FINAL MEMORANDUM

Date: June 26, 2018

To: David Pedersen, General Manager, Las Virgenes Municipal Water District

From: Amy Childress, Ph.D.
Chair, NWRI Independent Advisory Panel for Las Virgenes-Triunfo Pure Water Project

Kevin M. Hardy, J.D., Executive Director, National Water Research Institute

Subject: NWRI Independent Advisory Panel for Las Virgenes-Triunfo Pure Water Project: Findings and Recommendations from the Panel Meeting held May 4, 2018

The National Water Research Institute (NWRI) is pleased to provide this consensus memorandum of the findings and recommendations of the NWRI Independent Advisory Panel (Panel) to review the Las Virgenes-Triunfo Pure Water Project (Project), a proposed indirect potable reuse project involving surface water augmentation (SWA) of the Las Virgenes Reservoir in Westlake Village, California.

The Panel was established by NWRI in 2018 at the request of the Las Virgenes-Triunfo Joint Powers Authority to provide a third-party peer review of the technical, scientific, regulatory, and policy aspects of the proposed Project. Members of the Panel included:

- Panel Chair: Amy Childress, Ph.D., University of Southern California
- Michael Anderson, Ph.D., University of California, Riverside
- Richard Bull, Ph.D., MoBull Consulting
- William Mitch, Ph.D., P.E., Stanford University
- Matthew Verbyla, Ph.D., San Diego State University

Biographies of the Panel Members are provided in **Attachment A.**

A meeting of the Panel was held on May 4, 2018, at the Las Virgenes Municipal Water District in Calabasas, California. The objectives of the meeting included:

- Provide the Panel with an overview of the Pure Water Project, including historical information and drivers for the project.

- Present information to assist the Panel in evaluating both (1) the validity of the Reservoir Model and (2) the results of various operational scenarios evaluated by the Reservoir Model.

- Solicit Panel feedback on (1) the results of the Reservoir Model and (2) the feasibility of the Pure Water Project to comply with reservoir requirements of the SWA regulations.

The meeting agenda is provided in **Attachment B**, and meeting attendees are listed in **Attachment C**.

All six Panel members reviewed pre-meeting documents, participated at the meeting and an on-site tour of the Las Virgenes Reservoir and Westlake Filtration Plant, and prepared and reviewed this memorandum before it was finalized.

PROJECT BACKGROUND

The Las Virgenes Municipal Water District (LVMWD) and the Triunfo Sanitation District (TSD) created the Las Virgenes-Triunfo Joint Powers Authority (JPA) in 1964 to plan and support construction, operations, and maintenance for a joint wastewater treatment system. Beginning in 1972, the JPA began serving recycled water treated at the Tapia Water Reclamation Facility (WRF) to customers for landscape irrigation. All water produced by the 12-million gallons per day (MGD) facility is treated to Title 22 standards for disinfected tertiary recycled water.

Although the Tapia WRF generates a steady supply of recycled water, the quantity required to meet the community's irrigation needs varies significantly between the dry summer months and the wetter months of winter. In the winter, excess recycled water not needed by customers is discharged to surface water or sprayed on fields maintained by the JPA in conformance with applicable permit conditions. Surface water discharges must comply with stringent nutrient Total Maximum Daily Load (TMDL) discharge permit requirements for Malibu Creek and Malibu Lagoon, including:

- Current Discharge Limitations. The current nutrient TMDL limits include 8 mg/L for nitrate+nitrite-N and 3 mg/L for total phosphorus. According to an established permit and creek flow monitoring protocols, no discharge is allowed from April 15 to November 15 unless flows in Malibu Creek drop below 2.5 cubic feet per second.

- 2022 Discharge Limitations. The JPA must comply with new summer limits (April 15-November 15) of 1 mg/L total nitrogen and 0.1 mg/L total phosphorus by May 16, 2022.

- 2030 Discharge Limitations. The JPA must comply with new winter limits (November 16-April 14) of 4 mg/L total nitrogen and 0.2 mg/L total phosphorus by November 16, 2030.

To optimize local water production, reduce reliance on imported water, support recognized beneficial uses of Malibu Creek and Lagoon, and comply with increasingly stringent discharge limitations, the JPA is seeking to undertake a water supply augmentation project that can provide multiple benefits to the community.

