THE WATER RESEARCH FOUNDATION

WRF Independent Advisory Panel

Meeting Report #1:

Northern Nevada Indirect Potable Reuse Feasibility Study

Based on the Panel Meeting Held January 26, 2018

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Disclaimer

This report was administered by The Water Research Foundation (WRF). Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

About WRF

WRF works to create the definitive research organization to advance the science of all things water to better meet the evolving needs of its subscribers and the water sector. The purpose of WRF is to engage exclusively in nonprofit, charitable and educational activities designed to initiate, supervise, coordinate, promote, and finance research in the technology, operation, and management of water, wastewater, reuse and stormwater collection, treatment and supply systems, toward ensuring water quality and improving water service to the public.

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1. Purpose and History of the Panel

A 501c3 nonprofit organization, The Water Research Foundation (WRF) facilitates expert panels that provide third-party scientific and technical review by leading experts. WRF was asked by the Washoe County Department of Water Resources of Reno, Nevada, to form and coordinate an Independent Advisory Panel to provide a science-based review of the "Northern Nevada Indirect Potable Reuse Feasibility Study," a multi-year study that involves determining the feasibility of implementing indirect potable reuse (IPR) as a viable water management option for the region. The goal of this feasibility study is to demonstrate treatment technologies and operational strategies while engaging the public and building awareness of IPR.

A Northern Nevada Regional Project Team of eight public agencies is jointly sponsoring the feasibility study to evaluate whether the State of Nevada's newly adopted "A+" reclaimed water category offers significant water resources management benefits. The study consists of technical, social, environmental and financial analyses, regulatory compliance, public engagement, advanced treatment pilot testing, geotechnical investigations, and field scale treatment demonstration projects.

The Regional Team consists of the following organizations:

- City of Reno
- City of Sparks
- Northern Nevada Water Planning Commission
- Truckee Meadows Water Authority
- Truckee Meadows Water Reclamation Facility
- University of Nevada, Reno
- Washoe County
- Western Regional Water Commission

The goal of the Panel review is to assist the project team in framing and validating approaches for project implementation. The Panel review was conducted through an in-person meeting. This report summarizes the Panel's findings based on the discussions and outcomes of the meeting.

The Panel consists of six (6) individuals with expertise in a range of disciplines relevant to the review of the project, such as hydrogeology, groundwater modeling, water reuse regulations, and advanced treatment technologies, among others. Panel members include:

- Chair: James Crook, PH.D., P.E., Water Reuse Consultant
- Robert Hultquist, P.E., California Department of Public Health (retired)
- Andrew Salveson, P.E., Carollo Engineers
- Keel Robinson, Trussell Technologies
- Andy Campbell, P.G., CH.G., Inland Empire Utilities Agency
- Mark Millan, Data Instincts

Brief biographies of the Panel members can be found in **Appendix A**.

2. Panel Meeting #1

A one-day meeting of the Panel was held on January 26, 2018 at Truckee Meadows Water Authority in Reno, NV. This meeting represents the first time the Panel has convened to review the efforts to implement Northern Nevada Indirect Potable Reuse Study.

2.1 Background Material

In advance of the meeting, the Panel received the following materials for review:

- Project Summary
- Reno Sewer Map
- Reno Treatment Plant Summary
- One Page Project Handout
- Trailer Concept

2.2 Meeting Agenda

The detailed agenda can be found in **Appendix B**. The agenda was based on meeting the following objectives:

- Establish the need and legitimacy of the project.
- Provide critical input to implementing the feasibility study.
- Develop public opinion and outreach concepts.

The majority of the meeting was devoted to presentations made by the project partners. Presentations included:

- Background and overview of the project concept.
- Review of project elements and challenging topics.
- Public outreach.

3. Finding and Recommendations

The findings and recommendations are organized under the following categories:

- Project Development
- Nevada Regulations
- Community Outreach
- Pilot testing technologies/demonstration project
- Hydrogeologic Investigations
- Funding

3.1 Project Development

Regarding project development, the Panel recommends clearly and succinctly defining the project purpose to communicate the challenge and value of the potential project. Consider the following:

- Describe the long term view on water supply for the region and planning for future water resilience in the face of climate variability, changing regulations, limited water resources, and water rights.
- Highlight sustainable and integrated water management in the region through regional collaboration.
- Emphasize the leadership role of the University of Nevada, Reno to further build public confidence.

3.2 Nevada Regulations

The state of Nevada has adopted regulations that enable indirect potable reuse (IPR) via groundwater recharge. The changes add a new category of reclaimed water (category A+) that may be used to augment groundwater by surface spreading basins or injection wells.

To address the threat posed by pathogenic microorganisms the proposed regulations specify the following:

- A+ reclaimed water must have been subjected to a:
    - 12-log enteric virus reduction, which must be demonstrated from the point where raw sewage enters a treatment works to the point of extraction from an aquifer for potable use.
    - 10-log *Giardia lamblia* cyst reduction and ten-log *Cryptosporidium* oocyst reduction, which must be demonstrated from where raw sewage enters the treatment works to the zone of saturation.
- For a spreading basin:
    - Reclaimed water discharged to the basin must meet the minimum requirements for bacteriological quality for reuse category A (i.e., maximum 30-day geometric mean total

coliform CFU or MPN of 2.2/100 mL with a maximum daily total coliform CFU or MPN of 23/100 mL).

- Each month reclaimed water is retained underground may be credited with 1-log enteric virus reduction. Up to 10-log *Giardia lamblia* cyst reduction and up to 10-log *Cryptosporidium* oocyst reduction may be credited for treatment within the vadose zone.

