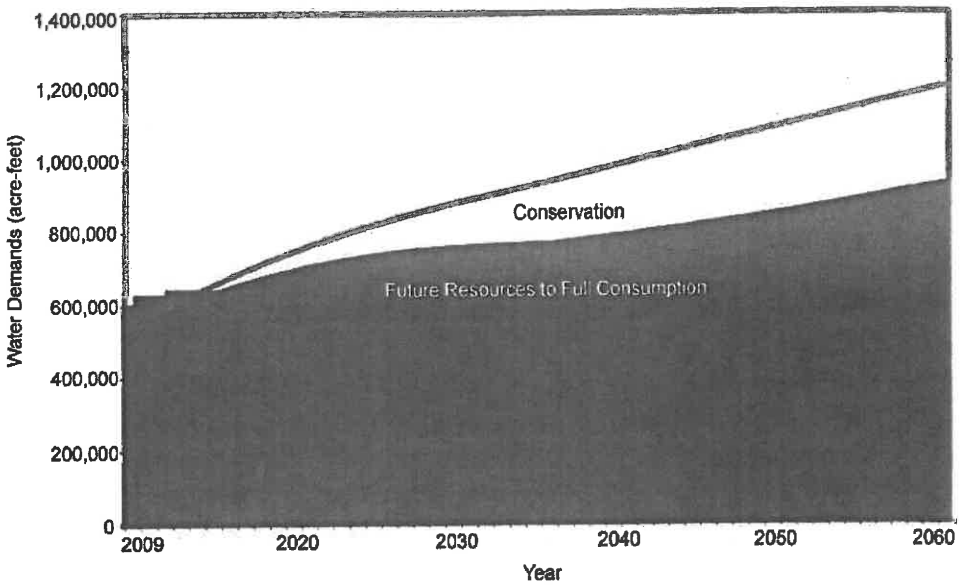
The SNWA depends on the Colorado River for 90 percent of its water-resource needs. Based on Colorado River hydrology and permitted uses, a long-term, non-Colorado River supply is needed to meet demands and provide protection for current and future drought.

DEMAND FORECAST

Several factors affect the timing of when and how resources are brought on-line, including growth, drought, cost and environmental permitting. Having a portfolio of resource options gives the SNWA enough flexibility to shift some resources if any of its other resources prove insufficient or unavailable over the long-term.

The current economic downturn affecting local, national and even global economies has presented unique challenges to planners as to when the local economic condition will recover and what future growth rates will occur. As a result, the 2009 Water Resource Plan reflects planning adjustments taken by the SNWA in response to latest conditions. Figure 1 displays the projected demands, the amount of conservation projected to be achieved and the additional resources needed to meet future demands through 2060.

FIGURE 1 – Summary of Projected Water Demands and Water Resources



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CHAPTER 1

A Brief History of Water in Southern Nevada

This chapter provides an overview of milestones and events that have shaped water management issues in the Southern Nevada region during the past century. An awareness and general appreciation of this history is necessary to understand the context in which the SNWA and its member agencies presently manage Southern Nevada's water future.

The chapter is divided into four sections – Introduction, History (1905 to 1945), History (1945 to 1990) and History (1990 to present) – each of which focuses on water demands and the resources that were used to meet those demands. This sets the stage for discussion of the SNWA water resource portfolio in Chapter 2, how SNWA plans to meet future demands in Chapter 3 and how the SNWA will meet demands during shortages in Chapter 4. Chapter 5 discusses the environmental planning and compliance activities relating to SNWA water resource planning and development.

INTRODUCTION

The history of Southern Nevada is inextricably tied to water. For much of its past, the area now known as Clark County was little more than a collection of scarce watering holes for various trails through the Mojave Desert. With the birth of Las Vegas in 1905 as a way station for the San Pedro, Los Angeles and Salt Lake Railroad, Southern Nevada began to attract a large number of residents and businesses. Over the next century, a series of social and economic developments – including legalized gaming, the construction of Hoover Dam, industrial production for the Second World War, atomic testing, tourism and the advent of the modern mega-resort – would steadily increase local populations and associated demands for water. These increases in population and water demand were often large and unanticipated, particularly in the latter half of the 20th century. As the following sections illustrate, long-term growth forecasts, and consequently water demands, have routinely not kept pace with the actual march of history in Southern Nevada. Forecasting is an effective and necessary tool for planning, but its accuracy over long periods of massive social and economic change (such as that experienced in the Las Vegas Valley) reflects, at best, only an educated guess. Typically, short-term forecasts are more accurate because they are based on the recent past. However, the current economic downturn affecting local, national and even global economies has presented unique challenges to planners as to when the economy will recover and what future growth rates will occur. This inherent uncertainty in forecasting is a routine challenge faced by local planners, one that will continue into the future. Water planning in present-day Southern Nevada is best understood with this in mind, and in the context of past and current events and the various constraints these events impose over time on contemporary resource management.

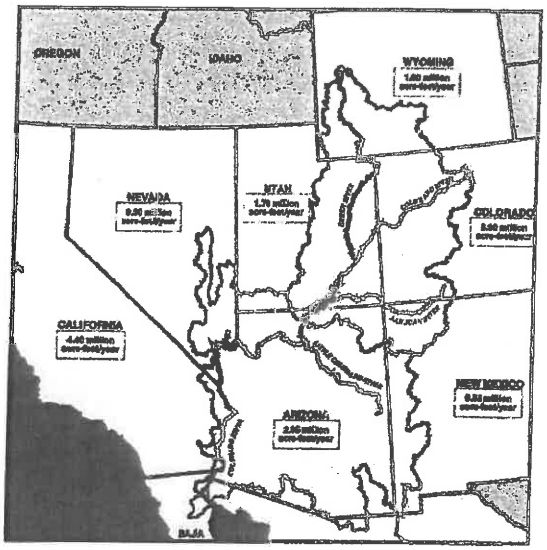
HISTORY (1905 to 1945)

From the beginning, the Las Vegas Valley was favored by immigrants, wayfarers and the railroad because of its artesian springs. With the coming of the railroad in 1905, the privately operated Las Vegas Land and Water Company was formed to build and operate the area's first system for moving local spring water. By 1913, a little more than 3,000 people resided in Clark County and there were approximately 100 groundwater wells in the Las Vegas Valley. In these early years and lasting for the next several decades,

the community viewed its supply of artesian water as virtually inexhaustible and more than adequate to meet the needs of any growth that might occur. By the mid-1920s, the population of Las Vegas would reach about 5,000.[1]

In 1922, the Colorado River Compact defined the geographic areas of the upper and lower basins of the Colorado River. It also apportioned 7.5 million acre-feet per year (AFY) to the upper basin and the same amount to the lower basin, in which Nevada is located (Figure 2). Of the lower basin's 7.5 million AFY, the 1928 Boulder Canyon Project Act authorized the apportionment of 300,000 AFY to Nevada, 2.8 million AFY to Arizona, and 4.4 million AFY to California. At the time, Nevada's negotiators viewed 300,000 AFY as a more than reasonable amount of water – Southern Nevada had no significant agricultural or industrial users, groundwater seemed plentiful and no one foresaw the changes that would occur.[2]

FIGURE 2 – Colorado River Basin and States



Although the United States suffered economically during the Depression in the 1930s, Southern Nevada flourished. Construction of Hoover Dam attracted thousands of workers to the area, resulting in the establishment of a camp that soon incorporated as the City of Boulder City. The region's first use of Colorado River water occurred when a small water line was built from Hoover Dam to supply water to the many construction workers living in the camp. The dam was completed in 1936 and turned over to the Bureau of Reclamation for operation. The creation of Hoover Dam eventually produced Lake Mead, the largest reservoir on the Colorado River and Nevada's source for its Colorado River allocation.[3]

While the Colorado River Compact and Hoover Dam made Colorado River water a viable future resource for Southern Nevada, the lack of infrastructure and sufficient funding for capital improvements precluded any immediate use. At this time, groundwater was still considered the basic water resource for the area. By 1940, groundwater use had reached almost 20,000 AFY and local resource managers began expressing concerns about limited water supplies, water waste and declining water levels. Their initial attempts to manage local water demands more effectively – for example, efforts to repeal a statutory ban on water meters – were not successful.[4]

With the advent of American involvement in the Second World War, several factors converged to accelerate Southern Nevada growth rates and water demands. In 1941, the City of Las Vegas and the Army Air Force signed an agreement for the establishment of the Las Vegas Aerial Gunnery School. To supply specialized materials for the war effort, construction began in the southeastern Las Vegas Valley on a vast industrial complex later known as Basic Management Inc. (BMI). The complex was granted access to Colorado River water and a small pipeline was built to deliver the water from Lake Mead. That same year, Thomas Hull, a Southern California hotel and motel owner, opened the El Rancho Vegas – the start of Southern Nevada's modern resort industry. This confluence of events significantly heightened interest in the area, attracted more businesses and residents, and led to rapid increases in demands for water.[5] It also marked the beginning of resource and forecasting challenges that continue to this day.

HISTORY (1945 to 1990)

Following the end of the Second World War, population growth continued to accelerate in the southwestern United States, particularly in Southern Nevada. In 1947, the Nevada Legislature created the Las Vegas Valley Water District (LVVWD). Over the next seven years, the LVVWD would acquire the assets of the Las Vegas Land and Water Company to become the municipal water purveyor for Las Vegas and unincorporated Clark County.[6]

By 1950, Southern Nevada's population was more than 40,000, groundwater use was almost 35,000 AFY in the Las Vegas Valley, and the BMI complex diverted about 15,000 acre-feet of Colorado River water annually. Planners forecasted that the area's population would not exceed 100,000 until the end of the century. The City of North Las Vegas was incorporated in 1946 and the City of Henderson in 1953. By the mid-1950s, the LVVWD had entered into agreements with BMI to expand the BMI water line. This effort resulted in the first delivery of Colorado River water into the valley to serve residences and businesses.

At this time, the region still relied significantly on groundwater – the LVVWD owned and operated 13 wells out of approximately 500 to 1,000 wells in the Las Vegas Valley. Planners no longer expected this reliance on groundwater to continue indefinitely. Consequently, the initial delivery of Colorado River water into the community – and the prospect of additional deliveries in the future – resulted in a short-term planning decision with long-term implications for overall resource management.

The Nevada Division of Water Resources (also known as the State Engineer), which is the state agency responsible for managing all non-Colorado River surface water, groundwater and well permits in Nevada, began to issue temporary permits for the Las Vegas Valley in 1955. A temporary permit allowed the permit-holder to pump groundwater, but with the understanding that the state would revoke the right if or when Colorado River water was available to the property.[7]

The decision had two far-reaching effects. First, it created a separate class of water rights ("revocable" water rights) that had to be co-managed with permanent water rights in the Las Vegas Valley. Second, it resulted in the issuance of pumping rights in excess of the perennial yield of the groundwater basin. Essentially, the idea was to over-pump the basin in the near term to meet increasing demands, but eventually to shift that excess use (represented by the temporary permits) to Colorado River water and return groundwater pumping to sustainable levels. In conjunction with the state decision, the LVVWD instituted water metering. Beginning in 1955, meters were installed for any new construction connecting to the LVVWD's distribution system.[8]

Changes also were made in the management of local wastewater. In 1954, the Clark County Sanitation District (now the Clark County Water Reclamation District) was created; the new district began treating county wastewater flows two years later. By 1957, the City of Las Vegas had installed a new sewer system and relocated its wastewater-treatment plant. The local wastewater facilities discharged their treated flows to the Las Vegas Wash, which until then was predominantly an ephemeral stream that ran into the Las Vegas Bay portion of Lake Mead.[9]

By 1960, the local population was just under 120,000, surpassing the forecast made only 10 years earlier for the year 2000. Land use in the Las Vegas Valley had almost doubled and groundwater use was just under 50,000 AFY. The BMI complex, City of Henderson and the LVVWD were receiving about 18,000 acre-feet of Colorado River water each year. Planners estimated that existing water supplies would be fully used in the next 10 years, at most.

Given the astonishing pace of growth and existing limits to the BMI pipeline, the LVVWD began formal engineering studies for new facilities to import additional Colorado River water into the Las Vegas Valley. The Colorado River Commission of Nevada and local leaders spent several years negotiating with the federal government for loans to pay for the work. After funding was approved in 1967, construction

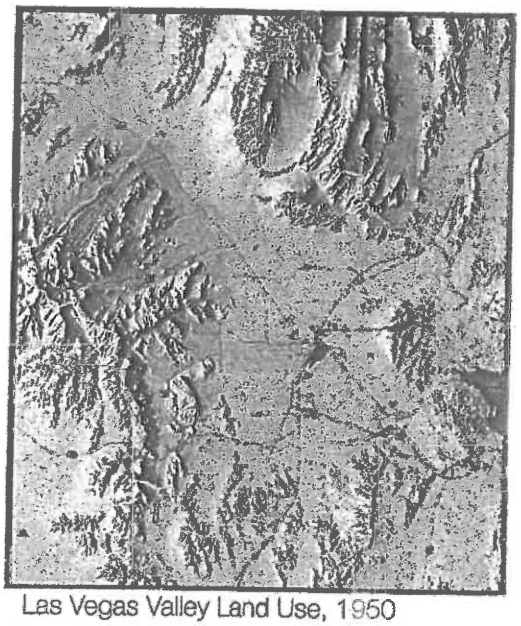
began in 1968 on the Southern Nevada Water System.[10] The project would prove timely. By 1970, population in the Las Vegas Valley had more than doubled to 263,000. Groundwater use had reached about 86,000 AFY and almost 35,000 acre-feet of Colorado River water was being imported annually through the BMI water line.

In 1971, the first stage of the Southern Nevada Water System was complete. It consisted of intake facilities and the Alfred Merritt Smith Water Treatment Facility at Lake Mead, eight pumping stations, a pipeline to Boulder City, a four-mile-long tunnel through the River Mountains and about 34 miles of major pipelines to deliver treated water into the Las Vegas Valley. The first stage provided a maximum capacity of 200 million gallons per day (MGD), and plans were underway for a second stage that would increase this to 400 MGD. It was now forecasted that available Colorado River water would meet local needs beyond 2020. Population for 2000 was forecasted to be 585,000.

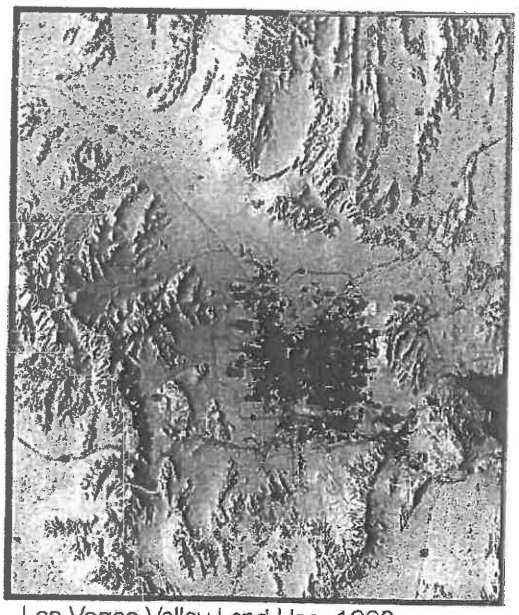
Over the next 20 years, population growth would increase almost threefold, surpassing the 2000 forecast of 1970 by almost 30 percent with many years yet to go. By 1982, the second stage of the Southern Nevada Water System was complete. However, water demands had continued to increase so unpredictably – moving up 13 percent from 1987 to 1988, and 14 percent from 1988 to 1989 – that planners estimated the region would reach the limits of its Colorado River apportionment within a few years, rather than in the next 40 or so years as projected in 1970.

As a result of the profound uncertainties created by massive population growth and the prospect of reaching its limits on Colorado River water, the LVVWD filed 148 applications in 1989 for unappropriated water in the counties of Clark, Lincoln, Nye and White Pine. Most of these applications were for rural groundwater with the exception of a few surface water applications on the Virgin River, which runs through northern Clark County into Lake Mead. After the initial filings with the Nevada Division of Water Resources, the LVVWD reviewed each hydrologic basin, eventually withdrawing a number of its applications. As the next section describes, by the mid-1990s, regional water management efforts, including conservation and other initiatives, returned to the Colorado River.

FIGURE 3 – Valley Land Use, 1950 and 1990



Las Vegas Valley Land Use, 1950



Las Vegas Valley Land Use, 1990

HISTORY (1990 to Present)

In 1990, there were almost 750,000 people in the Las Vegas Valley and land use exceeded 71,000 acres, more than 10 times that in 1950 (Figure 3). The 2000 population was forecast at one million residents, and planners estimated the community would reach its limit of Colorado River water sometime in the early years of the next century. Resource challenges at the end of the 1980s had reached a crisis point; with the new decade, local leaders began to aggressively explore different options for extending and managing water resources, while meeting the ongoing demands of the community. The following subsections discuss the major water management initiatives that were undertaken during this time.

WRMI Process

In 1990, municipal water providers in Southern Nevada began a comprehensive analysis of water resources and facilities. A consulting firm, Water Resource Management Inc., led the project and the effort became known as the "WRMI Process."[11] Population forecasts were provided by the Center for Business and Economic Research at the University of Nevada Las Vegas[12] and a conservation analysis was conducted by Planning and Management Consultants, Limited.[13] The 1991 published results were clear – without serious conservation, Southern Nevada would reach the limit of its existing Colorado River water supply by the mid-1990s; with conservation, the limit could be extended to 2007. The WRMI Process provided the impetus for creation of the SNWA, a study of water-facility expansion, implementation of an ongoing search for new water supplies and a renewed commitment to regional water conservation efforts. In 1991, the community implemented its first major conservation measure in decades – Operation Desert Lawn. The program resulted in ordinances by the local municipalities restricting lawn watering during the hottest times of the day.

Review of Water Commitments

One consequence of the WRMI Process was a temporary cessation of all new water commitments. The LVVWD, as the largest water provider in the Las Vegas Valley, had to ascertain how much water was already committed to new and planned development projects in its service area. To do this, it stopped accepting new applications for water service in February 1991. Upon completion of its analysis, the LVVWD instituted a more formalized water commitment process with the City of Las Vegas and Clark County. Henderson and North Las Vegas also instituted more formal commitment processes. Perhaps more than any other event, it was the temporary cessation of water commitments that awakened the community to the gravity of the water situation. This elevated awareness contributed in large part to the subsequent success of regional water management initiatives.

Creation of the SNWA

One of the most significant outcomes of the WRMI Process was the formation of the SNWA. The SNWA was created in 1991 through a cooperative agreement among the following seven water and wastewater agencies:[14]

- Big Bend Water District
- City of Boulder City
- City of Henderson
- City of Las Vegas
- City of North Las Vegas
- Clark County Water Reclamation District
- Las Vegas Valley Water District

The Big Bend Water District provides water service to Laughlin. The cities of Boulder City and Henderson provide water and wastewater service to their respective communities. The City of Las Vegas provides wastewater service to its residents. The City of North Las Vegas provides wastewater service to its residents, and water service to its residents, adjacent portions of Las Vegas and unincorporated Clark County. The City of North Las Vegas will be constructing its own water reclamation facility and currently has contract wastewater treatment services with the City of Las Vegas and the Clark County Water Reclamation District. The Clark County Water Reclamation District provides wastewater service for unincorporated Clark County and Laughlin. The LVVWD provides water service to Las Vegas and

portions of unincorporated Clark County. The SNWA was formed by these seven entities for the purpose of acquiring and managing water resources for Southern Nevada, constructing and managing regional water facilities, and promoting responsible water use.

Integrated Resource Planning

In April 1994, the SNWA began an integrated resource planning process to identify the appropriate combination of resources, facilities and conservation programs to meet future water demands in Southern Nevada. Integrated resource planning brings important concepts to traditional resource and facility planning, including involvement of the public early in the planning process; analysis of both supply-side (resources and facilities) and demand-side (conservation) solutions; consideration of different community goals; and analysis of the trade-offs among different, sometimes conflicting, goals.

Following more than a year of study and public interaction with a stakeholder advisory committee, the SNWA adopted a series of recommendations to guide its future planning efforts (Appendix 2). Principal recommendations related to water resources included:

- Seek permanent, long-term water supplies.
- Formulate a water resources plan that utilizes all available water supplies, including unused Colorado River apportionments, surpluses, leases and other water supplies.
- Place top priority on development of Colorado River water over development of a Virgin River pipeline or water in rural counties.
- Maximize use of the Las Vegas Valley shallow groundwater, when and where practical.

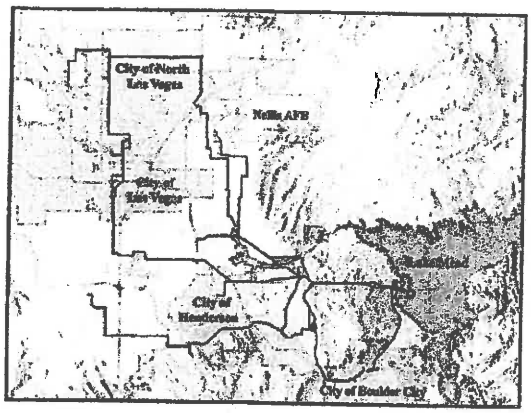
The recommendations also supported the "phasing in" of new regional facilities to meet future water demands.[15] As part of a subsequent planning phase in 1996, recommendations were developed on how to pay for new regional water facilities; specific proposals included a regional connection charge, regional water surcharge and sales tax increase.[16]

Expansion of Regional Facilities

The recommendations of the SNWA integrated resource planning effort supported the expansion of existing water treatment and transmission facilities for the Las Vegas Valley. The SNWA Board of Directors approved the recommendations; design and construction of new infrastructure, including a second intake at Lake Mead and a second water treatment facility (River Mountains Water Treatment Facility) in eastern Henderson, began later that year. The phased expansion increased the treatment capacity of the Southern Nevada Water System to 480 MGD by 1997, 600 MGD by 1999, 750 MGD by 2002, and 900 MGD by 2007.

Additional improvements have included major pipelines and pumping stations in and around the Las Vegas Valley; upgraded communications systems; process improvements at both treatment facilities; upgraded intake pumping capacity; and an emergency bypass pipeline from the second intake to the existing water treatment facility. Today, the Southern Nevada Water System has a treatment and delivery capacity of 900 MGD (Figure 4).

FIGURE 4 – Southern Nevada Water System



Environmental Initiatives

To support its resource planning and facility expansion activities, the SNWA began to participate in a number of environmental initiatives and coalitions in the mid-1990s, taking a proactive and integrated approach to environmental planning with respect to water resource management. The SNWA's commitment to

environmental responsibility typically goes beyond the steps necessary to ensure compliance with applicable regulations or statutes. Efforts have included the support of research and recovery activities related to federally endangered fish and birds, involvement in broader regional programs that address issues such as habitat conservation and water quality, and financial and staff support for environmental research and studies. These environmental planning efforts are discussed in more detail in Chapter 5.

Las Vegas Valley Groundwater Management Program
In conjunction with integrated resource planning and its focus on Colorado River water, the SNWA began working with local well users and the Nevada Division of Water Resources in 1996 to address groundwater management in the Las Vegas Valley. As a result of these efforts, state legislation was passed in 1997 and 1999 implementing a groundwater management program for the Las Vegas Valley hydrographic basin.[17] The Las Vegas Valley Groundwater Management Program (Groundwater Management Program) protects the local groundwater basin from over-drafting and potential sources of contamination. Efforts have included an inventory of all wells in the Las Vegas Valley; a cost-benefit analysis of permanent recharge; increased education of groundwater users; and development of well conversion, landscape conversion, sub-meter assistance and permanent recharge programs to benefit existing and future well users. To pay for these activities, the Nevada legislature authorized the SNWA to assess well users in the Las Vegas Valley hydrographic basin an annual fee.

Water Resource Plans
In 1996, the SNWA Cooperative Agreement was amended to require adoption of a Water Resource Plan. After the first plan was adopted in 1996, the SNWA has reviewed the plan annually, adopting revisions as needed. The 2009 Water Resource Plan represents the eighth revision in 13 years. As reviews and revisions demonstrate, the plan is a dynamic document, intended to reflect changing developments in the water resource picture for Southern Nevada. Since the plan's inception, those developments have come principally from increased water demands, as well as from landmark changes in rules, agreements or other factors affecting the use of Colorado River water (for example, water banking, intentionally created surplus and drought).

In-State Agreements
In the late-1990s, the SNWA and the LVVWD began to work closely with Lincoln, White Pine and Nye counties, as well as other in-state interests to negotiate equitable water-sharing arrangements for available water resources in areas outside the Las Vegas Valley. The various agreements have involved such resources as surface water rights on the Virgin and Muddy rivers, and groundwater rights and applications in Coyote Spring Valley and Lincoln County. These agreements, which are discussed in Chapter 2 in reference to the associated water resources, typify the philosophy that the SNWA brings to the development of in-state water resources. In every instance, the SNWA is open to working closely with counties of origin and local residents to address concerns and identify opportunities for the sharing of resources -- not only to meet Southern Nevada's future water needs, but also to help these outlying areas develop the resources needed to meet their own near- and long-term plans for the future.

In-State Water Banking
To maximize the use of Nevada's Colorado River allocation, SNWA member agencies began storing or "banking" water in the Las Vegas Valley in 1987. In Southern Nevada, banking is accomplished by artificially recharging Nevada's unused Colorado River water into the local groundwater aquifer. This provides Southern Nevada with additional resources that can help bridge potential shortfalls in meeting demands while other resources in the SNWA resource portfolio are being developed.

Interstate Agreements

Beginning in the early-1990's and continuing to the present day, the SNWA has worked closely with other basin states to maximize opportunities for the flexible use of Colorado River water, thereby extending available supplies. The following sections highlight the principal achievements to date.

Arizona Water Banking. To develop its storage concepts further, the SNWA participated in a banking demonstration project with Arizona in 1993. Three years later, Arizona dramatically expanded its recharge and banking efforts when the state created and funded the Arizona Water Banking Authority (AWBA). The primary purpose of the AWBA is to ensure all of Arizona's unused Colorado River apportionment is utilized fully for the benefit of Arizona. The 1996 state legislation that created the AWBA also allowed for the creation of an interstate bank to give Nevada and California the opportunity to bank water in Arizona. Federal regulations to facilitate interstate banking were approved by the Secretary of the Interior in 1999 and 2001, allowing Arizona and Nevada to begin formal negotiations for Nevada's participation in Arizona's interstate bank. Shortly thereafter, other agreements were forged to establish, clarify and expand business arrangements for interstate banking efforts in Arizona.

California Water Banking. In October 2004, under existing federal regulations for interstate banking, the SNWA entered into an agreement with the Metropolitan Water District of Southern California (MWD) that allows the SNWA to store a portion of Nevada's unused Colorado River allocation in California for SNWA's future use. Provisions for the recovery of banked resources are discussed in Chapter 2.

Management of Surplus Colorado River Water. In 2001, the Secretary of the Interior implemented a methodology for managing additional supplies in the Colorado River. Interim Surplus Guidelines were established to help the Upper Colorado River Basin states preserve their respective apportionments, while providing time for California to reduce its uses on the Colorado River to its 4.4 million AFY allocation. The Interim Surplus Guidelines also provided the states of Nevada and Arizona with the opportunity to access temporary surplus Colorado River water above their respective basic apportionments for domestic uses through 2016, if there was adequate water storage in Lake Mead.[18]

As a result of worsening drought conditions, the Secretary of the Interior initiated a planning process in 2005 to develop lower basin shortage guidelines and management options for the coordinated operation of lakes Powell and Mead during low reservoir conditions. This planning process resulted in agreements among the seven basin states and a 2007 Record of Decision that modified and extended the 2001 Interim Surplus Guidelines. The process also established new Interim Guidelines for managing shortages, coordinating operations of lakes Mead and Powell, encouraging augmentation and conservation of water supplies in the lower basin. This agreement is discussed in more detail later in this chapter.

Drought

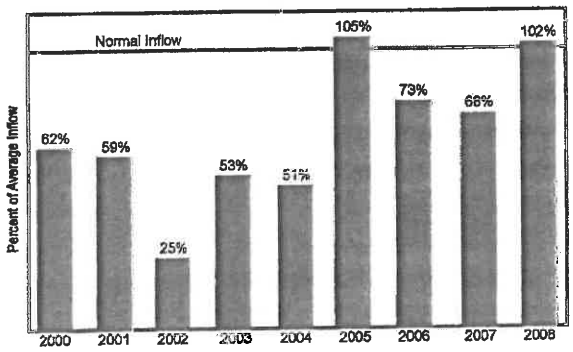
Defining drought can be difficult, since droughts are not distinct climatological events like floods, fires or hurricanes. Instead, numerous factors in the environment interact in complex ways that create conditions where water supplies are not replenished normally. Southern Nevada is dependent on flows from the Colorado River, which in turn are derived from snowmelt and runoff in the Rocky Mountains of the Upper Colorado River Basin. Recent years of below average snow pack in the Colorado Rocky Mountains have resulted in below average runoff to the Colorado River, the source of approximately 90 percent of the water delivered by SNWA and its purveyor members.

In 1999, the Colorado River Basin began to experience drought conditions that, from 2000 to 2004, became the worst five-year drought in the recorded history of the basin. These conditions were aggravated by several years of extremely dry soil conditions, which further reduced total runoff. As a result, water levels in the two primary storage

reservoirs on the Lower Colorado River (Lake Mead and Lake Powell) declined to levels not observed since Lake Powell began filling in the early-1960s. Over the next several years, snowfall and runoff in the basin was well below normal, the worst year (thus far) being 2002, when runoff to Lake Powell was approximately 25 percent of average (Figure 5).[19]

From 1999 to 2004, water levels in Lake Mead and Lake Powell declined by approximately 110 and 80 feet, respectively. These declines reduced the combined water storage in the two reservoirs to 46 percent of capacity.

FIGURE 5 – Lake Powell Annual Inflows[20]



To help offset the impacts of drought, the SNWA and its member agencies conducted a drought planning process in 2002 that resulted in the development of an aggressive plan to lower demands during times of significantly reduced Colorado River inflows. As described later in this chapter and in Chapter 2, this effort has resulted in both interim and permanent changes to how the community uses water.

Except for years 2005 and 2008, when the Colorado River Basin received slightly above-normal runoff (105 percent and 102 percent, respectively), drought conditions in the basin continued to persist. At the end of 2008, the combined storage of Lake Mead and Lake Powell was 52 percent of capacity and Lake Mead water level was about 100 feet lower than that experienced in the late-1990s.

Integrated Water Planning

Several in-state groundwater resources available within Nevada have long been part of the SNWA's water resource portfolio. These resources are available within our state in the form of unused groundwater in Clark, Lincoln and White Pine counties. The LVVWD and SNWA have been working for nearly two decades to secure some of this unused water.

Given persistent drought conditions in the Colorado River Basin, the SNWA began to accelerate the development of these in-state resources in early 2004. At that time, the SNWA Board of Directors approved a concepts document and a work plan for integrated water planning (discussed below) that together provide a framework for development of these in-state resources. Moving some of this unused water to Southern Nevada will increase the reliability of the region's water supply during droughts or future shortages on the Colorado River and also help to meet future demands.

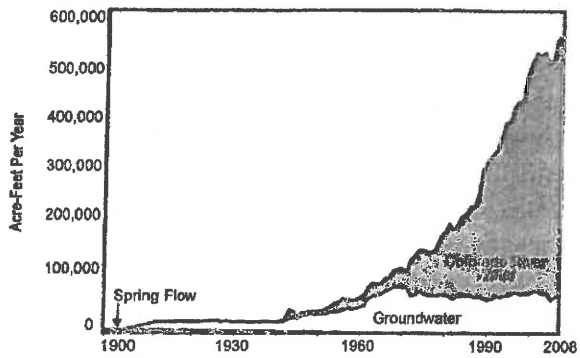
Development of some or all of these in-state water resources has potential implications for a wide range of water resource management and operational issues, as well as environmental and rural economic development issues. To address these questions in a comprehensive manner consistent with the overall resource goals of Southern Nevada, the SNWA initiated an integrated water planning process in early 2004. The purpose of this process was to identify the appropriate combination of in-state resources, facilities and conservation levels needed to provide greater drought protection for Southern Nevada, as well as meet future water demands given SNWA's reliance on Colorado River water (Figure 6). In this respect, the process focused on how best to integrate in-state resources into current SNWA planning and management activities, given the dramatic changes in Colorado River conditions.

Integrated Water Planning Advisory Committee

The SNWA convened an Integrated Water Planning Advisory Committee (IWPAC) to assist in its long-range planning effort. The IWPAC was comprised

of 29 stakeholder representatives. Unlike previous SNWA committees, the IWPAC included not only stakeholder representatives from the metropolitan Las Vegas area, but also representatives from Lincoln, Nye and White Pine counties, as well as the Moapa and Virgin Valley Water Districts. For more than a year, the committee worked with staff to explore various options and scenarios for in-state resource development, building on the previous work done by the Integrated Resource Planning Advisory Committee process of the mid-1990s. In September 2005, the IWPAC finalized 22 recommendations and presented them to the SNWA Board of Directors in November 2005 (Appendix 1).[21]

FIGURE 6 – Water Use by Source, 2008



In an effort to maintain and build upon the success of the community's conservation efforts, the committee recommended that the SNWA and its member agencies pursue more aggressive conservation achievements, including permanent implementation of major drought-related demand reduction tools.

Interim Guidelines and Associated Agreements

In response to severe Colorado River Basin drought conditions, the Secretary of the Interior, in cooperation with the seven basin states, initiated a process in 2005 to explore management options for lakes Mead and Powell. These efforts resulted in the Secretary of the Interior issuing a Record of Decision (ROD) in 2007 for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead, "Interim Guidelines."[22]

Key elements of the Interim Guidelines include modification and extension of the 2001 Interim Surplus Guidelines, establishing how shortages in the lower basin will be implemented, and the adoption of coordinated operations of lakes Powell and Mead. In addition, the Interim Guidelines define the availability of Colorado River water for use in the lower basin based on the water surface elevation of Lake Mead and create a new type of surplus called Intentionally Created Surplus (ICS). The SNWA has a number of water resources available for use under rules for ICS and other agreements. These resources and provisions for recovery are discussed in detail in Chapter 2.

Intake No. 3

Ongoing drought conditions pose a number of challenges for Southern Nevada, including operational challenges associated with intake facilities at Lake Mead. To help protect Southern Nevada's access to Colorado River resources, the SNWA Board of Directors in 2005 approved the design and construction of a new water intake in Lake Mead.

In addition to preserving supply capacity, Intake No. 3 will provide access to better water quality as Lake Mead water levels decline in times of drought. Construction of Intake No. 3 is currently underway. The project is scheduled to be completed in 2013.

In-State Resource Developments

The SNWA continues to pursue permitting activities associated with development of its Clark, Lincoln and White Pine Counties Groundwater Development Project. Following administrative hearings in 2007 and 2008, the Nevada State Engineer granted the SNWA water rights in Spring, Delamar, Dry Lake and Cave valleys.[23] An administrative hearing for the SNWA's pending applications in Snake Valley is scheduled for 2011.

In conjunction with these water rights processes, the SNWA entered into stipulations with several federal agencies to establish a process for working together to monitor and protect federal resources as the rights are developed and managed.[24] Specific activities include the development of a regional groundwater

flow model; establishment of a regional groundwater monitoring network; the collection and analysis of additional information regarding the relationship between the development of groundwater resources and surface water resources; and the establishment of a technical review panel, biological work group and an executive committee to oversee the implementation of a monitoring, management and mitigation plan.

To more effectively manage water and environmental resources in the project area, the SNWA acquired ranch properties and associated surface and groundwater rights in Spring Valley. These land and water resources were acquired as part of the SNWA's commitment to the adaptive management of the groundwater basins that encompass SNWA's development of water in Clark, Lincoln and White Pine counties. The SNWA does not plan to export any of the acquired surface water resources; instead, the surface water will be used to recharge the basin and help manage and protect the aesthetic and environmental resources in Spring Valley. These surface water resources also will be used to continue ranching and agricultural activities in the area.

Conservation

The SNWA has a long history of setting and achieving water conservation goals to promote water efficiency and extend the availability of limited resources. To build upon this success and to induce additional water savings, the SNWA adopted a new, more aggressive, conservation goal in 2009.

To achieve its new goal of 199 gallons per capita per day (GPCD) by 2035, the SNWA's member agencies began working together to permanently implement previously approved major demand reduction tools such as landscape development codes, turf restrictions and golf course water budgets as part of the community's overall conservation effort. Further discussion is provided in Chapter 2.

The combined effect of Southern Nevada's conservation response and changing water use patterns have resulted in a reduction of consumptive use by approximately 21 billion gallons annually between 2002 and 2008, despite the addition of more than 400,000 residents during that time. A small portion of the reduction is likely due to the economic down-turn.

Climate Change

The onset of drought in the Colorado River has heightened attention to the broader issue of climate change, both within the Colorado River Basin and beyond. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."[25] Climate change impacts on the Colorado River and the American Southwest are expected to be significant. The majority of regional climate models project a more arid climate and reductions in Colorado River runoff in the future.[26] These reductions are expected to be in addition to natural-flow variabilities and temporary drought conditions.

In an effort to begin a dialogue on future impacts of climate change for water management, the SNWA partnered with the Natural Resources Defense Council and the Desert Research Institute to host the Urban Water Supplies and Climate Change in the West Conference in September 2005.[27] Since then, the SNWA has worked collaboratively with water utilities across the country to raise awareness of the impacts that climate change will have on municipal water agencies and regional water management.

In 2008, the SNWA partnered with some of the nation's largest water agencies to form the Water Utility Climate Alliance (WUCA).[28] This group works to improve research related to the impacts of climate change on water utilities; develop strategies for adapting to climate change; and implement tactics to reduce their greenhouse gas emissions. Through ongoing collaboration, the SNWA will continue to support research and track potential influences of climate change and increased hydrologic variability.

CONCLUSION

By the end of the 20th Century, the Las Vegas economy had reinvented itself with new mega-resorts and a southwestern lifestyle that continues to attract people from around the world. By 2008, Southern Nevada's population had increased to nearly 2 million people, most of whom reside in the Las Vegas Valley (Figure 7).