The proposed Project includes building a new Advanced Water Treatment Plant (AWTP) to treat recycled water from the Tapia WRF to drinking water standards. The advanced treated water will be piped to the Las Virgenes Reservoir (Reservoir) for blending and additional treatment at the Westlake Filtration Plant. Ultimately, the proposed Project has the potential to provide up to 15 percent of the drinking water supply for the JPA's customers. Refer to Figure 1 for a schematic of the proposed Project.

Figure 1. Schematic of the Las Virgenes-Triunfo Pure Water Project (Credit: Trussell Technologies).

The proposed Project must comply with the SWA regulations recently approved by the California State Water Resources Control Board. The SWA process involves adding advanced treated water to a surface water reservoir that is used as a source of drinking water (SWRCB, 2018). The SWA regulations include requirements for dilution and retention time in the reservoir, advanced treatment criteria, and minimum log reduction values for pathogens (i.e., enteric virus, *Giardia*, and *Cryptosporidium*).

Las Virgenes Reservoir receives imported water from the Metropolitan Water District of Southern California (MWD). Owned and operated by LVMWD, the Reservoir provides seasonal and emergency storage for the service area. As part of the proposed Project, a three-dimensional (3D) hydrodynamic model was developed and calibrated to evaluate the dilution of advanced treated water in the Reservoir and to ensure future compliance under different operating scenarios. Specifically, three operating scenarios were used:

- **Routine Scenario**: Recycled water from the Tapia WRF is discharged into the Reservoir during winter months, and water is withdrawn from the Reservoir during the summer months for treatment at the Westlake Filtration Plant. That is, the input of recycled water to the Reservoir and withdrawal of water from the Reservoir do not occur simultaneously.

- **Boundary Scenario**: The Westlake Filtration Plant operates continuously throughout the year. In the winter and "shoulder" (i.e., spring and fall) months, recycled water produced by the Tapia WRF is discharged to the Reservoir. In the summer, recycled water is used to meet irrigation demand, resulting in minimal input of recycled water to the Reservoir. No other water source (e.g., MWD water) enters the Reservoir in this scenario.

- **Emergency Scenario**: The feeder line that delivers imported water from MWD to the Reservoir becomes inoperable. In this scenario, both the AWTP and Westlake Filtration Plant are operated at their maximum capacities of 6 MGD and 15 MGD, respectively.

Prior to the meeting, the Panel received a technical report titled *Las Virgenes-Triunfo Joint Powers Authority Pure Water Program: Las Virgenes Reservoir Model Calibration and Results*, prepared by Trussell Technologies, Inc. The document provided background information about the proposed Project and SWA regulations, but focused on the 3D hydrodynamic model, specifically: the development of the model, three operating scenarios, results and conclusions of the hydrodynamic modeling, and next steps for the Project.

PANEL FINDINGS AND RECOMMENDATIONS

The Panel's findings and recommendations for the proposed Project are based on information provided in the technical report prepared by Trussell Technologies, presentations made by the project team at the Panel meeting, and tour of Las Virgenes Reservoir and Westlake Filtration Plant.

1. General Comments

- The Panel appreciated the informative and well-organized technical report prepared by Trussell Technologies and the meeting presentations prepared by the project team.

- The tour of Las Virgenes Reservoir and Westlake Filtration Plant was helpful to the Panel's review process.

2. Project Background and Drivers

- The Panel appreciated the excellent presentation on the background of the proposed Project and the history of the JPA.

- The Panel supports the JPA's efforts to diversify its water portfolio with advanced treated water.

- It is important to recognize that the proposed Project is the first SWA project in Los Angeles County and that it differs from the two existing SWA projects in California: (1) The City of San Diego's Pure Water Program, and (2) Padre Dam Municipal Water District's East County Advanced Water Purification Program. Considerations related to environmental discharges, water supply, water reuse, seasonal operation, and other factors are unique to the proposed Project.

- The proposed Project has a number of benefits, as highlighted during the presentation. The Panel identified additional possible benefits, including:

    - **Reduction in bromide**. As a result of reverse osmosis (RO) treatment, the bromide content of the advanced treated water will be lower than that of imported water. The lower bromide content should decrease the production of brominated disinfection

byproducts (which are more toxic than their chlorinated analogues) at the Westlake Filtration Plant and facilitate compliance with regulatory limits on disinfection byproducts.

