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April 14, 2010

Mr. Patrick Sheilds
Executive Manager of Operations
Inland Empire Utilities Agency
6075 Kimball Ave., Bldg. B
Chino, California 91708

Subject: NWRI Independent Advisory Panel Final Report Regarding the Inland Empire Utilities Agency's Groundwater Recharge Permit Amendment

Dear Mr. Sheilds:

The National Water Research Institute (NWRI) is pleased to submit the final report of the NWRI Independent Advisory Panel for Inland Empire Utilities Agency's Groundwater Recharge Permit Amendment.

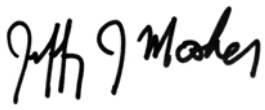
The report is based on presentations and discussions that occurred at a meeting held February 8-9, 2010, in Chino, California. All six Panel members attended this meeting and participated in the development of the 17-page final report, which includes findings and recommendations for the following:

- Source Control Program
- Soil Aquifer Treatment
- Recycled Water Management Plan
- Diluent Water
- Calculating Underflow as a Source of Diluent Water
- Extending the RWC to 120 Months

If you have any questions, please do not hesitate to call me at (714) 378-3278 or email jmosher@nwri-usa.org.

Sincerely,

NATIONAL WATER RESEARCH INSTITUTE



Jeffrey J. Mosher
Executive Director

Enclosures
cc: James Crook, Ph.D., P.E., Panel Chair

NATIONAL WATER RESEARCH INSTITUTE

Final Report

of the February 8-9, 2010, Meeting of the

Independent Advisory Panel

for the

Inland Empire Utilities Agency's Groundwater Recharge Permit Amendment

April 14, 2010
Fountain Valley, California

Disclaimer

This report was prepared by an NWRI Independent Advisory Panel, which is administered by the National Water Research Institute (NWRI). Any opinions, findings, conclusions, or recommendations expressed in this report were prepared by the Panel. This report was published for informational purposes.

Purpose of the Panel

In 2009, the Inland Empire Utilities Agency (IEUA) of Chino, California, received approval from the California Regional Water Quality Board, Santa Ana Region (Regional Board) to increase the Recycled Water Contribution (RWC) averaging period for the Chino Basin Recycled Water Ground Water Recharge Program from its current 60-month averaging period to a 120-month averaging period[1]. The purpose of this change is to address the water supply shortage of imported water from the State Water Project needed as diluent water for IEUA's groundwater recharge basins.

IEUA requested that the National Water Research Institute (NWRI) of Fountain Valley, California, form an Independent Advisory Panel (Panel) in 2009 to monitor, evaluate, and report on IEUA's current groundwater recharge projects and on any possible implications that may result from extending the averaging period for RWC from 60 months to 120 months and from using underflows into the basin as diluent water. This Panel was developed to meet requirement F.22 (Required Notices and Reports) of the amended Regional Board Order No. R8-2009-0057, which stated that IEUA "shall submit a written report based on the findings of a scientific peer reviewed panel."[2]

Specifically, the Panel is charged with:

1. Evaluating the change in the calculation period for a running monthly average RWC from 60 months to an extended RWC compliance period for 120 months (including reporting changes for IEUA's annual "Recycled Water Management Plan").
2. Reviewing the assessment of diluent water contributions, including underflows into the basin, for calculating the RWC.
3. Reviewing the criteria needed to provide an "equivalent level of public health protection" while operating under the amended permit that extends the RWC averaging period and allows for consideration of using underflows into the basin as diluent water.

Panel members include:

- *Chair*: James Crook, Ph.D., P.E., Environmental Engineering Consultant (Boston, MA)
- Richard Bull, Ph.D., MoBull Consulting (Richland, WA)
- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, CA)
- Dr.-Ing. Jörg Drewes, Colorado School of Mines (Golden, CO)
- Peter Fox, Ph.D., Arizona State University (Tempe, AZ)
- Dennis Williams, Ph.D., P.G., CHG, GEOSCIENCE Support Services, Inc. (Claremont, CA)

A short biography of each Panel member is included in **Appendix A**.