From 1910 through 2000, the annual population growth in Southern Nevada averaged 7 percent per year, whereas growth in the United States over the same period has averaged about 1 percent (Figure 8).

Along with the rest of the nation, the Las Vegas Valley has been impacted by recent economic conditions. This has resulted in a near-term leveling of population growth. It is difficult to predict when these conditions will improve, but most forecasts agree that this trend is temporary. To this end, water managers and local planners must continue to take the steps necessary to ensure community water resources are available when needed. Current drought conditions in the Colorado River Basin and climate change predictions emphasize the need for continued assessment of resources, regardless of actual population trends. Current conditions require Southern Nevada to reduce its heavy reliance on Colorado River water and develop more of the non-Colorado River resources contained in its water resource portfolio. Existing in-state resources and other alternatives must be developed to bridge and supplement Nevada's Colorado River resources and provide a sustainable and diverse mix of water resources for the long-term.

In many respects, the challenges of the future of Southern Nevada are not dissimilar to the challenges of its past. Regardless of these challenges, the SNWA and its member agencies will continue to work diligently to anticipate, manage and meet the future water demands of the region. As described in Chapter 2, the SNWA has an extensive portfolio of existing and developing resources. The challenge will remain one of balancing the timing, development and use of these specific resource options.

The dynamic nature of water forecasting is among the key reasons the SNWA reviews its resource plan annually and makes adjustments as needed.

FIGURE 7 – Clark County Population, 2008

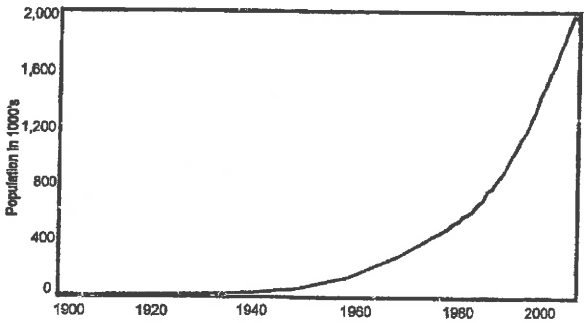
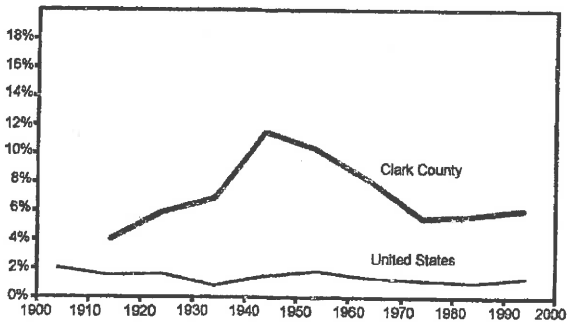


FIGURE 8 – Annual Change in Population



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CHAPTER 2

The SNWA Water Resource Portfolio

Since 1991, the SNWA has worked to develop and manage a flexible portfolio of diverse water resource options. This approach is commonly used in the field of resource planning and is essential in responding to future conditions that may result from drought or other forms of shortage.

The portfolio approach allows the SNWA to assess its overall resource options and make appropriate decisions regarding what to bring on-line when necessary. In determining the priority of resources, some of the factors considered include reliability, availability, accessibility, cost and need. As a result, the SNWA Water Resource Plan is reviewed annually and updated as needed to reflect changing conditions and developments in Southern Nevada's resource picture.

The 2009 Water Resource Plan includes conservation, Colorado River water, groundwater resources and augmentation in its portfolio of current and future resources that will be used to meet demands as needed. This chapter describes each of the water resources available to Southern Nevada over the planning horizon. It is important to note that while most resources are currently quantified, such as Nevada's Colorado River allocation, others are still being assessed, developed or are pending action by the state.

The development of some of the future resources discussed below depends on a number of factors, such as rulings by the Nevada State Engineer, interpretations of Colorado River law, negotiations with other users, and need. Consistent with its approach to capital improvements planning, the SNWA considers phasing when assessing the timing and use of resources. By securing future water resources, obtaining appropriate state and federal permitting and building infrastructure in advance of when they are needed, the SNWA retains the ability to adapt to changing demand and supply conditions. The resources currently available or under development to meet Southern Nevada's demands are described in the following sections.

CONSERVATION

Promoting the efficient use of water is central to the mission of the SNWA. The ability to increase efficient water use and reduce water waste wherever possible has a direct impact on the amount of resources that will be needed in the future. Conservation is a resource, but it is fundamentally different from other resources available in the SNWA portfolio. Unlike typical "wet" resources, which are acquired to meet demands, conservation is a tool that is used to reduce overall demands (relative to levels that would have occurred in the absence of conservation) and extend supplies. The more successful a community's conservation achievement becomes, the lower the community's overall demand for water and the more efficient its use of existing supplies.

However, the more aggressive and responsive a community is to calls for increased conservation, the more difficult it becomes to realize additional conservation gains. This phenomenon of diminishing returns is referred to as "demand hardening." For growing communities where a majority of the water supply comes from one source (such as Southern Nevada), the prospect of demand hardening requires development of additional alternative water supplies regardless of conservation levels achieved. The SNWA is pursuing such resource development as described

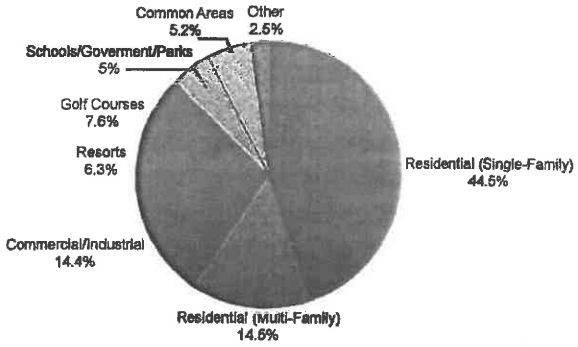
later in this plan. Conservation and the remaining elements of the SNWA water resource portfolio are described further in this chapter.

Conservation in Southern Nevada

Since its creation in 1991, the SNWA has implemented a number of conservation programs focused on reducing water use throughout the community. While the SNWA actively promotes indoor conservation, in Southern Nevada the greatest opportunity for water conservation lies in curbing outdoor water use.

According to consolidated data provided by SNWA member agencies, residents account for approximately 59 percent of water use (Figure 9). Most of that water is used consumptively for outdoor landscaping. While business and commercial customers account for a substantially smaller portion of the community's overall water use, the SNWA continues to work with all customer classes to identify opportunities for increased conservation.

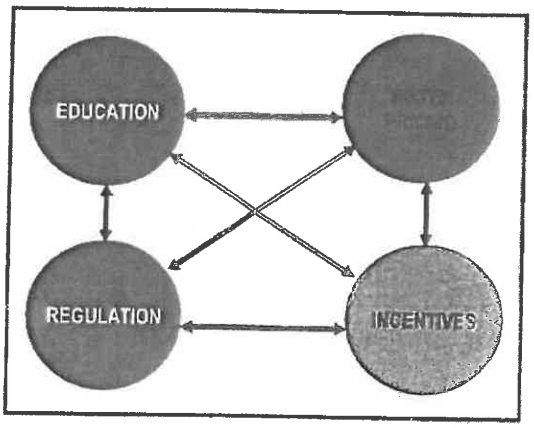
FIGURE 9 – Municipal Metered Water Use, 2007



CONSERVATION TOOLS

The SNWA and its member agencies utilize a variety of tools to promote conservation and reduce overall water use. These include a combination of regulation, water pricing, incentives and education to elicit the necessary community response to reduce demands (Figure 10). Because the biggest potential for water savings comes from reductions in consumptive water demands, primarily in the form of outdoor water uses such as landscape irrigation, the major conservation tools are designed to achieve results in these areas. Each conservation tool is related to the community's total conservation effort – used in concert, these tools maximize the water conservation potential in the community. The following sections describe the major conservation initiatives used by the SNWA and its member agencies.

FIGURE 10 – Demand Management Tools



Regulation

During the past 18 years, city and county governments have adopted a variety of land use codes and water use ordinances to promote more efficient use of water resources in Southern Nevada. In 1991, local government agencies adopted watering restrictions that prohibited watering during the hottest times of the day in the warmer months. In 2003 and in response to the onset of severe drought conditions in the Colorado River Basin, SNWA member agencies adopted more stringent policies designed to offset drought impacts. These policies included additional restrictions on landscape watering, vehicle washing, lawn installation, mist systems and golf course water use (budgets) during declared drought. In 2005, a citizen advisory committee recommended permanent adoption of these restrictions as a way to help meet long-term resource needs for the community. In the years following, the SNWA and its member agencies began working together to permanently implement the measures detailed below as part of the region's overall conservation effort.

- Landscape watering: customers are assigned mandatory watering groups that limit watering to one day a week in winter, three days a week in spring and fall, and prohibit watering from 11 a.m. to 7 p.m. in summer.
- Vehicle washing: a positive shutoff nozzle is required for residential vehicle washing. Commercial vehicle washing is prohibited unless water is captured to the sanitary sewer where that water can be treated and reused.
- Lawn installation: turf installation is prohibited in new residential front yards and is limited to a maximum of 50 percent the landscapeable area in new residential backyards. Turf is prohibited in new commercial development.
- Mist systems: use of commercial mist systems is limited to summer months.
- Golf course water budgets: golf courses are subject to mandatory water budgets (6.3 acre feet of water per year, per irrigated acre).
- Fountains and ornamental water features: these features are prohibited except as allowed by jurisdiction policy.
- Water waste: allowing water to runoff into streets and/or adjoining property is prohibited. It also is considered water waste to violate policies that limit the time of day or assigned days of the week when watering may occur.

Water Pricing

Water rates, including increasing block rate structures (tiered rates), are one of the most effective conservation tools. Tiered rate structures charge higher rates as water use increases. These rate structures encourage efficiency, while ensuring the affordability of water for essential uses.

While the SNWA member agencies have adopted conservation oriented water rates, the rates must be revisited regularly to ensure that they keep up with inflation and maintain their effectiveness in encouraging conservation. The SNWA member agencies regularly review their water rates to assess their effectiveness and make adjustments as needed.

In adjusting rates for conservation, one complexity that water managers must consider is the relationship between water pricing and the fiscal integrity of the water utility. Conservation results in a decline in purveyor water sales. When coupled with increasing operating costs, conservation that exceeds expectations may require additional rate increases to maintain financial integrity. This can, in turn, result in a further decrease in water sales, resulting in price instability, fiscal uncertainty and a loss of community confidence in the utility. As a result, water utilities must delicately balance pricing to ensure rate stability while sending an appropriate pricing signal that supports the community's conservation goals.

Incentives

Where regulation and water pricing are considered more common approaches to achieving conservation, incentives are more flexible tools that invite the community to participate in the conservation effort. Incentives give customers flexibility in determining how they will manage and reduce their overall water use. The SNWA has a number of "water smart" incentive programs that are critical to achieving its conservation goals.

Water Smart Landscapes Rebate Program. This program provides incentives for residential and commercial property owners to upgrade lawn to water-efficient landscaping. The current program rebate amount is $1.50 for the first 5,000 square feet of lawn removed and $1 for additional lawn removed, up to $300,000. Since program inception, more than 130 million square-feet of lawn have been replaced, saving an estimated 7 billion gallons of water annually.

Efficient Landscape Irrigation Equipment. This program pays up to half the cost of replacing inefficient irrigation controllers with new generation "smart" controllers. Smart controllers have the ability to predict plant water needs and apply the necessary amount of water at the appropriate time. These controllers are capable of reducing water use by 15 to 30 percent. This program also pays up to half the cost of rain sensors that can interrupt irrigation whenever the valley receives significant rainfall.

Water Efficient Technologies. Business customers who choose from a menu of proven conservation technologies, or who select a custom technology that conserves at least 500,000 gallons of water per year, qualify for a rebate of up to $150,000 per property. The program can be used to facilitate retrofit of existing equipment or to purchase certain approved technologies for new installations. It is estimated that businesses in Southern Nevada have conserved more than 1.75 billion gallons through participation in this program since its inception.

Water Smart Car Wash. The Water Smart Car Wash program is a public-private partnership that encourages residents to use commercial car wash facilities instead of washing their vehicles at home. Water Smart Car Washes recover all of their wastewater for treatment and reuse. Water used at these facilities is either reused on site, or treated and returned to Lake Mead for return-flow credits. In contrast, water used for car washing at home is largely lost to evaporation.

Pool Cover Rebate Program. The SNWA Pool Cover Rebate Program pays up to half the cost of a swimming pool cover. Typical use of a cover is estimated to save 13,000 gallons annually on an average-size pool. Since inception, the program has assisted more than 14,000 customers and produced estimated water savings of more than 187 million gallons annually.

Water Smart Contractor Program. The Water Smart Contractor Program is a highly successful partnership program in which landscape contractors assure that their projects meet specific criteria to conserve water. Close to 100 landscape contractors in Southern Nevada currently participate in the program. To obtain status as a Water Smart Contractor, licensed landscape contractors must attend SNWA water efficiency training and pass a proficiency exam.

Water Smart Homes. Launched in 2005, the Water Smart Home Program certifies new homes as water smart, ensuring that homeowners are purchasing a home that can save as much as 75,000 gallons of water per year. This is the nation's largest program for water efficiency in new homes, with almost 7,000 water smart homes constructed so far.

Water Upon Request. The SNWA and several local partners teamed up with local restaurants, which agree to serve water only when patrons request it. This program saves participating restaurants water, time and money by eliminating unconsumed glasses of water. For every glass of water not served, as much as 1.5 to 3 gallons of water is saved. There are currently more than 300 restaurants participating in the program.

Education

An integral element of the SNWA conservation strategy is education. Before communities will accept regulation and pricing mandates, or participate in incentive programs, they must recognize the importance of conservation and understand how they can conserve water most effectively. The SNWA public education programs described below are designed to elicit buy-in from the community and help residents to understand that responsible water use is a critical part of living in a desert environment.

Water Conservation Coalition. Established in 1995, the Water Conservation Coalition is a public-private partnership formed by community leaders to help increase water-efficient practices within the Southern Nevada business community and to promote community-wide water conservation. Through initiatives such as its speakers bureau, Business-to-Business Challenge and various public projects, the Coalition works closely with the SNWA to identify areas of conservation that are most beneficial to local businesses and the community's overall water conservation goal. For example, the Coalition has partnered with local resorts and other leading properties to initiate a Linen Exchange Program. As part of this voluntary program, linens are changed only on the third day of a guest's stay, unless otherwise requested.

Water Smart Innovations. In 2008, the SNWA, in partnership with the U.S. Environmental Protection Agency's WaterSense program, hosted the inaugural WaterSmart Innovations Conference & Expo. Roughly 1,200 participants from across the U.S. and 17 foreign nations came together to share information about conservation programs and water-efficient technologies.

Conservation Helpline. The Conservation Helpline is an information line that customers can call to obtain conservation information or report water waste. The Helpline is available in both English (258-SAVE) and Spanish (258-AGUA).

Publications and Media. The SNWA regularly executes a comprehensive campaign of television, print and radio ads that educates the community on the need for water conservation and offers help through the SNWA Web site and Conservation Helpline. In addition, the SNWA operates a speakers bureau, produces a news-and-information television show, and produces and distributes dozens of publications to help customers conserve water, including a landscape watering guide. The SNWA also continues to implement a bicultural outreach campaign specifically for Southern Nevada's Spanish-speaking audience.

Demonstration Gardens. Through the combined efforts of the SNWA and its member agencies, there is a demonstration garden in every part of the valley. The SNWA also promotes visits to the Springs Preserve, a 180-acre facility that offers hundreds of examples of water-efficient landscaping, as well as classes by master gardeners and horticulturists. Advice from the facility's staff is available seven days a week. Free tours also are available for area students.

The SNWA supports the development of smaller demonstration projects throughout the Las Vegas Valley to show the public that water-smart landscaping is attractive and a water-efficient choice for Southern Nevada. Currently, schools may apply annually for SNWA funded conservation grants of up to $5,000 to develop demonstration projects for their own campuses.

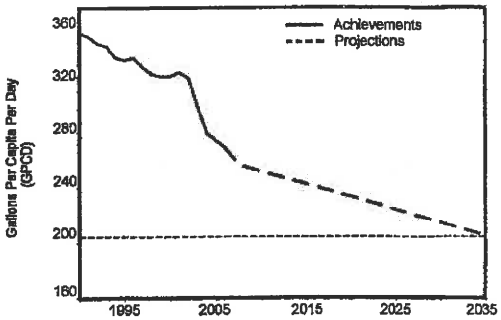
H2O University. The SNWA is committed to educating the next generation on the importance of water resources and conservation. To this end, the SNWA has partnered with the Springs Preserve to develop a comprehensive education program known as H2O University for teachers in the Clark County School District, one of the largest school districts in the nation. One innovative component of the program is the Youth Advisory Council, which allows select students to pursue an interest in water-related issues and further develop leadership skills.

Conservation Achievements

Since its formation in 1991, the SNWA has embarked on an aggressive long-term water conservation program that has contributed to extraordinary conservation gains. In recent years, participation in the SNWA's rebate programs realized record-breaking results, including peak participation levels in almost every area. The combined effect of Southern Nevada's conservation responses was a reduction of consumptive use by roughly 21 billion gallons annually between 2002 and 2008.

Figure 11 illustrates the results of past conservation efforts, reducing water use from approximately 350 gallons per capita per day (GPCD) in 1990 to approximately 250 GPCD in 2008.

FIGURE 11 – GPCD Reduction from Conservation



In an effort to maintain and build upon the community's response to calls for greater water conservation, the SNWA and its member agencies established a new conservation goal in early 2009 to reduce water use to 199 GPCD by 2035. Chapter 3

describes how this additional conservation will impact long-term water demand forecasts.

Conservation remains an important element in planning and balancing the various resource and infrastructure needs in Southern Nevada. Continued conservation, coupled with the acquisition and development of additional water resources, will allow SNWA to meet projected water demands through 2060.

COLORADO RIVER WATER

A series of documents composed of contracts and regulations, state/federal statutes and compacts, court cases, and a treaty known as the "Law of the River" governs how and where Colorado River water is used. The 1922 Colorado River Compact and the 1928 Boulder Canyon Project Act defined all apportionments of Colorado River water in "consumptive use" units. Consumptive use is defined as water diversions minus any water that is returned to the Colorado River (the latter is referred to as "return-flow credits").

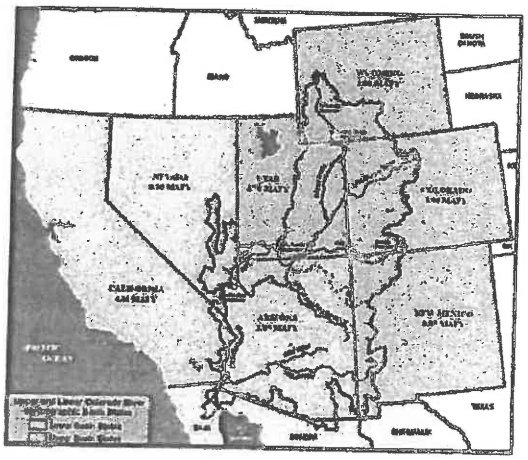
The 1948 Upper Basin Compact assigned the upper basin's apportionment of 7.5 million AFY among the states of Wyoming, Utah, Colorado and New Mexico. The 1964 Supreme Court Decree in Arizona v. California verified the lower basin apportionment of 7.5 million acre-feet among Arizona, California and Nevada, including Nevada's consumptive-use apportionment of 300,000 AFY of Colorado River water (Figure 12).[1]

With return-flow credits, Nevada can actually divert more than its 300,000 AFY apportionment, as long as there are sufficient return flows to ensure the consumptive or net use is no more than 300,000 AFY. Return flows in Nevada consist mainly of treated Colorado River wastewater that is returned to Lake Mead via the Las Vegas Wash and to the Colorado River at Laughlin, Nevada.

Nevada Basic Apportionment

Pursuant to the 1964 Supreme Court Decree in Arizona v. California, any entity wishing to divert Colorado River water within a state must have a specific contract with the Secretary of the Interior for the water. These contracts are typically called "delivery" contracts and are in diversion units, not consumptive-use units. Thus the sum of the delivery contract volumes within a state can be greater than the state's consumptive-use apportionment, as long as there are enough return flows to ensure that the consumptive or net use is within the consumptive-use apportionment.

FIGURE 12 – Colorado River Basin



Early on, the SNWA member agencies contracted for most of Nevada's 300,000 AFY of Colorado River water. Between 1992 and 1994, the SNWA determined that additional water was available and worked to acquire additional Colorado River water resources. The following subsections describe these contracts.

Colorado River Contracts (pre-SNWA). Prior to the SNWA's creation in 1991, total entitlements for diversion for Colorado River users in Nevada equaled 417,116 AFY (Appendix 3). Of that amount, 342,161 acre-feet of diversion rights belonged to the purveyors who would later form the SNWA.

1992 SNWA Colorado River Contract. In 1992, SNWA entered into a water delivery contract with the Secretary of the Interior that gave SNWA a right to the remainder of Nevada's consumptive-use apportionment that was not allocated under other

contracts.[2] This apportionment was estimated in 1992 to be 58,000 AFY, assuming a portion was returned to the river for return-flow credits. The 1992 contract also gave the SNWA the right to Colorado River water made available due to reduction, expiration or termination of a Nevada entitlement; surplus water; and unused Nevada apportionment and other states' unused apportionment. Portions of these rights are not quantifiable because they are dependent upon return-flow credits and the availability of Colorado River water (for example, surplus water).

1993 Colorado River Water (Edison). In 1993, Southern California Edison agreed to terminate its Colorado River water consumptive-use contract of 23,000 AFY. Under Section 4(a)(1) of the SNWA 1992 water delivery contract with the Secretary of the Interior, the SNWA has the right to Nevada Colorado River water made available by reason of entitlement termination. In return for Edison's contract termination, the SNWA purveyor members agreed to provide the Fort Mohave generating station in Laughlin with up to 19,000 AFY through July 2026.[3] The SNWA purveyor members agreed to meet the generating station's needs with unused/surplus Colorado River water available to Nevada, or with water that the LVWWD is storing for SNWA purveyor members in the Southern Nevada Water Bank.[4]

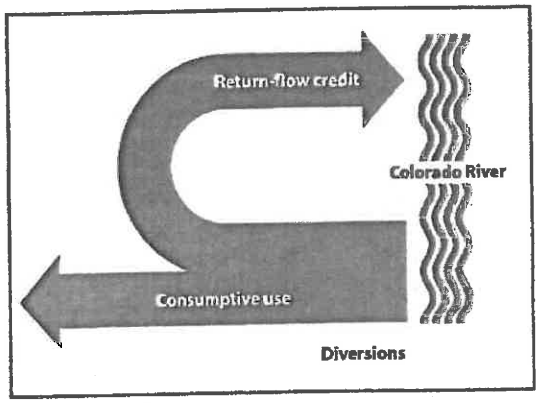
Several years ago, the station encountered substantial difficulties maintaining compliance with Clean Air Act standards and the plant was subsequently closed. There are no plans to reopen the plant at this time. As a result, the SNWA demand forecast presented in Chapter 3 no longer includes this obligation and the SNWA projects this water to be available for future use. Should the station come back on-line, the SNWA will meet the station's needs through 2026.

1994 Colorado River Water (BMI). In 1994, Basic Management Inc. agreed to transfer 14,550 AFY of its Colorado River consumptive use contract to the SNWA.[5] Under Section 4(a)(1) of the SNWA 1992 water delivery contract with the Secretary of the Interior, the SNWA has the right to use Nevada Colorado River water made available by reason of entitlement reduction.

Return-Flow Credits

As mentioned previously and shown in Figure 13, with return-flow credits, the total of Nevada's Colorado River delivery contracts is greater than the state's total Colorado River apportionment. Return-flow credits constitute a significant portion of the region's permanent Colorado River resource. The Las Vegas Valley returns most of its treated wastewater back to the Colorado River for return-flow credit via the Las Vegas Wash.[6]

FIGURE 13 – Return-Flow Credits



Unused Apportionment

Under the Law of the River, particularly the 1964 Supreme Court decision, at the Secretary of the Interior's discretion, Lower Basin States (Arizona, California and Nevada) are allowed to use the unused apportionment of another state. For example, if Arizona does not use all of its basic apportionment, the Secretary of the Interior may authorize Nevada and California to use the unused portion.

The SNWA also has a right to Nevada's unused Colorado River water as part of its 1992 Colorado River water contract. In recent years, a portion of Nevada's Colorado River apportionment contracted to Nevada users has been unused, and the SNWA has utilized this water. However, this water is expected to gradually decline in the long-term.

At present, Arizona plans on using or banking all of its apportionment in the future, as does California. As a result, none of the SNWA planning scenarios include unused apportionment from other Lower Basin States. However, the SNWA would utilize this resource if it becomes available to meet demands.

Flood Control Surplus

Each year, the Secretary of the Interior decides whether or not to declare a surplus of Colorado River water. The 1964 Supreme Court Decree in Arizona v. California defines "surplus" as follows: "If sufficient mainstream water is available for release, as determined by the Secretary, to satisfy annual consumptive use [in the Lower Division states of Arizona, California and Nevada] in excess of 7,500,000 acre-feet, such excess consumptive use is surplus."[7]

A surplus of water is typically a function of Colorado River reservoir storage and weather conditions, primarily snowmelt and the resulting runoff in the upper basin. Over the period of record, beginning in 1906, the average flow of the Colorado River has been 15 million AFY (Figure 14) at Lees Ferry, including flows from the Paria River just downstream of Lees Ferry.[8] However, the respective annual flows are highly variable – much higher or lower from year to year than the average. Because Colorado River uses are relatively constant, the variation in annual flows results in changes in reservoir storage, primarily in lakes Mead and Powell.

Surpluses have historically been limited to "flood control" surpluses, which allows the Lower Basin States to use excess water released from Lake Mead to control potential flooding along the Colorado River system. Every year, the Bureau of Reclamation issues its "Annual Operating Plan for Colorado River Reservoirs" and determines whether or not a surplus condition is expected to exist for the upcoming year. If additional water is available and demands are greater than 7.5 million acre-feet in the lower basin, then a surplus condition can be declared by the Secretary of the Interior.

A flood control surplus on the Colorado River was first declared in 1996 and in subsequent years through 2002 (Figure 15) because of the high storage content in Colorado River reservoirs. The 2009 Water Resource Plan does not assume the availability of flood control surplus during the planning horizon. However, the SNWA will utilize flood control surplus water when it is available and needed to meet demands.

FIGURE 14 – Colorado River Historical Flow

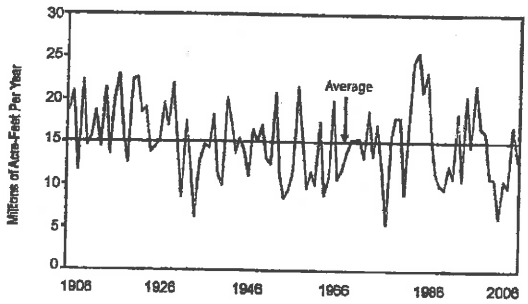
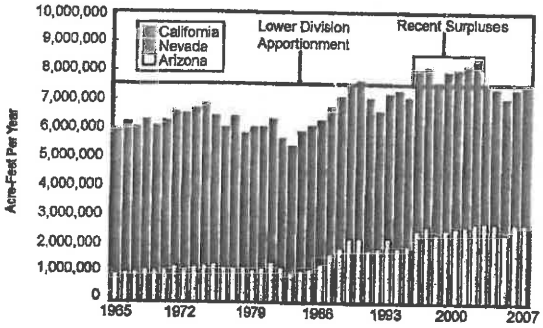


FIGURE 15 – Lower Basin Colorado River Water Usage



Domestic Surplus

As the water level in Lake Mead began to decline in the early 2000s, the Secretary of the Interior used the 2001 Interim Surplus Guidelines to declare "limited" surpluses from 2003 through 2007, based on specific Lake Mead elevations. During this period, the Lower Basin States did not utilize the limited surplus volumes and instead left the water in Lake Mead. As discussed in Chapter 1, the Interim Guidelines (implemented in December 2007) modified and extended the previously adopted 2001 Interim Surplus Guidelines.

Under provisions for "Domestic Surplus," when Lake Mead's elevation is above 1,145 feet, Nevada is allowed to consumptively use up to 400,000 AFY. In the future and until the Interim Guidelines expire in 2026, the SNWA will utilize domestic surplus water when it is available and needed to meet demands. However, the 2009 Water Resource Plan does not assume the use of domestic surplus during the planning horizon.

Intentionally Created Surplus

As discussed in Chapter 1, another element of the Interim Guidelines is the creation of a new type of surplus called Intentionally Created Surplus (ICS). In December 2007, the SNWA entered into a Delivery Agreement with the Secretary of the Interior and a Forbearance Agreement with lower basin water users that, in conjunction with the Interim Guidelines, ensure the availability and delivery of these water resources. ICS will enable the SNWA to develop some water resources by conveying them to the Colorado River for credit.[9] In addition, the SNWA will receive credits in exchange for funding a system efficiency project on the Colorado River. The SNWA's current ICS projects include:

- Virgin/Muddy Rivers Tributary Conservation ICS
- Coyote Spring Valley Groundwater Imported ICS
- Drop 2 Reservoir System Efficiency ICS

Tributary Conservation and Imported ICS credits can be created and used during any operating condition, including shortages. If the water is not used in the year it is created, it converts to Extraordinary Conservation ICS credits. Extraordinary Conservation ICS credits can be used like a bank account – the water is stored in Lake Mead for multiple years. The SNWA can accumulate up to 300,000 acre-feet of credits in Lake Mead for future use. Unlike other forms of ICS, Extraordinary Conservation ICS is not available during declared shortages.

Virgin/Muddy Rivers Tributary Conservation ICS. The SNWA is allowed to develop the full consumptive use of up to 95 percent of its Muddy and Virgin rivers rights that have a priority date that precedes the June 25, 1929 effective date of the 1928 Boulder Canyon Project Act. It is anticipated that more than 30,000 AFY of consumptive use rights will be acquired on the Muddy and Virgin rivers and conveyed to Lake Mead for ICS credit. Based on agreements with the Lower Division States, a maximum amount of 50,000 AFY could be acquired and used to create Tributary Conservation ICS.

These rights will be developed by allowing them to flow into Lake Mead as Tributary Conservation ICS under the Interim Guidelines. The ICS credits will then be withdrawn through existing SNWA facilities at Lake Mead. The SNWA is working with the U.S. Bureau of Reclamation and the Lower Basin States to account for the conveyance of SNWA's rights on the Muddy and Virgin rivers to Lake Mead.

In 2008, the SNWA began diverting approximately 10,000 AF of Muddy and Virgin Rivers Tributary Conservation ICS resources for use in Southern Nevada. Doing so marked an important milestone for the community – importation of these resources represents the first "new" water supply put to use in the region since large-scale diversions of Colorado River water began in the 1950s.

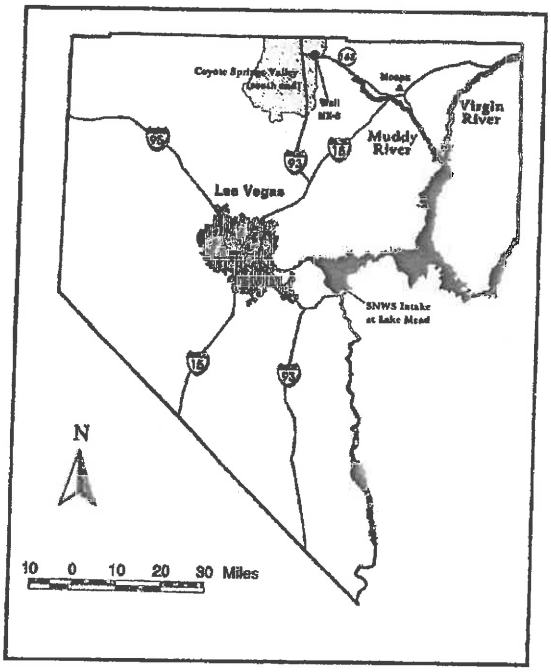
In 2009, the SNWA has approval from the Bureau of Reclamation to develop and use up to 30,000 AF (less 5 percent) of Tributary Conservation ICS. Creation of this ICS is based on SNWA's Muddy and Virgin rivers water rights discussed below and that the maximum amount that can be created is 50,000 AFY.

Muddy River. The Muddy River is a perennial river fed by the Muddy Springs in Southern Nevada, originating in Nevada and flowing into Lake Mead (Figure 16). The surface water on the Muddy River is fully appropriated with a priority date of pre-1905. Until recently, the majority of the flow was used for agriculture and power generation.

The SNWA has acquired about 9,200 AFY of Muddy River water rights represented by Muddy Valley Irrigation Company shares purchased from 1997 through 2009. In addition, SNWA is leasing

approximately 2,200 AF of Muddy Valley Irrigation Company shares in 2009. The leases are between the SNWA and individual shareholders and vary in length from one to 10 years.

FIGURE 16 – Virgin and Muddy Rivers



The SNWA also leases and owns water rights on the upper Muddy River. In March 2006, the SNWA and Moapa Valley Water District entered into a lease agreement with The Church of Jesus Christ of Latter-day Saints for 2,001 AFY of Muddy River water rights, allowing the SNWA to utilize half (1,000.5 AFY) of the leased rights. The term of the lease is 20 years with the option for two additional 10-year terms. The SNWA Board of Directors also approved the purchase of 1,340 AFY of upper Muddy River water rights in September 2008. In December 2008, the SNWA Board of Directors approved the purchase of 811 AFY, which will become available to the SNWA in 2011. In addition, the SNWA entered into a lease agreement with the Moapa Band of Paiutes in February 2009 to lease a portion of their upper Muddy River water rights for a period of five years. In 2009, this lease represents approximately 3,300 AF. The SNWA will receive Tributary Conservation ICS credits for conveying these and any other Muddy River water acquired to Lake Mead and can use the credits during any operating condition, including shortages.

Virgin River. The Virgin River originates in southwestern Utah, flows through the northwestern corner of Arizona and then into Nevada, where it eventually joins the Colorado River at Lake Mead (Figure 16). In 1994, the Nevada State Engineer granted to the SNWA an annual maximum diversion right to Virgin River surface flows of 190,000 AFY, with a long-term average annual diversion of 113,000 AFY. Under the Seven States' Agreement, the SNWA has agreed to postpone development of these rights while it makes efforts to pursue long-term Colorado River augmentation as described later in this chapter.

In 2000, the SNWA entered into an agreement with the Virgin Valley Water District establishing provisions for sharing surface water rights and groundwater rights from the Virgin Valley hydrographic basin. To ensure that future municipal water supplies exist for Virgin Valley Water District customers, the SNWA agreed to limit the amount of Virgin River water that will be purchased and transferred from Virgin Valley. In addition, for each acre-foot of Virgin River water acquired, the SNWA agreed to convey one acre-foot of its Virgin River rights to the Virgin Valley Water District. In 2003, pursuant to the agreement, the SNWA assigned an undivided one-half interest in 15 groundwater applications in the Virgin Valley hydrographic basin to the Virgin Valley Water District.

In July 2005, the SNWA entered into an agreement for the purchase of 350 shares in the Bunkerville Irrigation Company (representing approximately 3,710 AFY). Pursuant to its 2000 agreement with the Virgin Valley Water District, the SNWA transferred 3,710 AFY of its 1994 Virgin River rights to Virgin Valley. Acquisition of water rights from the Mesquite and Bunkerville Irrigation Companies is desired because these water rights have a priority date that precedes the Boulder Canyon Project Act.

In March 2008, the SNWA acquired 1,062 AFY of Virgin River surface water rights with a priority date

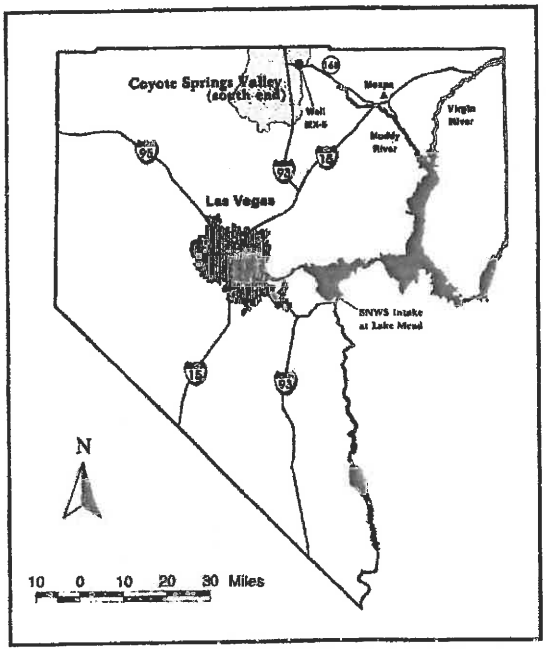
of 1914 and 1,200 AFY of surface rights with a priority date of 1990. Coincident with the purchase, the SNWA and Virgin Valley Water District entered into an agreement that exchanged the 1,200 AFY of 1990 priority rights for 89 shares in the Bunkerville Irrigation Company and removed the limitation on water rights SNWA could purchase and transfer from the Virgin River Valley. The SNWA also transferred to Virgin Valley Water District the remaining balance of the 5,000 AFY transfer obligation from its 1994 Virgin River rights pursuant to the 2000 Agreement. In addition, the SNWA transferred its remaining interest in the 15 groundwater applications in the Virgin Valley hydrographic basin to the Virgin Valley Water District.

Under the purchase agreements described above and recent purchases in 2008 and 2009 from shareholders in the Bunkerville and Mesquite Irrigation Companies, the SNWA has acquired about 5,000 AFY of pre-Boulder Canyon Project Act rights on the Virgin River. In addition, SNWA is leasing approximately 9,000 AF of Virgin River water rights in 2009. The SNWA will receive Tributary Conservation ICS credits for conveying these and any other Virgin River water acquired to Lake Mead and can use the credits during any operating condition, including shortages.