- **Reduction in salinity**. The Project will result in a net export of salts from the Malibu Creek Watershed, thereby producing long-term benefits for groundwater and surface water in the region.

- The JPA could consider the potential for beneficial reuse of the RO brine as opposed to disposal via the brine discharge pipeline. For example, Santa Clara Valley Water District is evaluating the use of engineered treatment cells (i.e., a gradient of wetlands with increasingly higher salinity) with eventual discharge in the San Francisco Bay as part of a Reverse Osmosis Concentrate Management Study. Given the brackish nature and valuable habitat of Malibu Creek and Malibu Lagoon, a similar strategy for the provision of brackish water habitat prior to ocean discharge could be an alternative to the brine discharge pipeline.

- It would be useful to identify the locations of the fields that are sprayed with excess recycled water not needed by customers in the winter and clarify any regulations pertaining to the recycled water that is sprayed.

3. Project Facilities

- Siting the AWTP adjacent to the Reservoir could have benefits for water quality. Specifically, the addition of chloramines – frequently applied after ultraviolet (UV) treatment in the AWTP to control microbial growth in pipelines leading to a reservoir – could possibly be avoided, which would reduce the inorganic nitrogen loading to the Reservoir and minimize the formation of nitrosamines.

- Operating the AWTP only during the summer may present several challenges to the Project. The project team should evaluate the implications associated with staffing, resources, operator process sensitivity and situational awareness, and the intermittent operation of membrane (and other treatment) processes.

4. California's Surface Water Augmentation Regulations

- The Panel appreciated the excellent summary of the SWA regulations. In particular, the table on Slide 18 on "Treatment Requirements" was informative.

- The current program and future plans for source control should be described in upcoming presentations and reports. For instance, it will be necessary to identify the chemicals of concern and potential sources of these chemicals in the sewershed, describe the monitoring and outreach programs, and outline the response plan for identified constituents. These communications should emphasize developing an accurate understanding of Project benefits among customers using applicable public health and JPA service standards as context.

- It is important to develop a monitoring plan that specifically identifies the constituents that will be monitored in the AWTP product water, Las Virgenes Reservoir, and Westlake Filtration Plant, and the frequency of monitoring and analysis for each location.

5. Reservoir Model: Build and Calibration

- The Panel believes the Reservoir Model Approach presented by the Project Team is valid. The Model reasonably reproduces temperature and water level in Las Virgenes Reservoir. Next steps should involve the development of a tracer test and validation of the ELCOM model using tracer results with respect to hydrodynamics and dilution in the Reservoir.

- The installation of the second weather station and comparison with existing weather station data will be important for future hydrodynamic modeling. Because information derived from these weather stations will be a factor contributing to public health decisions, the JPA should site each weather station with technical rigor.

- The Panel suggests that the Project Team consider conducting a sensitivity analysis of the model outputs (minimum dilution and theoretical retention time, V/Q) relative to the inputs of the hydrodynamic model, particularly wind and aeration, because these variables will affect dilution at the Reservoir outlet.

- A diagram of the Reservoir showing typical currents would be useful to the process of locating the outfall. It may be possible to identify locations where currents would convey the discharge away from the Westlake Filtration Plant under most conditions.

- While graphic representations of predicted and observed Reservoir surface elevations are helpful, the Panel recommends that more detailed statistics regarding calibration to the surface elevation data be provided. In particular, the scale for water surface elevation on Slide 15 makes it difficult to ascertain goodness-of-fit. Visually, it appears that some modest improvements in the water budget might be achieved through the consideration of local runoff, seepage, etc.

    - Perhaps further qualification is warranted of the statement that "precipitation and runoff from the surrounding area [are] roughly equal to seepage and evaporation in normal years" (see page 13 of the technical report).