[1] California Regional Water Quality Control Board, Santa Ana Region. Order No. R8-2009-0057, Amending Order No. R8-2007-0039, Water Recycling Requirements for Inland Empire Utilities Agency and Chino Basin Watermaster, Chino Basin Recycled Water Groundwater Recharge Program Phase 1 and Phase II Projects, San Bernardino County. Adopted October 23, 2009.
[2] Ibid.

Introduction

A two-day meeting of the NWRI Independent Advisory Panel for IEUA's Groundwater Recharge Permit Amendment was held February 8-9, 2010, at IEUA's facilities in Chino, California.

Representatives from IEUA gave presentations during this meeting on the following topics:

- Source Control Program
- Soil Aquifer Treatment (SAT)
- Recycled Water Management Plan Reporting
- Overview of WateReuse Study WRF-06-018 – "Tools to Access & Understand the Relative Risks of Indirect Potable Reuse Projects"
- Diluent Water
- Proposal for Calculating Underflow as a Source of Diluent Water

This meeting also included a site tour of two of IEUA's recharge basin sites: Turner and Eighth Street. The complete meeting agenda is included in **Appendix B**.

A complete list of meeting attendees is included in **Appendix C**.

Findings and Recommendations

The Panel's recommendations are strictly in the context of the IEUA project. These recommendations were made in consideration of the unique aspects of the IEUA system (e.g., the Chino Basin aquifer and associated hydrogeology is well characterized, there is a very deep vadose zone used for SAT, and the bulk of industrial wastewater generated in IEUA's service area is excluded from IEUA's water reclamation system).

1. Source Control Program

a. IEUA owns and operates two independent wastewater collection systems for its service area – a non-reclaimable wastewater system for industries with large industrial wastes and a regional sewer system that primarily serves residential customers, although there is some commercial and industrial input. Wastewater from the non-reclaimable wastewater system is collected and exported to treatment plants outside of its service area for treatment and discharge, while wastewater from the regional sewer system is treated at IEUA facilities. The separation of industrial discharges is a unique situation that minimizes the impact of industrial sources on the recycled water system.

b. Although IEUA's member cities manage their own source control programs, IEUA is the responsible control agency. It is the Panel's finding that IEUA has an efficient pretreatment program in place with appropriate program elements and oversight. There is a low probability that industrial toxic pollutants would be present in the recycled water

at levels that would adversely impact the treatment or use of the water for groundwater recharge.

2. Soil Aquifer Treatment

a. Based on data obtained at the recycled water recharge sites (or clusters of sites), the Panel concludes that:
   - The recycled water is amenable to treatment across the entire deep vadose zone (approximately 300 feet).
   - IEUA's current practice of determining the RWC at the compliance lysimeters (which are located between 20 and 35 feet below the top of the vadose zone) is a conservative measure of the total organic carbon (TOC) removal that occurs during SAT; additional TOC removal at deeper depths is likely.
   - Surrogate parameters (such as biodegradable organic carbon [BDOC]) and indicator compounds suitable to assess SAT performance suggest that SAT at the various recharge basins is primarily based on biological processes that indicate sustainable removal of TOC and trace organic chemicals.

b. The ongoing TOC monitoring program needs to be maintained and the results reported in the Recycled Water Groundwater Recharge Annual Report. The monitoring program is very extensive considering the large number of recharge sites operated by IEUA. The method used to determine the RWC provides very consistent results since the basins are flooded continuously and localized saturated flow conditions develop in the vadose zone. The ongoing TOC monitoring program should recognize variations in TOC concentrations as a consequence of basin maintenance, drying, and changes in infiltration rates. All of these factors may affect TOC concentration at an RWC compliance point. However, these variations should not affect TOC levels in the underlying groundwater since there is a deep vadose zone below the currently chosen RWC compliance points. The current Recycled Water Groundwater Recharge Annual Reports do not provide information on basin operations that could be relevant to observed TOC concentrations.

c. The Panel agrees that IEUA needs to utilize a consistent approach regarding operation and performance monitoring for all the recycled water recharge sites (single basin or cluster of basins). The Panel was presented with data from one site. Similar data from each site needs to be collected and reviewed by IEUA to confirm SAT performance.