- For an injection well:
  - Reclaimed water must pass through a minimum of three separate treatment processes for pathogen removal. A treatment process may be credited with a maximum of 6-log reduction and a minimum of 1-log reduction.
  - For *Giardia lamblia* cyst reduction and *Cryptosporidium* oocyst reduction, the point of compliance is at the point of injection.
  - For each month such reclaimed water is retained underground, the Division may credit the reclaimed water with 1-log enteric virus reduction. The point of compliance is the point of extraction.
- Evidence of the efficacy of engineered or natural treatment used to meet the organism log reduction requirements must be provided.

To address the threat posed by chemicals and physical constituents the regulations specify the following:

- The A+ reclaimed water compliance point for primary and secondary drinking water standards is the zone of saturation.
- The project proponent must provide a plan to address unregulated constituents of potential health concern. The plan must include a monitoring program for unregulated constituents and must identify surrogates and indicators used to demonstrate compliance with specific reduction goals for unregulated constituents.
- Assessment of the wastewater source control for the production and use of the reclaimed water is required.

There are requirements for underground injection control which state that injection may not endanger or degrade groundwater as a source of drinking water.

The proposed regulations are not definite with regard to where and how compliance with certain requirements or objectives is to be demonstrated. This has the benefit of allowing the project permit to be adjusted to fit site-specific circumstances. It also means, however, that a great deal of thought must go into the development of site-specific permit requirements that assure the regulation objectives are achieved. The permit writer must fully understand how the natural and engineered treatment facilities of the IPR project function to control health threats and what permit limits will assure compliance.

A critical step in the permit development is the validation of the organism log reductions credited to each treatment process. To validate a treatment log reduction value (LRV), the study would identify the

organism removal mechanism(s), identify the study organism, identify the operational factors that affect treatment performance, identify the operational parameters that can be correlated with log reduction performance, demonstrate a correlation of the LRV to be credited, and identify the operational parameter limits that can be included in a permit.

The LRV validation for the subsurface reduction of virus and protozoa depends upon the method of groundwater recharge (spreading or injection) and on the accurate determination of travel time.

- Full-scale spreading projects have shown 4 to 5-log reduction of virus, unrelated to travel time (Hogg et al., 2013). To the best of the Panel's knowledge, removal through subsurface saturated zones (e.g., groundwater injection instead of spreading) has yet to be demonstrated.
- The literature supports conservative virus inactivation with time (Drewes et al., 2014; Peng et al., 2008).
- The validation for protozoa (*Giardia* and *Cryptosporidium*) reduction during soil-aquifer transport could be based on suitable studies reported in the scientific literature (e.g., Hogg et al. 2013) if the conditions represent project conditions, or on a study addressing the validation elements mentioned above. Soil column studies used to determine LRVs can be correlated with some parameter that can be measured at the project spreading basins, though no effective surrogate other than time has been demonstrated to date. Column studies, which can represent removal through spreading and/or groundwater injection and subsurface transport show substantial promise for pathogen removal (Trussell et al., 2015; Trussell et al., 2017).
- The regulator will need to know to what extent soil column results can be relied on to predict project soil aquifer treatment performance.

The treatment demonstration studies present an opportunity for regulators to determine the type and quantity of data needed to credit LRVs. It is also the best time to identify the operational surrogate monitoring and compliance limits that will be used in the permit. Nevada regulators should be invited to be involved in the design of the treatment demonstration studies.

3.3 Community Outreach

The following items that should be considered related to communications and outreach for the effort:

- A phased outreach approach for informing and educating stakeholders and the public about the project should be considered. See attached Example of Phasing approach prepared by Data Instincts for King County WA in **Appendix C**.

- Start the next phase of outreach and messaging regarding the project with the internal staffs of partnering agencies and electeds of the various participating agencies. This experience will help to validate the messages.

- Develop a summary of similar ozone/BAF water reuse projects, including pilots and full-scale projects. Review the approaches for outreach to their communities of these projects. The Panel could facilitate a discussion of a range alternative plans and approaches. Examples include O_3/BAF projects (without RO) for potable water reuse, either full-scale or demonstration scale, including Altamonte Springs Florida (demonstration), Hampton Roads Sanitary District Virginia (demonstration), El Paso Texas (full-scale), Rio Rancho New Mexico (full-scale), and Gwinnett County Georgia (full-scale).

3.4 Pilot Testing Technologies / Demonstration Project

General

- The Panel requests that the project team provide the results of the pilot testing of treatment technologies at the South Truckee Meadows Water Reclamation Facility to the Panel. A full summary of results is necessary for the Panel to make informed suggestions.
- Regarding source control, the project team should review the new regulations and make suggestions on a program. For instance, what type of assessment and program objectives is needed? The project team can begin to formulate a plan by building on pretreatment programs.
- The demonstration project should serve as a training opportunity for operators, directly in line with the upcoming California/Nevada AWWA Advanced Water Treatment Certification program[1]. Operators can participate in start-up, commissioning and operating the demonstration facility. In addition, academic researchers should collaborate with the operators.
- The project team should continue the involvement of regulators in the planning and implementation of the project, including review of the demonstration facility test plan and of progress reports.
- The Panel requests that reports from the efforts by University of Nevada Reno be provided to the panel for review, including:
    - UNR task 1 – Project Rationale and Justification
    - UNR task 2 – Treatment Technologies Evaluations
    - UNR task 3 – Basis of Design – Demonstration Projects
    - UNR task 4 – Operating and Testing Plan

Treatment Train Configuration for IPR – Pathogen Crediting

- The treatment train proposed by the project team to treat secondary effluent for direct injection is COAG-FLOC-SED-FILT-O3-BAC-UV (i.e. coagulation-flocculation-sedimentaton-filtration-ozone-biologically activated carbon-ultraviolet light). The treatment train must be able to meet the public health objectives for pathogens. The Regional Team is preliminarily predicting the following log removals for the proposed treatment train:

Process	Virus Log Removal	*Giardia* Log Removal	*Cryptosporidium* Log Removal
Secondary Treatment	2	2	1
COAG-FLOC-SED-GMF	0	3	3
Ozonation	6	TBD	TBD
BAC	TBD	TBD	TBD
UV	5	6	6

[1] For further information, contact Steven Garner at sgarner@ca-nv-awwa.org.