Coyote Spring Valley Groundwater Imported ICS. Coyote Spring Valley is located in northern Clark County (Figure 17). In 1998, the SNWA purchased 7,500 AFY of water rights in this valley, along with five one-acre parcels of land for placement of future wells to develop the water rights.[10] Another 1,500 AFY was purchased in 2002, for a total of 9,000 AFY. In addition, the LVVWD has 27,512 AFY in applications, filed in 1989. Up to 15,000 AFY of the Coyote Spring Valley permits and applications can be used to develop Imported ICS credits.

In 1996, the SNWA signed an agreement with the Moapa Valley Water District outlining various water management strategies for the area.[11] As part of that agreement, the SNWA agreed to assign up to half of the LVVWD filings in Coyote Spring Valley to the Moapa Valley Water District.

FIGURE 17 – Coyote Spring Valley



In 2001, the Nevada State Engineer considered the LVVWD's 1989 applications (27,152 AFY), as well as applications filed by Coyote Springs Investment (CSI), LLC (108,000 AFY). The CSI applications were filed after the LVVWD applications in 1989.

In March 2002, the SNWA, LVVWD, CSI and Moapa Valley Water District agreed to terms regarding groundwater applications in Coyote Spring Valley. Under this agreement, the Moapa Valley Water District will receive the first 3,750 AFY. Any water granted by the Nevada State Engineer above 3,750 AFY will be divided on a percentage basis between the LVVWD and the Moapa Valley Water District (58/42, respectively). This agreement effectively divides the total applications between the two entities, but ensures that the first cut of available water provides long-term benefit to the Moapa Valley Water District.

In March 2002, the Nevada State Engineer also issued Order No. 1169[12] regarding the LVVWD's 1989 groundwater applications for 27,512 AFY of water rights in Coyote Spring Valley. Per the ruling, the SNWA is conducting extensive monitoring, which included the construction of eight monitoring wells.

The SNWA is also working with other stakeholders to implement the five-year study mandated by the ruling. The study includes a two-year aquifer test to identify what potential impacts additional permits, if granted, may have on existing water right holders and regional springs in adjacent basins.

In April 2006, the SNWA entered into a Memorandum of Agreement with the U.S. Fish and Wildlife Service, CSI, Moapa Valley Water District and the Moapa Band of Paiutes that established conservation measures, and management and monitoring criteria for the SNWA's development of its 9,000 AFY and the future development of other groundwater resources in the area. To facilitate the pump test and deliver SNWA's existing water rights to meet demands, the SNWA is constructing a 15-mile pipeline that will tie into the Moapa Valley Water District's water distribution system, enabling the SNWA to develop and convey its existing 9,000 AFY of Coyote Spring Valley groundwater rights to the Lower Moapa Valley and Lake Mead. The water conveyed to Lower Moapa Valley can be used by the Moapa Valley Water District or by the SNWA through the creation of Imported ICS credits.

Following the completion of Order No. 1169 testing, the SNWA will provide a hydrological report to the Nevada State Engineer, detailing the results of the test. It is anticipated that following the submittal of the report, the Nevada State Engineer will determine the volume of water to be permitted under the LVWWD applications for 27,512 AFY in Coyote Spring Valley.

Drop 2 Reservoir System Efficiency ICS. System Efficiency ICS allows a water user to fund a system efficiency project to conserve Colorado River water. The project must increase the amount of water available in the U.S. and a portion of the saved water will be credited to the user funding the project. A project that meets this criteria is the Drop 2 Storage Reservoir Project.

This project will capture U.S. Colorado River water that would otherwise go unused in the lower basin and pass into Mexico. The SNWA has agreed to fund a portion of this project in exchange for receiving 400,000 acre-feet of available water (consumptive use volume) from Lake Mead under normal conditions on the Colorado River at a maximum rate of 40,000 AFY (consumptive use volume) beginning in 2011. These resources will expire upon full use, or in 2036, whichever comes sooner.

In 2008, the Secretary of the Interior and other project partners broke ground on the project. The reservoir is designed to conserve about 70,000 AFY of water and help manage flows along the lower Colorado River.

Banked Resources

Through local and interstate arrangements, the SNWA has acquired a number of banked resources. As discussed in Chapter 4, these temporary supplies serve as an important management tool – banked resources can be used to offset reductions in permanent supplies due to shortages, meet short-term gaps and serve as a temporary bridge to meet demands while other permanent resources are being developed. As discussed below, these banked resources include the Arizona, California and Southern Nevada water banks.

Arizona Water Bank. The SNWA acquires a storage credit by paying the Arizona Water Banking Authority (AWBA) to bank a portion of Arizona's Colorado River allocation, or other available Colorado River water, in Arizona's underground aquifer. In 2004, the SNWA Board of Directors approved an amendment to a previously approved agreement with the AWBA, ensuring Southern Nevada access to 1.25 million acre-feet of water in the Arizona Water Bank. As part of the agreement, SNWA could recover 30,000 AFY in 2009 and 2010. For 2011 and beyond, the parties agreed to a maximum recovery rate of 40,000 AFY until the banked reserves have been fully exhausted. Banked water is stored in the form of "credits." For the SNWA to recover a portion of its storage credits, Arizona will utilize the banked water and forego the credited amount of Colorado River water to Nevada. The SNWA will then divert the water from existing facilities at Lake Mead.

California Water Bank. In October 2004, the SNWA and Colorado River Commission of Nevada entered into agreements with the Metropolitan Water District and Bureau of Reclamation to store a portion of Nevada's unused Colorado River water in Southern California until it is needed. Under the agreements, Nevada can recover up to 30,000 AFY from the storage account, with six months notice provided to Metropolitan. The SNWA has banked 70,000 acre-feet in the California Water Bank through 2008.

Southern Nevada Water Bank. Within the Las Vegas Valley Groundwater Basin, the LVVWD and the City of North Las Vegas artificially recharge Nevada's unused Colorado River water directly into the primary aquifer using recharge wells during the winter months. In addition, the agencies have conducted in-lieu recharge by refraining from pumping their respective non-revocable groundwater rights.[13]

Since 1987, the LVVWD has recharged 333,639 acre-feet in the Las Vegas Valley groundwater basin through direct and in-lieu recharge. In addition, 17,378 acre-feet has been recharged by LVVWD for the Las Vegas Valley Groundwater Management Program (LVVGMP). The LVVGMP has purchased 9,303 acre-feet of this volume and has been approved to purchase the remaining 8,075 acre-feet based on SNWA Board action approvals in November 2008. The water acquired by the LVVGMP is not available to the SNWA for future use.

Colorado River Augmentation

In accordance with the 2007 Seven States' Agreement, the SNWA has agreed to suspend development of its 1994 Virgin River water rights until at least 2014 in exchange for agreement with the other Colorado River Basin states to cooperatively pursue the development of 75,000 AFY of permanent water supplies to augment the Colorado River for Nevada.

The SNWA will not pursue its 1994 Virgin River rights so long as the 75,000 AFY has been obtained or a specific project is being developed by the year 2020. In 2007, the SNWA funded the "Study of the Long-Term Augmentation Options for the Water Supply of the Colorado River System."[14] This study examined water resource augmentation options, evaluating engineering feasibility, environmental viability, and potential for water resource yield. This is an important first step in identifying and assessing potential actions to implement water supply augmentation on the Colorado River or through exchanges of Colorado River water.

Colorado River Transfers/Exchanges

In concept, water transfers involve moving water resources from willing sellers to willing buyers. There are a variety of ways in which this can occur: interbasin, intrastate and interstate. However, discussions of transfers/exchanges generally describe lower basin, interstate transfers of Colorado River water. Full-scale transfers and exchanges, over and above Colorado River augmentation to offset development of 1994 Virgin River rights, are still in the distant future. Examples of both short- and long-term augmentation and transfers/exchanges include desalination and transfers of conserved water.

Seawater Desalination Exchanges. Advances in technology may alleviate the high costs associated with seawater desalination, making it a potentially viable future water resource for Southern Nevada. This would occur in the form of an exchange. For example, Southern Nevada could pay California or Mexico to construct and operate desalination facilities in exchange for an equivalent portion of their Colorado River water at Lake Mead. The SNWA is currently participating in a bi-national process between the United States and Mexico to discuss desalination opportunities. Any formal arrangement regarding desalination exchanges is still many years out and subject to international treaty obligations.

Brackish Water Desalination. The Yuma Desalting Plant (YDP), a brackish water reverse osmosis plant near Yuma, Arizona, was constructed to treat pumped agricultural drainage water from the United States' lower Gila River Valley area. The quality of the desalted water would be improved so that it could become part of the U.S. treaty deliveries to Mexico.[15] Construction of the YDP was complete in 1992. The

YDP operated at one-third capacity for six months in 1992-1993 until flood damage caused operations to cease. The YDP has not operated since, except for a 90 day test at 10 percent capacity in 2007. Since 1993, the pumped agricultural drainage water from the U.S. has been conveyed in a concrete lined canal and released on a salt flat near the upper end of the Gulf of California. This water is not counted as part of Mexico's 1.5 million AFY Colorado River treaty water because of its salinity.

Under a proposed agreement among municipal water agencies in Nevada, California and Arizona, and the U.S. Bureau of Reclamation, a pilot operation of the YDP could begin as early as fall 2009. The YDP would operate at one-third capacity to collect data on the viability of operating the plant at full capacity on a sustained basis.

Transfer of Conserved Water: This potential resource would include interstate transfer of water that has been conserved through a verifiable water conservation program or through the fallowing of agricultural land with a recent history of use.[16] This conserved water would be leased or purchased by the SNWA. There is also an opportunity for interstate transfers of Tribal water, but the topic still needs considerable discussion and agreement.

While Colorado River transfers and exchanges are an important future resource for Southern Nevada, they do not resolve supply shortages associated with drought conditions. This is because all of these options would involve an exchange for Colorado River water. This would increase Southern Nevada's dependency on Colorado River water at a time when the SNWA and other users are exploring ways to reduce their dependency on the river and make their supplies more drought tolerant.

GROUNDWATER

The SNWA has acquired and continues to develop a significant number of in-state groundwater resources. These resources are intended to provide Southern Nevada with a more balanced mix of Colorado River water and non-Colorado River water than currently exists.

Nevada Water Law

Unlike the water of the Colorado River, which is managed by the U.S. Bureau of Reclamation through a series of agreements, laws, contracts and judicial or administrative decisions known collectively as the Law of the River, the groundwater and surface waters of Nevada are managed and controlled by the state. The Nevada Division of Water Resources (also known as the Office of the State Engineer) is the state entity that regulates groundwater and surface water resources within Nevada (other than the Colorado River).

The Office of the State Engineer was created in 1903 to protect existing water rights and bring about a better method for utilizing the state's water resources. The General Water Law Act of 1913 gave the office jurisdiction over all wells tapping into artesian water or water in definable underground aquifers. The 1939 Nevada Underground Water Act granted the Nevada State Engineer total jurisdiction over all groundwater in the state. The 1939 Act has been amended a number of times and is now considered one of the most comprehensive groundwater laws in the West.[17]

Nevada water law follows the doctrine of prior appropriation, or "first in time, first in right" – meaning the first person to file on a water resource for beneficial use is typically considered first for a permanent right to the water, subject to the Nevada State Engineer's determination of available unappropriated water. The process for obtaining a permit to develop unappropriated groundwater or surface water includes: filing an application, having the Nevada State Engineer act on the application, and then issuing the permit or denying the application.

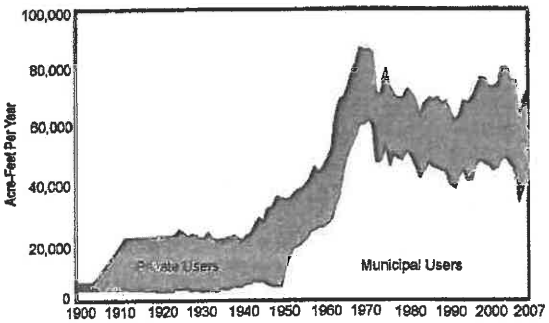
As indicated in Chapter 1, groundwater was the first and most critical resource for Southern Nevada for much of the last century. It remains a key component of Southern Nevada's water resource portfolio. In addition to the existing purveyor groundwater rights in the Las Vegas Valley, the SNWA has in-state groundwater rights and applications in hydrographic basins outside the Las Vegas Valley. Many of these rights and applications stem from filings made by the LVVWD, but others are the result of specific SNWA efforts that were initiated in the mid- to late-1990s. The following subsections discuss these in-state groundwater resources in more detail.

Las Vegas Valley Groundwater

Until large scale importation of Colorado River water was achieved in the early 1970s, the Las Vegas Valley relied on local groundwater supplies to meet demands. In this respect, it is worthwhile to note that older estimates of long-term annual groundwater supply or "perennial yield" for the Las Vegas Valley were about 30,000 AFY.[18] More recent analysis in the 1990s indicates the yield is approximately 57,000 AFY.[19] As part of its effort to manage excessive demands on this supply, the Nevada State Engineer designated a portion of the Las Vegas Valley as an underground artesian water basin in 1941. The designated area was expanded in 1944 and 1946, and a portion of the basin was closed to new irrigation rights in 1949. In 1955, the Nevada State Engineer began to issue temporary groundwater permits in the Las Vegas Valley. All permits within the designated portion of the basin and with a priority date after March 24, 1955, were issued as temporary rights subject to revocation.[20]

In the years that followed, the Nevada State Engineer issued a series of orders that systematically restricted the issuance of revocable water rights within the Las Vegas Valley. These orders culminated on April 15, 1992, with the issuance of Amended Order No. 1054. Order No. 1054 is significant because it means that, with few exceptions, all applications to appropriate groundwater in the Las Vegas Valley that are filed after March 23, 1992 will be denied.[21] Of the seven SNWA member agencies, the LVVWD and North Las Vegas have permanent groundwater rights totaling 40,629 acre-feet and 5,711 acre-feet, respectively. The two entities operate about 100 permitted municipal wells in the Las Vegas Valley. Figure 18 displays groundwater use in the Las Vegas Valley by type of user, and shows how this use shifted from primarily private wells around 1950 to primarily municipal wells by 1970.

FIGURE 18 – Groundwater Use by User Type



Although Southern Nevada's primary supply is Colorado River water (about 90 percent), the municipal groundwater rights of the SNWA member agencies are among the most senior groundwater rights in the valley, and groundwater remains a critical component of the area's resource picture. In particular, groundwater is instrumental in helping purveyors meet peak summer water demands.

In-State Groundwater Resources

In addition to the groundwater rights previously noted, the SNWA has a number of other groundwater permits and applications in southern and eastern Nevada. In 1989, the LVVWD filed 147 groundwater applications with the Nevada State Engineer to appropriate unallocated groundwater in 30 basins. Because of potential environmental concerns and existing appropriations, the LVVWD eventually withdrew some applications, limiting potential diversions to 21 basins in four Nevada counties, including Clark, Lincoln, Nye and White Pine (Figure 19).

FIGURE 19 – Groundwater Applications

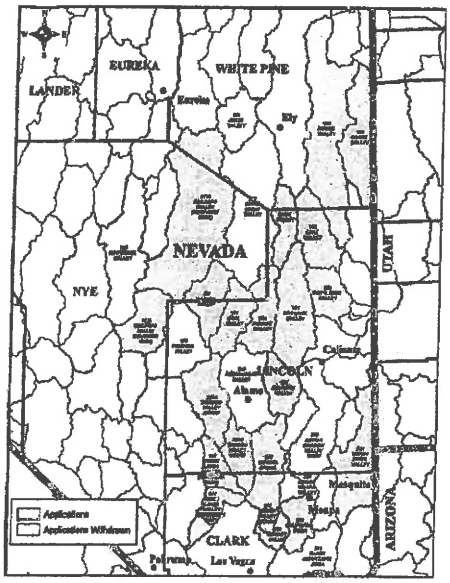
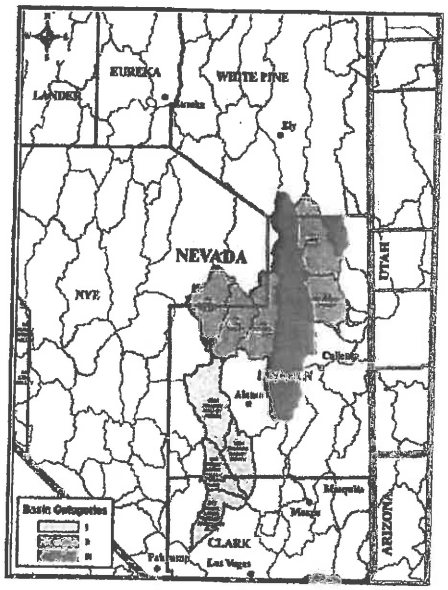


FIGURE 20 – Groundwater Basins Addressed in the SNWA/Lincoln County Agreement



Since 1989, the LVVWD and/or the SNWA have withdrawn, transferred or otherwise declined to pursue development of 49 of its original applications. In 2003, the SNWA entered into an agreement with Lincoln County that effectively resolved longstanding concerns over applications for groundwater in that county. Under the agreement, the applications in Lincoln County are divided into three categories (Figure 20):

- Category I Basins are allocated to the SNWA;
- Category II Basins are allocated to Lincoln County;
- Category III Basins are shared, where Lincoln County is entitled to the first 3,000 AFY from the water rights that may be granted in these basins.

The agreement established a cooperative relationship between Lincoln County, the LVVWD and SNWA that includes sharing resources and data during the development of groundwater in eastern and central Nevada.

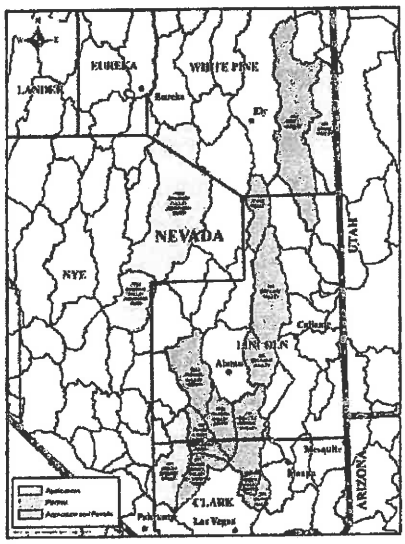
Several of the groundwater applications filed in 1989 have been reviewed by the Nevada State Engineer's office, and many have been permitted according to Nevada Water Law. The SNWA has also acquired groundwater rights through direct purchase. Figure 21 displays the groundwater basins in which the SNWA and/or LVVWD have groundwater rights, applications or both. The following sections describe the water rights and applications in these basins and the associated development projects.

Garnet and Hidden Valleys. The Nevada State Engineer permitted a combined total of 2,200 AFY to the LVVWD in 2001 based on the 1989 groundwater applications in these basins. The majority of these rights have been leased to dry-cooled power plants located in Garnet Valley, which are extremely water efficient. The SNWA owns a 25 percent interest in one of these facilities, the Silver Hawk facility, which is owned and operated by the NVEnergy Company.

California Wash Basin. In 2002, the Nevada State Engineer issued Ruling No. 5115, which permitted the SNWA 2,500 AFY of groundwater rights in the California Wash groundwater basin. The SNWA's other application in this basin was held in abeyance

until the completion of the study under Nevada State Engineer Order No. 1169. As part of the settlement agreement with the Moapa Band of Paiutes, which resolved regional water resources issues on the groundwater and surface water rights on the Muddy River, the 2,500 AFY of permitted rights and the application held in abeyance were transferred to the Moapa Band of Paiutes. The SNWA and the Moapa Band of Paiutes are working closely to manage and develop water resources on the Muddy River and surrounding groundwater basins.

FIGURE 21 –Groundwater Basins with Active Applications/Permits



Three Lakes Valley (North and South) and Tikaboo Valley (North and South). In 2003, the SNWA requested that the Nevada State Engineer act on 17,000 AFY of water right applications filed in 1989 for groundwater in Three Lakes Valley (North and South) and Tikaboo Valley (North and South). Following an administrative hearing in 2004, the Nevada State Engineer issued Ruling No. 5465 in 2005, approving permits totaling 8,905 AFY. Ruling No. 5465 also identified an additional 1,700 AFY of unappropriated water in Three Lakes Valley North. In 2005, the SNWA requested the Nevada State Engineer grant the 1,700 AFY under an existing SNWA application from 1989 that was not considered in Ruling No. 5465. The Nevada State Engineer subsequently issued Ruling No. 5533, granting SNWA the 1,700 AFY in Three Lakes Valley North, bringing the total rights from the four basins to 10,605 AFY.

In 2005, the SNWA filed applications to change points of diversion for a portion of the 8,018 AFY of water rights from Tikaboo Valley South and Three Lakes Valley North and South to proposed well sites. In 2006, the Nevada State Engineer issued Ruling No. 5621, which approved a portion of the change applications and denied others. The SNWA is working to develop options for the development of its 8,018 AFY of groundwater permits in Three Lakes Valley South and North and Tikaboo Valley South and deliver the water to the northwest part of the Las Vegas Valley. In 2008, the SNWA and LVVWD entered into an agreement with the Las Vegas Paiute Tribe establishing a right-of-way on the reservation for the proposed project.

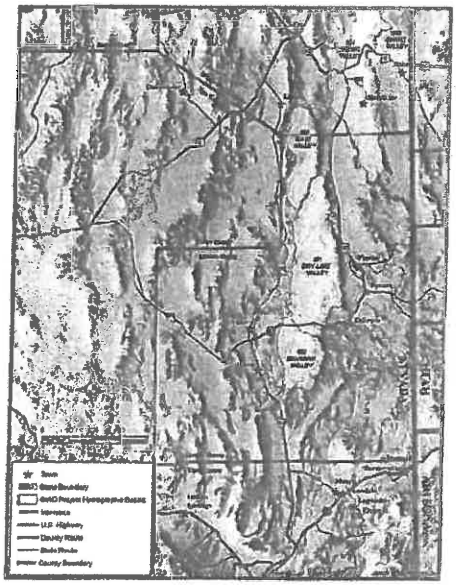
Indian Springs. In 2004, the SNWA filed applications for 16,000 AFY of groundwater in Indian Spring Valley. The availability and development of this resource is subject to further research and analysis.

Clark, Lincoln and White Pine Counties Groundwater. To develop and convey the SNWA's 1989 groundwater rights, applications, and acquired rights from Delamar, Dry Lake, Cave, Spring and Snake valleys for use by SNWA's member agencies in Clark County, the SNWA has proposed a pipeline project as defined in the Southern Nevada Water Authority Clark, Lincoln and White Pine Counties Groundwater Development Project. The proposed pipeline would extend from the Las Vegas Valley to Spring and Snake valleys (Figure 22). Based on the SNWA's current permitted rights, acquired rights, and pending applications, up to 137,000 AFY could be developed from these valleys, 3,000 AFY of which would be transferred to Lincoln County based on a 2003 agreement.

In 2006, the SNWA and the Lincoln County Water District (LCWD) passed a resolution through which the SNWA and the LCWD agreed to cooperate

in the National Environmental Policy Act (NEPA) process associated with the SNWA's proposed Clark, Lincoln and White Pine Counties Groundwater Development Project. The agreement provides that LCWD will pay a portion of any costs charged by the BLM to the SNWA for completing NEPA compliance. It also outlines the basic concepts for a future agreement that will allow the LCWD to acquire capacity rights in the future pipeline facilities to transmit water within Lincoln County, and sets forth a framework for a future operation, maintenance and replacement agreement.

FIGURE 22 – Clark, Lincoln and White Pine Counties Groundwater Development Project



While many of the water resources associated with the SNWA's Clark, Lincoln, and White Pine Counties Groundwater Development Project have been quantified, final project volumes remain uncertain because the SNWA still has applications in Snake Valley pending consideration by the Nevada State Engineer. The sections below discuss the SNWA's groundwater rights, applications, and acquired rights within the specific groundwater basins encompassed by the project.

Spring Valley. The Nevada State Engineer held an administrative hearing in 2006 to consider the SNWA's applications for 91,224 AFY of groundwater in Spring Valley hydrographic basin. In 2007, the Nevada State Engineer issued Ruling No. 5726, granting the SNWA 60,000 AFY of groundwater from Spring Valley, the pumping of which is limited to 40,000 AFY for the first ten years. In addition to these groundwater rights, the SNWA began acquiring various ranch properties in Spring Valley in mid-2006. In addition to substantial land holdings, the SNWA also acquired surface and groundwater rights associated with the properties. To date, the SNWA has acquired approximately 34,000 AFY of surface water rights, 6,000 AFY of groundwater rights and 24,000 AFY of supplemental water rights. The SNWA does not intend to export the surface water rights associated with these ranches. Instead, the surface water rights will be used to help manage the groundwater basin and support other environmental management activities associated with groundwater development.

Delamar, Dry Lake and Cave Valleys. In 2008, the Nevada State Engineer held an administrative hearing to consider the SNWA's applications for unappropriated groundwater in Delamar, Dry Lake and Cave valleys. Later that year, the Nevada State Engineer issued Ruling No. 5875 granting the SNWA 18,775 AFY of groundwater from these valleys.

Snake Valley. The Nevada State Engineer has scheduled a hearing for 2011 to consider the SNWA's applications for 50,679 AFY of unappropriated groundwater in Snake Valley. The Lincoln County Land Act requires that the states of Nevada and Utah reach an agreement regarding the division of water resources in the basin before water can be diverted. The two states continue to work together to reach an agreement that will allow the maximum sustainable beneficial use of the water resources and protect existing water rights.

RECLAIMED WATER RESOURCES

Southern Nevada currently reclaims all of its wastewater, either through return-flow credits

or direct reuse. The following sections describe Southern Nevada's efforts to maximize its use of both Colorado River and in-state groundwater resources.

Reclaimed Colorado River Water

While reclaimed Colorado River water may have distinct advantages in terms of environmental sustainability and lower cost, additional reuse does not extend Southern Nevada's Colorado River allocation. Comparing Figures 23a and 23b shows that the size of the total resource "pie" does not change when more wastewater is used to meet a reuse demand rather than returned to Lake Mead for return-flow credit. The reason for this is that an increase in reuse will offset or reduce the amount of water available for return-flow credit. That is, as wastewater reuse increases, the area's return-flow credits will decrease. However, the overall supply from consumptive use, return-flow credits and reclaimed water will not materially change.

Full Consumptive Use/Recycled In-State Groundwater Resources

The water resources described in this chapter have generally been quantified and discussed based on consumptive-use volumes. Through return-flow accounting and water reuse, the water supply available for diversion is approximately 70 percent greater than the consumptive-use volume.

Current Reclaimed Water Resources

The following describes current reclaimed-water activities among the SNWA member agencies.

Boulder City. Boulder City is both the potable and reclaimed water provider within its municipal boundaries. Currently a portion of its treated effluent is sold and used at sand and gravel operations (about 273 acre-feet in 2007).

City of Las Vegas. In the LVVWD service area, the City of Las Vegas provides reclaimed water within its municipal boundaries and unincorporated Clark County. The Water Pollution Control Facility (WPCF), the city's 91 million-gallon-per-day (MGD) main treatment plant, is located on the Las Vegas Wash in unincorporated Clark County. The WPCF currently provides reclaimed water to an adjacent power plant and four adjacent golf courses. The Bonanza Mojave Water Resource Center, a 1 MGD satellite reuse facility, became operational in May 1999. It is capable of providing approximately 1,120 AFY of reclaimed water to an adjacent park and golf course. The Northwest Water Resource Center, a 10 MGD satellite reuse facility, became operational in July 2001. It will ultimately be capable of providing more than 11,200 AFY of reclaimed water for use at golf courses, schools and parks. Total reuse for the City of Las Vegas in 2007 was about 5,538 acre-feet.

FIGURE 23a – SNWA Water Resources with Decreased Reuse

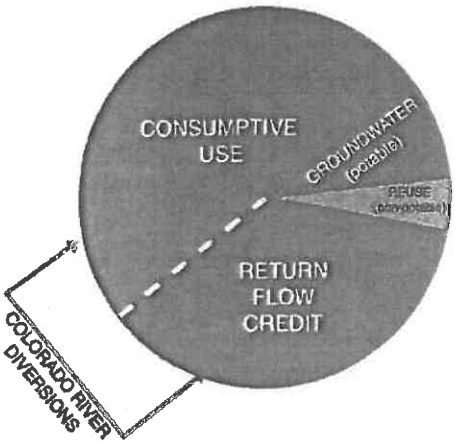
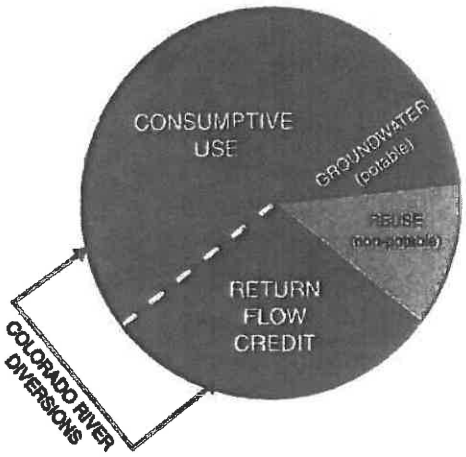


FIGURE 23b – SNWA Water Resources with Increased Reuse



Clark County Water Reclamation District. In the Clark County portion of the LVVWD service area, the Clark County Water Reclamation District currently provides reclaimed water to power plants, golf course irrigation and parks from the Water Pollution Control Facility, the county's 120 MGD main treatment plant located on the Las Vegas Wash. Phase I of the Desert Breeze Water Resource Center was completed in January 2003. The facility currently treats up to 5 MGD of reclaimed water. The facility can be expanded to 10 MGD, which is equivalent to 11,200 AFY, of reclaimed water for use at golf courses, schools and parks. In addition, Clark County now requires new golf courses and nearby landscape areas to utilize reclaimed water, when applicable. The Reclamation District recently completed an In-Valley Water Reclamation Facilities Master Plan to evaluate reclaimed water needs for the Reclamation District's service area. Total Reclamation District reuse in 2007 was approximately 12,693 acre-feet.

In Laughlin, the Clark County Water Reclamation District is currently supplying reclaimed water for dust control at a local landfill.

City of Henderson. The City of Henderson is both the potable-water and reclaimed-water provider within its boundaries. The city has a water-reclamation facility capable of treating 32 MGD of wastewater. Customers currently utilizing reclaimed water for irrigation include nine golf courses, highway landscaping and a mortuary. Total reclaimed water in 2007 was approximately 8,338 acre-feet.

City of North Las Vegas. The City of North Las Vegas currently receives wastewater treatment through an agreement with the City of Las Vegas. In November 2008, the City of North Las Vegas began construction of a water reclamation facility.[22] The City of North Las Vegas plans to construct a 50 MGD wastewater treatment facility to treat and reclaim a portion of its wastewater. The project is projected to consist of two phases with 25 MGD of operating capacity constructed in each phase. The first phase of construction is scheduled for completion in early 2011.

Valley-Wide Reuse Plans

The cities of Las Vegas, North Las Vegas and Henderson, the Clark County Water Reclamation District and the LVVWD completed an Area-Wide Reuse Study for the Las Vegas Valley in July 2000.[23] Opportunities for additional satellite reuse facilities were identified in North Las Vegas, the northwest area of the City of Las Vegas, and in the southwest area of Clark County near Henderson. The agencies are evaluating these opportunities to determine which projects might be the next most likely projects for development. A siting feasibility study in the southwest area of Clark County was jointly explored by Henderson, the Clark County Water Reclamation District and the LVVWD. This study, also completed in 2000, identified several locations for possible future satellite facilities in the valley, which are being considered independently by the Clark County Water Reclamation District. In response to the study, the City of Henderson has begun construction of its Southwest Water Reclamation Facility.

In September 2007, the SNWA and Clean Water Coalition initiated a cooperative effort to update the Area-Wide Reuse Study to reflect current conditions. The revised "Policy Regarding Recycled Water" presents seven recommendations for reuse practices in Southern Nevada. The plan was approved by the SNWA Board of Directors in December 2008.

ENDNOTES

1. "Compilation of Records in Accordance with Article V of the Decree of the Supreme Court in Arizona v. California et al. dated March 9, 1964," February 1967-June 2005, United States Bureau of Reclamation.

2. "Contract with the Southern Nevada Water Authority, Nevada for the Delivery of Colorado River Water," effective March 2, 1992; between Secretary of Interior, Colorado River Commission and Southern Nevada Water Authority. The contract was amended in 1994: "Amended and Restated Contract with the Southern Nevada Water Authority, Nevada for the Delivery of Colorado River Water," effective November 17, 1994.

3. "Contract for the Provision of Water to Mohave Generating Station," effective March 1, 1993; between Southern Nevada Water Authority Purveyors and Southern California Edison, on behalf of itself and the other co-tenants of the Mohave Generating Station.

4. "Cooperative Agreement for the Banking of Water in the Las Vegas Valley Groundwater Basin between the Southern Nevada Water Authority and the Las Vegas Valley Water District," effective February 21, 2006.

5. "Water Supply Agreement," effective November 17, 1994; among Victory Valley, SNWA, SNWA purveyors and BMI. "Amended Contract for Delivery of Water to Basic Management," effective November 17, 1994, between Secretary of Interior and BMI.

6. "Procedure for Determining Return Flow Credits to Nevada from Las Vegas Wash," 1984, U.S. Bureau of Reclamation. This procedure was modified slightly in "The Accounting of Return Flow Credits from Recharged Colorado River Water in the Las Vegas Valley," 1991, U.S. Bureau of Reclamation. There are three sources of water in the Las Vegas Wash – metered returns, which are mostly treated wastewater flows; urban runoff and intercepted shallow groundwater; and storm water. Nevada only receives credit for those return flows that are considered Colorado River water, not groundwater or storm water. There are meters on the wastewater flows exiting the wastewater-treatment plants, a meter on BMI's surface return flows, and a gauge at Lake Las Vegas that measures total flow in the Wash. However, these meters and gauges cannot physically measure what portion of the flows was originally Colorado River water. Given this limitation, the Bureau of Reclamation and the Colorado River Commission agreed in 1984 to a return-flow-credit methodology that would calculate how much of the flows in the Las Vegas Wash was originally Colorado River water diversions. Nevada is the only state on the Colorado River with such a detailed measuring procedure for its return flows. This procedure has been updated as needed in consultation with the U.S. Bureau of Reclamation.

7. Sometimes the phrases "lower division states" and "lower basin states" are used interchangeably. However, this document follows the definitions found in Article II of the "Upper Colorado River Basin Compact, 1948." Paraphrased, the lower division states are Arizona, California and Nevada; the lower basin states are Arizona, California, Nevada, New Mexico and Utah.

8. The U.S. Bureau of Reclamation and the U.S. Geological Survey estimate the yearly "natural flow" of the Colorado River at Lees Ferry, defined as the flow of the river without reservoirs, dams or diversions. Natural flow estimates for the period 1906 to 1995 are official, while estimates for the period 1996 to 2003 are provisional, October 2005, U.S. Bureau of Reclamation.

9. In the 2006 SNWA Water Resource Plan, SNWA's groundwater rights in Coyote Spring Valley and surface water rights in the Virgin and Muddy rivers were previously classified as an in-state water resource. The 2009 Water Resource Plan includes these resources under the Colorado River heading, since the Secretary of Interior's December 2007 Record of Decision concerning Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake

Mead (Interim Guidelines) allows the SNWA to receive Colorado River credit for conveying portions of these water resources to Lake Mead. Surface water rights controlled by the SNWA on the Virgin and Muddy rivers that pre-date June 25, 1929, the effective date of the 1928 Boulder Canyon Compact, can be used to generated Intentionally Created Surplus credits in Lake Mead. The Interim Guidelines allows the creation of up to 50,000 afy of Colorado River credits from the Virgin and Muddy rivers. In addition, Coyote Spring Valley groundwater rights controlled by SNWA can also be conveyed to Lake Mead for ICS credits. A maximum of 15,000 AFY of Colorado River credits can be created from Coyote Spring Valley. SNWA is credited for 95% of the water demonstrated to augment the Colorado River system from these sources. The remaining 5% benefits the Colorado River system-storage as a whole.

10. "Agreement for option, purchase and sale of water rights, real property and easements," approved by the SNWA Board of Directors on 4/16/98, between Southern Nevada Water Authority and Coyote Spring Investment, LLC.

11. "Agreement" signed February 14, 1996, between Southern Nevada Water Authority and Moapa Valley Water District.

12. The Nevada Division of Water Resources issued Order 1169 March 8, 2008, which addressed LVVWD's groundwater applications for 27,512 AFY. The Order also held in abeyance all groundwater applications in five nearby groundwater basins. The Order requires a 5-year minimum study during which at least 50% of the water rights currently permitted in the Coyote Spring Valley are pumped for at least 2 consecutive years. Following the study, the SNWA and Las Vegas Valley Water District (LVVWD) may update and resubmit its hearing documents from the July 2001 administrative hearing to include study results, allowing the Nevada State Engineer to further consider the LVVWD's groundwater applications in Coyote Spring Valley.

13. "In-Lieu Recharge Order," Order No. 1176, December 10, 2004, State of Nevada, Office of the Nevada State Engineer.

14. "Study of the Long-Term Augmentation Options for the Water Supply of the Colorado River System," March 2008. Prepared for the Colorado River Basin States by Colorado River Water Consultants - a joint venture by Black & Veatch and CH2MHill.

15. The 1944 United States-Mexico Treaty for Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande allots to Mexico a guaranteed annual quantity of water from these sources. Specifically, the treaty guarentees Mexico the delivery of 1.5 MAFY of Colorado River water, plus 200,000 AFY of any surplus Colorado River water. In 1974, an international agreement, interpreting the 1944 Treaty, guaranteed Mexico water of the same quality as that being used in the United States.

16. In 1989, the Metropolitan Water District paid the Imperial Irrigation District for canal lining and other conservation measures, in return for up to 106,000 acre-feet of conserved water per year for 35 years. In addition, from 1992 through 1994, 186,000 acre-feet of water was conserved from a land fallowing program that Metropolitan set up with the Palo Verde Irrigation District. The latest development is an agreement between the Imperial Irrigation District and the San Diego County Water Authority. Over an extended period San Diego will pay the Imperial Irrigation District to conserve up to 200,000 AFY.

17. "Groundwater and Wells in the Las Vegas Valley," 1998, Southern Nevada Water Authority and Clark County Conservation District.