6. Reservoir Model: Modeled Conditions and Results

- The Routine Scenario, in which advanced treated recycled water is discharged to the Reservoir during the winter and water is withdrawn from the Reservoir for treatment at Westlake Filtration Plant during the summer, represents a unique operational strategy compared with the other SWA projects currently under development. Because of the asynchronous nature of discharge and withdrawal, simulations for this scenario were not conducted. While the Panel agrees that an extensive modeling analysis is not warranted, some consideration of the switch-over period from discharge to withdrawal would be helpful. Modeling analyses indicate that there are conditions in which the initial project design fails to meet the 100:1 dilution criterion,

so seemingly there would be a finite probability that this situation could occur during the switch-over period in the spring. Under such circumstances, it may be necessary to define the minimum time interval that must elapse after the discharge of advanced treated water to the Reservoir has ended and before withdrawal to the filtration plant can begin to avoid possible non-compliance. Numerical tracer test results can be used to develop the relationship between the minimum dilution ratio and time-to-peak concentration. A plot or regression of these data should define the minimum time interval that must elapse after discharge of advanced treated water to the Reservoir has ended and before withdrawal to the filtration plant can begin. This interval is expected to be quite short, likely on the order of 1 to 2 days, but should be rigorously defined. If the project is demonstrated to achieve at least 100:1 dilution at all times, then the establishment of a minimum time interval would not be necessary.

- Future modeling efforts could follow one of the following two approaches:

    - Option 1: Modify the design of the diffuser/aerator system and/or the inlet configuration such that the model predicts that dilution criterion would be met in even the most challenging meteorological conditions under the Boundary Scenario.

    - Option 2: If it is not possible to maintain a dilution ratio above 100:1 under all meteorological conditions for all scenarios, then an operational framework that defines when withdrawal to the Westlake Filtration Plant can occur is necessary. The framework would ideally be based on real-time hydrodynamic modeling. Alternatively, a regression of the dilution ratio with respect to meteorological and hydraulic conditions should be developed. In this case, the confidence interval of the regression slope should be considered.

- Following the completion of the tracer test and validation of the hydrodynamic model with data from the new weather station, the project team should develop a probabilistic analysis of the dilution ratios achieved at the Westlake Filtration Plant intake under the range of operational, meteorological, and water column conditions (e.g., depth, stratification, etc.) of the Reservoir.

    - A probabilistic model could improve predictions of the likelihood of failure based on various environmental conditions beyond the ones that were simulated.

    - The probabilistic model also can facilitate choosing between the two options presented above. For example, if the risk of failing to meet the 100:1 dilution criterion is high, Option 1 should be selected; however, if the risk is low (for example, one day every two years), Option 2 may be preferable and/or more cost-effective.

- The operation of aerators has been demonstrated to mix the water column and increase the dilution of a pulse of off-specification water. It is valuable to note that aerators also help reduce taste and odor, algal blooms, and toxins in a reservoir, and can improve the treatability of raw water. The Panel does not believe that Solar Bees™ installed at the Reservoir would provide sufficient turbulent-kinetic energy to mix a reservoir of this depth.

7. Conclusions

Based on the information presented at this meeting, the Panel concluded the following:

- The JPA's Board of Directors and executive leadership appear committed to appropriate planning and investment to ensure regional water supply reliability.

- The proposed Project effectively addresses the necessary water supply, regulatory, and environmental considerations.

- The preliminary model analyses and scenarios are reasonable and provided the Panel with valuable insight into the proposed Project.

- The proposed Project, as presented to the Panel, appears to be capable of complying with the SWA regulations.

8. References

SWRCB (2018). *A Proposed Framework for Regulating Direct Potable Reuse in California*. State Water Resources Control Board, Sacramento, CA.

ATTACHMENT A: PANEL MEMBER BIOGRAPHIES

Amy Childress, Ph.D. (Panel Chair), is a Professor and the Director of Environmental Engineering at University of Southern California in Los Angeles. She has more than 25 years of experience researching membrane processes for water treatment, wastewater reclamation, and desalination. Most recently, she investigated membrane contactor processes for innovative solutions to contaminant and energy challenges; pressure-driven membrane processes as industry standards for desalination and water reuse; membrane bioreactor technology; and colloidal and interfacial aspects of membrane processes. Childress has directed research funded by federal, state, and private agencies, including the California Department of Water Resources, National Science Foundation, Electric Power Research Institute, and Strategic Environmental Research and Development Program. She also has received several awards, including the Bureau of Reclamation's More Water Less Concentrate Stage 1 Challenge, Association of Environmental Engineering and Science Professors Outstanding Publication Award, and a National Science Foundation CAREER Award, and has served as President of the Association of Environmental Engineering and Science Professors. She is currently a co-editor of *Desalination* and serves on several national committees. Childress received a B.S. degree in Civil Engineering from the University of Maryland, and an M.S. and a Ph.D. from the University of California, Los Angeles