Process	Virus Log Removal	*Giardia* Log Removal	*Cryptosporidium* Log Removal
Saturated Zone Travel Time	6	0	0
Total Log Reduction	19	12+	11+
Required Log Reduction	12	10	10

Regarding the listed LRVs, the Panel's perspective is as follows:

- **Primary/Secondary Treatment -** Pathogen crediting for secondary treatment is still evolving within the regulatory community (Olivieri et al., 2016). Two projects in California (i.e., Water Replenishment District Leo J. Vander Lans AWTF Expansion and City of Los Angeles Terminal Island Water Reclamation Plant AWPF Expansion) – were approved at 2-log virus, 2-log *Giardia*, and 1-log *Cryptosporidium* and 1.9-log virus, 0.8-log *Giardia*, and 1.2-log *Cryptosporidium*, respectively, using a literature-based crediting approach relying on data from the Rose et al. (2004) study along with a microbial risk assessment model. This approach has been accepted by California regulators (i.e., the State Water Resources Control Board's Division of Drinking Water or DDW) when the secondary treatment process is conventional activated sludge with nitrification-denitrification (NDN). Literature-based values for trickling filters with solids contact and/or lack of NDN may be more difficult to accept and to our knowledge have not been previously credited. As a result, the 2/2/1 log removal values in the table may be overstating the removal pending a review of the potential wastewater treatment plants (WWTPs) that may feed the advanced water treatment facilities (AWTFs). If any of the WWTPs in the region employ a form of secondary treatment less than NDN, then lower LRVs may be appropriate and a site-specific study of pathogen removal may be warranted.

- **COAG-FLOC-SED-GMF -** The Panel is not aware of where pathogen crediting has been established for COAG-FLOC-SED-GMF (GMF means granular media filtration) using the U.S. EPA drinking water approach (USEPA, 1998; USEPA, 2006; USEPA 2010) for wastewater reclamation. U.S. EPA criteria rely upon turbidity reduction to correlate with virus and protozoa removal (see Table 1, below). While the COAG-FLOC-SED-GMF will assist with TOC removal and improving water quality prior to ozonation, it is recommended that some demonstration testing would be needed to determine that the pathogen crediting based application of USEPA drinking water criteria to wastewater. As a result, the 0/3/3 log removal in the above table should be verified through testing and discussed with regulators. Hampton Road Sanitation District (HRSD) in Virginia has piloted a variation on the proposed treatment train using COAG-FLOC-SED-O3-BAC-GAC-UV (GAC: granular activated carbon). It should be possible to inquire about how HRSD is going to provide log removal credits for *Giardia* and *Cryptosporidium* for COAG-FLOC-SED in their pilot study.

- **COAG-FLOC-SED-GMF Alternative -** The project team suggested that GMF-based treatment train may be preferred over ultrafiltration (UF) as part of the treatment train. It may be useful for the project team to evaluate UF as an alternative to COAG-FLOC-SED-GMF. UF could provide some advantages with respect to pathogen crediting for protozoa (which is well-established nationally) and a reduced footprint. It is anticipated that UF could receive 0/4/4 credit, which is

Table 1: Summary of Existing and Potential Log Reduction Credits for Filtration at Conventional Surface WTPs (Adapted from NWRI, 2015)

Water Treatment Process	Required Benchmark	Current Log Removal Credits			Potential Log Removal Credits		
		G	C	V	G	C	V
Filtration Credit (Conventional)	<0.3 NTU 95% of the time, and never >1 NTU(1)	2.5	2.5	2	2.5	2.5	2
Combined Filter Turbidity Credit	<0.15 NTU 95% of the time(2)	--	--	--	0.5	0.5	--
Individual Filter Turbidity Credit	Each filter <0.15 NTU 95% of the time, and never >0.3 NTU(3)	--	--	--	0.5	0.5	--

1. Turbidity requirements on filters are prescribed in Interim Enhanced Surface Water Treatment Rule (IESWTR). Filter turbidity readings are collected every 15 minutes at each filter, and combined turbidity is measured every four (4) hours (USEPA, 1998).
2. Additional 0.5-log combined filter effluent (CFE) turbidity credit for *Cryptosporidium* can be achieved per Long Term 2 LT2 (USEPA, 2006). The same credit should be given to *Giardia*. Filter optimization may allow the WTP to meet these criteria reliably to achieve an additional 0.5-log protozoa credit (USEPA, 2010).
3. Additional 0.5-log individual filter effluent turbidity credit for *Cryptosporidium* can be achieved per LT2 (USEPA, 2006). The same credit should be given to *Giardia*. Filter optimization may allow the WTP to meet these criteria reliably to achieve an additional 0.5-log protozoa credit (USEPA, 2010).

more than what is being proposed by the COAG-FLOC-SED-GMF. This additional level of credits would add robustness and redundancy to the treatment train and reduce the need of relying on other treatment steps for credit. As with all membranes, water quality impacts on fouling should be considered and an engineering economic analysis should be performed comparing UF to COAG-FLOC-SED-GMF. Past potable reuse demonstration projects in San Diego, California and Altamonte Springs, Florida have shown significant improvements in UF performance (increase in flux rate (potentially double) and decrease in cleanings and thus decrease in both construction and operations cost) with O3-BAC upstream of UF.