18. "Available Water Supply of the Las Vegas Ground-Water Basin," U.S. Geological Survey Water Supply Paper 1780, 1965, G.T. Malmberg; "Geology and Water Resources of Las Vegas, Pahrump, and Indian Spring Valleys, Clark and Nye Counties, Nevada," State of Nevada, Office of the State Engineer Water Resources Bulletin No. 5, 1948, G.B. Maxey and C.H. Jameson.

19. "Hydrologic Implications of Greater Ground-Water Recharge to Las Vegas Valley, Nevada," Journal of the American Water Resources Association, Volume 36, Number 5, October 2000, David J. Donovan and Terry Katzer.

20. "Groundwater and Wells in the Las Vegas Valley," 1998, Southern Nevada Water Authority and Clark County Conservation District.

21. Ibid.

22. "Water Reclamation Facility Cost Analysis," October 20, 2004, prepared for the City of North Las Vegas by Black & Veatch.

23. "Area Wide Reuse Study Las Vegas Valley Area," July 2000, prepared by Black & Veatch for the City of Henderson, City of Las Vegas, City of North Las Vegas, Clark County Sanitation District and the Las Vegas Valley Water District.

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CHAPTER 3

Meeting Future Demands

This chapter discusses future water demands and resource options available to meet those demands, given current and projected conditions on the Colorado River and in Nevada.

Resource planning is dependent on conditions that may change in unpredictable ways. As evidenced by Southern Nevada's history, numerous factors can impact demands over long periods of time, as well as from year to year. The farther in the future that demands are projected, the greater the uncertainty in the forecast. This underscores the need for the SNWA to review its Water Resource Plan annually and make adjustments as needed.

To address this uncertainty, the SNWA has taken a portfolio approach to water resource development. The portfolio approach emphasizes acquisition and development of diverse resources, both surface water and groundwater (Colorado River and Nevada in-state resources), in an effort to offset risks typically associated with any single resource option (for example, availability, volume and timing of use). The SNWA water resource portfolio was described in Chapter 2.

Once a portfolio of resource options is acquired, the most challenging aspect is ensuring the development and availability of these resources when they are needed. Several of Southern Nevada's resource options require infrastructure investment or negotiation of legal, environmental, regulatory and administrative processes to bring the resources online. The SNWA works diligently to plan and prepare for these efforts, but the possibility always exists for short-term gaps to occur between demands and the specific resources identified in the SNWA Water Resource Plan to meet those demands. This is why conservation and banked resources are of paramount importance to Southern Nevada. Conservation helps reduce overall demands (relative to levels that would have occurred in the absence of conservation) and increase efficiency, thus extending the availability of existing developed resources over time. Banked resources, in turn, are intended to provide a bridge until permanent, long-term resources in the SNWA portfolio are fully developed and ready for use. Banked resources also provide flexibility in that these resources can help to offset reductions in permanent supplies due to shortages (discussed further in Chapter 4).

Meeting demands through 2060 will require both the efficient use of existing and future supplies and the development of additional water resources. Demands in the 2009 Water Resource Plan cover the SNWA member purveyor service area. The 2009 SNWA Water Budget, a companion document to the Water Resource Plan, provides more detailed forecasts by purveyor through the year 2011.

WATER DEMAND FORECAST

Forecasting is critical for the SNWA, which must plan and build costly infrastructure over a number of years to meet projected demands. Since 1996, the SNWA has adopted water resource plans that show demand forecasts for Southern Nevada across a long-term planning horizon, and the resources anticipated for meeting those demands. Water demand forecasting is based on both population projections and expected conservation. As a result, significant variations in

either factor can impact forecast demands. For example, both higher population and lower levels of conservation will result in higher demands and can significantly impact water resource planning.

The 2009 Water Resource Plan forecasts demands through 2060 based on the June 2008 Clark County Population Forecast prepared by the University of Nevada Las Vegas Center for Business and Economic Research (CBER) (Appendix 4).

Typically, short-term forecasts are more accurate because they are based on the recent past. However, the current economic downturn affecting local, national and even global economies has presented unique challenges to planners as to when the economy will recover and what future growth rates will occur.

As a result, the SNWA has made short-term adjustments to CBER's 2008 population forecast. To reflect current population trends for the year 2009, no growth/additional water demand is assumed; however, annual growth is assumed in future years to bring the forecast in line with the CBER 2008 Clark County Population Forecast. The SNWA will continue to assess these factors in future plan updates.

Figure 24 illustrates near-term adjustments and how water demand forecasts have changed over time as a result of conservation goals and achievements. The upper demand line reflects the SNWA's 2004 baseline water demand level of 274 GPCD. The middle demand line reflects the SNWA's 2005 water conservation goal of 250 GPCD by 2010 and 245 GPCD by 2035. The lower demand line reflects the SNWA's current conservation goal of 199 GPCD by 2035, which was established in 2009. Achieving this goal will reduce water demands by approximately 276,000 acre-feet in 2035, with additional savings in later years. Figure 25 shows the current SNWA demand forecast through 2035.

FIGURE 24 – Summary of SNWA Water Demands and Conservation

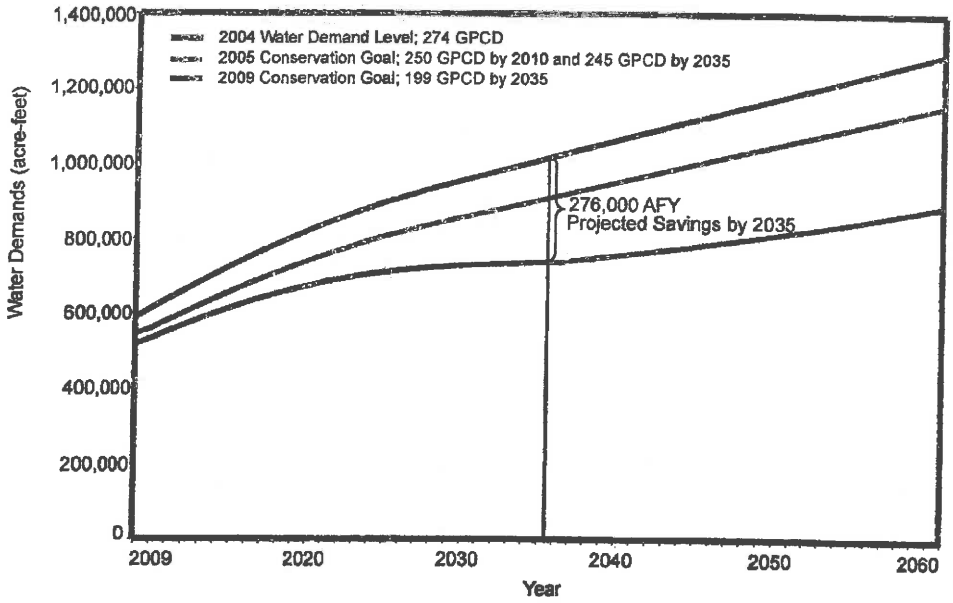


FIGURE 25 – SNWA Annual Demand Forecast*

Year	2010	2015	2020	2025	2030	2035
Demand	553	631	684	717	732	739

*Potable and Non-Potable voumes in thousands of acre-feet.
Excludes Fort Mohave Generating Station Water Demands

Colorado River Water and Las Vegas Valley Groundwater

To meet demands over the planning horizon, the SNWA intends to utilize a combination of Colorado River and groundwater resources. As discussed in Chapter 2, these include Nevada's basic consumptive-use apportionment of Colorado River water, return-flow credits, Las Vegas Valley groundwater rights, reclaimed water and unused Nevada Colorado River water. Figure 26 depicts these resources, as well as the updated demand forecast.

Nevada's Basic Apportionment and Return-Flow Credits

Nevada's basic Colorado River consumptive-use apportionment and associated return-flow credits is the first resource priority for use. Nevada is allocated 300,000 acre-feet of Colorado River water for consumptive use each year. When combined with return-flow credits, this allocation allows Southern Nevada to divert more than 300,000 acre-feet of water from the river annually. As the largest renewable resource in the SNWA portfolio, Nevada's basic Colorado River allocation and return-flow credits will be used throughout the planning horizon.

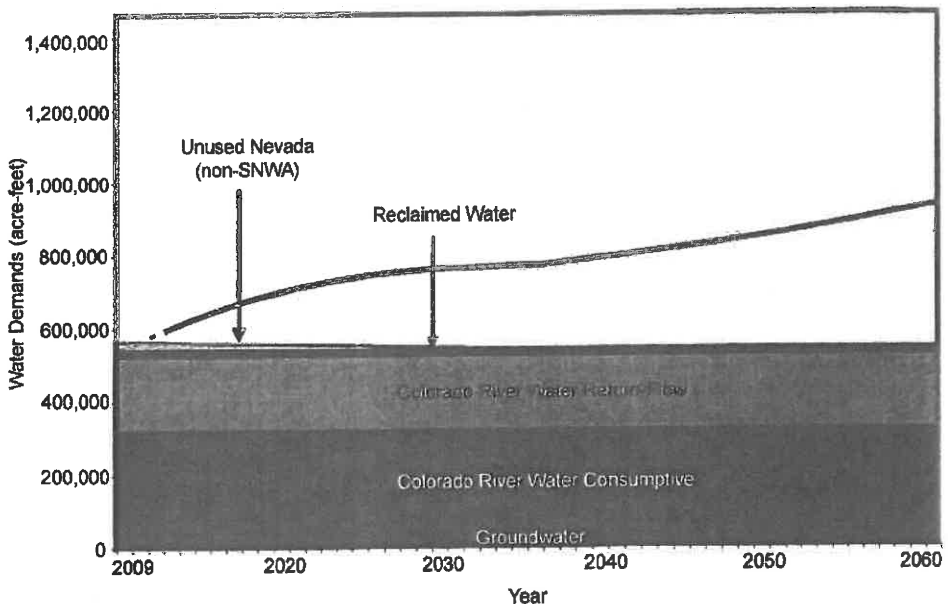
Las Vegas Valley Groundwater Rights

As its next priority, the SNWA will use a total of 46,340 acre-feet of permanent groundwater rights in the Las Vegas Valley each year to meet demands throughout the planning horizon. These groundwater rights are not only a fundamental resource, but also a critical tool to manage peak summer demands for municipal purveyors in the Las Vegas area.

Reclaimed Water

In addition to return-flow credits, Southern Nevada reuses a portion of its highly treated wastewater through direct reuse. This ensures maximum use of resources, including Colorado River and groundwater resources that are being used to meet the SNWA's water needs. As with Nevada's consumptive-use

FIGURE 26 – Water Demand Projections and Current Resources



apportionment and Las Vegas Valley groundwater rights, the SNWA will utilize reclaimed water throughout the planning horizon.

Unused Nevada Colorado River Water
Under existing contracts with the Secretary of the Interior, the SNWA has the right to utilize unused Nevada Colorado River water. In recent years, a portion of Nevada's Colorado River allocation that was contracted to other Nevada users has been unused. The SNWA may use this water to meet demands as appropriate. However, this water is expected to gradually decline in the long-term.

MEETING FUTURE DEMANDS

In addition to the resources just described, the following options are anticipated for use to meet water demands from 2009 through 2060.

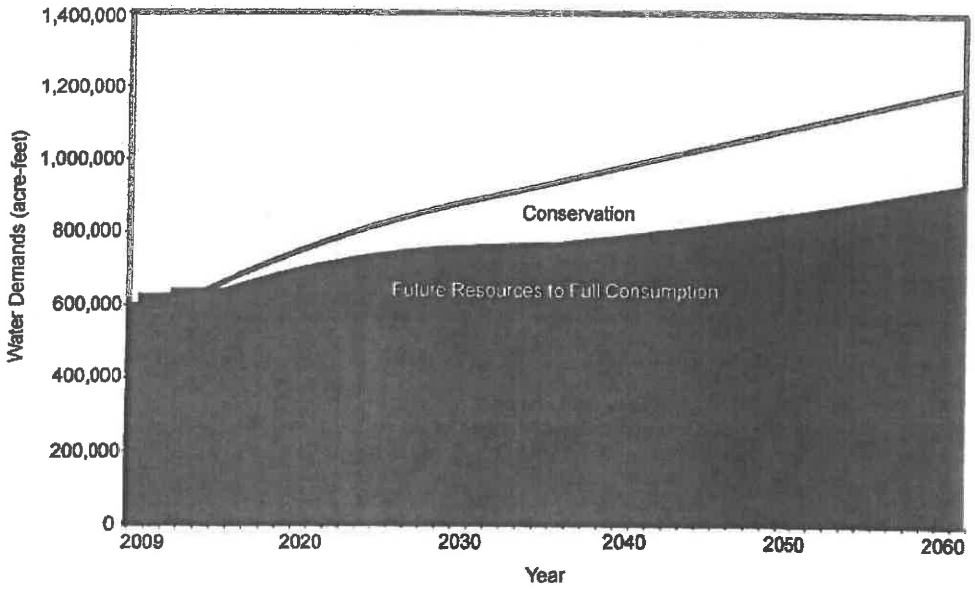
Conservation
As discussed in Chapter 2, achieving Southern Nevada's conservation goal is critical to meeting demands across the planning horizon. Figure 27 illustrates the amount of conservation projected to be achieved and the additional resources needed to meet future demands through 2060. The 2009 Water Resource Plan anticipates that conservation will save the community approximately 276,000 AFY by the year 2035.

Flood Control Surplus and Domestic Surplus
As noted in previous chapters, drought conditions on the Colorado River have affected storage on the river system and thus the availability of flood control surplus and domestic surplus water. The SNWA does not anticipate that flood control surplus or domestic surplus Colorado River water will be available in the near future, and does not include it as a resource available to meet future demands. If flood control surplus or domestic surplus water becomes available under the Interim Guidelines through 2026, these resources will be used to the fullest extent possible.

Intentionally Created Surplus
As discussed in Chapter 2, the SNWA anticipates developing ICS credits as discussed below.

Muddy River/Virgin River Tributary Conservation ICS.
The SNWA began using its pre-Boulder Canyon Project Act rights on the Muddy River in 2008. These

FIGURE 27 – Summary of Projected Water Demands and Water Resources



rights will be used in subsequent years and will be utilized to their full consumptive use volume through ICS. For planning purposes, it is anticipated that 30,000 AFY of these rights will be acquired and used to create ICS; however, more than 30,000 AFY may be acquired and used to create ICS in the future.

Coyote Spring Valley Groundwater Imported ICS. The SNWA is constructing a pipeline and facilities to convey its 9,000 AFY of Coyote Spring groundwater rights to the Muddy River and Lake Mead. The project is scheduled to be completed in 2010. These rights will be utilized to their full consumptive use volume through Imported ICS.

Drop 2 Reservoir System Efficiency ICS. The SNWA anticipates using 400,000 acre-feet of water generated by its financial contributions toward the construction of the Drop 2 reservoir project. A maximum of 40,000 AFY is available for recovery during normal conditions. Based on the Drop 2 agreement, the SNWA is limited to a cumulative use of 100,000 acre-feet from 2011 to 2015. The SNWA estimates that this resource could be fully exhausted by 2027.

In-State Groundwater

In-state groundwater resources are long-term, permanent resources that the SNWA will develop over time and manage in conjunction with its Colorado River water supplies. In-state groundwater resources are comprised of rights and applications for groundwater as discussed in Chapter 2, including existing groundwater rights from Three Lakes Valleys (North and South) and Tikaboo Valley South, and existing rights and applications associated with the Clark, Lincoln and White Pine Counties Groundwater Development Project. While many of the water resources associated with the project have been quantified, final project volumes remain uncertain because the SNWA still has applications pending consideration by the Nevada State Engineer.

The resource scenario presented in Figure 28 reflects the development of 134,000 AFY of groundwater associated with the Clark, Lincoln and White Pine Counties Groundwater Development Project. This amount represents the expected volume to be developed based on existing groundwater rights in Spring, Delamar, Dry Lake and Cave valleys, as well as the full volume of applications in Snake Valley that have not yet been acted upon by the Nevada State Engineer. This scenario also assumes the development of 8,018 AFY associated with permitted rights in Three Lakes Valleys (North and South) and Tikaboo Valley South. Current and possible future conditions in the Colorado River necessitate priority development of these resources to protect the community from drought and shortage impacts, and meet future demands.

Full Consumptive Use/Reclaimed In-State Water

As described in Chapter 2, the SNWA currently reclaims all of its wastewater through direct reuse or return-flow credits. Nevada's return-flow credit methodology acknowledges the diverse nature of SNWA's resource portfolio and provides Southern Nevada a method for accounting for future imports of Nevada in-state water to be consumptively used. This will increase the yield of the in-state groundwater imported to the Las Vegas Valley by approximately 70 percent. Figure 28 reflects this increased yield through the full consumption of these in-state resources.

Banked Resources

As discussed in Chapter 4, the SNWA does not anticipate the use of banked resources in the near-term planning horizon (2009-2024). While these resources are available for use if needed to meet short-term gaps between supply availability and demand, banked resources provide a critical tool for the SNWA to meet demands during shortage.

The amount and timing of banked resources that the SNWA ultimately uses will depend on the extent to which conservation continues to be effective in meeting demands, along with the progress achieved by the SNWA in its ongoing development of in-state groundwater resources. The SNWA projects utilizing up to 40,000 AFY of banked resources in Arizona beginning in 2025 until other permanent resources, such as in-state groundwater and Colorado River augmentation (below) are fully developed.

Colorado River Augmentation

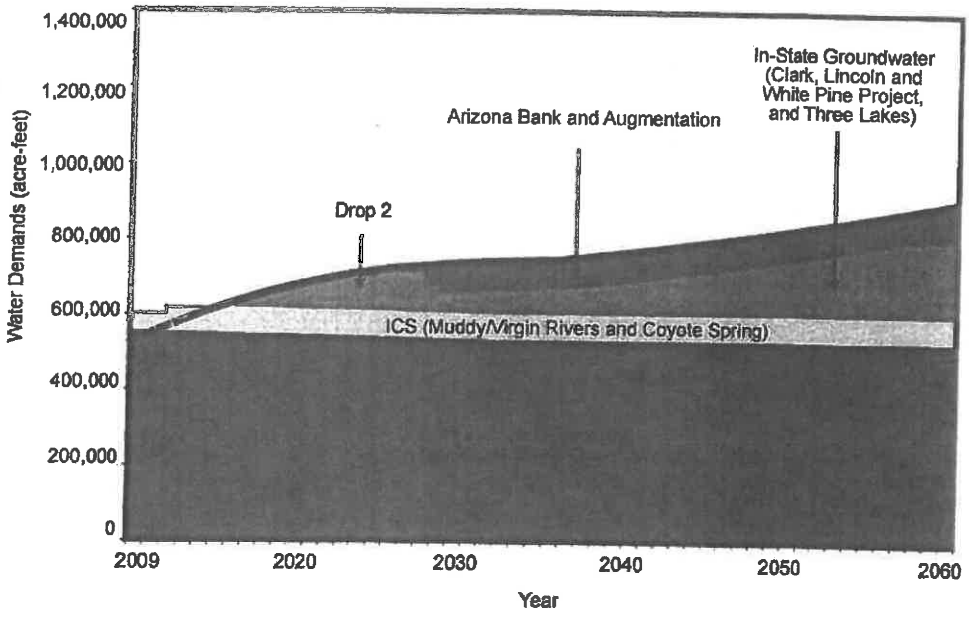
As described in Chapter 2, the other Basin States have committed to working with Nevada to develop additional permanent supplies through system augmentation projects in exchange for deferring development of SNWA's 1994 Virgin River rights. The 2009 Water Resource Plan reflects the consumptive use of up to 75,000 AFY anticipated to be available from future Colorado River augmentation projects. Augmentation is expected to replace banked resources when exhausted.

CONCLUSION

Based on current conditions, the SNWA has sufficient resources available or under development to meet water demands through the year 2060. Beyond continued conservation, Nevada's basic apportionment and Las Vegas Valley groundwater rights, the highest priority resources to meet demands will be development of ICS, in-state groundwater and non-Colorado River resources. When necessary, banked reserves and other temporary resources will be used to bridge demands while the SNWA brings other permanent in-state groundwater resources on-line.

As discussed in Chapter 2, several factors may affect the timing of when and how resources are brought on-line, including future agreements, cost and environmental concerns (see Chapter 5). As a result, having a portfolio of options permitted, under development or being pursued gives the SNWA the ability to adjust some resources if other resources are delayed or revised, or if demands decrease. Likewise, if options such as transfers or exchanges become a reality sooner rather than later, other options in the SNWA water resource portfolio may be given lower priority for development. As the SNWA continues its resource planning efforts, the outlook for future demands will be examined as part of the annual resource planning process and adjusted accordingly.

FIGURE 28 – Projected Water Demands and Future Resources (under normal Colorado River conditions)



CHAPTER 4

Meeting Demands During Shortage

From 2000 to 2004, the Colorado River Basin experienced the most severe 5-year drought in recorded flows on the Colorado River. This extreme drought has been followed by recent years of average and below average Colorado River in-flows.

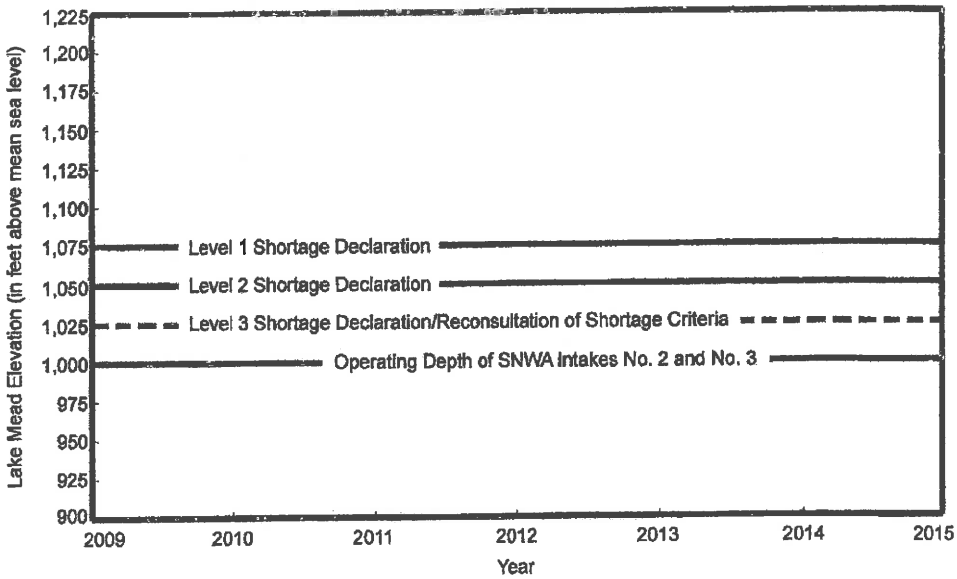
As a result, the water stored in Lake Mead and Lake Powell has declined to 52 percent of the total combined capacity. In early 2009, the surface elevation of Lake Mead was at 1,111 feet, down approximately 100 feet since the late 1990s.

These drought conditions may continue in the future, or may be further aggravated by the effects of climate change, which are not yet fully understood. For the SNWA, there are two primary consequences of continued declines in Lake Mead water levels: possible reduction of available Colorado River supplies and operating challenges associated with water intake facilities at Lake Mead.

This chapter describes how Colorado River shortages will be managed; the resources available to the SNWA during shortage; and what measures will be taken to ensure sufficient water resources are available to the SNWA in the event of supply reductions.

As described in Chapter 2, the Secretary of the Interior's Record of Decision on Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead established shortage levels based on Lake Mead elevation (Figure 29). Based on these levels, and according to the shortage sharing agreement

FIGURE 29 – Shortage Declarations



between Nevada and Arizona (Figure 30), the SNWA will incur shortages when Lake Mead water levels drop below 1,075 feet. The volume of water available to Nevada and Arizona decreases as lake levels continue to decline. If Lake Mead reaches an elevation of 1,025 feet, the lower division states of Arizona, Nevada, and California will re-consult with the Secretary of the Interior to determine what additional measures are necessary to minimize further declines in Lake Mead elevation and preserve Lower Basin States' access to Colorado River water.

Figure 30 – Nevada Share of Shortage

Lake Mead Water Level	Nevada Shortage	Arizona Shortage
1,075 - 1,050 ft.	13,000 afy	320,000 afy
1,050 - 1,025 ft.	17,000 afy	400,000 afy
Below 1,025 ft.	20,000 afy	480,000 afy
	Reconsultation	

As detailed in Chapter 3, the SNWA has a number of water resource options available for use under normal (non-shortage) conditions. However, many of these resources depend on the operation of existing and planned water intake facilities at Lake Mead. As a result, the community's ability to utilize these resources may be diminished as lake levels decline. To this end, the SNWA committed to sharing in Colorado River shortages to maintain Lake Mead surface elevations at or above 1,000 feet – the operational level of SNWA's lower intake facilities.

SHORTAGE RESPONSE

As outlined in Figure 30, reductions to Southern Nevada's Colorado River consumptive-use apportionment could reach 20,000 AFY when Lake Mead water levels are above 1,000 feet. Analysis of Colorado River Basin uses and inflow indicate a 1 percent probability that Lake Mead will reach an elevation of 1,075 feet by 2011 and 1,025 feet by 2014.

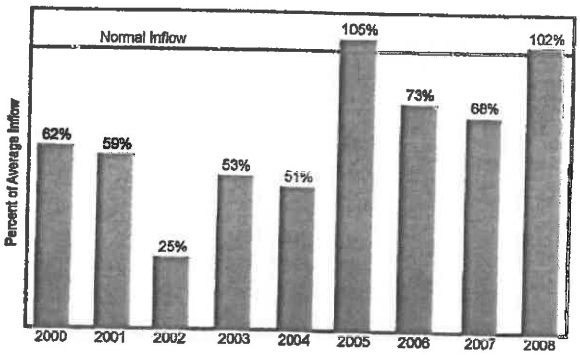
Figure 31 (page 46) displays one possible scenario for how the SNWA would adjust its water planning efforts to accommodate a long-term shortage through the year 2026.

The SNWA would continue to utilize tributary conservation and imported ICS water (Muddy/Virgin rivers and Coyote Spring Valley resources), but would be required to forego use of its System Efficiency ICS water (Drop 2 Storage Reservoir), which is restricted from use during a declared shortage. To bridge this gap, the SNWA could utilize temporary resources, including banked water supplies, until in-state groundwater is brought on-line.

SEVERE SHORTAGE RESPONSE

Between 2000 and 2008, the 9-year average historical inflow to Lake Powell was 66 percent of normal (Figure 32).

Figure 32 – Historical Lake Powell Annual Inflows



According to modeling conducted by the Bureau of Reclamation, with an average runoff of 69 percent of normal for the next six years (2009-2014), Lake Mead elevation could decline to 1,000 feet in as early as 2015. This elevation impairs the operational capability of SNWA intakes (Figure 33). Even more severe conditions, such as those experienced between 2000 and 2004 (50 percent of average) could cause Lake Mead water levels to decline even faster. In either case, water levels below 1,000 feet would impair SNWA's ability to access Colorado River water resources.

Figure 31 – Meeting Demands During Declared Shortage Conditions

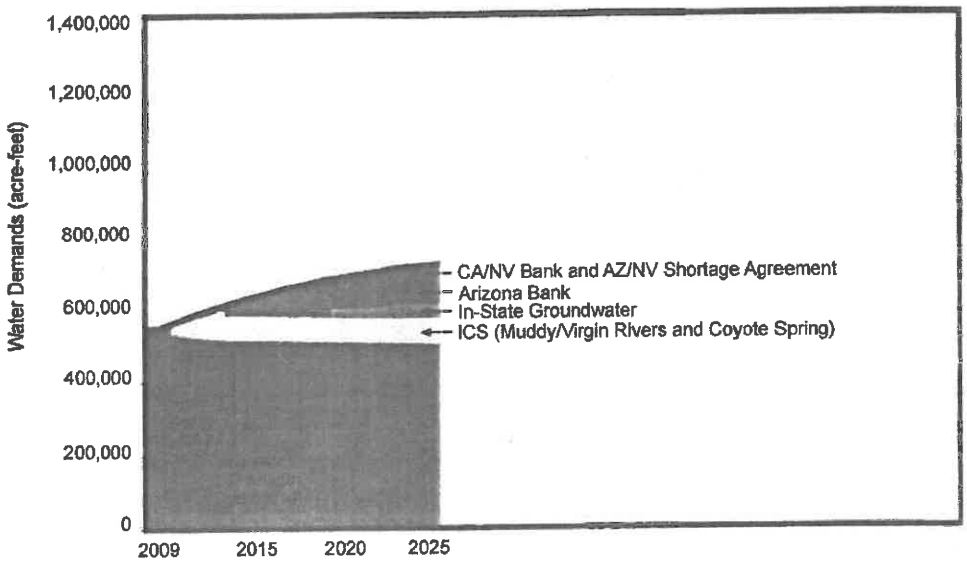
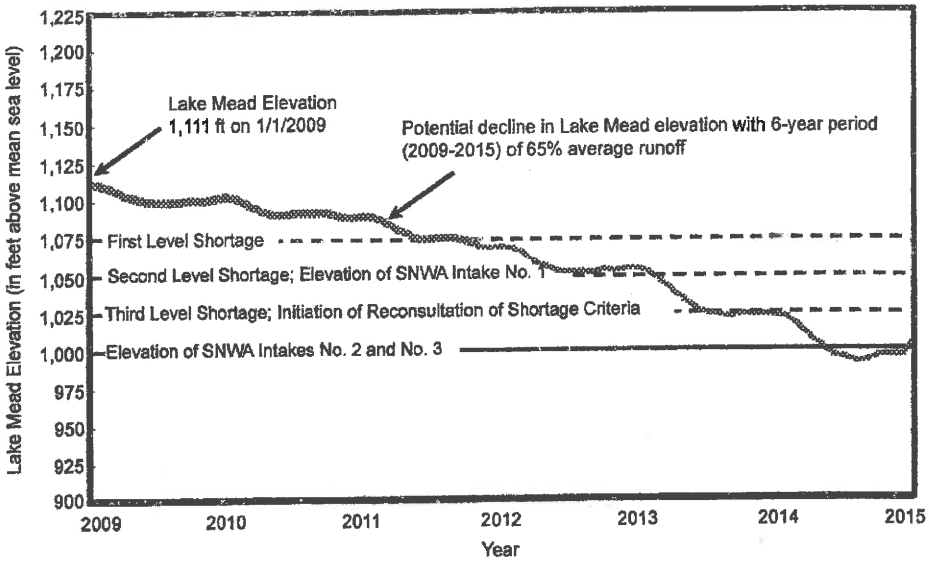


Figure 33 – Impacts to Lake Mead Intakes with Six Year Period of 65 Percent Average Runoff



The following section outlines SNWA's planned response to a "severe shortage." This response is intended to protect the SNWA by offsetting possible impacts of supply reductions and ensuring that sufficient resources are available to the community should the elevation of Lake Mead decline below 1,000 feet, the operational limit of SNWA's current and planned intake facilities.

A staged response, as detailed below, will occur based on Lake Mead water levels:

- 1,075 to 1,025 feet
- 1,025 to 1,000 feet
- Below 1,000 feet

Lake Mead Elevation 1,075 to 1,025 feet

Facility Construction. To preserve the lead time required to construct the Clark, Lincoln and White Pine Counties Groundwater Development Project, the SNWA will take the steps necessary to begin project construction when Lake Mead reaches a surface elevation of 1,075 feet; these resources are currently planned for use in 2020 under normal, non-shortage conditions.

Demand Management Assessment. The SNWA will also examine additional demand-management needs over and above existing water conservation goals and annual targets, as discussed in Chapter 2.

It is important to note that arbitrarily reducing water demands beyond those levels currently defined will not have a measurable benefit to Lake Mead water levels -- Nevada's Colorado River allocation represents approximately two percent of the recorded total average system flow. As an example, 100,000 acre-feet in Lake Mead is equivalent to about 1 foot of elevation. Evaporation on Lake Mead alone exceeds this amount by two to four times, depending on surface elevation. However, additional conservation will help extend the use of Nevada's existing supplies if severe shortages occur.

Lake Mead Elevation 1,025 to 1,000 feet

Reconsultation. In accordance with the Secretary of the Interior's 2007 Record of Decision, the Colorado River Basin states will re-consult on Colorado River management strategies when Lake Mead reaches a surface elevation of 1,025 feet and shortage volumes have the potential to exceed 500,000 AFY. Parties will work together to determine what measures can be employed to protect a Lake Mead surface elevation above 1,000 feet.

Demand Management. The SNWA will implement additional mandatory demand management tools defined by earlier assessment. These additional water saving measures will help to maximize the availability of existing supplies and new in-state supplies, when available.

Contingency Assessment. The SNWA will assess options for continued access to Colorado River resources in the event that Lake Mead intakes become inoperable. This includes examining the potential for temporary infrastructure to extend the operational capabilities of SNWA's intakes in Lake Mead to pump water below 1,000 feet into existing water intakes.

Lake Mead Elevation Below 1,000 feet

In the unlikely event that Lake Mead water levels reach a depth below 1,000 feet, the SNWA will have a significantly limited ability to withdraw its Colorado River apportionment, as well as other water supplies accessed through Lake Mead, including return-flow credits, ICS resources (Muddy/Virgin rivers and Coyote Spring), and banked resources such as the Arizona and California water banks.

Restrict Non-Essential Water Use. The SNWA will maximize in-state and locally banked resources when Lake Mead reaches 1,000 feet by restricting non-essential water uses. Doing so will ensure that critical supplies are preserved for health and safety uses.

Figure 34 provides a summary of these actions, as well as triggers associated with Lake Mead water levels.

Figure 34 – Severe Shortage Plan

Lake Mead Elevation	Goal	Action
1,075 to 1,025 ft.	Preserve lead time for new facility development.	Construct Clark, Lincoln and White Pine Counties Groundwater Development Project. Examine demand-management needs over and above existing conservation goals/annual targets.
1,025 to 1,000 ft.	Preserve Lake Mead elevation of 1,000 ft.	Reconsult with the Secretary of the Interior and Basin States on additional Colorado River shortage management strategies. Implement additional demand-management measures through mandatory policies to offset further Colorado River Basin supply shortages. Examine potential for temporary infrastructure to extend the operational capabilities of SNWA's intakes in Lake Mead.
Below 1,000 ft.	Preserve water supply for health and safety uses.	Maximize use of available groundwater supplies (Southern Nevada Groundwater Bank and in-state resources). Significantly limit non-essential uses.

CONCLUSION

Water managers throughout the West recognize that even if Colorado River system inflows consistently return to pre-drought levels, it will take several years of above-average runoff for system reservoirs to fully recover. Likewise, if drought conditions continue to persist, further declines to storage will occur, possibly resulting in shortages due to reduced water storage. Given the current elevation of Lake Mead, one exceptionally dry year – such as that experienced in 2002 (25 percent of average inflow) – could have a significant effect on area reservoirs.

To this end, the greatest protection the community has against further Lake Mead water level decline is development of in-state groundwater resources. Additional water conservation will also play a critical role by helping to reduce demands, but conservation alone will not provide sufficient protection to completely replace those supplies lost if access to Lake Mead is interrupted or otherwise significantly reduced.

To mitigate any possible supply reductions, the SNWA will utilize banked water resources to meet near-term community water demands during times of declared shortage or severe shortage. The SNWA must complete necessary permitting activities and construct in-state water facilities, as dictated by Colorado River hydrology, implement appropriate water demand management tools to extend available supplies during times of severe shortages and investigate alternatives for Colorado River access.

The SNWA will closely monitor drought conditions throughout the Colorado River Basin and enact the appropriate response necessary to help protect the community from possible supply reductions. While the SNWA Water Resource Plan is reviewed annually, a detailed assessment of Colorado River conditions will occur regularly to inform community response.

In the event Lake Mead water levels decline rapidly, the SNWA will take appropriate and measurable actions to ensure that sufficient resources are available to preserve essential municipal water supplies.

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CHAPTER 5

Environmental Commitment

To support its resource planning and facility expansion activities, the SNWA began to participate in a number of environmental initiatives and coalitions in the mid-1990s, taking a proactive and integrated approach to water resource management.

The SNWA's commitment to environmental responsibility typically goes beyond the steps necessary to ensure compliance with applicable regulations or statutes. Efforts have included the support of research and recovery activities related to federally endangered fish, birds and wildlife; involvement in broader regional programs that address issues such as habitat conservation and water quality; and financial and staff support for environmental research and studies.

As part of its long-term resource planning, the SNWA is working with various stakeholders in the region to address environmental issues and concerns through regional planning programs. Some of these programs form the basis for compliance with appropriate environmental laws and regulations.

The following sections briefly describe the SNWA's environmental initiatives – planning, compliance and environmental commitments – related to SNWA's water resource portfolio.

COLORADO RIVER

The majority of water used in Southern Nevada comes from the Colorado River, making Colorado River environmental issues among the most important to the SNWA. Alterations along the river have affected its ecosystems in both the United States and Mexico. Native fish, birds and other wildlife species have been listed by the U.S. Fish and Wildlife Service (USFWS) under the federal Endangered Species Act (ESA) as threatened and endangered. Riparian, wetland and aquatic habitats have been reduced and/or modified. These environmental issues have the potential to directly affect the SNWA's ability to construct necessary facilities and continue withdrawing water from the river.

Lower Colorado River Multi-Species Conservation Program

In 1994, major portions of the Colorado River were designated as critical habitat for four endangered fish. The four federally-listed endangered fish are the razorback sucker (Xyrauchen texanus), bonytail (Gila elegans), humpback chub (Gila cypha) and Colorado pikeminnow (Ptychocheilus lucius). The 1994 critical habitat designation meant that federal agencies had to consider not just potential project impacts on endangered fish, but also potential impacts on the habitat as well. This requires all federal agencies to consult with the USFWS under the ESA for most actions on the river, including the operation of existing facilities.

As a result of the critical habitat designation, Arizona, California, Nevada and the Department of Interior began developing the Lower Colorado River Multi-Species Conservation Program (MSCP) in 1994 and completed program development in 2004. The goal of the MSCP is to implement a coordinated conservation strategy that will permit federal and non-federal operations in the Lower Colorado River to continue with flexibility, while working toward the

recovery of listed species. A Steering Committee of stakeholders, including the SNWA, oversees program implementation, which will provide ESA compliance for federal and non-federal operations on the Lower Colorado River for the next 50 years.