Michael Anderson, Ph.D., is a Professor of Applied Limnology and Environmental Chemistry at University of California, Riverside, where he has taught courses since 1990. Anderson currently serves as Divisional Dean for Agriculture and Natural Resources, and previously served as Chair of the Department of Environmental Sciences. His research focuses on applied limnology and lake/reservoir management; surface water quality and modeling; fate of contaminants in waters, soils, and sediment; and environmental chemistry. He recently served as a member of the NWRI Expert Panel on Surface Water Augmentation and Potable Reuse, Independent Advisory Committees for indirect potable reuse projects for the City of San Diego and Padre Dam Municipal Water District, Salton Sea Science Advisory Committee, and the U.S. Environmental Protection Agency's Harmful Algal Blooms Grant Panel. He also served as Associate Editor for *Lake and Reservoir Management* from 2004-2017. Anderson received a B.S. in Biology from Illinois Benedictine College, an M.S. in Environmental Studies from Bemidji State University, and a Ph.D. in Environmental Chemistry from Virginia Tech.

Richard Bull, Ph.D., currently works as a Consulting Toxicologist and researcher with MoBull Consulting (Richland, WA), where he conducts studies on the chemical problems encountered in water for water utilities and for federal, state, and local governments. He became Professor Emeritus at Washington State University upon his retirement in 2003. Formerly, he served as a senior staff scientist at the U.S. Department of Energy's Pacific Northwest National Laboratory; Professor of Pharmacology and Toxicology at Washington State University; and Director of the Toxicology and Microbiology Division in the Cincinnati Laboratories for the U.S. Environmental Protection Agency (USEPA). His early research focused on central nervous system effects of heavy metals and progressed to studies of carcinogenic and toxicological effects of disinfectants and disinfection byproducts, halogenated solvents, acrylamide, and other contaminants of drinking water. He has served on international scientific working groups of the World Health Organization, and the International Agency for Research on Cancer, which addresses carcinogenic activity on environmental contaminants and medical devices. Bull served several terms as a member of the USEPA's Science Advisory Board and as Chair of the Drinking Water Committee and served as a member and/or chair of several committees convened by the National Academy of Sciences.

Bull received a Ph.D. in Pharmacology from the University of California San Francisco and a B.S. in Pharmacy from the University of Washington.

William Mitch, Ph.D., P.E., is a Professor in the Civil and Environmental Engineering Department at Stanford University, which he joined in 2013, after 13 years in the Chemical Engineering faculty at Yale University. His current research includes chemicals of concern associated with wastewater recycling and prevention of the formation of nitrogen-based disinfection byproducts. Mitch has authored more than 90 peer-reviewed journal articles, and the February 2018 cover of *Environmental Science and Technology* featured his interdisciplinary approach to identify disinfection byproducts, improve assessment techniques, and minimize risks from chemicals and pathogens in drinking water. He has served on the U.S. Environmental Protection Agency Scientific Advisory Board's Drinking Water Committee since 2010 and on several advisory panels as an expert on nitrosamines. Mitch received a Ph.D. In Civil and Environmental Engineering from University of California, Berkeley, and is a professional engineer in the State of California.

Matthew E. Verbyla, Ph.D., is an Assistant Professor of Environmental Engineering at San Diego State University, where he teaches courses related to sanitation, wastewater treatment, and microbiological processes for environmental engineering, and directs the Safe WaTER Research Group. His research aim is to understand the health-related microbiological processes in engineered natural systems and water, sanitation, and hygiene (WASH) systems, especially those that incorporate water reuse and resource recovery. Verbyla currently serves as co-editor for the Sanitation Technologies group of the Global Water Pathogens Project, an initiative led by UNESCO and Michigan State University to produce an online open access platform for scientific knowledge on pathogens in water. Verbyla received a B.S. in Civil Engineering from Lafayette College, a Ph.D. in Environmental Engineering from the University of South Florida, and a postdoctoral research assignment with the LCE virus group at École Polytechnique Fédérale de Lausanne in Switzerland.