- **Ozone -** Pathogen crediting for ozonation in wastewater/reuse applications is still new, but there is precedent with recent validation studies and challenge testing. California's DDW conditionally approved ozonation for unrestricted, non-potable reuse showing 6.5 log reduction of MS2 phage at a CT of 1 mg*min/L (Carollo Engineers, 2008). A more recent validation study and analysis indicated a good correlation between O3:TOC ratio and virus inactivation showing a 6.5 log reduction of MS2 at an O3:TOC ratio of 0.75 and higher (Xylem, 2015). However, neither of these studies evaluated *Giardia* or *Cryptosporidium* log reduction. The City of San Diego's North City Water Reclamation Plant (NCWRP) is currently applying for pathogen credit with DDW using the U.S. EPA's CT tables to receive a 1-log *Cryptosporidium* credit along with 6-log virus and 6-log *Giardia*. The project team should review the O3:TOC and CT levels for the ozonation system that was piloted and compare the information to the referenced projects, California Water Recycling Criteria and U.S. EPA requirements. High ozone doses can increase DBP formation (e.g., NDMA and bromate). While the formation of NDMA can be mitigated by downstream BAC and UV, the proposed treatment train will not be able to mitigate the

formation of bromate. Additional demonstration testing may be needed to ensure that both the pathogen log reduction credit and bromate MCL can be simultaneously achieved. Pertaining directly to the research teams listed credits (6-log virus, TBD protozoa), 6-log virus credit for ozonation is technically attainable, but has not been granted previously by a regulatory agency. To obtain *Giardia* and *Cryptosporidium* credit the CT concept would need to be used. From the Panel's perspective, utilizing a robust protozoa barrier such as UF allows for 4+ LRV of protozoa. Utilizing an O3:TOC dosing strategy without an ozone residual allows for robust virus reduction while potentially reducing formation of bromate or NDMA.

- **UV -** Pathogen crediting for UV in wastewater and reuse is well established. The Panel believes that the above estimate is conservative and the Regional Team should be able to achieve 6/6/6 based on many precedents. This assumes that the UV dose is high enough (>276 mJ/cm^2), which is used for photolysis applications involving NDMA. The UV dose of the proposed project should be confirmed. For UV, a 5-log virus credit is included in the above table. Can the project team confirm for the Panel that this was determined using adenovirus and what UV dose was used to determine the LVR?

- **Travel Time -** A 6-month travel time needs to be confirmed to achieve the 6-log reduction for virus via soil aquifer treatment. Modeling and/or a tracer study should be considered.

Treatment Train Configuration for IPR via Direct Injection – Chemical Control

- The currently proposed treatment train by the project to treat secondary effluent for direct injection is COAG-FLOC-SED-FILT-O3-BAC-UV. The treatment train must be able to meet the public health objectives for treatment chemical criteria.

- The Panel suggests that GAC be evaluated after O3-BAC and ahead of UV. This additional treatment step will have the benefits of removing CECs that pass through O3-BAC, providing additional TOC removal to minimize basin degradation and reduce DBP formation and chlorine demand in downstream drinking water wells, and to further improve the quality of water and significantly reduce the cost of the UV system.

- The Panel suggests that the fate of N-nitrosomorpholine (NMOR) be evaluated through the treatment train. The CEC Science Advisory Panel in California in a recent draft final report has identified NMOR as a human health indicator in their update of monitoring trigger levels (MTLs) based on available toxicological information. It is anticipated that UV photolysis will reduce the NMOR to some degree. Depending upon NMOR and NDMA concentrations ahead of UV, the UV dose (and thus UV cost) may need to be higher than for UV disinfection only, potentially requiring a dose two or three times greater than the dose needed for disinfection.

- The project team should consider testing the treatment train with and without GAC for evaluating TOC removal and CEC removal. In particular, perfluorooctanesulfonate acid (PFOS) and perfluorooctanoic acid (PFOA) removal should be tested based on the health criteria levels listed in the 2017 U.S. EPA Health Advisory.

Soil Aquifer Treatment

The benefit of Soil Aquifer Treatment (SAT) for pathogen removal was reviewed previously in this document. SAT also provides the benefit of TOC and chemical degradation/reduction. The project team should consider the use of column studies for demonstrating pathogen and chemical removal (TOC, DBPs, CECs, etc.). Previous studies have shown a significant reduction of TOCs, DBPs, and CECs through soil aquifer treatment (Trussell et al, 2015; Trussell et al., 2017). Should such studies proceed, careful consideration of the future spreading location should be done, to allow for the column studies to use representative soil samples for testing.