Implementation of the program began in 2005 and is estimated to cost $626 million (in 2003 dollars) over the 50-year life of the program. The Bureau of Reclamation will provide 50 percent of the program funding with the remaining 50 percent to be split between the three Lower Basin States (California – 50 percent, Nevada – 25 percent, Arizona – 25 percent). The MSCP Steering Committee meets three times a year to discuss and approve action items for the MSCP. The Steering Committee has 56 members including federal agencies, state agencies, Indian tribes, and interested conservation organizations. The Bureau of Reclamation is currently pursuing more than 60 restoration and research projects as part of the Fiscal Year 2009 Work Plan.

Some of the MSCP projects currently underway in Nevada include razorback sucker studies on Lake Mead and southwestern willow flycatcher surveys along the Virgin and Muddy rivers. In December 2005, the SNWA purchased the Boy Scout Property in Laughlin, Nevada, a 15-acre property located along the Colorado River and surrounded by Big Bend State Park. In October 2008, the MSCP Steering Committee agreed to fund restoration of the property. The SNWA is currently working with Nevada State Parks, Nevada Department of Wildlife and the Bureau of Reclamation to develop a restoration plan.

In addition to the MSCP, the SNWA participates in species-specific research and conservation efforts related to Nevada's Colorado River resource. The information gained from these activities has proven instrumental to ensuring the best available information is utilized in making critical decisions concerning water resources and species conservation.

Colorado River Delta

Historically, the Colorado River Delta (Delta) in Mexico sustained significant wetland and estuarine ecosystems that support a diverse array of plant and animal species including several that are listed as endangered in both the U.S. and Mexico. During the last century, the construction of dams, and subsequent diversion of water from the Colorado River in the U.S. and Mexico to support agricultural and urban uses, reduced water and sediment flows to the Delta. This contributed to a substantial reduction of riparian and wetland areas in the Delta from pre-dam levels and resulted in listing of several species as endangered. Many environmental organizations have advocated increased water flows and changed management of the river flows to improve and restore more of the Delta ecosystem.

The SNWA participates in a bi-national process formed by the United States and Mexico International Boundary and Water Commissions. This process includes bi-national efforts to explore potential cooperative actions in the areas of water conservation, new water sources, environmental issues and system operations.

Continued drought and increased demands for Colorado River water resources will likely increase the complexity of Colorado River Delta issues.

Las Vegas Wash and Lake Mead

The Las Vegas Wash (Wash) plays an important role in the environmental and water-resource issues facing Southern Nevada. The Wash is the primary drainage channel for all stormwater flows, surface runoff, highly-treated wastewater flows and shallow groundwater flows in the Las Vegas Valley. These flows represent less than 2 percent of the flow into Lake Mead, but are an important component since they contribute to return-flow credits associated with Nevada's Colorado River allocation. Historically, wetlands to the Wash have served to remove pollutants and suspended solids as urban flows pass into the Colorado River system. However, since the 1970s, erosion and head-cutting have dramatically reduced the amount of wetlands in the Wash, leading to

increased sedimentation into Lake Mead, habitat loss and water quality concerns.

In 1998, the Las Vegas Wash Coordination Committee (Coordination Committee) was formed to address the many issues associated with the Wash. The Coordination Committee consists of 30 member entities, representing federal, state and local agencies, organizations and citizens. In 1999, the Coordination Committee completed the Las Vegas Wash Comprehensive Adaptive Management Plan, which provides a comprehensive set of management actions for stabilizing and enhancing the Wash. Implementing these actions are needed to improve water quality and protect the valley's watershed. Erosion control, environmental monitoring, and wetlands restoration and enhancement are key priorities. The plan was adopted by the SNWA Board of Directors in 2000.

Later that year, the SNWA was designated the lead agency for the implementation of the Las Vegas Wash Comprehensive Adaptive Management Plan and established the Las Vegas Wash Project Coordination Team to provide administrative and technical support to the Coordination Committee. Since its inception, the Coordination Committee and its partners have constructed eleven grade control structures, installed roughly 40,000 linear feet of stream bank protection, conducted bioassessment monitoring as well as water quality and tributary monitoring, implemented a variety of fish and wildlife surveys, revegetated more than 195 acres with native plants, and performed archaeological investigations. These efforts have resulted in a nearly 80 percent total sediment reduction, improving water quality in both the Wash and Lake Mead.

The Clean Water Coalition (CWC), comprised of the City of Las Vegas, City of North Las Vegas, City of Henderson and Clark County Water Reclamation District, has been studying alternatives to the discharge of treated effluent in the Wash for several years, known as the Systems Conveyance and Operations Program (SCOP). In 2002, the CWC formed a citizens advisory committee to address alternatives to protect water quality in the Wash and Las Vegas Bay of Lake Mead so that conditions do not degrade or result in regulatory action. In February 2004, the committee's recommendations were approved by the CWC Board. A Final EIS for the SCOP was completed in October 2006 and Records of Decision from both the National Park Service and Bureau of Reclamation were issued on July 5 and July 9, 2007, respectively.

Given the nexus between water and wastewater in Southern Nevada, the SNWA is working closely with the CWC to coordinate various activities. In January 2007, the SNWA entered into a Memorandum of Understanding (MOU) with the CWC, National Park Service and Bureau of Reclamation committing to participate in the development and implementation of the Boulder Basin Adaptive Management Plan (BBAMP). A subsequent MOU was approved that included a representative from the Metropolitan Water District of Southern California as a member of the Technical Coordination Team for the BBAMP. In September 2007, the USFWS was added as a participant in the BBAMP.

The BBAMP will:

1. Establish management objectives regarding water quality, nutrient management and recreational uses;
2. Establish procedures for and undertake water quality monitoring and analysis of the data;
3. Develop management indices and decision making processes to address areas of concern;
4. Develop an annual operation and management action plan; and
5. Establish a core management team to oversee and manage the BBAMP.

Four Technical Advisory Teams have been established, which include:

- Water Quality Objectives
- Monitor and Modeling
- Selenium Management
- Plant Operations

Las Vegas Valley Watershed Advisory Committee
In May 2007, SNWA adopted a resolution supporting the establishment of regional water quality goals and the development of a regional water quality committee. In support of this effort and in coordination with several regional partners, the Las Vegas Valley Watershed Advisory Committee (LVVWAC) was created. LVVWAC is comprised of the following agencies:

- Clean Water Coalition
- Clark County
- Clark County Regional Flood Control District
- Clark County Water Reclamation District
- City of Henderson
- City of Las Vegas
- City of North Las Vegas
- Las Vegas Valley Water District
- Southern Nevada Water Authority

Through its mission, the LVVWAC works to protect, preserve and enhance the quality and quantity of water resources in the Las Vegas Valley watershed and to sustain economic well-being and protect the environment for present and future generations. Another important charge of the LVVWAC is coordinating management decisions associated with the Las Vegas Wash.

A major accomplishment of the LVVWAC was the development of a Regional Water Quality Plan (Plan) in 2008. The Plan represents a demonstrated effort among agencies in Southern Nevada to coordinate all existing plans, policies, documents and efforts related to water quality in the Las Vegas Valley watershed and Lake Mead. The Plan identifies seven goals and associated strategies that work to protect the overall water quality of the Las Vegas Valley watershed, while also working to protect the watershed's resources, uses and values.

LVVWAC Regional Water Quality Goals include:

1. Protect Lake Mead as a source of water for Southern Nevada and downstream users.
2. Meet or surpass federal, state and local standards and regulations.
3. Preserve and enhance the natural, cultural, historic and recreational values for the watershed and Lake Mead.
4. Coordinate water resource management.
5. Manage flood risks.
6. Sustain water and energy resources for future generations.
7. Build community awareness and support for regional watershed management.

The regional member agencies of the LVVWAC (CWC, Clark County Regional Flood Control District and SNWA) have began developing Annual Operating Plans that detail operational-level tactics to achieve the water quality goals adopted in the plan.

MUDDY RIVER AND COYOTE SPRING VALLEY

As noted in Chapter 2, the SNWA has Muddy River surface water rights and Coyote Spring groundwater rights. This section describes the environmental initiatives underway with respect to the development of these resources. The Interim Guidelines include provisions that will allow the SNWA to recover Muddy River water rights it owns or leases that pre-date the Boulder Canyon Project Act and its Coyote Spring Valley groundwater rights as Intentionally Created Surplus (ICS) from Lake Mead through existing infrastructure. The mainstem Muddy River tributaries and springs of the upper Muddy River provide habitat for several fish species that are considered rare and sensitive. The Muddy River and the Warm Springs area are home to the endangered Moapa dace (Moapa coriacea) as well as species of concern, which include the Moapa White River springfish (Crenichthys baileyi moapae), the Moapa speckled dace (Rhinichthys osculus moapae), and the Virgin River chub (Gila seminuda).

The USFWS manages the Moapa Valley National Wildlife Refuge (MVNWR) in this area for conservation of the Moapa dace, as well as additional sensitive species on the river including three fish, two snails and two insect species. Conservation of the Muddy River species is a priority for local, state and federal agencies.

In April 2006, the SNWA approved a Memorandum of Agreement (MOA) among the USFWS, Coyote Springs Investment, LLC (CSI), Moapa Band of Paiutes (Tribe), Moapa Valley Water District (MVWD) and the SNWA, which establishes a plan for monitoring, management and mitigation that allows for groundwater development in Coyote Spring Valley and California Wash groundwater basins, while simultaneously working to protect and recover the Moapa dace. The MOA is also the subject of a Programmatic Biological Opinion that covers a total of 16,100 AFY of groundwater development. The 16,100 AFY includes 9,000 AFY by the SNWA in Coyote Spring Valley; 4,600 AFY by CSI in Coyote Spring Valley; and 2,500 AFY by the Tribe in California Wash.

The MOA and Programmatic Biological Opinion specify conservation measures to be implemented by the signatories. In 2007, the SNWA Board of Directors approved an agreement with USFWS to implement the following conservation measures:

- Construction of fish barriers in the Muddy River. The SNWA will contribute $50,000 towards construction of fish barriers.
- Eradication of non-native fishes. The SNWA will provide $25,000 to help eradicate tilapia and other non-native fishes on privately-owned lands in the area.
- Improvement/restoration of Moapa dace habitat on the Apcar Unit of the MVNWR. The SNWA will provide $750,000 to implement non-native vegetation removal and stream restoration within the Apcar Unit of MVNWR.
- Development of a Recovery Implementation Program. The SNWA will provide $300,000 towards development of a recovery program that will prioritize and identify implementation of recovery measures for the Moapa dace.
- Development of an Ecological Model. The SNWA and USFWS will provide $125,000 each for development of an ecological model for the Moapa dace. It is anticipated that the U.S. Geological Survey will develop the ecological model under contract with the USFWS.
- Establishment of a Hydrologic Review Team (HRT). The signatories to the MOA formed the HRT to develop and coordinate regional monitoring efforts of the groundwater pumping proposed under the MOA. The HRT members discuss and perform analyses of groundwater pumping effects and natural climatic variation on the Muddy River and Muddy Springs.

Muddy River Recovery Implementation Program

Development of the Muddy River Recovery Implementation Program (RIP) was identified in the Programmatic Biological Opinion. The purpose of the RIP is to provide a comprehensive umbrella ESA program for water resource management in the Coyote Spring Valley, as well as the Warm Springs and Muddy River areas, while working toward recovery of listed species and identifying opportunities for sensitive species and their habitat. The RIP Executive Committee is comprised of the SNWA, USFWS, CSI, the Tribe, and MVWD. The RIP geographic program area extends from the upper Muddy River to Lake Mead.

The RIP is expected to be completed in mid-2009 and program implementation will begin shortly thereafter. When the RIP is finalized, SNWA and the Executive Committee members will be able to undertake restoration actions that contribute toward the recovery of listed species. The restoration actions will contribute to a species recovery bank and can be utilized as credit toward future water development actions requiring ESA compliance.

Warm Springs Natural Area

In February 2006, the Secretary of the Interior approved funding through the Southern Nevada Public Lands Management Act (SNPLMA) for SNWA to purchase 1,218 acres of land historically known as the Warm Springs Ranch, located in the Moapa Valley. In July 2006, the SNWA Board approved a purchase agreement for the property located in the Moapa Valley, and completed the purchase in 2007. Because that funding was secured under the SNPLMA "Parks, Trails and Natural Areas" category, SNWA committed to protect and preserve the property as a natural

area. SNWA began convening cooperators to identify long-term management priorities and renamed the property the "Warm Springs Natural Area."

By purchasing the property, the SNWA was able to protect the majority of the endangered Moapa dace population and its habitat, and prevent the property from being developed for residential purposes. By protecting the Moapa dace and its habitat, the SNWA can responsibly move forward with development of SNWA's water resources in the Muddy River and Coyote Spring areas.

The Warm Springs Natural Area and the Moapa Valley National Wildlife Refuge encompass about 20 springs that form the headwaters of the Muddy River. The springs and their outflows onto the Warm Springs Natural Area are home to the majority of the Moapa dace population. A total of 18 endangered, sensitive and endemic species are found on the Warm Springs Natural Area. In addition, the property has the largest breeding population of vermillion flycatchers in Nevada.

Although the primary purpose is to manage the property for the protection of the Moapa dace, the SNWA committed to manage the entire property as a natural area and develop a long-term management plan. SNWA also committed to manage the property in close coordination with the Moapa Valley National Wildlife Refuge and the Nature Conservancy Muddy River property.

VIRGIN RIVER

As noted in Chapter 2, the SNWA has water rights in the Virgin River. The Secretary of the Interior's Interim Guidelines include provisions that will allow the SNWA to recover its Virgin River rights that pre-date the effective date of the 1928 Boulder Canyon Projects Act as ICS through existing facilities in Lake Mead. This section describes the environmental initiatives currently underway with respect to these resources.

The SNWA has been involved in environmental studies on the Virgin River since 1993. In fact, much of the available biological information concerning the lower Virgin River has been collected as a result of efforts by the SNWA. This includes population and habitat surveys for fish, birds, mammals, amphibians and sensitive plants. The SNWA participates in a number of environmental stakeholder forums involving the upper and lower Virgin River. For example, the SNWA has been a member of the Virgin River Fishes Recovery Team since 1994.

The Virgin River is one of the largest riparian corridors in the desert southwest and is home to the federally endangered woundfin (Plagopterus argentissimus), Virgin River chub, southwestern willow flycatcher (Empidonax traillii extimus) and Yuma clapper rail (Rallus longirostris yumanensis), and the candidate species yellow-billed cuckoo (Coccyzus americanna) and Virgin River spinedace (Lepidomeda mollispinis mollispinis). There are more than 200 other species of wildlife that also utilize this riparian corridor as a residence or seasonal migration route. Supporting a high level of biodiversity, the Virgin River is regarded by federal and state resource agencies and environmental organizations as an integral component of the desert southwest ecosystem.

In the upper Virgin River, in the State of Utah, federal, state and local agencies and various other stakeholders are implementing the Virgin River Resource Management and Recovery Program. This program provides environmental compliance for water development and flood-control projects by implementing resource-management agreements aimed at recovery of listed species, conservation of native species and protection of the river corridor.

The lower Virgin River in Nevada is increasingly facing similar ESA issues surrounding development pressures and as a result, has been begun a regional environmental planning effort called the Virgin River Habitat Conservation and Recovery Program.

Virgin River Habitat Conservation and Recovery Program

Developing the Virgin River Habitat Conservation and Recovery Program (VRHCRP) was a requirement of the Mesquite Lands Act of 1998. This Act authorized the BLM to sell 10,620 acres of BLM land to the City of Mesquite. The City of Mesquite plans to sell that land to developers and reserve some acreage for an airport.

In October 2002, special legislation as part of the Clark County Conservation of Public Land and Natural Resources Act of 2002 was passed in Congress. The legislation allows the City of Mesquite to use proceeds from the BLM land sale for the development of the VRHCRP and a Hydrological Monitoring and Mitigation Program (HMMP). The intention of the HMMP is to address future unknown potential effects of groundwater pumping on the Virgin River. The HMMP is designing a monitoring program and will collect and evaluate data from new and existing groundwater monitoring wells and existing surface water gages. The data will be used to determine a baseline and whether increased groundwater pumping by Virgin Valley Water District (VVWD) is affecting habitat or species along the Virgin River.

The City of Mesquite started development of the VRHCRP in 2004. In 2005, an Executive Committee was formed consisting of the City of Mesquite, SNWA, Clark County, VVWD, National Park Service, Nevada Department of Wildlife and BLM. Technical committees have also been established to provide recommendations to the Executive Committee. The VRHCRP is expected to become final through an implementation agreement in 2009.

In addition to the VRHCRP effort, the Lower Virgin River Recovery Implementation Team is working to develop a conservation action plan for the endangered woundfin and Virgin River chub. This team is also conducting research and implementing interim conservation measures for these listed fish. The Virgin River Conservation Partnership is a stakeholder group composed of federal, state and local agencies working to share information and make recommendations to planning efforts like the VRHCRP. The SNWA is a key participant in these Virgin River environmental efforts to ensure they are coordinated with the development of SNWA's water rights in the Virgin River.

CLARK COUNTY

After the ESA listing of the desert tortoise (Gopherus agassizii) in 1989, local agencies in Clark County recognized the need to address concerns about listed or sensitive species that could affect development in the county.

Clark County Multiple Species Habitat Conservation Plan

Beginning in 1998, the Clark County Multiple Species Habitat Conservation Plan (MSHCP) was developed to address biological resources within Clark County. In addition to the desert tortoise, the program provides ESA coverage for 77 additional species. The key purpose of the MSHCP is to achieve a balance between the conservation and recovery of listed and sensitive species in Clark County and the orderly beneficial use of land in order to meet the needs of the growing population in Clark County. The SNWA actively participates in the MSHCP. The MSHCP serves as an insurance policy to cover future federal listings of species in areas where urban development is taking place.

CLARK, LINCOLN AND WHITE PINE COUNTIES GROUNDWATER

In August 2004, the SNWA applied to the BLM for rights-of-way to construct facilities to develop the Clark, Lincoln and White Pine Counties Groundwater Development Project (GWP) in eastern Nevada. The BLM has determined that it is necessary to prepare an EIS and Biological Assessment (BA) to evaluate the environmental impacts of issuing these rights-of-ways. Public scoping for the EIS was held from April through August 2005, and again from July through August 2006.

The SNWA has submitted a draft Conceptual Plan of Development for the project to the BLM, which describes information such as project

location, construction methods, and operation and maintenance. The SNWA has conducted hydrologic and environmental research in this region since the early 1990s and has provided these data to the BLM for their consideration through the environmental compliance process. Biological information provided includes survey data for bats, small mammals, pygmy rabbits, sage grouse, raptors and ferruginous hawks, breeding birds, sensitive plants, general wildlife, weeds, terrestrial invertebrates and aquatic ecosystems The SNWA has also collected extensive geologic and hydrologic data from published sources, field surveys and studies, and new monitoring and testing wells. A groundwater flow model is being developed from this data as part of the EIS analysis, which will evaluate potential effects of groundwater production on water levels and spring flows. This information will allow SNWA and the BLM to better predict potential impacts from groundwater development and develop hydrologic monitoring and management plans to reduce or avoid impacts.

The EIS will analyze potential effects of the project on the human environment, which includes such resource topics as geology, soils, water, biology, paleontology, geologic hazards, land ownership and use, special use areas, noise, air quality, visual, cultural resources and socioeconomics. It is anticipated that the EIS will be available for public review in late-2009 and completed in late-2010. The BA will analyze potential project effects on federally listed and candidate species, and will be submitted to the USFWS late-2009

As noted in previous chapters, the SNWA entered into a stipulated agreement with the USFWS, National Park Service, BLM and Bureau of Indian Affairs (Department of Interior Agencies) to work together to protect the Great Basin National Park and the groundwater dependent ecosystems in Spring Valley. The stipulation establishes an Executive Committee, a Biological Work Group and a Technical Review Panel to develop and implement monitoring, management and mitigation measures. Both Hydrological and Biological monitoring plans have been completed and approved by the Nevada State Engineer, and implementation will begin in early 2009.

In 2008, the SNWA again entered into a stipulated agreement with the Department of Interior (DOI) Agencies, and a separate agreement with the Moapa Band of Paiutes. The stipulated agreement with the DOI is intended to protect groundwater dependent ecosystems and federal resources within Dry Lake, Delamar and Cave valleys, three of the five basins included in the GWP, and in White River and Pahranagat valleys. As with Spring Valley, this agreement provides for monitoring, management and mitigation measures, which are currently being developed by biological and hydrological technical committees. Baseline monitoring for Dry Lake, Delamar and Cave valleys is anticipated to begin in 2010.

To support groundwater development in eastern Nevada, the SNWA has acquired seven ranch properties comprised of more than 24,000 acres, approximately 950,000 acres in grazing allotment permits, more than 5,000 head of livestock, and more than 33,900 AFY in surface water rights. These land, water and livestock resources are an important suite of management tools that will allow SNWA to meet its environmental commitments by integrating their management with groundwater development. Protection of sensitive habitats, wildlife and the aesthetic values of eastern Nevada can be balanced with SNWA groundwater development through proactive integrated resource management.

THREE LAKES VALLEY GROUNDWATER

In April 2004, the SNWA applied to the BLM for rights-of-way to construct facilities to develop groundwater resources in Three Lakes Valley. After decisions have been made regarding water right points of diversion by the Nevada State Engineer, an Environmental Assessment will be prepared so the BLM can assess the environmental issues associated with this action. In addition to potential effects on desert tortoise from construction, the potential impacts from groundwater pumping on sensitive springs located at Ash Meadows, Corn Creek and Indian Springs would also be analyzed.

CONCLUSION

Access to water resources can be affected by a number of environmental laws, regulations or issues. Compliance requirements can significantly influence when certain resources are made available, or whether certain resources are ultimately made available at all. To facilitate development of future water resource options while taking steps to preserve and protect species and habitats, the SNWA participates in a broad range of environmental processes. The SNWA's commitment to the environment as well as these environmental processes are a critical component of SNWA planning, and will assist the SNWA in maintaining and developing a portfolio of water resource options, as described in Chapter 2.

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Appendices

Appendix 1
SOUTHERN NEVADA WATER AUTHORITY
INTEGRATED WATER PLANNING ADVISORY COMMITTEE
RECOMMENDATIONS

CONSERVATION

1. Pursue more aggressive promotion of water conservation and regulation of water use through methods such as the reduction of turf.

2. Decrease total water demand from 272 GPCD to 250 GPCD by 2010 and to 245 GPCD by 2035.

   a. Permananently implement major Drought Alert demand reduction tools identifi ed in the SNWA Drought Plan, including landscape watering restrictions, landscape development codes, golf course water budgets and increased water waste fi nes and enforcement

   b. Sustain current pricing signals by ensuring water rates keep pace with inflation.

   c. Maintain or exceed the 2004 participation levels in the SNWA Water Smart Landscapes Rebate Program.

3. Assess conservation achievement annually, investigate the potential for further GPCD reductions and revise conservation goals accordingly.

RESOURCE DEVELOPMENT

4. Pursue development of all the resource options considered in the IWPAC planning scenarios.

   - Arizona Water Bank
   - Coyote Spring Valley Groundwater Rights
   - Three Lakes Valley Groundwater Rights
   - Pre-Compact Water Rights (Virgin and Muddy Rivers)
   - Virgin River Water Rights
   - Clark, Lincoln and White Pine Counties Groundwater Applications
   - Augmentation Credits
   - Additional Conservation

5. Provide additional safeguards for communities and the environment in areas where in-state groundwater resources are developed.

   a. Implement a committee with SNWA and White Pine County representatives to develop annual pumping strategies for Spring and/or Snake Valleys.

   b. Comprehensively monitor and manage any in-state groundwater pumping to assess hydrological effects, sustain the resource and protect the surrounding environment.

   c. Review groundwater situation in Spring and/or Snake Valleys in 75 years, including White Pine County supply needs, basin hydrology and overall pumping data, and revise SNWA permits if conditions warrant it.

6. Work with the Colorado River Basin States and the Bureau of Reclamation to implement augmentation credits for in-state, non-Colorado River resources.

7. Pursue delivery of pre-compact Muddy and Virgin River water rights through Lake Mead and the existing Southern Nevada Water System ("lake conveyance").

8. Pursue "lake conveyance" for the development and use of post-compact Virgin River water rights.

9. Pursue an interstate agreement with Utah and Arizona concerning use of the Virgin River.

10. Pursue fl exible use of Colorado River resources over the long term.

11. Utilize the Southern Nevada Water Bank and California Water Bank as "bridge resources" to help meet any supply deficits.

12. Utilize surplus and interim surplus Colorado River water, if and when they are available.

13. Continue to pursue ocean desalination as a long-term resource.

14. Pursue additional wastewater reuse to maximize supply availability if augmentation credits can not be implemented.

RESOURCE MANAGEMENT

15. Restrict or eliminate the use of salt-using water softeners at residential and commercial facilities to reduce total dissolved solids ("salts") in wastewater discharge and to improve reuse and raw water quality.

16. Utilize the Integrated Water Planning Advisory Committee's evaluation criteria when assessing priorities for the development of in-state water resources.

17. Utilize and maintain water supplies in a sustainable manner.

FUNDING

18. Continue to support the use of diverse funding sources.

    - Commodity Charges (water rates)
    - Connection Charges
    - Sales Tax
    - Southern Nevada Public Land Management Act (SNPLMA) Funding
    - Other state and federal funding as available

19. Revisit the current funding formula for fairness and affordability when a specific project/funding scenario is determined.

20. Pursue an extension of the ¼ cent sales tax to help pay for future water infrastructure.

21. Support the continued allocation of 10% of the funds received from the SNPLMA to the SNWA.

22. Increase conservation education, including the financial ramifications that could occur if additional conservation is not achieved.

Appendix 2
SOUTHERN NEVADA WATER AUTHORITY
INTEGRATED RESOURCE PLAN ADVISORY COMMITTEE
RECOMMENDATIONS
(Adopted June 1995 by SNWA Board of Directors)

1.0 RESOURCES

1.1 Seek permanent, long-term water supplies. However, a water resources plan should be formulated to meet future water demands that utilizes all available water supplies, including unused apportionments, surpluses, leases, and other water supplies.

1.2 Place top priority on development of Colorado River water to meet future water demands over development of a Virgin River pipeline or the Cooperative Water Project.

1.3 Maximize the use of the Las Vegas Valley shallow aquifer when and where practical.

2.0 FACILITIES

2.1 Implement a water facilities program that is phased and expandable in order to respond to future uncertainties (e.g., demands, regulations, etc.).

2.2 Expand the existing Southern Nevada Water System from its existing capacity of 400 million gallons per day (MGD) to its ultimate capacity of 600 MGD as soon as possible.

2.3 Maximize the reuse of wastewater when and where practical.

2.4 Maximize artificial recharge when and where practical.

2.5 Build a new treatment and transmission facility (TTF) as soon as possible that is big enough to be reliable (avoid shortages) and to provide backup capability in the event of a catastrophic failure.

3.0 CONSERVATION

3.1 Achieve a 10% - 15% reduction in maximum day usage by summer 2000 through the "planned" conservation program or something similar. For facility planning purposes, assume this reduction will occur until further study.

3.2 Study conservation possibilities immediately to see if a higher level than "planned" is achievable, and incorporate as practical. Make adjustments to the facilities program as necessary.

3.3 Establish an SNWA water conservation committee to examine water conservation measures.

3.4 Promote economic incentives and provide economic information to encourage the efficient use of water.

4.0 FINANCE

4.1 Study the impacts of water and wastewater programs on customer costs.

4.2 Study demand elasticity (i.e., the impact of customer costs on water demands).

4.3 Study different approaches to financing and rate setting.

5.0 PLANNING

5.1 Continue the SNWA Integrated Resource Planning (IRP) process.

5.2 Integrate wastewater planning fully into the IRP process.

5.3 Maintain the SNWA Integrated Resource Plan Advisory Committee as a critical inputto the IRP process.

5.4 Continue to update water demand projections as needed.

Appendix 3
NEVADA COLORADO RIVER ENTITLEMENTS
PRIOR TO 1991 / PRE-SNWA

Entitlement Holder	Year[1]	Nature of Entitlement	Diversion Amount*
Fort Mojave Tribe	1890	Present perfected right	12,534
U.S. For Lake Mead Recreation Area	1926	Present perfected right	500
U.S. for Lake Mead Recreation Area[2]	1930	Perfected right	1,500
Basic Management, Inc.	1969	Contract	23,158
Lakeview Company[3]	1965	Contract	0
Pacifi c Coast Building Products	1965	Contract	928
CRC for Nellis AFB portion	1967/77	Contract	4,000
Southern Nevada Water System (SNWS)			
U.S.	1992	Secretarial Reservation	300
Nevada Division of Wildlife	1972	Contract (consumptive use)	25
Boy Scouts of America	1978	Contract	10
CRC for Southern California Edison	1966	Contract	23,000
Total			**65,955**
SNWA Purveyors (pre-SNWA)			
Boulder City[4]	1931	Prefected right	5,876
Las Vegas Valley Water District	1969	Contract	15,407
CRC for SNWS (minus 4,000 AFY Nellis, 9,000 AFY system loss)	1967/77	Contract	295,000
Big Bend Water District	1983	Contract	10,000
City of Henderson	1990	Contract	15,878
Total			**342,161**
CRC for SNWS (system loss)	1967/77	Contract	9,000
TOTAL NEVADA ENTITLEMENTS (prior to 1991 / pre-SNWA)			**417,116**

*All figures provided in acre-feet per year

[1] Year is priority date of present perfected rights and perfected rights and initial contract year for contract rights.
[2] Estimate; "annual quantities reasonably necessary to fulfill the purpose" of the Rec. Area. (1964 Supreme Court Decree).
[3] The contract entitlement is 120 AFY, which the Bureau of Reclamation currently has reduced to zero.
[4] Estimate; Boulder City's 1960 water delivery contract right was for 3,650 gallons-per-minute "maximum rate of delivery."

Appendix 4

CLARK COUNTY POPULATION FORECAST USED BY SNWA IN PREPARATION OF WATER RESOURCE DEMAND FORECAST IN SNWA 2009 WATER RESOURCE PLAN

Year	Population
2000*	1,428,690
2001*	1,498,274
2002*	1,578,332
2003*	1,641,529
2004*	1,747,025
2005*	1,815,700
2006*	1,912,654
2007*	1,996,542
2008	2,080,000
2009	2,166,000
2010	2,253,000
2011	2,336,000
2012	2,418,000
2013	2,498,000
2014	2,575,000
2015	2,649,000
2016	2,721,000
2017	2,790,000
2018	2,855,000
2019	2,917,000
2020	2,978,000
2021	3,036,000
2022	3,091,000
2023	3,144,000
2024	3,194,000
2025	3,243,000
2026	3,288,000
2027	3,332,000
2028	3,374,000
2029	3,414,000
2030	3,454,000
2031	3,492,000
2032	3,530,000
2033	3,569,000
2034	3,607,000
2035	3,646,000

*Historical Estimates

Source: "Clark County Nevada Population Forecast 2008-2035," June 2008, Center for Business and Economic Research (CBER) at the University of Nevada, Las Vegas.

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Water Budget	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors adopt the 2013 Water Budget for the 2015 calendar year.	

Fiscal Impact:
None by approval of the above recommendation.

Background:
The SNWA 1995 Amended Cooperative Agreement requires the Authority to adopt a Water Budget, and thereafter review the Water Budget at least annually, revising when necessary. On November 21, 2013, the Board of Directors adopted the 2013 Water Budget, which shows annual supply and demand projections through 2016.

The Water Budget is intended to complement the Water Resource Plan by providing short-term, detailed forecasts, while the Water Resource Plan focuses on longer-term resource and demand projections.

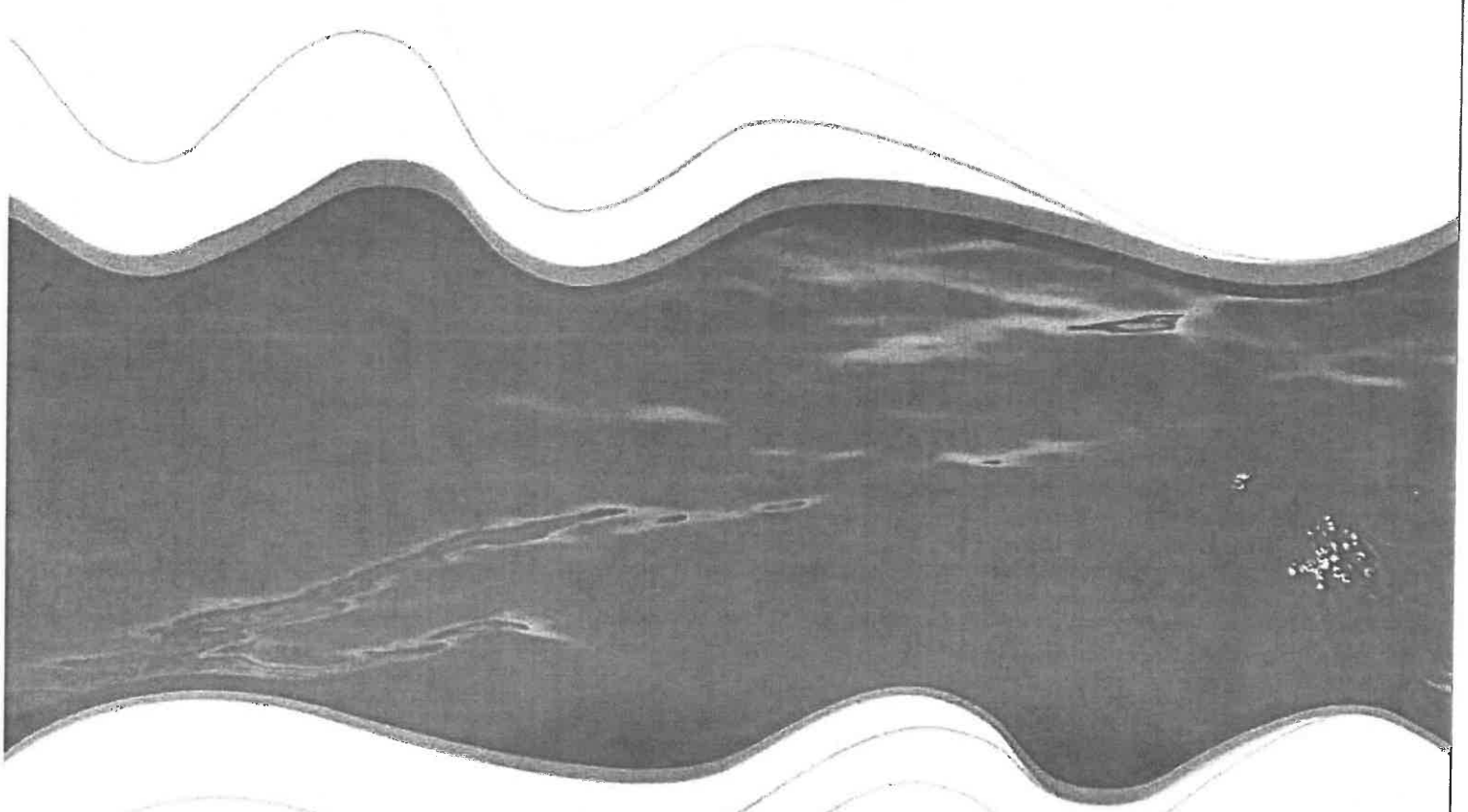
The Authority has completed this year's review of the Water Budget in conjunction with updated information provided by the Authority's member agencies. This updated information did not materially change the short-term water demand outlook, and the Water Budget continues to demonstrate sufficient resources to meet the Authority's member agency demands under the range of potential Colorado River water supply conditions through the 2016 horizon.

This action is authorized pursuant to Sections 5(j) and 8(h) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved this agenda item.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:ZLM:AB:JJ:TM:lmv:nsh
Attachment

AGENDA ITEM # 13



Water Budget 13

SOUTHERN NEVADA WATER AUTHORITY

Southern Nevada Water Authority

Board of Directors

Mary Beth Scow, Chair
Las Vegas Valley Water District

Sam Bateman, Vice Chair
City of Henderson

Susan Brager
Clark County Water Reclamation District

Bob Coffin
City of Las Vegas

Duncan McCoy
City of Boulder City

Steve Sisolak
Big Bend Water District

Anita Wood
City of North Las Vegas

Patricia Mulroy, General Manager

Member Managers
J. David Fraser, City of Boulder City • Elizabeth Fretwell, City of Las Vegas
Jeffrey Buchanan, City of North Las Vegas • Jacob Snow, City of Henderson
Tom Minwegen, Clark County Water Reclamation District
Patricia Mulroy, Las Vegas Valley Water District and Big Bend Water District

Summary

The Southern Nevada Water Authority (SNWA), pursuant to its Cooperative Agreement, is required to produce a water budget showing water resources available to the SNWA and its member agencies and water demands for each purveyor member. It is reviewed annually by the SNWA Board of Directors and revised as needed.

The SNWA staff prepared this 2013 Water Budget with input from technical representatives of the member agencies. The document consists of eight tables and four corresponding appendices showing annual potable and non-potable water demand projections by purveyor for the years 2013 through 2016, as well as actual demands for the years 2011 through 2012.

The Water Budget is short-term in focus, with detailed forecasts provided by each purveyor for its respective service area. The water demands in this Water Budget differ from the regional forecasts in the Water Resource Plan. Water demands in the Water Resource Plan are generated for the SNWA service area as a whole. The intent of the Water Resource Plan is to focus on the resources available to the region for the long-term. The Water Resource Plan should be consulted to understand what water resources are projected to meet long-term regional water demands. The Water Budget, on the other hand, is a good source document for water demand and supply details of a specific purveyor service area for the next few years.