ATTACHMENT B: PANEL MEETING AGENDA

NATIONAL WATER RESEARCH INSTITUTE

Independent Advisory Panel for
Las Virgenes-Triunfo Pure Water Project

May 4, 2018

AGENDA

LOCATION	CONTACTS
Las Virgenes Municipal Water District Board Room 4232 Las Virgenes Road Calabasas, CA 91302-1994	NWRI Office: (714) 378-3278 Kevin Hardy: (760) 801-9111 (cell) Dawna Hernandez: (949) 345-9999 (cell) Suzanne Sharkey: (949) 258-2093 (cell)

The NWRI Independent Advisory Panel was established to provide expert review of the reservoir modeling results for the Las Virgenes-Triunfo Pure Water Project as proposed by the Las Virgenes-Triunfo Joint Powers Authority in Calabasas, California.

MEETING OBJECTIVES

- Provide the Panel with an overview of the Pure Water Project, including historical information and drivers for the project.
- Present information to assist the Panel in evaluating both (1) the validity of the Reservoir Model and (2) the results of various operational scenarios evaluated by the Reservoir Model.
- Solicit Panel feedback on (1) the results of the Reservoir Model and (2) the feasibility of the Pure Water Project to comply with reservoir requirements of the Surface Water Augmentation regulations.

08:00 am	Welcome and Introductions	Kevin M. Hardy, National Water Research Institute (NWRI)
08:15 am	Projection Background, Drivers, and Overview	David Pedersen (LVMWD) and Shane Trussell (Trussell Tech)

09:00 am	Overview of California's Surface Water Augmentation Regulation	Brian Pecson (Trussell Tech)
09:30 am	Reservoir Model: Build and Calibration	Bryan Trussell (Trussell Tech)
10:00 am	**BREAK**	
10:15 am	Reservoir Model: Modeled Conditions and Results	Shane Trussell (Trussell Tech)
11:00 am	Open Discussion / Q & A	Facilitated by Kevin Hardy
11:30 am	**WORKING LUNCH / Continue Discussion**	
12:15 pm	Depart District Offices for Las Virgenes Reservoir (32601 Torchwood Place)	
1:30 pm	Return to District	
2:00 pm	Panel-Only Working Session	Facilitated by Panel Chair and NWRI
4:30 pm	Report Out to Project Team	Facilitated by Panel Chair
5:00 pm	**ADJOURN**	

ATTACHMENT C: PANEL MEETING ATTENDEES

Panel Members

- Amy Childress, Ph.D., University of Southern California (Panel Chair)
- Michael Anderson, Ph.D., University of California, Riverside
- Richard Bull, Ph.D., MoBull Consulting
- William Mitch, Ph.D., P.E., Stanford University
- Matthew Verbyla, Ph.D., San Diego State University

National Water Research Institute

- Kevin M. Hardy, Executive Director
- Dawna Hernandez, Event Manager
- Suzanne Sharkey, Water Resources Scientist and Project Manager (remote access)
- Gina Vartanian, Communications Manager

Las Virgenes Municipal Water District

- Brett Dingman, Water Reclamation Manager
- David Lippman, Director of Facilities and Operations
- Joe McDermott, Resource Conservation and Public Outreach
- David Pedersen, General Manager
- John Zhao, District Principal Engineer

Trussell Technologies Project Team

- Shane Trussell
- Bryan Trussell
- Brian Pecson
- Chao-Chun Yang
- Li Ding (remote access)

Los Angeles Regional Water Quality Control Board

- Cris Morris, Watershed Regulatory Section Chief
- Steven Webb, Municipal Permitting

State Water Resource Control Board, Division of Drinking Water

- Randy Barnard, Recycled Water Unit Chief (remote access)
- Brian Bernados, Technical Specialist (remote access)
- Dmitriy Gizburg, Southern California Drinking Water Field Operations Branch
- Saeed Hafeznezami, Technical Operations Section
- Jeff O'Keefe, Chief, Los Angeles Region
- Shu-Fang Orr, Southern California Drinking Water Field Operations Branch
- Erica Wolski, Technical Operations Section (remote access)

Other Consultants to Las Virgenes Municipal Water District

- Dawn Taffler, Kennedy Jenks (remote access)