3.5 Hydrogeologic Investigations

The Panel has the following comments related to hydrogeologic investigations:

- The Panel requests additional information for planned surface recharge and injection recharge test sites. Such information would include basic and available hydrogeologic data such as aquifer type, formation materials, depth to water, hydraulic gradient, and water chemistry.
- Soil column testing would be best conducted using sediments from potential full-scale recharge sites in parallel with current tests at sites that are not being considered for full scale recharge operations.
- For any planned surface recharge or injection well sites, provide the Panel access to relevant geologic and engineering investigation reports and the results of any past studies of these sites.
- Provide a numerical evaluation that demonstrates the anticipated impact of a 10 to 30 gpm recharge test on base conditions. Such an evaluation could be a monitoring well siting plan that illustrates the spacing and expected water level changes at the wells from a 10 to 30 gal/min recharge rate following the anticipated test period (one year or less). The well spacing and design should be based on groundwater flow equations or mathematical models using known or approximate aquifer parameters and conditions.
- The value of a 10 to 30 gpm demonstration project is limited to the created and observable impacts on water levels and water quality. If conducted, at a test basin, such a test would best use as small a footprint recharge basin as possible to match the source water supply rate to increase opportunity to make locally measurable and meaningful observations. For surface recharge at this rate, monitoring groundwater level changes and quality may be difficult depending of the depth to groundwater and near surface heterogeneity. Thus, recharge monitoring should include utilizing lysimeters constructed from 5 to 30 feet below the bottom of the test basin.
- Provide the work plan for the Cold Springs lysimeter installation, monitoring, and sampling protocols for Panel review as well as other known hydrogeologic site details.
- For both an injection test and surface recharge test, the 10 to 30 gpm recharge rate might not be valuable for transport monitoring due to blending or potentially small water level changes, but may be useful in assessing potential for geochemical incompatibilities or well biofouling using the project source water. A large blending ratio of recharge water, local groundwater, or

past larger scale recharge water sources may make detection of chemical changes difficult at the groundwater table.

3.6 Funding

The Panel recommends taking the following actions related to funding:

- Consider developing a funding strategy for various aspects of the project.
- Brief existing lobbyists on scope of project (both state & federal).
- Apply for water related grants. Since they are very competitive, consider the use of lobbyists at a state and federal level.
- Alert partner staff to the need – educate them on project aspects that could potentially qualify for grants. Assign the areas of focus and effort regarding maximizing opportunities for grants and low interest loans.
- Include the grant funding effort and success within the public engagement components of this project.
- Consider funding opportunities that look at unique characteristics of your geographic and demographic region: social justice, regional sharing of water resources, economic development.

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Appendix A: Panel Biographies

Jim Crook, Ph.D., P.E., Water Reuse and Environmental Engineering Consultant (Boston, MA). Jim Crook is an environmental engineer with more than 45 years of experience in state government and consulting engineering arenas, serving public and private sectors in the U.S. and abroad. He has authored more than 100 publications and is an internationally recognized expert in water reclamation and reuse. He has been involved in numerous projects and research activities involving public health, regulations and permitting, water quality, risk assessment, treatment technology, and all facets of water reuse. Crook spent 15 years directing the California Department of Health Services' water reuse program, during which time he developed California's first comprehensive water reuse criteria. He also spent 15 years with consulting firms overseeing water reuse activities and is now an independent consultant specializing in water reuse. He currently serves on several advisory panels and committees sponsored by NWRI and others. Among his honors, he was selected as the American Academy of Environmental Engineers' 2002 Kappe Lecturer and the WateReuse Association's 2005 Person of the Year. Crook received a B.S. in Civil Engineering from the University of Massachusetts and both an M.S. and Ph.D. in Environmental Engineering from the University of Cincinnati.

Robert H. Hulquist, P.E., Retired, Chief of the Drinking Water Technical Operations Section, California Department of Public Health (Sacramento, CA). Bob Hultquist retired from the Division of Drinking Water and Environmental Management at the California Department of Public Health (CDPH) after over 30 years of service. Over the course of his career, he worked closely with all regions of California regarding the permitting of recycled water projects. At CDPH, Hultquist was responsible for the development of criteria for drinking water and recycled water regulations for the State of California. He was the lead author of the California's Draft Groundwater Recharge Reuse Regulations, which regulate the recharge of groundwater with recycled water. At present, he works for CDPH on a part-time basis on finalizing the draft Recharge Regulations and regulations for the augmentation of surface water bodies with recycled water. Hultquist received a B.S. in Civil Engineering from San Diego State University and an M.S. in Sanitary Engineering from the University of California, Berkeley. He is a registered civil engineer in California.

Andrew Salveson, P.E., Water Reuse Chief Technologist, Carollo Engineers (Walnut Creek, CA). Andy Salveson is Vice President and Water Reuse Chief Technologist at the national engineering firm of Carollo Engineers, Inc., where he leads advanced technology research and development and oversees Carollo's advanced wastewater treatment designs. He leads the planning, permitting, and design of direct and indirect potable reuse facilities across the Southwestern United States. He has led more than $6 million in advanced treatment research, including numerous projects for the California Direct Potable Reuse Initiative. In addition, he serves on an NWRI Independent Advisory Panel for the development of potable reuse regulatory guidance in New Mexico, as well as serves on the World Health Organization's team to develop international guidelines for direct and indirect potable reuse. Salveson received a BS in Civil Engineering from San Jose State University and an M.S. in Environmental Engineering Technology/Environmental Technology from the University of California, Davis.

Keel Robinson, Trussell Technologies (Oakland, CA). Keel Robinson has over 22 years of experience as a professional in industrial process, environmental remediation, municipal drinking water, municipal wastewater, and reuse applications including ion exchange, adsorption, membranes, and oxidation. Keel's career began as a field service engineer at U.S. Filter (now Evoqua) leading full-scale start-ups of large process and water treatment systems. He then became a process and application engineer leading

the treatability testing and equipment sizing to design full-scale treatment systems. This "real-world field experience" and "process expertise" has since provided the foundation for Keel to excel at various engineering and management positions throughout his career working for both an environmental consultant (URS, now AECOM) and equipment manufacturers (APTwater and Xylem). Keel in involved with projects ranging from drinking water to wastewater with an emphasis for water reuse. He is a recognized expert in ozone- and UV-based oxidation processes along with being a thought leader in advanced treatment reuse applications. He has lead the pilot-scale, demo-scale, and full-scale implementation of numerous innovative potable reuse technologies including UV/chlorine AOP, Ozone/peroxide AOP, and Ozone/BAF applications that have advanced the state of water treatment throughout the USA. Keel has a B.S. in Chemical Engineering from the University of Wisconsin at Madison.