Major findings of 2013 Water Budget

- Nevada's 2012 Colorado River consumptive use was approximately 237,000 acre-feet, including approximately 1,100 acre-feet of water banked through direct and in-lieu recharge in the Las Vegas Valley. SNWA delivered and created Intentionally Created Surplus (ICS) credits during 2012 by conserving purchased and leased water rights on the Muddy and Virgin Rivers and pumping Coyote Spring Valley Groundwater and conveying it to Lake Mead for storage and delivery. During 2012 SNWA delivered 1,000 acre-feet of Coyote Spring Valley Groundwater Imported ICS for use in the Las Vegas Valley and stored approximately 32,600 acre-feet of ICS credits in Lake Mead from these projects. Nevada directed approximately 63,000 acre-feet of unused Nevada Colorado River water for storage in California.

- The 2013 Water Budget projects Nevada Colorado River water consumptive use without direct recharge to be between approximately 230,000 and 242,000 acre-feet a year between 2013 and 2016. If Colorado River drought conditions persist, Lake Mead water levels may fall below 1,075 feet, resulting in a shortage declaration and a reduction in Nevada's Colorado River apportionment by up to 20,000 acre-feet annually. The 2013 Water Budget projections of Colorado River water use are well within this potential reduced annual Colorado River apportionment of 280,000 acre-feet, demonstrating SNWA's ability to meet water resource needs during declared shortages through 2016.

- SNWA plans to store between 15,000 and 30,000 acre-feet of ICS credits annually during this same period. During this period, SNWA will manage available water resources through a combination of water banking in the Las Vegas Valley, interstate banking, and leaving a portion of the available unused water in Lake Mead, benefiting Colorado River System storage and Lake Mead elevation.

- Between 2013 and 2016, projections show some purveyors may utilize all of their long-term resources and available purveyors' unused Nevada Colorado River water, as allowed for in the SNWA Water Delivery Contract and Cooperative Agreement. In addition, other water sources detailed in the 2009 Water Resource Plan may be used to meet demands during this period. The utilization of reclaimed water (wastewater reuse) is projected to be between 16,000 and 19,500 acre-feet a year during the period 2013 to 2016.

- The Las Vegas Valley Water District (LVVWD) is planning to recover water stored in the Las Vegas Valley Groundwater Basin during the period 2013 to 2016 to provide operational flexibility in the management of system water quality for the period of time before the Third Intake is completed. The recovery volumes are estimated to be 3,500 acre-feet during 2013, 7,000 acre-feet in 2014, 7,000 acre-feet in 2015 and 3,500 acre-feet in 2016, if needed. The source of this recovered water would include 7,621 acre-feet of in lieu storage credits held by LVVWD, with the remaining amount to be recovered from the SNWA's credits held in the Southern Nevada Groundwater Bank.

2013 SNWA Water Budget, November 21, 2013

TABLE 1: CUSTOMER WATER USAGE, numbers in acre-feet per year (a)

POTABLE	2011	2012	2013	2014	2015	2016
Groundwater customer usage (GW)						
LVVWD	40,629	40,404	40,629	40,629	40,629	40,629
North Las Vegas	1,236	4,876	4,919	5,250	5,250	5,250
Total	41,865	45,280	45,548	45,879	45,879	45,879
Colorado River customer usage (CR)						
Deliveries						
Big Bend (Laughlin)	4,339	4,646	4,153	4,403	4,447	4,491
Boulder City (b)	10,079	10,473	10,934	10,934	10,934	10,934
Henderson (b)	77,258	77,689	77,967	78,096	78,572	79,781
LVVWD	278,423	285,007	278,678	279,321	282,338	289,312
North Las Vegas	48,260	45,793	46,784	47,360	48,162	48,862
Total	418,359	423,608	418,515	420,114	424,453	433,380
Recovery of artificial recharge (AR recovery)						
Big Bend (Laughlin)	0	0	0	0	0	0
Boulder City	0	0	0	0	0	0
Henderson	0	0	0	0	0	0
LVVWD (c)	156	0	3,500	7,000	7,000	3,500
North Las Vegas	0	0	0	0	0	0
Total	156	0	3,500	7,000	7,000	3,500
Total Colorado River customer usage (CR + AR recovery)						
Big Bend (Laughlin)	4,339	4,646	4,153	4,403	4,447	4,491
Boulder City (b)	10,079	10,473	10,934	10,934	10,934	10,934
Henderson (b)	77,258	77,689	77,967	78,096	78,572	79,781
LVVWD (c)	278,579	285,007	282,178	286,321	289,338	292,812
North Las Vegas	48,260	45,793	46,784	47,360	48,162	48,862
Total	418,515	423,608	422,015	427,114	431,453	436,880
Total customer usage (GW + CR + AR recovery)						
Big Bend (Laughlin)	4,339	4,646	4,153	4,403	4,447	4,491
Boulder City (b)	10,079	10,473	10,934	10,934	10,934	10,934
Henderson (b)	77,258	77,689	77,967	78,096	78,572	79,781
LVVWD (c)	319,208	325,411	322,807	326,950	329,967	333,441
North Las Vegas	49,496	50,669	51,703	52,610	53,412	54,112
Total	460,380	468,888	467,563	472,993	477,332	482,759
NON-POTABLE (Wastewater Reuse)						
Customer usage						
Boulder City	146	263	263	263	263	263
CCWRD : Las Vegas Valley (d)	5,620	6,048	5,715	5,784	5,859	5,938
CCWRD : Laughlin	0	0	0	0	0	0
Henderson	6,268	6,924	6,600	6,600	6,600	6,600
Las Vegas (d)	4,688	4,256	3,500	4,500	5,000	5,500
North Las Vegas	0	0	0	600	1,200	1,200
Total	16,722	17,491	16,078	17,747	18,922	19,501
TOTAL POTABLE AND NON-POTABLE						
Customer usage (GW + CR + AR recovery + Wastewater Reuse)						
Big Bend (Laughlin)	4,339	4,646	4,153	4,403	4,447	4,491
Boulder City (b)	10,225	10,736	11,197	11,197	11,197	11,197
CCWRD : Las Vegas Valley (d)	5,620	6,048	5,715	5,784	5,859	5,938
CCWRD : Laughlin	0	0	0	0	0	0
Henderson (b)	83,526	84,613	84,567	84,696	85,172	86,381
Las Vegas (d)	4,688	4,256	3,500	4,500	5,000	5,500
LVVWD (c)	319,208	325,411	322,807	326,950	329,967	333,441
North Las Vegas	49,496	50,669	51,703	53,210	54,612	55,312
Total	477,102	486,379	483,641	490,740	496,254	502,260

NOTES

(a) Source(2011+): SNWA member.

(b) A portion of water usage is met with raw water used for irrigation.

(c) Includes banking operation recovery (e.g. water resource centers).

(d) CCWRD and LV provide sewer service to their service areas; both are in LVVWD's service area.

2013 SNWA Water Budget, November 21, 2013

TABLE 2: RESOURCES AVAILABLE, numbers in acre-feet per year

	Potable water resource									
	Colorado River water									
	Federal SNWS Water Delivery Contract (a)	SNWA Delivery Contract (b)	SNWA Delivery Contract (c)	Other Delivery Contracts (d)	Total Colorado Riv. water	Ground-Water	Total Potable Resource	Non-Potable Resource (e)	Total Long-term Resource (f)	Total Short-term Resource
Big Bend	0	5,352	0.0	10,000	15,352.0	0	15,352.0	0	15,352.0	-
Boulder City	8,918	3,948	0.0	5,876	18,742.0	0	18,742.0	0	18,742.0	-
CCWRD (h)(i)	0	0	0.0	0	0.0	0	0.0	11,100	11,100.0	-
Henderson	27,021	19,858	2,137.5	15,878	64,894.5	0	64,894.5	7,500	72,394.5	-
Las Vegas (h)	0	0	0.0	0	0.0	0	0.0	2,000	2,000.0	-
LVVWD	232,426	78,799	362.5	15,407	326,994.5	40,629	367,623.5	0	367,623.5	-
N. Las Vegas	26,635	15,043	0.0	0	41,678.0	6,201	47,879.0	1,200	49,079.0	-
Total	295,000	123,000	2,500.0	47,161	467,661.0	46,830	514,491.0	21,800	536,291.0	(g)

NOTES

(a) Contract 7-07-30-W0004 between SNWA and the Department of the Interior ("Federal SNWS Water Delivery Contract" or "SNWS Repayment and Delivery Contract"). Quantities for individual purveyors are outlined in Section 8(b) of the SNWA Cooperative Agreement.

(b) In Contract 2-07-30-W0266 between SNWA and the Department of the Interior ("SNWA Water Delivery Contract"), Sections 4(a)(1) and (2) gives to SNWA the right to use any remaining, uncontracted Nevada apportionment and water available because of reduction, expiration or termination of individual entitlements within Nevada. Section 8 (c) of the SNWA Cooperative Agreement (amended January 1, 1996) apportions among the purveyors 123,000 AFY of Colorado River water made available to SNWA under Sections 4(a)(1) and (2).

(c) As described in Section 8(d) of the SNWA Cooperative Agreement and in the Water Supply Agreement (formal agreement that transfers portion of BMI water to SNWA), 2,500 AFY of the transferred water is held in reserve by SNWA for Victory Valley (BMI land development company) projects. Once a specific project is proposed, the reserved water is transferred to the purveyor in whose service area the project is to be located; this transfer is effective upon the date that a service area "Purveyor Service Designation" letter is issued.

(d) Other delivery contracts as follows: 2-07-30-W0269 (Big Bend), 14-06-300-978 (Boulder City), 0-07-30-W0246 (Henderson), 14-06-300-2130 (LVVWD).

(e) Maximum 21,800 reuse per Cooperative Agreement, safeguards return flows to the Colorado River for return-flow credit. If reuse is greater than the reuse quantities outlined in the Agreement AND IF the excess reuse results in a reduction of return-flow credits which in turn reduces other purveyors' Colorado River water supplies, then the excess reuse quantity is reduced from the potable purveyor in whose service area the reuse provider resides.

(f) Expected to be available in perpetuity.

(g) Short-term resource includes: unused Colorado River apportionments, banked water as described in the SNWA's 2009 Water Resource Plan and flood control and domestic surplus Colorado River water made available to Nevada on a year-to-year basis by the Secretary of the Interior. Surplus Colorado River water includes Muddy and Virgin River Tributary Conservation Intentionally Created Surplus (ICS) credits and Coyote Spring Valley Groundwater Imported ICS.

(h) Both Clark County Water Reclamation District (CCWRD) and Las Vegas (City of) sewer service areas are within LVVWD's water service area. If reuse demands for either CCWRD or Las Vegas are greater than the reuse in the SNWA Cooperative Agreement AND IF they reduce return flow credits which in turn reduces other purveyors' Colorado River water supplies, then the excess reuse quantity is subtracted from LVVWD's potable water resource.

(i) Maximum reuse for CCWRD includes reuse for CCWRD in Laughlin and in the Las Vegas Valley.

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TABLE 3: FACILITY USAGE BY SNWA PURVEYOR, numbers in acre-feet per year (a)

	2011	2012	2013	2014	2015	2016
Colorado River facility usage (includes artificial recharge, but no recovery of artificial recharge)						
Big Bend Water District	4,339	4,646	4,153	4,403	4,447	4,491
Boulder City						
SNWS	10,079	10,473	10,934	10,934	10,934	10,934
USBR (raw water) system	0	0	0	0	0	0
Total	10,079	10,473	10,934	10,934	10,934	10,934
Henderson						
SNWS	62,152	63,482	62,482	63,351	64,172	65,381
BMI system						
Potable	12,193	11,700	13,433	12,495	12,150	12,150
Raw	2,913	2,507	2,051	2,250	2,250	2,250
Total	15,106	14,207	15,484	14,745	14,400	14,400
Total	77,258	77,689	77,967	78,096	78,572	79,781
LVVWD (SNWS)						
Customer usage (no AR recovery)	278,423	285,007	278,678	279,321	282,338	289,312
Artificial recharge						
Current year banking operations (b)	531	0	0	0	0	0
Other (c)	2,761	0	0	0	0	0
Total Artificial recharge	3,292	0	0	0	0	0
Total	281,715	285,007	278,678	279,321	282,338	289,312
North Las Vegas (SNWS)						
Customer usage (no AR recovery)	48,260	45,793	46,784	47,360	48,162	48,862
Artificial recharge	0	0	0	0	0	0
Total	48,260	45,793	46,784	47,360	48,162	48,862
Total Colorado River purveyor usage						
Customer usage (no AR recovery)	418,359	423,608	418,515	420,114	424,453	433,380
Artificial recharge	3,292	0	0	0	0	0
Total	421,651	423,608	418,515	420,114	424,453	433,380
SNWS system loss to LVV (d)	3,056	2,024	3,040	3,056	3,091	3,158
Total Colorado River purveyor usage (including SNWS system loss)	424,707	425,632	421,555	423,170	427,544	436,538
Groundwater facility usage (includes recovery of artificial recharge)						
LVVWD						
Pumpage of groundwater rights	40,629	40,404	40,629	40,629	40,629	40,629
Pumpage of artificial recharge (recovery)						
Banking operations (e)	156	0	0	0	0	0
Recovery for purveyor members (f)	0	0	3,500	7,000	7,000	3,500
Total pumpage of AR	156	0	3,500	7,000	7,000	3,500
Total	40,785	40,404	44,129	47,629	47,629	44,129
North Las Vegas						
Pumpage of groundwater rights	1,236	4,876	4,919	5,250	5,250	5,250
Total pumpage of AR	0	0	0	0	0	0
Total	1,236	4,876	4,919	5,250	5,250	5,250
Total groundwater facility usage	42,021	45,280	49,048	52,879	52,879	49,379

NOTES

(a) Source(2011+): SNWA member.

(b) Recharge recovered during current year for system management and water resource centers.

(c) Recharge for SNWA purveyors and Groundwater Management Program.

(d) Southern Nevada Water System system loss, see Appendix 4.

(e) Recovery for system management and water resource centers. Excludes recovery by Las Vegas Paiutes.

(f) LVVWD plans to recover water from the Las Vegas Valley Water Bank for operational reasons.

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TABLE 4: USAGE BY FACILITY, numbers in acre-feet per year (a)

	2011	2012	2013	2014	2015	2016
Usage by Colorado River facilities (includes artificial recharge, but no recovery of artificial recharge)						
Big Bend system	4,339	4,646	4,153	4,403	4,447	4,491
BMI system:						
Henderson	15,106	14,207	15,484	14,745	14,400	14,400
BMI Complex (b)	5,585	5,288	5,437	5,437	5,437	5,437
Total	20,691	19,495	20,921	20,182	19,837	19,837
BMI system loss (c)	690	999	669	646	635	635
Total BMI	21,381	20,494	21,590	20,828	20,472	20,472
Southern Nevada Water System (SNWS)						
Boulder City	10,079	10,473	10,934	10,934	10,934	10,934
Henderson	62,152	63,482	62,482	63,351	64,172	65,381
LVVWD	281,715	285,007	278,678	279,321	282,338	289,312
Nellis AFB (b)	1,129	1,075	1,102	1,102	1,102	1,102
North Las Vegas	48,260	45,793	46,784	47,360	48,162	48,862
Total	403,335	405,830	399,980	402,068	406,708	415,591
SNWS system loss (c)	3,056	2,024	3,040	3,056	3,091	3,158
Total SNWS	406,391	407,854	403,020	405,124	409,799	418,749
USBR (raw water) system						
Boulder City	0	0	0	0	0	0
Total Colorado River diversions by facility	432,111	432,994	428,763	430,355	434,718	443,712
Usage by groundwater facilities (includes AR recovery)						
SNWA purveyors (d)						
Pumpage of groundwater rights						
LVVWD	40,629	40,404	40,629	40,629	40,629	40,629
North Las Vegas	1,236	4,876	4,919	5,250	5,250	5,250
Total	41,865	45,280	45,548	45,879	45,879	45,879
Pumpage of AR (AR recovery)						
LVVWD	156	0	3,500	7,000	7,000	3,500
North Las Vegas	0	0	0	0	0	0
Total	156	0	3,500	7,000	7,000	3,500
Total SNWA pumpage	42,021	45,280	49,048	52,879	52,879	49,379
Las Vegas Valley groundwater pumpers						
Nellis AFB (e)	838	900	869	869	869	869
Private/permitted wells (e)	25,055	24,750	24,903	24,903	24,903	24,903
Total	25,893	25,650	25,772	25,772	25,772	25,772
Total pumpage of GW rights	67,758	70,930	71,320	71,651	71,651	71,651
Total pumpage of GW rights and pumpage of AR (AR recovery)	67,914	70,930	74,820	78,651	78,651	75,151

NOTES

(a) Source(2011+): SNWA member.

(b) Source(2011-2012): Colorado River Commission. Source(2013+): average 2011-2012.

(c) Southern Nevada Water System and BMI System loss, see Appendix 4.

(d) Total pumpage includes direct customer usage and recovery of artificial recharge.

(e) Source(2011-2012): NV Division of Water Resources. Source(2013+): average 2011-2012.

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TABLE 5: SNWA PURVEYOR POTABLE USAGE (including artificial recharge) BY RESOURCE, numbers in acre-feet per year

	2011	2012	2013	2014	2015	2016	Resources Available
Purveyor potable usage (including artificial recharge) by resource							
Big Bend Water District							
Groundwater rights	0	0	0	0	0	0	0
Federal Delivery Contract (a)	0	0	0	0	0	0	0
SNWA Delivery Contract (b)	0	0	0	0	0	0	5,352
Other contracts	4,339	4,646	4,153	4,403	4,447	4,491	10,000
Short-term resource (c)	0	0	0	0	0	0	(c)
Total	4,339	4,646	4,153	4,403	4,447	4,491	
Boulder City							
Groundwater rights	0	0	0	0	0	0	0
Federal Delivery Contract (a)	8,918	8,918	8,918	8,918	8,918	8,918	8,918
SNWA Delivery Contract (b)	1,161	1,555	2,016	2,016	2,016	2,016	3,948
Other contracts (USBR)	0	0	0	0	0	0	5,876
Short-term resource (c)	0	0	0	0	0	0	(c)
Total	10,079	10,473	10,934	10,934	10,934	10,934	
Henderson							
Groundwater rights	0	0	0	0	0	0	0
Federal Delivery Contract (a)	27,021	27,021	27,021	27,021	27,021	27,021	27,021
SNWA Delivery Contract (b)	19,858	19,858	19,858	19,858	19,858	19,858	19,858
SNWA Delivery Contract (d)	2,138	2,138	2,138	2,138	2,138	2,138	2,138
Other contracts (BMI)	15,106	14,207	15,484	14,745	14,400	14,400	15,878
Short-term resource (c)	13,136	14,466	13,466	14,335	15,156	16,365	(c)
Total	77,258	77,689	77,967	78,096	78,572	79,781	
LVVWD (includes artificial recharge)							
Groundwater rights	40,629	40,404	40,629	40,629	40,629	40,629	40,629
Federal Delivery Contract (a)	232,426	232,426	232,426	232,426	232,426	232,426	232,426
SNWA Delivery Contract (b)	33,882	37,174	30,845	31,488	34,505	41,479	78,799
SNWA Delivery Contract (d)	0	0	0	0	0	0	363
Other contracts (15,407)	15,407	15,407	15,407	15,407	15,407	15,407	15,407
Short-term resource (c)	0	0	3,500	7,000	7,000	3,500	(c)
Total	322,344	325,411	322,807	326,950	329,967	333,441	
North Las Vegas (includes artificial recharge)							
Groundwater rights	1,236	4,876	4,919	5,250	5,250	5,250	6,201
Federal Delivery Contract (a)	26,635	26,635	26,635	26,635	26,635	26,635	26,635
SNWA Delivery Contract (b)	15,043	15,043	15,043	15,043	15,043	15,043	15,043
Other contracts	0	0	0	0	0	0	0
Short-term resource (c)	6,582	4,115	5,106	5,682	6,484	7,184	(c)
Total	49,496	50,669	51,703	52,610	53,412	54,112	
Total purveyor usage by water resource (includes artificial recharge)							
Groundwater	41,865	45,280	45,548	45,879	45,879	45,879	46,830
Colorado River water (includes artificial recharge)							
Federal Delivery Contract(a)	295,000	295,000	295,000	295,000	295,000	295,000	295,000
SNWA Delivery Contract (b)	69,944	73,630	67,762	68,405	71,422	78,396	123,000
SNWA Delivery Contract (d)	2,138	2,138	2,138	2,138	2,138	2,138	2,500
Other contracts	34,852	34,260	35,044	34,555	34,254	34,298	47,161
Short-term resource (c)	19,718	18,561	22,072	27,017	28,640	27,049	(c)
Total	421,651	423,608	422,015	427,114	431,453	436,880	
Total	463,516	468,888	467,563	472,993	477,332	482,759	

NOTES

(a) Section 8(b) water in the SNWA Cooperative Agreement (295,000 AFY).

(b) Section 8(c) water in the SNWA Cooperative Agreement. This estimate corresponds with Table 2.

(c) Includes any Section 8(b) or 8(c) water that is unused by another individual SNWA purveyor; also includes "short-term resource" described in Table 2.

(d) Section 8(d) water in the SNWA Cooperative Agreement.

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TABLE 6: WASTEWATER AND USE OF WASTEWATER, numbers in acre-feet per year (a)

Wastewater effluent	2011	2012	2013	2014	2015	2016
Las Vegas Valley						
BMI Discharge (b)	4,392	4,625	4,509	4,509	4,509	4,509
City of Las Vegas (c)	57,034	46,526	46,900	47,200	47,400	47,600
CCWRD: Las Vegas Valley	106,867	105,795	106,609	107,888	109,291	110,818
Henderson	22,561	22,350	22,383	22,515	22,760	23,121
North Las Vegas	9,816	18,427	18,676	18,863	19,050	19,236
Total	200,670	197,723	199,076	200,975	203,009	205,283
Boulder City	1,227	1,462	1,462	1,462	1,462	1,462
CCWRD: Laughlin	2,096	2,099	2,111	2,123	2,137	2,152
Total (LVV + BC + Laughlin)	203,993	201,284	202,649	204,560	206,608	208,897
Use of wastewater effluent						
Las Vegas Valley						
Direct reuse (reclaimed water)						
City of Las Vegas	4,688	4,256	3,500	4,500	5,000	5,500
CCWRD: Las Vegas Valley	5,620	6,048	5,715	5,784	5,859	5,938
Henderson	6,268	6,924	6,600	6,600	6,600	6,600
North Las Vegas	0	0	0	600	1,200	1,200
Total	16,576	17,228	15,815	17,484	18,659	19,238
Disposal to groundwater						
City of Las Vegas	0	0	0	0	0	0
CCWRD: Las Vegas Valley	0	0	0	0	0	0
Henderson	1,878	1,245	1,500	1,500	1,500	1,500
North Las Vegas	0	0	0	0	0	0
Total	1,878	1,245	1,500	1,500	1,500	1,500
Returns to surface water						
BMI Discharge	4,392	4,625	4,509	4,509	4,509	4,509
City of Las Vegas (c)	52,346	42,270	43,400	42,700	42,400	42,100
CCWRD: Las Vegas Valley	101,247	99,747	100,894	102,104	103,432	104,880
Henderson	14,415	14,181	14,283	14,415	14,660	15,021
North Las Vegas	9,816	18,427	18,676	18,263	17,850	18,036
Total	182,216	179,250	181,761	181,991	182,850	184,545
Boulder City (d)						
Direct reuse (reclaimed water)	146	263	263	263	263	263
Disposal to groundwater	1,081	1,199	1,199	1,199	1,199	1,199
Returns to surface water	0	0	0	0	0	0
CCWRD: Laughlin						
Direct reuse (reclaimed water)	0	0	0	0	0	0
Disposal to groundwater	0	0	0	0	0	0
Returns to surface water	2,096	2,099	2,111	2,123	2,137	2,152
Total direct reuse (reclaimed water)	16,722	17,491	16,078	17,747	18,922	19,501
Total Disposal to groundwater	2,959	2,444	2,699	2,699	2,699	2,699
Total returns to surface water	184,312	181,349	183,872	184,114	184,987	186,697
Wastewater used in return-flow credit calculation (returns to surface water + reuse) (e)						
Las Vegas Valley						
BMI Discharge	4,392	4,625	4,509	4,509	4,509	4,509
City of Las Vegas (c)	57,034	46,526	46,900	47,200	47,400	47,600
CCWRD: LVV	106,867	105,795	106,609	107,888	109,291	110,818
Henderson (f)	20,683	21,105	20,883	21,015	21,260	21,621
North Las Vegas (f)	9,816	18,427	18,676	18,863	19,050	19,236
Total	198,792	196,478	197,576	199,475	201,509	203,783

NOTES

(a) Source(2011+): SNWA member.

(b) Source(2011-2012): Colorado River Commission. Source(2013+): average 2011-2012.

(c) City of Las Vegas flows exclude dewatering flows to Las Vegas Wash at the Water Pollution Control Facility.

(d) Boulder City does not return to surface water.

(e) Consists of returns to surface water and direct reuse that could have been returned to surface water.

(f) Includes Henderson direct reuse and returns to surface water.

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TABLE 7: WASTEWATER REUSE AND REUSE THRESHOLD, numbers in acre-feet per year (a)

	2011	2012	2013	2014	2015	2016	Section 9 Threshold
1. Wastewater reuse by SNWA wastewater purveyor (a)							
Boulder City (b)	—	—	—	—	—	—	(b)
City of Las Vegas (c)	4,688	4,256	3,500	4,500	5,000	5,500	2,000
CCWRD:							
LVV (c)	5,620	6,048	5,715	5,784	5,859	5,938	10,550 (e)
Laughlin (d)	0	0	0	0	0	0	550 (e)
Total	5,620	6,048	5,715	5,784	5,859	5,938	11,100
Henderson	6,268	6,924	6,600	6,600	6,600	6,600	7,500
North Las Vegas	0	0	0	600	1,200	1,200	1,200
2. Wastewater reuse > Section 9(a) threshold (f)							
Boulder City (b)	—	—	—	—	—	—	(b)
City of Las Vegas	2,688	2,256	1,500	2,500	3,000	3,500	
CCWRD							
LVV	0	0	0	0	0	0	
Laughlin	0	0	0	0	0	0	
Total	0	0	0	0	0	0	
Henderson	0	0	0	0	0	0	
North Las Vegas	0	0	0	0	0	0	

3. If a purveyor reuses more than its 9(a) threshold, then its corresponding potable supply of 8(c) water (purveyor portion of 123,000 AFY) is reduced by an amount that will assure deliveries to other purveyors will not be less.(g)

Even though the reuse of some purveyors is projected to be greater than the quantified threshold, there is also projected to be potable water available such that all projected demands will be met. Therefore, no purveyor's potable supply has been reduced in the accompanying tables.

NOTES

(a) Source(2011+): SNWA member.

(b) Not applicable to Boulder City (Section 9c of SNWA Cooperative Agreement).

(c) In the LVVWD service area, LVVWD is the water provider. City of Las Vegas and CCWRD are the sewer services and reuse providers. If the City of Las Vegas and CCWRD combined reuse is greater than its combined threshold AND the other purveyors' deliveries are less as a result, then LVVWD's Section 8(c) potable resource is reduced correspondingly.

(d) In the Laughlin area, Big Bend Water District is the potable water provider and CCWRD is the sewer services and reuse provider. If CCWRD reuse is greater than its threshold AND the other purveyors' deliveries are less as a result, then Big Bend Water District's Section 8(c) potable resource is reduced correspondingly.

(e) In the SNWA Cooperative Agreement, there are no individual thresholds for CCWRD - LVV and CCWRD - Laughlin. Thresholds in this table are agreed to for planning purposes to determine whether the amount over the threshold comes out of LVVWD or Big Bend Water District.

(f) Source: Section 9 of the SNWA Cooperative Agreement.

(g) Source: Section 9(b) of the SNWA Cooperative Agreement as follows: "If in any year a Member uses or authorizes the use of Reuse Water in excess of the amounts specified in sub article 9(a) [refers to the purveyor portions of 21,800], then the allocation made by or pursuant to sub article 8(c) [123,000 AFY] to the Purveyor Member that serves such Member shall be reduced by an amount that will assure that deliveries to the other Purveyor Members of water (i) allocated to such other Purveyor Members by or pursuant to this Agreement, or (ii) to which such other Purveyor Members have a right pursuant to separate contracts with the United States will not be less than they would have been in the absence of such excess use of Reuse Water." In other words, if excess reuse causes a reduction in return-flow credits, which in turn causes a reduction in other purveyor's Colorado River supplies, the excess reuse quantity is subtracted from the potable purveyor in whose service area the reuse provider resides.

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TABLE 8: COLORADO RIVER DIVERSIONS, RETURN FLOW CREDITS AND CONSUMPTIVE USE IN NEVADA, in acre-feet per year

Colorado River diversions	2011	2012	2013	2014	2015	2016	Available Resources
SNWA Purveyor Members customer usage (includes recharge for current year banking operations) (a)							
Big Bend	4,339	4,646	4,153	4,403	4,447	4,491	
Boulder City	10,079	10,473	10,934	10,934	10,934	10,934	
Henderson	77,258	77,689	77,967	78,096	78,572	79,781	
LVVWD	278,954	285,007	278,678	279,321	282,338	289,312	
North Las Vegas	48,260	45,793	46,784	47,360	48,162	48,862	
Total	418,890	423,608	418,515	420,114	424,453	433,380	
SNWA Net Artificial Recharge (includes recharge for carryover banking operations and other recharge) (a) (l)							
LVVWD	2,761	0	0	0	0	0	
North Las Vegas	0	0	0	0	0	0	
Total	2,761	0	0	0	0	0	
SNWA Purveyor Members CR diversions (customer usage + artificial recharge)							
Big Bend	4,339	4,646	4,153	4,403	4,447	4,491	
Boulder City	10,079	10,473	10,934	10,934	10,934	10,934	
Henderson	77,258	77,689	77,967	78,096	78,572	79,781	
LVVWD	281,715	285,007	278,678	279,321	282,338	289,312	
North Las Vegas	48,260	45,793	46,784	47,360	48,162	48,862	
Total	421,651	423,608	418,515	420,114	424,453	433,380	
Usage (customer + AR)	421,651	423,608	418,515	420,114	424,453	433,380	
Total System Loss (b)	3,746	3,023	3,709	3,702	3,726	3,793	
TOTAL	425,397	426,631	422,224	423,816	428,179	437,173	
Other Colorado River Users (c) (d)							
BMI Complex (e)	5,585	5,288	5,437	5,437	5,437	5,437	8,208
Fort Mohave Indian Res. (e)	4,738	4,670	4,704	4,704	4,704	4,704	12,534
Nellis AFB (e)	1,129	1,075	1,102	1,102	1,102	1,102	4,000
LMNRA at Lake Mead (e) (f)	431	427	429	429	429	429	2,000
LMNRA at Lake Mohave (e) (f)	189	151	170	170	170	170	
Pabco (e)	607	864	736	736	736	736	928
Secretarial Reservation (e)	40	29	35	35	35	35	300
Southern Cal. Edison	97	0	0	0	0	0	(g)
Nev. Division of Wildlife (e) (h)	220	244	232	232	232	232	
Small water users (e)	4	3	4	4	4	4	
TOTAL	13,040	12,751	12,849	12,849	12,849	12,849	
Total Nevada diversions	438,437	439,382	435,073	436,665	441,028	450,022	
Nevada Return flow credits							
Las Vegas Valley (c) (i)	211,693	198,299	200,835	201,257	202,277	204,174	
Laughlin (a) (c)	2,096	2,099	2,111	2,123	2,137	2,152	
Secretarial Reservation (c) (e)	28	22	25	25	25	25	
Nev. Division of Wildlife (c) (h)	208	234	221	221	221	221	
Unmeasured Returns (c) (j)	1,563	1,542	1,568	1,568	1,568	1,568	
TOTAL	215,588	202,196	204,760	205,194	206,228	208,140	
Nevada Consumptive use							
Consumptive use with AR (k)	222,849	237,186	230,313	231,471	234,799	241,882	
Net Artificial Recharge (l)	2,761	0	0	0	0	0	
Consumptive use no AR	220,088	237,186	230,313	231,471	234,799	241,882	

NOTES

(a) Source: SNWA members, see Table 3 and Table 6.
(b) From Appendix 4.
(c) Source(2011-2012): Bureau of Reclamation.
(d) Available resource assumed as consumptive use.
(e) Source(2013+): average 2011 to 2012.
(f) Lake Mead National Recreation Area (LMNRA).
(g) Terminated water supply agreement in 2011.
(h) Available resource is a consumptive use amount of 25 AFY.
(i) Source(2013+): Appendix 1, line 18.
(j) Source(2013+): one-third of Ft. Mojave Indian Res. use above.
(k) Excludes interstate banking.
(l) Total recharge less recovery, excludes in-lieu recharge.

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APPENDIX 1: RETURN FLOW CREDITS (U.S. Bureau of Reclamation method) AND NEVADA CONSUMPTIVE USE CALCULATIONS ADJUSTED FOR ICS AND INTERSTATE BANKING, numbers in acre-feet per year

CALCULATION OF DIVERSIONS AND RETURN FLOW CREDITS	2011	2012	2013	2014	2015	2016
ABOVE HOOVER DAM						
1. Total Colorado River Water Diverted Above Hoover Dam	429,070	429,912	426,042	427,384	431,703	440,653
2. Gauged Flow of Las Vegas Wash below Lake Las Vegas (USGS Station No. 09419800)	213,778	212,478	205,798	206,219	207,240	209,136
3. Precipitation Runoff (Estimated)	3,085	15,179	5,962	5,962	5,962	5,962
4. Imported Groundwater and Surface Water	0	0	0	0	0	0
5. 2% of Imported Groundwater and Surface Water	0	0	0	0	0	0
6. Effluent Reaching LM From the LV Valley M&I Groundwater Pumping (a)	0	0	0	0	0	0
7. Total Las Vegas Wash Adjusted Gauge Flow (2-3-5-6)	210,693	197,299	199,835	200,257	201,277	203,174
8. Total Other Nevada Flow to Lake Mead Above Hoover Dam	236	256	246	246	246	246
9. Colorado River Bypassing Gauge, less Phreatophyte Use below Gauge (a)	1,000	1,000	1,000	1,000	1,000	1,000
10. Total Flow to Colorado River Above Hoover Dam (7+8+9)	211,929	198,555	201,081	201,503	202,523	204,420
11. Consumptive Use Above Hoover Dam (1-10)	217,141	231,357	224,961	225,881	229,179	236,233
BELOW HOOVER DAM						
12. Total Colorado River Water Diverted Below Hoover Dam	9,367	9,470	9,031	9,281	9,325	9,369
13. Total Flow to Colorado River Below Hoover Dam	3,659	3,641	3,679	3,691	3,705	3,720
14. Consumptive Use Below Hoover Dam (12-13)	5,708	5,829	5,352	5,590	5,620	5,649
SUMMARY						
15. Total Nevada Diversions from Colorado River (1+12)	438,437	439,382	435,073	436,665	441,028	450,022
16. Total Nevada Return Flow Credit (10+13)	215,588	202,196	204,760	205,194	206,228	208,140
17. Total Nevada Consumptive Use Before Interstate Banking (15-16) (b)	222,849	237,186	230,313	231,471	234,799	241,882
18. Total Las Vegas Valley Return Flow Credit (7+9)	211,693	198,299	200,835	201,257	202,277	204,174
NEVADA CONSUMPTIVE USE CALCULATIONS ADJUSTED FOR ICS AND INTERSTATE BANKING						
19. Nevada Basic Apportionment	300,000	300,000	300,000	300,000	300,000	300,000
20. Total Volume of ICS Created (b)	32,025	33,573	29,300	25,800	14,900	14,900
21. Overrun Payback	0	0	0	0	0	0
22. ICS Delivery	0	1,000	0	0	0	0
23. ICS volume banked in Lake Mead (20-21-22) (c)	(32,025)	(32,573)	(29,300)	(25,800)	(14,900)	(14,900)
24. Resources available for Consumptive Use (19+20-21+23)	300,000	301,000	300,000	300,000	300,000	300,000
25. Total Nevada Consumptive Use (d)	222,849	237,186	230,313	231,471	234,799	241,882
26. Resources available for Interstate Banking / Colorado River System Benefit (24-22-25)	77,151	62,814	69,687	68,529	65,201	58,118
27. Nevada Underrun/(Overrun) (24-22-25-26) (d)	0	0	0	0	0	0

NOTES

(a) If Las Vegas Valley M&I Groundwater rights exceed 47,340, then lines 6 and 9 above will be recalculated based on the method approved by the USBR as referenced in a letter dated December 5, 2007.

(b) Total Verified Tributary Conservation ICS and Imported ICS after 5 percent deduction for system benefit.

(c) SNWA plans to store between 15,000 and 30,000 acre-feet of ICS credits between 2013 and 2016.

(d) May be subject to final USBR accounting.