Andy Campbell, PG, CHG, Deputy Manager of Planning, Water Resources at Inland Empire Utilities Agency. Andy Campbell serves as the Groundwater Recharge Coordinator and Hydrogeologist of the Inland Empire Utilities Agency (IEUA). In this capacity, he manages the operation and maintenance for the Chino Basin Recycled Water Groundwater Recharge Program, which include recycled water and imported water distribution systems, and storm water capture infrastructure. He has implemented the start-up testing of 10 recycled water recharge sites and has been instrumental in updating IEUA recharge permits. As IEUA's Hydrogeologist, he provides planning and engineering guidance and review of recharge master plan projects, the preparation of the Santa Ana River Watermaster reports, and the preparation of program compliance reports. Before joining IEUA, he served as a Project Manager/Hydrogeologist for URS Corporation and as a Hydrogeologist for the Orange County Water District. Campbell received a BS in Geology/Earth Science from California State Polytechnic University, Pomona, is a California Professional Geologist and Certified Hydrogeologist.

Mark Millan, Principal, Data Instincts. Mark Millan is the principal of Data Instincts, Public Outreach Consultants – a professional consultancy specializing in public outreach and public engagement for implementing recycled water projects. Mark has over 35 years of experience in marketing and public relations with the last twenty-two focusing on recycled water related projects and issues. Millan's firm has introduced new techniques to the public involvement and outreach process for recycled water projects and has conducted extensive surveys and focus groups on public perceptions of recycled water uses. For seven years he served nationally as Chair of the Public Outreach and Education Committee for the WateReuse Association (WRA), and recently co-authored the WateReuse Research Foundation's *Developing Model Communication Plans for Advancing Awareness and Fostering Acceptance of Potable Reuse* with Patsy Tennyson, Katz & Associates and Dr. Shane Snyder, University of Arizona.

Appendix B: Meeting Agenda

Independent Advisory Panel:
Northern Nevada Indirect Potable Reuse Feasibility Study

Meeting Agenda

January 26, 2018
8:30 am – 3:30 pm

Location	**Contacts:**
Truckee Meadows Water Authority 1355 Capital Blvd Reno, NV 89502	**Jeff Mosher, WRF** 714-705-3722 (cell) **Fidan Karimova, WRF** 240-273-2637 (cell) **Lydia Peri (Washoe County)** 775-762-6108 (cell)

Meeting Objectives:

- Critical review and insights on feasibility study activities
- Discuss planning to implement the technology demonstration project
- Discuss demonstration projects for spreading basin option and direct injection option