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APPENDIX 2: PROJECTION OF ACCRUALS AND GAUGE FLOWS (used in calculation of return flow credits), numbers in acre-feet per year

ASSUME GAUGE FLOWS = EFFLUENT TO WASH + STORMWATER + ACCRUALS

1. Estimate accruals	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
(Accruals = Gauge Flows - Effluent to Wash - Stormwater)																			
a. Measured Wash flow at gauge (a)	132,099	143,496	146,017	170,514	170,329	170,585	160,246	173,235	173,302	193,412	203,195	218,115	219,972	213,163	206,609	206,377	215,501	213,778	212,478
b. Effluent to Wash (b)	(123,040)	(127,434)	(132,245)	(143,025)	(145,770)	(149,781)	(155,174)	(159,337)	(160,811)	(169,754)	(177,312)	(186,468)	(187,816)	(188,569)	(187,791)	(185,709)	(184,871)	(182,216)	(179,250)
c. Stormwater (e)	(2,155)	(3,898)	(1,429)	(8,696)	(11,357)	(5,405)	(2,746)	(2,959)	(1,410)	(7,049)	(14,377)	(15,369)	(1,761)	(2,829)	(1,678)	(1,910)	(9,993)	(3,085)	(15,179)
d. Total (accruals) (c)	6,904	12,166	12,343	18,793	13,202	15,399	2,326	10,939	11,081	16,609	11,506	16,278	30,395	21,765	17,140	18,758	20,637	28,477	18,049
2. Calculate ratio of accruals/LVV customer usage																			
a. Accruals	6,904	12,166	12,343	18,793	13,202	15,399	2,326	10,939	11,081	16,609	11,506	16,278	30,395	21,765	17,140	18,758	20,637	28,477	18,049
b. Total LVV customer usage (b)																			
1. LVV customer usage (d)	373,396	377,699	413,741	415,082	412,450	452,639	480,652	503,977	519,685	497,726	490,346	499,109	532,335	540,446	515,624	502,337	484,813	478,569	485,782
2. SNWS system loss	2,206	2,452	4,772	11,066	2,691	5,675	8,287	1,744	11,648	2,593	8,950	12,813	6,969	5,330	6,001	3,484	3,254	3,056	2,024
3. Total	375,602	380,151	418,513	426,148	415,141	458,314	488,939	505,721	531,333	500,319	499,296	511,922	539,304	545,776	521,625	505,821	488,067	481,625	487,806
c. Accruals/Total LVV usage (%)	1.84%	3.20%	2.95%	4.41%	3.18%	3.38%	0.48%	2.16%	2.09%	3.32%	2.30%	3.18%	5.64%	3.99%	3.29%	3.71%	4.23%	5.91%	3.70%
3. Calculate median accruals/Total LVV usage (e)	3.71%																		

4. Project future accruals	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
a. Total LVV usage (b)																							
1. LVV usage (d)																				484,787	489,967	494,282	499,645
2. SNWS system loss																				3,040	3,056	3,091	3,158
3. Total																				487,827	493,023	497,353	502,803
3.71% * Total LVV usage																				18,074	18,266	18,427	18,629

5. Project future gauge flows	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2012	2013	2014	2015
(Gauge flows = Effluent to Wash + Stormwater + Accruals)																							
a. Effluent to Wash (b)																				181,761	181,991	182,850	184,545
b. Stormwater (average of 1994 - 2012)																				5,962	5,962	5,962	5,962
c. Accruals																				18,074	18,266	18,427	18,629
d. Estimated Wash flows at gauge																				205,798	206,219	207,240	209,136
6. Measured and estimated gauge flows	132,099	143,496	146,017	170,514	170,329	170,585	160,246	173,235	173,302	193,412	203,195	218,115	219,972	213,163	206,609	206,377	215,501	213,778	212,478	205,798	206,219	207,240	209,136

NOTES
(a) Source(1994 - 2001): U.S. Geologic Survey, "Water Resources Data Nevada". Source(2002 -2012): data reflected in the Year End Return Flow Credit Data (Colorado River Commission.)
(b) From Appendix 3.
(c) Accruals calculations and projections adjusted to correspond with Las Vegas Valley Return Flow Methodology adopted December 5, 2007.
(d) Includes recovery of artificial recharge (AR recovery)
(e) Median corresponds with the period 2003-2012, and the establishment of the current location of the gage at Las Vegas Wash below Lake Las Vegas on June 28, 2002.

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APPENDIX 3: LAS VEGAS VALLEY WATER USAGE AND WASTEWATER FLOWS (used in calculation of return flow credits), numbers in acre-feet per year

Las Vegas Valley customer usage	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Resources Available
Colorado River customer diversion (no AR; no AR recovery)(a)																								
SNWA Purveyor Members																								
Henderson	42,033	42,676	52,247	48,982	55,256	63,305	67,248	73,832	79,187	73,833	73,986	76,039	83,401	85,576	79,641	80,748	77,835	77,258	77,689	77,987	78,096	78,572	79,781	
LVVWD	223,298	223,682	244,824	249,210	243,140	272,749	294,109	304,368	313,091	297,111	288,216	305,349	320,495	319,644	304,945	292,845	283,514	278,423	285,007	278,678	279,321	282,338	289,312	
North Las Vegas	29,503	30,704	32,523	31,527	32,151	35,889	38,198	39,430	41,264	43,984	45,473	47,389	52,606	55,812	52,438	51,203	50,270	48,260	45,793	46,784	47,360	48,162	48,862	
Total	294,834	297,062	329,594	329,719	330,547	371,943	399,555	417,630	433,542	414,928	407,675	428,777	456,502	461,032	437,024	424,596	411,619	403,941	408,489	403,429	404,777	409,072	417,955	
Other Las Vegas Valley Users																								
BMI Complex (b)	6,496	5,064	4,988	6,730	6,339	5,469	5,286	5,210	5,372	5,332	5,861	5,820	6,184	5,696	5,946	5,355	5,079	5,585	5,288	5,437	5,437	5,437	5,437	
Nellis AFB (b)	3,193	3,015	3,251	2,781	2,525	2,248	2,206	1,760	2,410	1,993	1,787	2,271	2,118	2,873	2,107	1,672	1,371	1,129	1,075	1,102	1,102	1,102	1,102	
Total	9,689	8,099	8,239	9,511	8,864	7,737	7,492	6,970	7,782	7,325	7,648	8,091	8,302	8,569	8,055	7,027	6,450	6,714	6,363	6,539	6,539	6,539	6,539	
Total System Loss	2,816	3,043	5,439	11,698	2,691	5,763	6,896	2,194	11,625	2,721	9,144	13,401	7,067	5,831	6,166	3,972	3,818	3,746	3,023	3,709	3,702	3,726	3,793	
Total	307,339	308,204	343,272	350,928	342,102	385,443	413,943	426,794	453,149	424,974	424,467	450,269	471,871	475,432	451,245	435,595	421,887	414,401	417,875	413,678	415,018	419,337	428,287	
Pumpage of Artificial Recharge Recovery (c)																								
SNWA Purveyor Members																								
LVVWD	0	2,473	1,596	164	0	0	0	494	1,092	1	265	0	0	303	42	11	0	156	0	3,500	7,000	7,000	3,500	
North Las Vegas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	0	2,473	1,596	164	0	0	0	494	1,092	1	265	0	0	303	42	11	0	156	0	3,500	7,000	7,000	3,500	
Groundwater Usage																								
SNWA Purveyor Members (a)																								
LVVWD	37,907	40,247	39,947	40,152	39,857	39,028	38,255	40,128	40,126	40,126	40,612	31,661	35,845	40,629	40,629	40,629	39,208	40,629	40,404	40,629	40,629	40,629	40,629	40,629
North Las Vegas	2,569	3,345	5,669	5,614	5,687	4,135	5,226	5,449	5,586	4,878	2,398	1,694	1,355	749	1,725	1,511	633	1,236	4,876	4,919	5,250	5,250	5,250	6,201
Total	40,476	43,592	45,616	45,766	45,544	43,163	43,481	45,575	45,712	45,004	43,010	33,355	37,200	41,376	42,354	42,140	39,841	41,865	45,280	45,548	45,879	45,879	45,879	46,830
Other Las Vegas Valley Users																								
Nellis AFB (b)	920	815	1,019	1,144	1,005	1,530	2,083	2,367	2,206	1,955	1,816	1,242	1,151	1,399	657	907	927	838	900	869	869	869	869	2,950
Private/Permitted Wells (d)	27,477	25,658	27,677	28,778	26,490	28,266	28,041	30,941	29,351	28,513	29,932	27,844	29,180	27,765	27,492	27,656	25,976	25,055	24,750	24,903	24,903	24,903	24,903	
Total	28,397	26,473	28,696	29,922	27,495	29,796	30,124	33,308	31,557	30,468	31,748	29,086	30,331	29,164	28,149	28,563	26,903	25,893	25,650	25,772	25,772	25,772	25,772	
Total	68,873	70,065	74,312	75,688	73,039	72,959	73,605	78,883	77,269	75,472	74,758	62,241	67,531	70,542	70,503	70,703	66,744	67,758	70,930	71,320	71,651	71,651	71,651	
Las Vegas Valley Total Usage (includes recovery) (including system loss)	376,212	380,742	419,180	426,780	415,141	458,402	487,548	506,171	531,510	500,447	499,490	512,510	539,402	546,277	521,790	506,309	488,631	482,315	488,805	488,496	493,669	497,988	503,438	
Las Vegas Valley Total Usage (includes recovery) (Excluding system loss)	373,396	377,699	413,741	415,082	412,450	452,639	480,652	503,977	519,685	497,726	490,346	499,109	532,335	540,446	515,624	502,337	484,613	478,569	485,782	484,787	489,967	494,262	499,645	
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
LVV wastewater flow to Wash																								
Influent (e)	129,824	135,827	142,188	154,001	159,974	164,750	173,371	177,543	182,902	191,165	200,460	210,945	213,164	215,138	211,547	203,899	201,843	198,792	198,478	197,578	199,475	201,509	203,783	
Reuse (f)	6,784	8,393	9,943	10,976	14,204	14,969	18,197	18,206	22,091	21,411	23,148	24,477	25,348	26,569	23,756	16,190	16,972	16,576	17,228	15,815	17,484	18,659	19,238	
Effluent to Wash (influent - effluent)	123,040	127,434	132,245	143,025	145,770	149,781	155,174	159,337	160,811	169,754	177,312	186,468	187,816	188,569	187,791	185,709	184,871	182,216	179,250	181,761	181,991	182,850	184,545	

NOTES
(a) Source(1994 - 2012): actual; Source(2013+): SNWA Member.
(b) Source(1994 - 2012): actual; Source(2013+): Table 8.
(c) Includes recovery for banking operations and for purveyor members.
(d) Source(1994 - 2012): Nevada Division of Water Resources. Source(2013+): Table 4.
(e) Includes Henderson returns to the Colorado River, Henderson reuse, and BMI discharges to the wash beginning in 1994.
(f) Includes Henderson reuse beginning in 1994

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APPENDIX 4: COLORADO RIVER USAGE (CUSTOMER + AR) BY SYSTEM AND ESTIMATES OF SNWS SYSTEM LOSS, numbers in acre-feet per year

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Colorado River diversions by system (includes AR, but no AR recovery)(a)																							
Big Bend Water District	4,833	5,286	5,315	5,034	4,970	5,162	5,232	5,268	5,325	5,315	4,922	4,639	4,914	4,653	4,433	4,423	4,345	4,339	4,646	4,153	4,403	4,447	4,491
Boulder City																							
SNWS	7,325	7,327	8,098	7,708	7,670	8,858	10,616	10,168	13,346	12,254	11,013	10,130	11,406	11,302	11,369	10,980	10,663	10,079	10,473	10,934	10,934	10,934	10,934
USBR system	246	280	279	171	132	179	223	434	950	23	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	7,571	7,607	8,377	7,879	7,802	9,037	10,839	10,602	14,296	12,277	11,013	10,130	11,406	11,302	11,369	10,980	10,663	10,079	10,473	10,934	10,934	10,934	10,934
Henderson																							
SNWS	29,467	29,280	36,405	35,969	40,973	51,691	53,494	61,493	66,158	64,100	61,017	63,469	68,618	71,326	63,279	65,309	64,654	62,152	63,482	62,482	63,351	64,172	65,381
BMI system	12,566	13,396	15,842	13,013	14,283	11,614	13,754	12,339	13,029	9,733	12,969	12,570	14,783	14,250	16,362	15,439	13,281	15,106	14,207	15,484	14,745	14,400	14,400
Total	42,033	42,676	52,247	48,982	55,256	63,305	67,248	73,832	79,187	73,833	73,986	76,039	83,401	85,576	79,641	80,748	77,935	77,258	77,689	77,967	78,096	78,572	79,781
LVVWD (SNWS)	243,418	240,343	256,829	267,001	270,286	304,810	323,830	325,637	315,345	325,651	305,332	321,217	340,471	337,659	309,990	292,736	292,306	281,715	285,007	278,678	279,321	282,336	289,312
North Las Vegas (SNWS)	31,283	33,215	33,982	32,661	32,568	36,189	38,262	39,537	41,264	44,151	45,473	47,389	52,606	55,812	52,438	51,203	50,270	48,260	45,793	46,784	47,360	48,162	48,862
Systems with multiple users																							
BMI System:																							
Henderson	12,566	13,396	15,842	13,013	14,283	11,614	13,754	12,339	13,029	9,733	12,969	12,570	14,783	14,250	16,362	15,439	13,281	15,106	14,207	15,484	14,745	14,400	14,400
BMI Complex	6,496	5,084	4,988	6,730	6,339	5,489	5,286	5,210	5,372	5,332	5,861	5,820	6,184	5,696	5,948	5,355	5,079	5,585	5,288	5,437	5,437	5,437	5,437
Total	19,062	18,480	20,830	19,743	20,622	17,103	19,040	17,549	18,401	15,065	18,830	18,390	20,967	19,946	22,310	20,794	18,360	20,691	19,495	20,921	20,182	19,837	19,837
Southern Nevada Water System (at turnouts)																							
Boulder City	7,325	7,327	8,098	7,708	7,670	8,858	10,616	10,168	13,346	12,254	11,013	10,130	11,406	11,302	11,369	10,980	10,663	10,079	10,473	10,934	10,934	10,934	10,934
Henderson	29,467	29,280	36,405	35,969	40,973	51,691	53,494	61,493	66,158	64,100	61,017	63,469	68,618	71,326	63,279	65,309	64,654	62,152	63,482	62,482	63,351	64,172	65,381
LVVWD	243,418	240,343	256,829	267,001	270,286	304,810	323,830	325,637	315,345	325,651	305,332	321,217	340,471	337,659	309,990	292,736	292,306	281,715	285,007	278,678	279,321	282,336	289,312
Nellis AFB	3,193	3,015	3,251	2,781	2,525	2,248	2,205	1,760	2,410	1,993	1,787	2,271	2,118	2,873	2,107	1,672	1,371	1,129	1,075	1,102	1,102	1,102	1,102
North Las Vegas	31,283	33,215	33,982	32,661	32,568	36,189	38,262	39,537	41,264	44,151	45,473	47,389	52,606	55,812	52,438	51,203	50,270	48,260	45,793	46,784	47,360	48,162	48,862
Total	314,686	313,180	338,565	346,120	354,022	403,796	428,408	438,595	438,523	448,149	424,622	444,476	475,219	478,972	439,183	421,900	419,164	403,335	405,830	399,980	402,068	406,708	415,591
Estimate of BMI system loss																							
1. BMI diversions at intake (b)	18,615	18,466	20,830	19,743	20,828	17,191	18,353	17,999	18,578	15,193	19,024	18,393	21,065	20,447	22,475	21,282	18,924	21,381	20,494				
2. BMI diversions at turnout	19,062	18,480	20,830	19,743	20,622	17,103	19,040	17,549	18,401	15,065	18,830	18,390	20,967	19,946	22,310	20,794	18,360	20,691	19,495				
3. System loss (intake-turnout)(c)	-447	6	0	0	206	88	-687	450	177	128	194	3	98	501	165	488	564	690	999				
4. System loss percentage (%): (system loss/diversion at turnout)	(c)	(c)	(c)	(c)	1.00%	0.51%	(c)	2.56%	0.96%	0.85%	1.03%	(c)	0.47%	2.51%	0.74%	2.35%	3.07%	3.33%	5.12%				
5. Median of reasonable system loss %(c)																			3.20%				
6. Replace unreasonable system loss figures and project (* BMI diversions at turnout) (3.20% * BMI div.at turnout)	610	591	667	632	660	88	609	450	177	128	194	588	98	501	165	488	564	690	999	669	646	635	635
Estimate of SNWS system loss																							
1. SNWS diversions at intake (b)	316,892	315,632	343,337	357,186	353,067	409,471	434,695	440,339	450,171	450,742	433,572	457,289	482,188	484,302	445,184	425,384	422,416	406,391	407,854				
2. SNWS diversions at turnout	314,686	313,180	338,565	346,120	354,022	403,796	428,408	438,595	438,523	448,149	424,622	444,476	475,219	478,972	439,183	421,900	419,164	403,335	405,830				
3. System loss (intake-turnout)(c)	2,206	2,452	4,772	11,066	(955)	5,675	6,287	1,744	11,648	2,593	8,950	12,813	6,969	5,330	6,001	3,484	3,254	3,056	2,024				
4. System loss percentage (%): (system loss/diversion at turnout)	0.70%	0.78%	1.41%	3.20%	(c)	1.41%	1.47%	0.40%	2.66%	0.58%	2.11%	2.88%	1.47%	1.11%	1.37%	0.83%	0.78%	0.76%	0.50%				
5. Median of reasonable system loss %(c)																			0.76%				
6. Replace unreasonable system loss figures and project (* SNWS diversions at turnout) (0.76% * SNWS div.at turnout)	2,206	2,452	4,772	11,066	2,691	5,675	6,287	1,744	11,648	2,593	8,950	12,813	6,969	5,330	6,001	3,484	3,254	3,056	2,024	3,040	3,056	3,091	3,158
Estimate of Total system loss	2,816	3,043	5,439	11,698	3,351	5,763	6,896	2,194	11,825	2,721	9,144	13,401	7,067	5,831	6,166	3,972	3,818	3,746	3,023	3,709	3,702	3,726	3,793

NOTES

(a) Includes artificial recharge (AR) which is part of the Colorado River diversion; does not include recovery of artificial recharge (AR recovery) which is not a diversion.

(b) Source: "Colorado River Water Diverted for Use in Southern Nevada," CRC internal spreadsheets.

(c) System loss is estimated by subtracting turnout meter reading from intake meter reading. Because of meter imprecision, system loss figures are sometimes unreasonable, i.e., negative numbers or very small numbers.

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: SNWS Operating Plan	**Director's Backup**
Petitioner: David L. Johnson, Deputy General Manager, Engineering/Operations	
Recommendations: That the Board of Directors adopt the Annual Operating Plan for the Southern Nevada Water System.	

Fiscal Impact:
None by approval of the above recommendation.

Background:
The Southern Nevada Water System (SNWS) Facilities and Operations Agreement (F&O Agreement) among the Authority and its purveyor members receiving water through the SNWS (SNWS Purveyors) requires the Authority to maintain in effect and revise at least annually an Operating Plan (Plan) for the SNWS. The attached Plan is for the period of January 1, 2015, through December 31, 2017, and represents the joint effort of the SNWS Purveyors and SNWS operating staff.

The Plan is designed to establish key operational parameters for the SNWS that will meet each SNWS Purveyor's water needs. The Plan includes, on a monthly basis, the maximum and average daily flows requested by the SNWS Purveyors to be delivered at their respective turnouts, target levels of chlorine, and target hydraulic grade lines.

The Plan has been reviewed and approved by the SNWS Work Group, established as a requirement of the F&O Agreement and consisting of one representative of the Authority, one for each SNWS Purveyor, and one for each non-Purveyor contract user receiving delivery of water through SNWS, currently Nellis Air Force Base.

This action is authorized pursuant to Section 3.1 of the Authority's 2012 Amended Facilities and Operations Agreement. The office of the General Counsel has reviewed and approved this agenda item.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DLJ:MRJ:GLN:VK:dc
Attachment

AGENDA ITEM # 14

ANNUAL OPERATING PLAN
FOR THE
SOUTHERN NEVADA WATER SYSTEM

The Annual Operating Plan for the Southern Nevada Water System (SNWS) covers the period of **January 1, 2015** through **December 31, 2017**. This Plan represents the purveyors' best estimate of projected water demands for the duration of the Plan under normal operating conditions. The Southern Nevada Water Authority (SNWA) expects to supply water to meet these purveyor demands at the desired chlorine concentrations and hydraulic grade lines.

MAXIMUM AND AVERAGE FLOWS

The enclosed tabulations present the maximum and average daily flows requested by the purveyors by month for each turnout for the calendar years **2015, 2016,** and **2017**. The maximum and average daily flows requested are within the capacity of the system.

CHLORINE CONCENTRATIONS

Also included in the tabulations are the purveyors' requested chlorine concentrations for each turnout. SNWA expects to meet these requested chlorine residuals at each turnout.

HYDRAULIC GRADE LINES

The tabulations also include the purveyors' requested hydraulic grade lines for each turnout. SNWA expects to meet these requested hydraulic grade lines at each turnout.

CURRENT SYSTEM CAPACITY

The current maximum treatment capacity of the Alfred Merritt Smith Water Treatment Facility (AMSWTF) is 600 million gallons per day (MGD). The River Mountains Water Treatment Facility (RMWTF) capacity is 400 MGD, creating a combined treatment capacity for the SNWS of 1,000 MGD. The high lift pumping system that delivers potable water from AMSWTF has a nominal capacity of 580 MGD. The River Mountains Pumping Station that delivers potable water from RMWTF has a nominal capacity of 300 MGD, creating a combined potable water delivery to the Las Vegas Valley of 880 MGD. Pumping Station 1A that delivers potable water from AMSWTF to Boulder City has a nominal capacity of 20 MGD.

2015 - 2017 Annual Water Flow Projections

SUMMARY

MONTH	LVVWD Flow (MGD) Avg	LVVWD Flow (MGD) Max	COH Flow (MGD) Avg	COH Flow (MGD) Max	NLV Flow (MGD) Avg	NLV Flow (MGD) Max	BC Flow (MGD) Avg	BC Flow (MGD) Max	NELLIS Flow (MGD) Avg	NELLIS Flow (MGD) Max	TOTAL Flow (MGD) Avg	TOTAL Flow (MGD) Max
Jan	184	204	36.0	52.5	27	33	5.3	9.7	0.9	1.7	253.1	301.1
Feb	189	210	36.5	53.5	29	42	5.3	9.1	1.1	2.3	261.0	316.9
Mar	238	272	45.0	63.5	35	46	8.4	13.3	1.7	2.3	328.0	396.5
Apr	281	320	51.0	71.0	37	43	10.7	17.2	1.8	2.4	381.5	453.5
May	325	361	69.5	88.5	44	52	13.0	20.2	2.0	2.8	453.5	524.8
Jun	295	330	84.0	101.0	54	62	14.2	20.7	2.3	3.0	449.5	516.2
Jul	316	340	91.0	107.0	62	68	16.2	22.2	3.0	3.9	**488.2**	**541.3**
Aug	308	337	91.0	107.0	60	67	15.2	21.6	2.6	3.9	476.8	536.7
Sep	251	301	71.0	88.0	53	60	15.0	23.7	2.2	3.5	392.2	476.6
Oct	294	340	58.0	75.0	40	47	12.3	18.0	1.4	2.0	405.7	481.8
Nov	239	285	42.0	61.5	32	38	8.2	15.5	0.9	2.0	322.1	402.1
Dec	203	228	35.0	52.0	28	33	5.0	9.4	0.9	1.9	271.9	324.1

2015

MONTH	LVVWD Flow (MGD) Avg	LVVWD Flow (MGD) Max	COH Flow (MGD) Avg	COH Flow (MGD) Max	NLV Flow (MGD) Avg	NLV Flow (MGD) Max	BC Flow (MGD) Avg	BC Flow (MGD) Max	NELLIS Flow (MGD) Avg	NELLIS Flow (MGD) Max	TOTAL Flow (MGD) Avg	TOTAL Flow (MGD) Max
Jan	204	225	42.0	60.0	28	34	5.3	9.7	0.9	1.7	280.1	330.8
Feb	207	227	42.0	61.0	31	45	5.3	9.1	1.1	2.3	286.5	344.3
Mar	249	283	51.5	69.5	35	46	8.4	13.3	1.7	2.3	345.5	413.5
Apr	286	325	58.0	77.0	37	43	10.7	17.2	1.8	2.4	393.5	464.5
May	330	367	75.5	96.5	46	55	13.0	20.2	2.0	2.8	466.5	541.2
Jun	302	337	88.5	108.5	54	62	14.2	20.7	2.3	3.0	461.0	530.7
Jul	323	347	97.0	114.5	62	68	16.2	22.2	3.0	3.9	**501.2**	**555.8**
Aug	315	344	97.0	114.5	61	68	15.2	21.6	2.6	3.9	490.8	552.4
Sep	257	308	79.0	96.0	53	60	15.0	23.7	2.2	3.5	406.2	491.6
Oct	299	345	64.5	81.0	40	47	12.3	18.0	1.4	2.0	417.2	492.8
Nov	243	289	50.5	69.0	32	38	8.2	15.5	0.9	2.0	334.6	413.6
Dec	206	231	42.0	59.5	28	33	5.0	9.4	0.9	1.9	281.9	334.6

2016

MONTH	LVVWD Flow (MGD) Avg	LVVWD Flow (MGD) Max	COH Flow (MGD) Avg	COH Flow (MGD) Max	NLV Flow (MGD) Avg	NLV Flow (MGD) Max	BC Flow (MGD) Avg	BC Flow (MGD) Max	NELLIS Flow (MGD) Avg	NELLIS Flow (MGD) Max	TOTAL Flow (MGD) Avg	TOTAL Flow (MGD) Max
Jan	208	228	44.5	61.5	28	34	4.3	8.0	0.9	1.7	285.7	333.7
Feb	210	231	44.5	62.5	32	46	4.2	7.3	1.1	2.3	291.9	349.5
Mar	253	288	53.5	72.0	35	46	7.4	11.8	1.7	2.3	350.6	419.5
Apr	290	330	58.5	80.0	37	43	9.7	15.5	1.8	2.4	397.0	470.9
May	336	373	78.0	99.0	47	56	12.0	18.8	2.0	2.8	475.0	549.5
Jun	308	344	90.0	110.5	55	63	13.2	19.4	2.3	3.0	468.5	539.6
Jul	330	354	100.0	117.5	63	69	15.2	20.9	3.0	3.9	**511.1**	**565.6**
Aug	321	351	100.0	117.5	61	68	14.2	20.2	2.6	3.9	498.8	561.0
Sep	262	314	81.5	99.5	55	63	14.0	22.2	2.2	3.5	414.7	501.9
Oct	304	350	66.5	84.0	41	48	11.3	16.5	1.4	2.0	424.2	500.5
Nov	247	294	52.0	70.0	32	38	7.2	13.7	0.9	2.0	339.1	417.8
Dec	209	235	44.0	61.0	28	33	4.0	7.8	0.9	1.9	285.9	338.4

2017

2015 - Annual Water Flow Projections

LAS VEGAS VALLEY WATER DISTRICT

	CAMPBELL					STEWART					FAYLE *					LINDEN	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	16	18	1835.9	1846	1	10	12	1973.5	1987.5	1	37	38	2175.3	2187.3	1	0	0
Feb	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	40	41	2175.3	2187.3	1	0	0
Mar	26	29	1835.9	1846	1	11	15	1973.5	1987.5	1	43	49	2175.3	2187.3	1	0	0
Apr	34	41	1835.9	1846	1	13	18	1973.5	1987.5	1	49	52	2175.3	2187.3	1	0	0
May	39	43	1835.9	1846	1	14	15	1973.5	1987.5	1	51	52	2175.3	2187.3	1	0	0
Jun	36	42	1835.9	1846	1	17	18	1973.5	1987.5	1	52	58	2175.3	2187.3	1	0	0
Jul	44	49	1835.9	1846	1	17	18	1973.5	1987.5	1	53	55	2175.3	2187.3	1	0	0
Aug	44	49	1835.9	1846	1	17	18	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Sep	36	46	1835.9	1846	1	13	17	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Oct	32	39	1835.9	1846	1	12	16	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Nov	18	19	1835.9	1846	1	11	14	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Dec	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0

	BROADBENT					CHARLESTON HEIGHTS					CARLTON SQUARE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	16	18	2182.6	2190.8	1	9	11	2154.7	2161.7	1	8	9	2207.7	2220	1
Feb	16	18	2182.6	2190.8	1	9	11	2154.7	2161.7	1	9	10	2207.7	2220	1
Mar	17	21	2182.6	2190.8	1	14	15	2154.7	2161.7	1	12	14	2207.7	2220	1
Apr	18	24	2182.6	2190.8	1	19	19	2154.7	2161.7	1	15	19	2207.7	2220	1
May	28	31	2182.6	2190.8	1	14	14	2154.7	2161.7	1	20	22	2207.7	2220	1
Jun	23	31	2182.6	2190.8	1	0	0	2154.7	2161.7	1	11	12	2207.7	2220	1
Jul	30	33	2182.6	2190.8	1	0	0	2154.7	2161.7	1	12	13	2207.7	2220	1
Aug	55	60	2182.6	2190.8	1	0	0	2154.7	2161.7	1	16	19	2207.7	2220	1
Sep	46	56	2182.6	2190.8	1	0	0	2154.7	2161.7	1	14	17	2207.7	2220	1
Oct	63	72	2182.6	2190.8	1	11	14	2154.7	2161.7	1	22	26	2207.7	2220	1
Nov	50	60	2182.6	2190.8	1	9	11	2154.7	2161.7	1	16	18	2207.7	2220	1
Dec	43	45	2182.6	2190.8	1	8	10	2154.7	2161.7	1	13	15	2207.7	2220	1

	DECATUR / TROPICAL					WARM SPRINGS					BERMUDA					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	17	18	2527.1	2540.5	1	50	55	2412.6	2427.6	1	21	25	2415	2427.4	1	**184**	**204**
Feb	18	20	2527.1	2540.5	1	50	54	2412.6	2427.6	1	21	25	2415	2427.4	1	**189**	**210**
Mar	21	26	2527.1	2540.5	1	69	75	2412.6	2427.6	1	25	28	2415	2427.4	1	**238**	**272**
Apr	26	29	2527.1	2540.5	1	78	85	2412.6	2427.6	1	29	33	2415	2427.4	1	**281**	**320**
May	27	35	2527.1	2540.5	1	102	114	2412.6	2427.6	1	30	35	2415	2427.4	1	**325**	**361**
Jun	15	17	2527.1	2540.5	1	110	117	2412.6	2427.6	1	31	35	2415	2427.4	1	**295**	**330**
Jul	18	19	2527.1	2540.5	1	111	118	2412.6	2427.6	1	31	35	2415	2427.4	1	**316**	**340**
Aug	16	18	2527.1	2540.5	1	129	138	2412.6	2427.6	1	31	35	2415	2427.4	1	**308**	**337**
Sep	14	18	2527.1	2540.5	1	100	117	2412.6	2427.6	1	28	30	2415	2427.4	1	**251**	**301**
Oct	31	34	2527.1	2540.5	1	97	109	2412.6	2427.6	1	26	30	2415	2427.4	1	**294**	**340**
Nov	24	28	2527.1	2540.5	1	87	107	2412.6	2427.6	1	24	28	2415	2427.4	1	**239**	**285**
Dec	23	25	2527.1	2540.5	1	67	77	2412.6	2427.6	1	23	25	2415	2427.4	1	**203**	**228**

* Fayle Reservoir will be taken out of service for rehabilitation from August 2015 through September 2016. No flows at Fayle and increased flows at Broadbent and Warm Springs turnouts

2015 - Annual Water Flow Projections

CITY OF HENDERSON

MONTH	PARKWAY					BLACK MOUNTAIN					EQUESTRIAN					COLLEGE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	13	17	2493	2500	1	4	5.5	2230	2238	1	2.5	3.5	2232	2239	1	2.5	3.5	2494	2501	1
Feb	13	18	2493	2500	1	4	5.5	2230	2238	1	2.5	3.5	2232	2239	1	3	3.5	2494	2501	1
Mar	16	21	2493	2500	1	4	6	2230	2238	1	3	4	2232	2239	1	3.5	4.5	2494	2501	1
Apr	19	25	2493	2500	1	5	7	2230	2238	1	3	4	2232	2239	1	4	4.5	2494	2501	1
May	24	29	2493	2500	1	6.5	8.5	2230	2238	1	3.5	4.5	2232	2239	1	5	6	2494	2501	1
Jun	29	32	2493	2500	1	7	9	2230	2238	1	4	5	2232	2239	1	6	7	2494	2501	1
Jul	30	33	2493	2500	1	7.5	9.5	2230	2238	1	5	6	2232	2239	1	6.5	7	2494	2501	1
Aug	30	33	2493	2500	1	7.5	9.5	2230	2238	1	5	6	2232	2239	1	6.5	7	2494	2501	1
Sep	24	28	2493	2500	1	7	8.5	2230	2238	1	4	5	2232	2239	1	5	5.5	2494	2501	1
Oct	20	25	2493	2500	1	5	7	2230	2238	1	3.5	4	2232	2239	1	4.5	5	2494	2501	1
Nov	15	21	2493	2500	1	4	6	2230	2238	1	2.5	3.5	2232	2239	1	3.5	4	2494	2501	1
Dec	12	17	2493	2500	1	4	5	2230	2238	1	2.5	3.5	2232	2239	1	2.5	3.5	2494	2501	1

MONTH	HORIZON RIDGE					GIBSON / GALLERIA					PUMPING STATION NO. 3					NORTH				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	6	10	2362	2369	1	3	4.5	1865	1873	1	2	3	2093	2101	1	0.8	1.5	1831	1839	1
Feb	6	10	2362	2369	1	3	4.5	1865	1873	1	2	3	2093	2101	1	0.8	1.5	1831	1839	1
Mar	8	12	2362	2369	1	4	6	1865	1873	1	2.5	3.5	2093	2101	1	1.0	1.8	1831	1839	1
Apr	9	14	2362	2369	1	4	6	1865	1873	1	2.5	3.5	2093	2101	1	1.3	2.0	1831	1839	1
May	13	17	2362	2369	1	8	10.5	1865	1873	1	3.5	4.5	2093	2101	1	1.5	2.3	1831	1839	1
Jun	18	22	2362	2369	1	9	11	1865	1873	1	4	5.5	2093	2101	1	2.0	2.8	1831	1839	1
Jul	21	25	2362	2369	1	9	11	1865	1873	1	4	5.5	2093	2101	1	2.3	2.8	1831	1839	1
Aug	21	25	2362	2369	1	9	11	1865	1873	1	4	5.5	2093	2101	1	2.3	2.8	1831	1839	1
Sep	14	18	2362	2369	1	8	10.5	1865	1873	1	3.5	4.5	2093	2101	1	1.5	2.3	1831	1839	1
Oct	12	16	2362	2369	1	4.5	6.5	1865	1873	1	3	4	2093	2101	1	1.5	2.0	1831	1839	1
Nov	8	13	2362	2369	1	3.5	5	1865	1873	1	2	3	2093	2101	1	1.0	1.8	1831	1839	1
Dec	6	10	2362	2369	1	3	4.5	1865	1873	1	2	3	2093	2101	1	0.8	1.5	1831	1839	1

MONTH	MAGIC					FOOTHILLS					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	0.8	1.5	1831	1839	1	1.5	2.5	1906	1907	1	36.0	52.5
Feb	0.8	1.5	1831	1839	1	1.5	2.5	1906	1907	1	36.5	53.5
Mar	1.0	1.8	1831	1839	1	2	3	1906	1907	1	45.0	63.5
Apr	1.3	2.0	1831	1839	1	2	3	1906	1907	1	51.0	71.0
May	1.5	2.3	1831	1839	1	3	4	1906	1907	1	69.5	88.5
Jun	2.0	2.8	1831	1839	1	3	4	1906	1907	1	84.0	101.0
Jul	2.3	2.8	1831	1839	1	3.5	4.5	1906	1907	1	91.0	107.0
Aug	2.3	2.8	1831	1839	1	3.5	4.5	1906	1907	1	91.0	107.0
Sep	1.5	2.3	1831	1839	1	2.5	3.5	1906	1907	1	71.0	88.0
Oct	1.5	2.0	1831	1839	1	2.5	3.5	1906	1907	1	58.0	75.0
Nov	1.0	1.8	1831	1839	1	1.5	2.5	1906	1907	1	42.0	61.5
Dec	0.8	1.5	1831	1839	1	1.5	2.5	1906	1907	1	35.0	52.0

2015 - Annual Water Flow Projections

NORTH LAS VEGAS

	6C					TWIN LAKES PUMPING STATION					CARLTON SQUARE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	3	4	2016	2027.5	1	1	1	2199.5	2207.5	1	10	12	2215.5	2224.5	1
Feb	4	6	2016	2027.5	1	1	1	2199.5	2207.5	1	11	16	2215.5	2224.5	1
Mar	5	7	2016	2027.5	1	1	1	2199.5	2207.5	1	13	17	2215.5	2224.5	1
Apr	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	13	15	2215.5	2224.5	1
May	6	7	2019	2027.5	1	1	1	2199.5	2207.5	1	13	15	2215.5	2224.5	1
Jun	6	7	2019	2027.5	1	1	1	2199.5	2207.5	1	16	18	2215.5	2224.5	1
Jul	9	10	2019	2027.5	1	1	1	2199.5	2207.5	1	17	19	2215.5	2224.5	1
Aug	8	9	2019	2027.5	1	1	1	2199.5	2207.5	1	17	19	2215.5	2224.5	1
Sep	5	6	2019	2027.5	1	1	1	2199.5	2207.5	1	16	18	2215.5	2224.5	1
Oct	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	15	18	2215.5	2224.5	1
Nov	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	11	13	2215.5	2224.5	1
Dec	3	4	2016	2027.5	1	1	1	2199.5	2207.5	1	10	12	2215.5	2224.5	1

	GRAND TETON					DEER SPRINGS					DECATUR / MOCCASIN					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	2	2	2323.5	2329	1	4	5	2317	2329	1	7	9	2420	2430	1	27	33
Feb	2	3	2323.5	2329	1	4	6	2317	2329	1	7	10	2420	2430	1	29	42
Mar	2	3	2323.5	2329	1	5	7	2317	2329	1	9	12	2420	2430	1	35	46
Apr	3	3	2323.5	2329	1	5	6	2317	2329	1	10	12	2420	2430	1	37	43
May	7	8	2323.5	2329	1	6	7	2322	2329	1	11	13	2422	2430	1	44	52
Jun	12	14	2323.5	2329	1	7	8	2322	2329	1	12	14	2422	2430	1	54	62
Jul	14	15	2323.5	2329	1	8	9	2322	2329	1	13	14	2422	2430	1	62	68
Aug	14	16	2323.5	2329	1	8	9	2322	2329	1	12	13	2422	2430	1	60	67
Sep	14	16	2323.5	2329	1	7	8	2322	2329	1	10	11	2422	2430	1	53	60
Oct	4	5	2323.5	2329	1	5	6	2317	2329	1	10	12	2420	2430	1	40	47
Nov	2	2	2323.5	2329	1	5	6	2317	2329	1	8	10	2420	2430	1	32	38
Dec	2	2	2323.5	2329	1	5	6	2317	2329	1	7	8	2420	2430	1	28	33