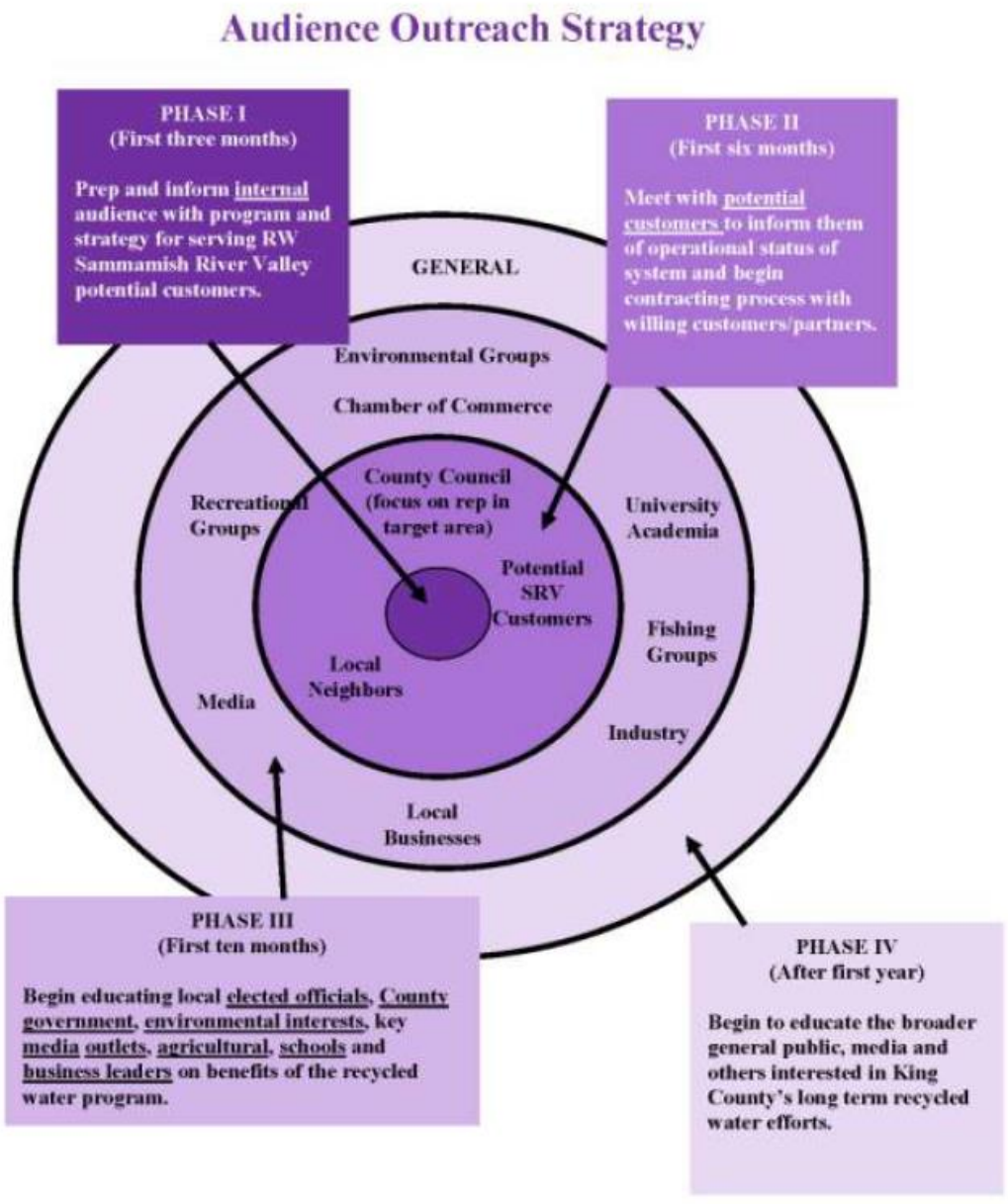
Friday, January 26, 2018

8:30 am	Welcome and Introductions	Jeff Mosher
8:45 am	Meeting Objectives	Lydia Peri, Washoe County
9:00 am	Review Project Elements & Challenging Topics	Rick Warner, Washoe County John Enloe, TMWA
9:45 am	**BREAK**	
10:00 am	Review Project Elements & Challenging Topics	Rick Warner, Washoe County John Enloe, TMWA
12:00 noon	**Lunch**	
12:45 pm	Project Overview & Discussion	Rick Warner, Washoe County Jeff Mosher
2:15 pm	Final Thoughts	Jeff Mosher
2:30 pm	Panel Only Discussion	Panel
3:30 pm	**ADJOURN**	

Appendix C: Example of Phasing approach prepared by Data Instincts for King County

Outreach Scheduling

Example graphic of a phased outreached approach.



IAP Comments and Responses

Pathogen Log Reduction Value (LRV)

Comments	Responses
To validate a treatment log reduction value (LRV), identify: • Organism • Organism removal mechanism(s) • Operational factors that affect treatment performance • Operational parameters that can be correlated with log reduction performance • Correlation of the LRV to be credited • Operational parameter limits that can be included in the permit.	UNR-Washoe County team is currently investigating and evaluating LRV credits across WesTech Trident HS (Coag-Floc-Sed-Filtration) and Xylem Oxelia (Ozone-BAC) treatment units at STMWRF as part of the Washoe County's USBR Low Energy Treatment Project.
Soil Column studies, which can represent removal through spreading and/or groundwater injection and subsurface transport show substantial promise for pathogen removal.	UNR-Washoe County team is currently planning the soil column studies for pathogen removal evaluation to be conducted at Cold Springs WRF.

Coag-Floc-Sed-Granular Media Filtration

Comments	Responses
Hampton Road Sanitation District (HRSD) in Virginia has piloted a variation on the proposed treatment train using COAG-FLOC-SED-O3-BAC-GAC-UV. It should be possible to inquire about how HRSD is going to provide LRV for Giardia and Cryptosporidium for COAG-FLOC-SED in their study.	UNR team has requested pathogen removal data from HRSD.
It is anticipated that UF could receive 0/4/4 credit, which is more than what is being proposed by the COAG-FLOC-SED-GMF. This additional level of credits would add robustness and redundancy to the treatment train and reduce the need of relying on other treatment steps for credit.	The proposed 0/3/3 LRV credit with COAG-FLOC-SED-GMF will be verified at STMWRF. Based on the verification results, UNR team will confirm the type of the filtration barrier for RSWRF injection well demonstration project (i.e., UF vs. COAG-FLOC-SED-GMF). Washoe County is working with Stantec to develop design for IPR research trailer (i.e., UV-GAC trailer), which will have the flexibility to house an UF unit, if needed.

Coag-Floc-Sed-Granular Media Filtration

Comments	Responses
Water quality impacts on fouling should be considered and an engineering economic analysis should be performed comparing UF to COAG-FLOC-SED-GMF. Past potable reuse demonstration projects in San Diego and Altamonte Springs, Florida have shown significant improvements in UF performance (increase in flux rate (potentially double) and decrease in cleanings and thus decrease in both construction and operations cost) with O3-BAC upstream of UF.	Upon completing the COAG-FLOC-SED-GMF pathogen removal investigation at STMWRF, UNR team will develop an engineering economic analysis comparing the two filtration barrier options. COAG-FLOC-SED-GMF option may offer advantages such as heavy metal removal and potentially enhanced TOC removal when compared to UF option. UNR team is currently investigating this at STMWRF.

Ozone-BAC

Comments	Responses
California's DDW conditionally approved ozonation for unrestricted, non-potable reuse showing 6.5 log reduction of MS2 phage at a CT of 1 mg*min/L (Carollo Engineers, 2008). A more recent validation study and analysis indicated a good correlation between O3:TOC ratio and virus inactivation showing a 6.5 log reduction of MS2 at an O3:TOC ratio of 0.75 and higher (Xylem, 2015). However, neither of these studies evaluated Giardia or Cryptosporidium log reduction.	UNR team will evaluate Giardia and Crypto log reduction across ozonation and BAC treatment process as part of the Washoe County's USBR project.