2015 - Annual Water Flow Projections

BOULDER CITY

MONTH	HEMENWAY					PUMPING STATION NO. 7				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	0.1	0.3	2305	2310	1	1.8	3.0	2560	2569	1
Feb	0.1	0.5	2305	2310	1	2.1	3.9	2560	2569	1
Mar	0.2	0.6	2305	2310	1	2.8	4.5	2562	2569	1
Apr	0.3	1.2	2305	2310	1	3.7	6.8	2562	2569	1
May	0.3	0.9	2310	2311.2	1	4.9	7.1	2565	2569	1
Jun	0.4	1.1	2310	2311.2	1	5.3	6.6	2565	2569	1
Jul	0.4	1.4	2310	2311.2	1	5.9	8.3	2565	2569	1
Aug	0.4	0.6	2310	2311.2	1	6.0	9.9	2565	2569	1
Sep	0.6	0.7	2310	2311.2	1	4.8	7.7	2565	2569	1
Oct	0.4	0.6	2305	2310	1	4.4	7.2	2562	2569	1
Nov	0.1	0.6	2305	2310	1	2.8	5.3	2560	2569	1
Dec	0.1	0.7	2305	2310	1	1.6	3.3	2560	2569	1

MONTH	PUMPING STATION NO.7B					BC RAW WATER PUMPING SYSTEM				Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	Avg	Max
Jan	2.7	4.2	2655	2660	1	0.7	2.1	2655	2660	**5.3**	**9.7**
Feb	2.5	3.3	2655	2660	1	0.6	1.3	2655	2660	**5.3**	**9.1**
Mar	3.0	4.2	2655	2660	1	2.3	4.0	2655	2663	**8.4**	**13.3**
Apr	3.2	4.1	2655	2660	1	3.4	5.1	2655	2663	**10.7**	**17.2**
May	3.7	5.0	2660	2667	1	4.0	7.3	2660	2668	**13.0**	**20.2**
Jun	3.8	4.2	2660	2667	1	4.7	8.8	2660	2668	**14.2**	**20.7**
Jul	4.9	5.2	2660	2667	1	5.1	7.3	2660	2668	**16.2**	**22.2**
Aug	4.7	5.3	2660	2667	1	4.1	5.8	2660	2668	**15.2**	**21.6**
Sep	4.5	5.6	2660	2667	1	5.2	9.6	2660	2668	**15.0**	**23.7**
Oct	3.7	4.9	2655	2660	1	3.8	5.4	2655	2663	**12.3**	**18.0**
Nov	3.3	5.4	2655	2660	1	2.0	4.2	2655	2660	**8.2**	**15.5**
Dec	3.0	4.2	2655	2660	1	0.3	1.3	2655	2660	**5.0**	**9.4**

NELLIS

MONTH	NELLIS	
	Flow (MGD)	
	Avg	Max
Jan	0.9	1.7
Feb	1.1	2.3
Mar	1.7	2.3
Apr	1.8	2.4
May	2.0	2.8
Jun	2.3	3.0
Jul	3.0	3.9
Aug	2.6	3.9
Sep	2.2	3.5
Oct	1.4	2.0
Nov	0.9	2.0
Dec	0.9	1.9

2016 - Annual Water Flow Projections

LAS VEGAS VALLEY WATER DISTRICT

	CAMPBELL					STEWART					FAYLE *					LINDEN	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Feb	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Mar	26	28	1835.9	1846	1	11	15	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Apr	34	40	1835.9	1846	1	14	19	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
May	39	45	1835.9	1846	1	15	16	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Jun	39	45	1835.9	1846	1	17	18	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Jul	44	49	1835.9	1846	1	17	18	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Aug	39	44	1835.9	1846	1	22	23	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Sep	32	41	1835.9	1846	1	18	22	1973.5	1987.5	1	0	0	2175.3	2187.3	1	0	0
Oct	27	34	1835.9	1846	1	17	21	1973.5	1987.5	1	51	60	2175.3	2187.3	1	0	0
Nov	20	22	1835.9	1846	1	12	16	1973.5	1987.5	1	42	52	2175.3	2187.3	1	0	0
Dec	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	35	38	2175.3	2187.3	1	0	0

	BROADBENT					CHARLESTON HEIGHTS					CARLTON SQUARE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	41	42	2182.6	2190.8	1	9	11	2154.7	2161.7	1	15	16	2207.7	2220	1
Feb	42	44	2182.6	2190.8	1	9	11	2154.7	2161.7	1	14	15	2207.7	2220	1
Mar	50	55	2182.6	2190.8	1	14	16	2154.7	2161.7	1	16	19	2207.7	2220	1
Apr	48	58	2182.6	2190.8	1	20	21	2154.7	2161.7	1	18	21	2207.7	2220	1
May	68	77	2182.6	2190.8	1	15	15	2154.7	2161.7	1	21	24	2207.7	2220	1
Jun	55	60	2182.6	2190.8	1	0	0	2154.7	2161.7	1	15	20	2207.7	2220	1
Jul	57	61	2182.6	2190.8	1	0	0	2154.7	2161.7	1	19	21	2207.7	2220	1
Aug	56	60	2182.6	2190.8	1	0	0	2154.7	2161.7	1	18	21	2207.7	2220	1
Sep	47	57	2182.6	2190.8	1	0	0	2154.7	2161.7	1	15	18	2207.7	2220	1
Oct	39	44	2182.6	2190.8	1	10	12	2154.7	2161.7	1	21	25	2207.7	2220	1
Nov	29	33	2182.6	2190.8	1	9	11	2154.7	2161.7	1	16	19	2207.7	2220	1
Dec	23	25	2182.6	2190.8	1	9	11	2154.7	2161.7	1	13	15	2207.7	2220	1

	DECATUR / TROPICAL					WARM SPRINGS					BERMUDA					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	22	24	2527.1	2540.5	1	68	76	2412.6	2427.6	1	23	25	2415	2427.4	1	204	225
Feb	23	24	2527.1	2540.5	1	69	77	2412.6	2427.6	1	24	25	2415	2427.4	1	207	227
Mar	24	27	2527.1	2540.5	1	82	95	2412.6	2427.6	1	26	28	2415	2427.4	1	249	283
Apr	28	31	2527.1	2540.5	1	96	104	2412.6	2427.6	1	28	31	2415	2427.4	1	286	325
May	27	34	2527.1	2540.5	1	115	125	2412.6	2427.6	1	30	31	2415	2427.4	1	330	367
Jun	15	20	2527.1	2540.5	1	129	138	2412.6	2427.6	1	32	36	2415	2427.4	1	302	337
Jul	18	21	2527.1	2540.5	1	135	141	2412.6	2427.6	1	33	36	2415	2427.4	1	323	347
Aug	17	21	2527.1	2540.5	1	131	139	2412.6	2427.6	1	32	36	2415	2427.4	1	315	344
Sep	15	19	2527.1	2540.5	1	101	120	2412.6	2427.6	1	29	31	2415	2427.4	1	257	308
Oct	31	34	2527.1	2540.5	1	76	84	2412.6	2427.6	1	27	31	2415	2427.4	1	299	345
Nov	23	28	2527.1	2540.5	1	68	81	2412.6	2427.6	1	24	27	2415	2427.4	1	243	289
Dec	23	25	2527.1	2540.5	1	55	60	2412.6	2427.6	1	22	26	2415	2427.4	1	206	231

* Fayle Reservoir will be taken out of service for rehabilitation from August 2015 through September 2016. No flows at Fayle and increased flows at Broadbent and Warm Springs turnouts

2016 - Annual Water Flow Projections

CITY OF HENDERSON

	PARKWAY					BLACK MOUNTAIN					EQUESTRIAN					COLLEGE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	13	18	2493	2500	1	4	5.5	2230	2238	1	2.5	3.5	2232	2239	1	3	4	2494	2501	1
Feb	13	19	2493	2500	1	4	5.5	2230	2238	1	2.5	3.5	2232	2239	1	3	4	2494	2501	1
Mar	17	22	2493	2500	1	4.5	6	2230	2238	1	3	4	2232	2239	1	4	5	2494	2501	1
Apr	20	26	2493	2500	1	5	7	2230	2238	1	3	4	2232	2239	1	4.5	5	2494	2501	1
May	25	31	2493	2500	1	6.5	8.5	2230	2238	1	3.5	4.5	2232	2239	1	5.5	6	2494	2501	1
Jun	29	33	2493	2500	1	7	9	2230	2238	1	4.5	5.5	2232	2239	1	6.5	7	2494	2501	1
Jul	30	34	2493	2500	1	7.5	9.5	2230	2238	1	5.5	6	2232	2239	1	7	7.5	2494	2501	1
Aug	30	34	2493	2500	1	7.5	9.5	2230	2238	1	5.5	6	2232	2239	1	7	7.5	2494	2501	1
Sep	25	28	2493	2500	1	7	8.5	2230	2238	1	4.5	5.5	2232	2239	1	5.5	6	2494	2501	1
Oct	21	25	2493	2500	1	5.5	7.5	2230	2238	1	3.5	4.5	2232	2239	1	5	5.5	2494	2501	1
Nov	16	21	2493	2500	1	4.5	6	2230	2238	1	3	4	2232	2239	1	4	4.5	2494	2501	1
Dec	13	18	2493	2500	1	4	5.5	2230	2238	1	2.5	3.5	2232	2239	1	3	4	2494	2501	1

	HORIZON RIDGE					GIBSON / GALLERIA					PUMPING STATION NO. 3					NORTH				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	11	15	2362	2369	1	3	5	1865	1873	1	2	3	2093	2101	1	1.0	1.8	1831	1839	1
Feb	11	15	2362	2369	1	3	5	1865	1873	1	2	3	2093	2101	1	1.0	1.8	1831	1839	1
Mar	12	16	2362	2369	1	4	6	1865	1873	1	2.5	3.5	2093	2101	1	1.3	2.0	1831	1839	1
Apr	14	18	2362	2369	1	4	6	1865	1873	1	2.5	3.5	2093	2101	1	1.5	2.3	1831	1839	1
May	17	22	2362	2369	1	8	11	1865	1873	1	3.5	4.5	2093	2101	1	1.8	2.5	1831	1839	1
Jun	21	27	2362	2369	1	9	11.5	1865	1873	1	4	5.5	2093	2101	1	2.3	3.0	1831	1839	1
Jul	25	30	2362	2369	1	9.5	11.5	1865	1873	1	4.5	5.5	2093	2101	1	2.3	3.0	1831	1839	1
Aug	25	30	2362	2369	1	9.5	11.5	1865	1873	1	4.5	5.5	2093	2101	1	2.3	3.0	1831	1839	1
Sep	18	23	2362	2369	1	9	11	1865	1873	1	3.5	5	2093	2101	1	1.8	2.5	1831	1839	1
Oct	16	20	2362	2369	1	5	7	1865	1873	1	3	4	2093	2101	1	1.5	2.0	1831	1839	1
Nov	13	18	2362	2369	1	4	6	1865	1873	1	2	3	2093	2101	1	1.0	1.8	1831	1839	1
Dec	11	15	2362	2369	1	3	5	1865	1873	1	2	3	2093	2101	1	1.0	1.5	1831	1839	1

	MAGIC					FOOTHILLS					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	1.0	1.8	1831	1839	1	1.5	2.5	1906	1907	1	42.0	60.0
Feb	1.0	1.8	1831	1839	1	1.5	2.5	1906	1907	1	42.0	61.0
Mar	1.3	2.0	1831	1839	1	2	3	1906	1907	1	51.5	69.5
Apr	1.5	2.3	1831	1839	1	2	3	1906	1907	1	58.0	77.0
May	1.8	2.5	1831	1839	1	3	4	1906	1907	1	75.5	96.5
Jun	2.3	3.0	1831	1839	1	3	4	1906	1907	1	88.5	108.5
Jul	2.3	3.0	1831	1839	1	3.5	4.5	1906	1907	1	97.0	114.5
Aug	2.3	3.0	1831	1839	1	3.5	4.5	1906	1907	1	97.0	114.5
Sep	1.8	2.5	1831	1839	1	3	4	1906	1907	1	79.0	96.0
Oct	1.5	2.0	1831	1839	1	2.5	3.5	1906	1907	1	64.5	81.0
Nov	1.0	1.8	1831	1839	1	2	3	1906	1907	1	50.5	69.0
Dec	1.0	1.5	1831	1839	1	1.5	2.5	1906	1907	1	42.0	59.5

2016 - Annual Water Flow Projections

NORTH LAS VEGAS

MONTH	6C					TWIN LAKES PUMPING STATION					CARLTON SQUARE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	4	5	2016	2027.5	1	1	1	2199.5	2207.5	1	10	12	2215.5	2224.5	1
Feb	5	7	2016	2027.5	1	1	1	2199.5	2207.5	1	11	16	2215.5	2224.5	1
Mar	5	7	2016	2027.5	1	1	1	2199.5	2207.5	1	13	17	2215.5	2224.5	1
Apr	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	13	15	2215.5	2224.5	1
May	6	7	2019	2027.5	1	1	1	2199.5	2207.5	1	13	15	2215.5	2224.5	1
Jun	6	7	2019	2027.5	1	1	1	2199.5	2207.5	1	16	18	2215.5	2224.5	1
Jul	9	10	2019	2027.5	1	1	1	2199.5	2207.5	1	17	19	2215.5	2224.5	1
Aug	8	9	2019	2027.5	1	1	1	2199.5	2207.5	1	17	19	2215.5	2224.5	1
Sep	5	6	2019	2027.5	1	1	1	2199.5	2207.5	1	16	18	2215.5	2224.5	1
Oct	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	15	18	2215.5	2224.5	1
Nov	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	11	13	2215.5	2224.5	1
Dec	3	4	2016	2027.5	1	1	1	2199.5	2207.5	1	10	12	2215.5	2224.5	1

MONTH	GRAND TETON					DEER SPRINGS					DECATUR / MOCCASIN					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	2	2	2323.5	2329	1	4	5	2317	2329	1	7	9	2420	2430	1	28	34
Feb	2	3	2323.5	2329	1	4	6	2317	2329	1	8	12	2420	2430	1	31	45
Mar	2	3	2323.5	2329	1	5	7	2317	2329	1	9	12	2420	2430	1	35	46
Apr	3	3	2323.5	2329	1	5	6	2317	2329	1	10	12	2420	2430	1	37	43
May	8	10	2323.5	2329	1	6	7	2322	2329	1	12	14	2422	2430	1	46	55
Jun	12	14	2323.5	2329	1	7	8	2322	2329	1	12	14	2422	2430	1	54	62
Jul	14	15	2323.5	2329	1	8	9	2322	2329	1	13	14	2422	2430	1	62	68
Aug	14	16	2323.5	2329	1	8	9	2322	2329	1	13	15	2422	2430	1	61	68
Sep	14	16	2323.5	2329	1	7	8	2322	2329	1	10	11	2422	2430	1	53	60
Oct	4	5	2323.5	2329	1	5	6	2317	2329	1	10	12	2420	2430	1	40	47
Nov	2	2	2323.5	2329	1	5	6	2317	2329	1	8	10	2420	2430	1	32	38
Dec	2	2	2323.5	2329	1	5	6	2317	2329	1	7	8	2420	2430	1	28	33

2016 - Annual Water Flow Projections

BOULDER CITY

MONTH	HEMENWAY					PUMPING STATION NO. 7				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	0.1	0.3	2305	2310	1	1.8	3.0	2560	2569	1
Feb	0.1	0.5	2305	2310	1	2.1	3.9	2560	2569	1
Mar	0.2	0.6	2305	2310	1	2.8	4.5	2562	2569	1
Apr	0.3	1.2	2305	2310	1	3.7	6.8	2562	2569	1
May	0.3	0.9	2310	2311.2	1	4.9	7.1	2565	2569	1
Jun	0.4	1.1	2310	2311.2	1	5.3	6.6	2565	2569	1
Jul	0.4	1.4	2310	2311.2	1	5.9	8.3	2565	2569	1
Aug	0.4	0.6	2310	2311.2	1	6.0	9.9	2565	2569	1
Sep	0.6	0.7	2310	2311.2	1	4.8	7.7	2565	2569	1
Oct	0.4	0.6	2305	2310	1	4.4	7.2	2562	2569	1
Nov	0.1	0.6	2305	2310	1	2.8	5.3	2560	2569	1
Dec	0.1	0.7	2305	2310	1	1.6	3.3	2560	2569	1

MONTH	PUMPING STATION NO.7B					BC RAW WATER PUMPING SYSTEM				Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	Avg	Max
Jan	2.7	4.2	2655	2660	1	0.7	2.1	2655	2660	**5.3**	**9.7**
Feb	2.5	3.3	2655	2660	1	0.6	1.3	2655	2660	**5.3**	**9.1**
Mar	3.0	4.2	2655	2660	1	2.3	4.0	2655	2663	**8.4**	**13.3**
Apr	3.2	4.1	2655	2660	1	3.4	5.1	2655	2663	**10.7**	**17.2**
May	3.7	5.0	2660	2667	1	4.0	7.3	2660	2668	**13.0**	**20.2**
Jun	3.8	4.2	2660	2667	1	4.7	8.8	2660	2668	**14.2**	**20.7**
Jul	4.9	5.2	2660	2667	1	5.1	7.3	2660	2668	**16.2**	**22.2**
Aug	4.7	5.3	2660	2667	1	4.1	5.8	2660	2668	**15.2**	**21.6**
Sep	4.5	5.6	2660	2667	1	5.2	9.6	2660	2668	**15.0**	**23.7**
Oct	3.7	4.9	2655	2660	1	3.8	5.4	2655	2663	**12.3**	**18.0**
Nov	3.3	5.4	2655	2660	1	2.0	4.2	2655	2660	**8.2**	**15.5**
Dec	3.0	4.2	2655	2660	1	0.3	1.3	2655	2660	**5.0**	**9.4**

NELLIS

MONTH	NELLIS	
	Flow (MGD)	
	Avg	Max
Jan	0.9	1.7
Feb	1.1	2.3
Mar	1.7	2.3
Apr	1.8	2.4
May	2.0	2.8
Jun	2.3	3.0
Jul	3.0	3.9
Aug	2.6	3.9
Sep	2.2	3.5
Oct	1.4	2.0
Nov	0.9	2.0
Dec	0.9	1.9

2017 - Annual Water Flow Projections

LAS VEGAS VALLEY WATER DISTRICT

MONTH	CAMPBELL					STEWART					FAYLE					LINDEN	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	38	39	2175.3	2187.3	1	0	0
Feb	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	41	42	2175.3	2187.3	1	0	0
Mar	19	22	1835.9	1846	1	13	17	1973.5	1987.5	1	48	54	2175.3	2187.3	1	0	0
Apr	24	31	1835.9	1846	1	17	22	1973.5	1987.5	1	54	57	2175.3	2187.3	1	0	0
May	29	33	1835.9	1846	1	19	20	1973.5	1987.5	1	57	58	2175.3	2187.3	1	0	0
Jun	32	38	1835.9	1846	1	21	22	1973.5	1987.5	1	59	66	2175.3	2187.3	1	0	0
Jul	38	42	1835.9	1846	1	21	22	1973.5	1987.5	1	64	66	2175.3	2187.3	1	0	0
Aug	38	44	1835.9	1846	1	22	23	1973.5	1987.5	1	57	61	2175.3	2187.3	1	0	0
Sep	32	42	1835.9	1846	1	18	22	1973.5	1987.5	1	42	51	2175.3	2187.3	1	0	0
Oct	25	32	1835.9	1846	1	17	21	1973.5	1987.5	1	51	60	2175.3	2187.3	1	0	0
Nov	18	20	1835.9	1846	1	14	17	1973.5	1987.5	1	45	55	2175.3	2187.3	1	0	0
Dec	16	19	1835.9	1846	1	10	12	1973.5	1987.5	1	36	39	2175.3	2187.3	1	0	0

MONTH	BROADBENT					CHARLESTON HEIGHTS					CARLTON SQUARE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	23	25	2182.6	2190.8	1	9	11	2154.7	2161.7	1	13	14	2207.7	2220	1
Feb	23	25	2182.6	2190.8	1	9	11	2154.7	2161.7	1	13	14	2207.7	2220	1
Mar	22	26	2182.6	2190.8	1	15	16	2154.7	2161.7	1	15	17	2207.7	2220	1
Apr	21	27	2182.6	2190.8	1	20	20	2154.7	2161.7	1	16	20	2207.7	2220	1
May	29	32	2182.6	2190.8	1	15	15	2154.7	2161.7	1	21	23	2207.7	2220	1
Jun	25	28	2182.6	2190.8	1	0	0	2154.7	2161.7	1	12	17	2207.7	2220	1
Jul	34	37	2182.6	2190.8	1	0	0	2154.7	2161.7	1	13	14	2207.7	2220	1
Aug	33	36	2182.6	2190.8	1	0	0	2154.7	2161.7	1	16	19	2207.7	2220	1
Sep	24	29	2182.6	2190.8	1	0	0	2154.7	2161.7	1	14	17	2207.7	2220	1
Oct	40	45	2182.6	2190.8	1	10	12	2154.7	2161.7	1	21	25	2207.7	2220	1
Nov	30	34	2182.6	2190.8	1	9	11	2154.7	2161.7	1	16	19	2207.7	2220	1
Dec	23	26	2182.6	2190.8	1	9	11	2154.7	2161.7	1	13	15	2207.7	2220	1

MONTH	DECATUR / TROPICAL					WARM SPRINGS					BERMUDA					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	22	23	2527.1	2540.5	1	55	59	2412.6	2427.6	1	22	26	2415	2427.4	1	208	228
Feb	23	25	2527.1	2540.5	1	53	57	2412.6	2427.6	1	22	26	2415	2427.4	1	210	231
Mar	24	29	2527.1	2540.5	1	71	78	2412.6	2427.6	1	26	29	2415	2427.4	1	253	288
Apr	28	32	2527.1	2540.5	1	80	87	2412.6	2427.6	1	30	34	2415	2427.4	1	290	330
May	28	36	2527.1	2540.5	1	107	119	2412.6	2427.6	1	31	37	2415	2427.4	1	336	373
Jun	15	20	2527.1	2540.5	1	112	119	2412.6	2427.6	1	32	34	2415	2427.4	1	308	344
Jul	19	21	2527.1	2540.5	1	110	119	2412.6	2427.6	1	31	33	2415	2427.4	1	330	354
Aug	19	23	2527.1	2540.5	1	105	111	2412.6	2427.6	1	31	34	2415	2427.4	1	321	351
Sep	15	19	2527.1	2540.5	1	88	102	2412.6	2427.6	1	29	32	2415	2427.4	1	262	314
Oct	30	33	2527.1	2540.5	1	82	90	2412.6	2427.6	1	28	32	2415	2427.4	1	304	350
Nov	22	27	2527.1	2540.5	1	69	83	2412.6	2427.6	1	24	28	2415	2427.4	1	247	294
Dec	22	24	2527.1	2540.5	1	58	63	2412.6	2427.6	1	22	26	2415	2427.4	1	209	235

2017 - Annual Water Flow Projections

CITY OF HENDERSON

	PARKWAY					BLACK MOUNTAIN					EQUESTRIAN					COLLEGE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	14	18	2493	2500	1	4.5	6	2230	2238	1	3	4	2232	2239	1	3	4	2494	2501	1
Feb	14	19	2493	2500	1	4.5	6	2230	2238	1	3	4	2232	2239	1	3	4	2494	2501	1
Mar	17	22	2493	2500	1	4.5	6	2230	2238	1	3.5	4.5	2232	2239	1	4	5	2494	2501	1
Apr	20	26	2493	2500	1	5	7	2230	2238	1	3.5	4.5	2232	2239	1	4.5	5.5	2494	2501	1
May	25	31	2493	2500	1	7	9	2230	2238	1	4	5	2232	2239	1	5.5	6	2494	2501	1
Jun	29	33	2493	2500	1	7	9	2230	2238	1	4.5	5.5	2232	2239	1	6.5	7	2494	2501	1
Jul	31	34	2493	2500	1	7.5	9.5	2230	2238	1	5.5	6.5	2232	2239	1	7	7.5	2494	2501	1
Aug	31	34	2493	2500	1	7.5	9.5	2230	2238	1	5.5	6.5	2232	2239	1	7	7.5	2494	2501	1
Sep	25	29	2493	2500	1	7	9	2230	2238	1	4.5	5.5	2232	2239	1	6	6.5	2494	2501	1
Oct	21	25	2493	2500	1	5.5	7.5	2230	2238	1	3.5	4.5	2232	2239	1	5	6	2494	2501	1
Nov	16	21	2493	2500	1	4.5	6	2230	2238	1	3	4	2232	2239	1	4	5	2494	2501	1
Dec	14	18	2493	2500	1	4.5	6	2230	2238	1	2.5	3.5	2232	2239	1	3	4	2494	2501	1

	HORIZON RIDGE					GIBSON / GALLERIA					PUMPING STATION NO. 3					NORTH				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	11	15	2362	2369	1	3	5	1865	1873	1	2	3	2093	2101	1	1.0	1.8	1831	1839	1
Feb	11	15	2362	2369	1	3	5	1865	1873	1	2	3	2093	2101	1	1.0	1.8	1831	1839	1
Mar	13	17	2362	2369	1	4	6	1865	1873	1	2.5	4	2093	2101	1	1.3	2.0	1831	1839	1
Apr	13	19	2362	2369	1	4	6	1865	1873	1	3	4	2093	2101	1	1.5	2.3	1831	1839	1
May	18	23	2362	2369	1	8	11	1865	1873	1	3.5	4.5	2093	2101	1	2.0	2.8	1831	1839	1
Jun	22	28	2362	2369	1	9	12	1865	1873	1	4	5.5	2093	2101	1	2.3	3.0	1831	1839	1
Jul	26	31	2362	2369	1	10	12	1865	1873	1	4.5	6	2093	2101	1	2.5	3.3	1831	1839	1
Aug	26	31	2362	2369	1	10	12	1865	1873	1	4.5	6	2093	2101	1	2.5	3.3	1831	1839	1
Sep	19	24	2362	2369	1	9	11	1865	1873	1	4	5	2093	2101	1	2.0	2.8	1831	1839	1
Oct	17	21	2362	2369	1	5.5	8	1865	1873	1	3	4	2093	2101	1	1.8	2.3	1831	1839	1
Nov	14	18	2362	2369	1	4	6	1865	1873	1	2	3	2093	2101	1	1.3	2.0	1831	1839	1
Dec	11	15	2362	2369	1	3	5	1865	1873	1	2	3	2093	2101	1	1.0	1.8	1831	1839	1

	MAGIC					FOOTHILLS					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
MONTH	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	1.0	1.8	1831	1839	1	2	3	1906	1907	1	44.5	61.5
Feb	1.0	1.8	1831	1839	1	2	3	1906	1907	1	44.5	62.5
Mar	1.3	2.0	1831	1839	1	2.5	3.5	1906	1907	1	53.5	72.0
Apr	1.5	2.3	1831	1839	1	2.5	3.5	1906	1907	1	58.5	80.0
May	2.0	2.8	1831	1839	1	3	4	1906	1907	1	78.0	99.0
Jun	2.3	3.0	1831	1839	1	3.5	4.5	1906	1907	1	90.0	110.5
Jul	2.5	3.3	1831	1839	1	3.5	4.5	1906	1907	1	100.0	117.5
Aug	2.5	3.3	1831	1839	1	3.5	4.5	1906	1907	1	100.0	117.5
Sep	2.0	2.8	1831	1839	1	3	4	1906	1907	1	81.5	99.5
Oct	1.8	2.3	1831	1839	1	2.5	3.5	1906	1907	1	66.5	84.0
Nov	1.3	2.0	1831	1839	1	2	3	1906	1907	1	52.0	70.0
Dec	1.0	1.8	1831	1839	1	2	3	1906	1907	1	44.0	61.0

* City of Henderson demand projections for 2017 assume full operational capacity of its Water Treatment Plant (COHWTP). However, if the COHWTP is unable to operate due to dropping Lake Mead lake levels, demand projections will have to be modified, accordingly.

2017 - Annual Water Flow Projections

NORTH LAS VEGAS

MONTH	6C					TWIN LAKES PUMPING STATION					CARLTON SQUARE				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	4	5	2016	2027.5	1	1	1	2199.5	2207.5	1	10	12	2215.5	2224.5	1
Feb	5	7	2016	2027.5	1	1	1	2199.5	2207.5	1	11	16	2215.5	2224.5	1
Mar	5	7	2016	2027.5	1	1	1	2199.5	2207.5	1	13	17	2215.5	2224.5	1
Apr	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	13	15	2215.5	2224.5	1
May	6	7	2019	2027.5	1	1	1	2199.5	2207.5	1	14	17	2215.5	2224.5	1
Jun	6	7	2019	2027.5	1	1	1	2199.5	2207.5	1	17	19	2215.5	2224.5	1
Jul	9	10	2019	2027.5	1	1	1	2199.5	2207.5	1	17	19	2215.5	2224.5	1
Aug	8	9	2019	2027.5	1	1	1	2199.5	2207.5	1	17	19	2215.5	2224.5	1
Sep	6	7	2019	2027.5	1	1	1	2199.5	2207.5	1	16	18	2215.5	2224.5	1
Oct	5	6	2016	2027.5	1	1	1	2199.5	2207.5	1	15	18	2215.5	2224.5	1
Nov	4	5	2016	2027.5	1	1	1	2199.5	2207.5	1	11	13	2215.5	2224.5	1
Dec	3	4	2016	2027.5	1	1	1	2199.5	2207.5	1	10	12	2215.5	2224.5	1

MONTH	GRAND TETON					DEER SPRINGS					DECATUR / MOCCASIN					Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)	Avg	Max
Jan	2	2	2323.5	2329	1	4	5	2317	2329	1	7	9	2420	2430	1	28	34
Feb	2	3	2323.5	2329	1	5	7	2317	2329	1	8	12	2420	2430	1	32	46
Mar	2	3	2323.5	2329	1	5	7	2317	2329	1	9	12	2420	2430	1	35	46
Apr	3	3	2323.5	2329	1	5	6	2317	2329	1	10	12	2420	2430	1	37	43
May	8	10	2323.5	2329	1	6	7	2322	2329	1	12	14	2422	2430	1	47	56
Jun	12	14	2323.5	2329	1	7	8	2322	2329	1	12	14	2422	2430	1	55	63
Jul	15	17	2323.5	2329	1	8	9	2322	2329	1	13	14	2422	2430	1	63	69
Aug	14	16	2323.5	2329	1	8	9	2322	2329	1	13	15	2422	2430	1	61	68
Sep	14	16	2323.5	2329	1	7	8	2322	2329	1	11	13	2422	2430	1	55	63
Oct	4	5	2323.5	2329	1	6	7	2317	2329	1	10	12	2420	2430	1	41	48
Nov	3	4	2323.5	2329	1	5	6	2317	2329	1	8	10	2420	2430	1	32	38
Dec	2	2	2323.5	2329	1	5	6	2317	2329	1	7	8	2420	2430	1	28	33

2017 - Annual Water Flow Projections

BOULDER CITY

MONTH	HEMENWAY					PUMPING STATION NO. 7				
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Cl_2
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	(mg/L)
Jan	0.1	0.3	2305	2310	1	1.4	2.4	2560	2569	1
Feb	0.1	0.4	2305	2310	1	1.6	3.0	2560	2569	1
Mar	0.2	0.5	2305	2310	1	2.4	3.8	2562	2569	1
Apr	0.3	1.0	2305	2310	1	3.2	5.8	2562	2569	1
May	0.3	0.8	2310	2311.2	1	4.4	6.3	2565	2569	1
Jun	0.4	1.0	2310	2311.2	1	4.7	5.9	2565	2569	1
Jul	0.3	1.2	2310	2311.2	1	5.3	7.5	2565	2569	1
Aug	0.3	0.6	2310	2311.2	1	5.5	9.1	2565	2569	1
Sep	0.5	0.6	2310	2311.2	1	4.3	6.9	2565	2569	1
Oct	0.3	0.5	2305	2310	1	3.9	6.3	2562	2569	1
Nov	0.1	0.5	2305	2310	1	2.4	4.5	2560	2569	1
Dec	0.1	0.5	2305	2310	1	1.3	2.6	2560	2569	1

MONTH	PUMPING STATION NO.7B					BC RAW WATER PUMPING SYSTEM				Total	
	Flow (MGD)		HGL (ft)		Cl_2	Flow (MGD)		HGL (ft)		Flow (MGD)	
	Avg	Max	Min	Max	(mg/L)	Avg	Max	Min	Max	Avg	Max
Jan	2.1	3.3	2655	2660	1	0.7	2.1	2655	2660	**4.3**	**8.0**
Feb	1.9	2.6	2655	2660	1	0.6	1.3	2655	2660	**4.2**	**7.3**
Mar	2.5	3.5	2655	2660	1	2.3	4.0	2655	2663	**7.4**	**11.8**
Apr	2.8	3.6	2655	2660	1	3.4	5.1	2655	2663	**9.7**	**15.5**
May	3.3	4.4	2660	2667	1	4.0	7.3	2660	2668	**12.0**	**18.8**
Jun	3.4	3.7	2660	2667	1	4.7	8.8	2660	2668	**13.2**	**19.4**
Jul	4.4	4.8	2660	2667	1	5.1	7.3	2660	2668	**15.2**	**20.9**
Aug	4.3	4.8	2660	2667	1	4.1	5.8	2660	2668	**14.2**	**20.2**
Sep	4.0	5.1	2660	2667	1	5.2	9.6	2660	2668	**14.0**	**22.2**
Oct	3.3	4.3	2655	2660	1	3.8	5.4	2655	2663	**11.3**	**16.5**
Nov	2.7	4.5	2655	2660	1	2.0	4.2	2655	2660	**7.2**	**13.7**
Dec	2.3	3.3	2655	2660	1	0.3	1.3	2655	2660	**4.0**	**7.8**

NELLIS

MONTH	NELLIS	
	Flow (MGD)	
	Avg	Max
Jan	0.9	1.7
Feb	1.1	2.3
Mar	1.7	2.3
Apr	1.8	2.4
May	2.0	2.8
Jun	2.3	3.0
Jul	3.0	3.9
Aug	2.6	3.9
Sep	2.2	3.5
Oct	1.4	2.0
Nov	0.9	2.0
Dec	0.9	1.9

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Comprehensive Annual Financial Report	**Director's Backup**
Petitioner: David H. Wright, Chief Financial Officer	
Recommendations: That the Board of Directors accept the Authority's Comprehensive Annual Financial Report for the period ending June 30, 2014, as presented by the Authority's external auditors, Piercy Bowler Taylor & Kern, and authorize its submission to the Nevada Department of Taxation.	

Fiscal Impact:
None by approval of the above recommendation.

Background:
The Authority's independent auditors, Piercy Bowler Taylor & Kern, will present the financial report to the Board of Directors, which includes their opinion and findings as required by State statutes.

At this time, the Board is being asked to accept the financial report. This report will be submitted to the Nevada Department of Taxation as outlined by NRS 354.624 and State regulations.

This action is required pursuant to NRS 354.624(6) and Section 6(p) of the SNWA 1995 Amended Cooperative Agreement. The office of the General Counsel has reviewed and approved this agenda item.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:DHW:RRS:np
Attachments

AGENDA ITEM # 15

SOUTHERN NEVADA WATER AUTHORITY
BOARD OF DIRECTORS
AGENDA ITEM

December 10, 2014

Subject: Update on Water Resources	**Director's Backup**
Petitioner: Gregory J. Walch, General Counsel	
Recommendations: That the Board of Directors receive an update from staff on water resources including, but not limited to, drought conditions in the Colorado River Basin, the results of the implementation of the Authority's Water Resource and Conservation Plans, activities on the Colorado River, the development of in-state water resources, and the status of the third intake project.	

Fiscal Impact:
None by approval of the above recommendation.

Background:
The Colorado River Basin has been experiencing a severe drought that began in 2000. The severity of these conditions has become increasingly evident in lake levels along the lower Colorado River Basin, where major reservoirs such as Lake Powell and Lake Mead are experiencing some of the lowest water levels in recent memory.

The nature of the drought in the Colorado River Basin has direct effects on water resources and future planning. The drought has prompted communities to launch major conservation initiatives to reduce water use among citizens and businesses, and has resulted in the development and implementation of the Authority's Water Resource and Conservation Plans.

In May 2005, the Board of Directors approved a project for design and construction of a third intake in Lake Mead with the primary objective of protecting southern Nevada's water supply from significant loss of system capacity resulting from a continuing decline in lake elevation. The project design and environmental approvals were completed by 2007. Construction began on the project in March 2008.

This agenda item provides for an update from staff on the drought, the results of the implementation of the Authority's Water Resource and Conservation Plans, activities on the Colorado River, the development of in-state water resources, and the status of the third intake project.

The office of the General Counsel has reviewed and approved this agenda item.

Respectfully submitted:

John J. Entsminger, General Manager
JJE:PDS:GJW:td

AGENDA ITEM # 16

DISCLOSURE OF RELATIONSHIP

List any disclosures below:
(Mark N/A, if not applicable.)

NAME OF BUSINESS OWNER/PRINCIPAL	NAME OF SNWA EMPLOYEE OR OFFICIAL AND JOB TITLE	RELATIONSHIP TO SNWA EMPLOYEE OR OFFICIAL	SNWA EMPLOYEE'S/OFFICIAL'S DEPARTMENT
N/A			

"Consanguinity" is a relationship by blood. "Affinity" is a relationship by marriage.

"To the second degree of consanguinity" applies to the candidate's first and second degree of blood relatives as follows:

- Spouse – Registered Domestic Partners – Children – Parents – In-laws (first degree)
- Brothers/Sisters – Half-Brothers/Half-Sisters – Grandchildren – Grandparents – In-laws (second degree)

For SNWA Use Only:

If no Disclosure or Relationship is noted above or if the section is marked N/A, please check this box:

☒ No Disclosure

If any Disclosure of Relationship is noted above, please complete the following:

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in the contracting/selection process for this particular agenda item?

☐ Yes ☐ No Is the SNWA employee(s) noted above involved in any way with the business in performance of the contract?

Notes/Comments:

David H Wright

Signature

David H. Wright

Print Name

Authorized Department Representative