GAC

Comments	Responses
The Panel suggests that GAC be evaluated after O3-BAC and ahead of UV. This additional treatment step will have the benefits of removing CECs that pass through O3-BAC, providing additional TOC removal to minimize basin degradation and reduce DBP formation and chlorine demand in downstream drinking water wells, and to further improve the quality of water and significantly reduce the cost of the UV system.	Washoe County is working with Stantec to develop IPR research trailer design, which will include GAC treatment step.

UV

Comments	Responses
This assumes that the UV dose is high enough (>276 mJ/cm2), which is used for photolysis applications involving NDMA. The UV dose of the proposed project should be confirmed. For UV, a 5-log virus credit is included in the above table. Can the project team confirm for the Panel that this was determined using adenovirus and what UV dose was used to determine the LVR?	Washoe County is working with Stantec to develop IPR research trailer design, which will include UV system. UNR team will investigate and confirm the log reduction value across UV utilizing adenovirus once IPR research trailer is available.
It is anticipated that UV photolysis will reduce the NMOR to some degree. Depending upon NMOR and NDMA concentrations ahead of UV, the UV dose (and thus UV cost) may need to be higher than for UV disinfection only, potentially requiring a dose two or three times greater than the dose needed for disinfection.	UV system currently under design is being designed with flexibility to be operated in both disinfection (low dose) and photolysis (high dose) mode.

CEC Monitoring

Comments	Responses
The project team should consider testing the treatment train with and without GAC for evaluating TOC removal and CEC removal. In particular, perfluorooctanesulfonate acid (PFOS) and perfluorooctanoic acid (PFOA) removal should be tested based on the health criteria levels listed in the 2017 U.S. EPA Health Advisory.	UNR team has included PFOS and PFOA to the monitoring list. Additional information can be found in Task 4 Draft Report.
The Panel suggests that the fate of N-nitrosomorpholine (NMOR) be evaluated through the treatment train. The CEC Science Advisory Panel in California in a recent draft final report has identified NMOR as a human health indicator in their update of monitoring trigger levels (MTLs) based on available toxicological information.	UNR team has included NMOR to the monitoring list. Additional information can be found in Task 4 Draft Report.

Soil Columns and Injection Wells

Comments	Responses
The project team should consider the use of column studies for demonstrating pathogen and chemical removal (TOC, DBPs, CECs, etc.). Previous studies have shown a significant reduction of TOCs, DBPs, and CECs through soil aquifer treatment	UNR-Washoe County team is currently planning the soil column studies for chemical and pathogen removal evaluation to be conducted at Cold Springs WRF.
Provide a numerical evaluation that demonstrates the anticipated impact of a 10 to 30 gpm recharge test on base conditions.	TMWA has numerically evaluated the impact of recharge and determined that based on travel time, soil conditions and distance between new monitoring wells, a recharge rate of >25 gpm is needed to see an impact
Recharge monitoring should include utilizing lysimeters constructed from 5 to 30 feet below the bottom of the test basin.	Lysimeters will be installed at 5, 10, 15, 20 & 25 feet below the surface of the test basin. Additional shallow monitoring wells will be installed downgradient of the test basins
Provide the work plan for the Cold Springs lysimeter installation, monitoring, and sampling protocols for Panel review as well as other known hydrogeologic site details.	Washoe County with assistance from TMWA is currently developing a work plan and applying for MW permits. Sampling plans are being developed based on similar SAT projects. A brief report of hydrogeologic site details is being prepared – there are several hydrogeologic studies that have been performed at Cold Springs, but additional infiltration test are needed.
The regulator will need to know to what extent soil column results can be relied on to predict project soil aquifer treatment performance.	Soil columns will be packed with cores directly from test basins and will simulate current conditions as best as possible. Soil columns will provide flexibility to change conditions but lysimeters and MW's will illustrate current SAT performance.

NDEP and Other Topics

Comments	Responses
The treatment demonstration studies present an opportunity for regulators to determine the type and quantity of data needed to credit LRVs. It is also the best time to identify the operational surrogate monitoring and compliance limits that will be used in the permit. Nevada regulators should be invited to be involved in the design of the treatment demonstration studies.	For discussion during the June 15th meeting.
The Panel requests that the project team provide the results of the pilot testing of treatment technologies at the South Truckee Meadows Water Reclamation Facility to the Panel. A full summary of results is necessary for the Panel to make informed suggestions.	Results from STMWRF pilot testing conducted as part of the WRF Reuse-15-10 project is currently being compiled and will be available at the end of Q3 of 2018.
The project team can begin to formulate a plan by building on pretreatment programs.	For discussion during the June 15th meeting.

NDEP and Other Topics

Comments	Responses
The demonstration project should serve as a training opportunity for operators, directly in line with the upcoming California/Nevada AWWA Advanced Water Treatment Certification program. Operators can participate in start-up, commissioning and operating the demonstration facility. In addition, academic researchers should collaborate with the operators.	For discussion during the June 15th meeting.
The project team should continue the involvement of regulators in the planning and implementation of the project, including review of the demonstration facility test plan and of progress reports.	For discussion during the June 15th meeting.

Community Outreach

Comments	Responses
Phase outreach approach. Start the next phase of outreach and messaging regarding the project with the internal staffs of partnering agencies and electeds of the various participating agencies	Team is currently working with Data Instincts on developing content and handouts for project. Once that is complete, the next phase is to begin educating internal staff and electeds.
Develop a summary of similar ozone/BAF water reuse projects, including pilots and full-scale projects. Review the approaches for outreach to their communities of these projects.	Currently have HRSD's outreach materials and have had a meeting with their PIO. Team will continue to gather information on other project successes and failures