d. The Panel supports continuing the monitoring program and, if necessary, enhancing it to include monitoring of selected persistent wastewater indicators (intrinsic) tracers to assess the degree of impact of recycled water on production wells. Such monitoring is also needed to validate the groundwater flow model assumptions, which are directly dependent on groundwater elevations. Specifically, groundwater elevations can be obtained from depth to groundwater measurements in the monitoring wells. These groundwater elevations can then be used to construct the limiting flow lines around each recharge basin (see Section 5.b). Monitoring of an intrinsic tracer could benefit IEUA by verifying TOC removal at a mound monitoring point. Verification of hydrological model predictions can also be done by monitoring intrinsic tracer compound concentrations at

drinking water wells. This could first be done by estimating the travel time and concentrations that will begin to affect drinking water wells. Existing models can be used to estimate the time at which intrinsic tracer concentrations will reach detection levels. In addition, the models may be used to estimate the maximum percentage of reclaimed water at a drinking water well. Both of these model estimations could be verified by monitoring of intrinsic tracers. Because of the large size of the IEUA groundwater basin, there should be ample time to develop a cost-effective monitoring strategy to verify the model. IEUA currently uses conductivity and major ion chemistry to estimate recycled water content. A carefully developed intrinsic tracer monitoring plan may be used to verify estimates based on conductivity and major ions within the basin. If current estimates using conductivity are verified, intrinsic tracer monitoring may not be necessary indefinitely.

3. Recycled Water Management Plan

a. The Panel concurs that, unless the quantities of recycled water delivered to spreading basins are curtailed, IEUA is likely to exceed the current allowable RWC if credit for dilution is not given to the underflow of the Chino Basin aquifer.

b. The use of the underflow as diluent water is logical for the IEUA project, since the Chino Basin is large and the underflow has been clearly defined. Due to the hydrogeological characteristics of the groundwater basin (i.e., recharge or underflow occurs over a broader area than is captured by the extraction wells), not all of the underflow will contribute to dilution of the recycled water at a potable water extraction well. Even if a conservative approach is taken to determine the mix of recycled water and diluent water that is extracted at potable water wells (i.e., allocating less than 100 percent of the underflow as diluent water), it is the Panel's opinion that the quantity of underflow that mixes with the recycled water provide sufficient diluent water to meet the RWC requirement.

c. One of the Regional Board amendments to Order No. R8-2007-0039 requires IEUA to suspend recycled water deliveries upon reaching the RWC limit on or after month 96 of the 120 month period. In the event this occurs, the Panel is in agreement with the amended Regional Board order that IEUA prepare a plan to achieve compliance with the RWC limit prior to resuming recycled water deliveries. The plan should address the fate of the treated wastewater (e.g., disposal or nonpotable reuse) if it is not delivered to the recharge basins.

d. IEUA should update its RWC Management Plan to address compliance with the maximum RWC by the 120^{th} month at each recharge basin or cluster of basins. IEUA should provide documentation via modeling or other means (e.g., water quality measurements of typical recycled water constituents at key wells hydraulically upgradient, downgradient, and crossgradient of spreading basins may be used to validate the modeling) that any cluster of basins represents a single capture zone for recycled water and underflow. IEUA should describe how the Plan will be updated to reflect estimated diluent water and recycling water contributions for the upcoming year and what

steps will be taken to ensure compliance with the maximum RWC and TOC limits for each basin or cluster of basins.

e. There is concern regarding total dissolved solids (TDS) and nitrate concentration levels rising in the basin as the result of decreased recharge of diluent waters. In particular, the lack of State Water Project water from the Metropolitan Water District of Southern California (MWD) to recharge the basin in future years could result in an increase in TDS concentrations in the groundwater. The Panel supports the findings of IEUA's current ambient study conducted to review the impact of TDS and nitrate levels in the basin and recommends that IEUA continue to investigate means to assure that TDS and nitrogen concentrations in the groundwater do not exceed acceptable levels.

f. The use of underflow as diluent water in conjunction with the high degree of TOC removal observed at IEUA recharge sites could allow for a significant increase in the volume of recycled water that may be recharged annually. The Panel recognizes that this potential significant increase in the recharge of recycled water will not endanger public health. Moreover, the potential issues related to TDS would be an overriding factor that may limit any major increase in the volume of recycled water recharged without additional treatment and/or management strategies. IEUA has historically attempted to use recycled water for uses other than groundwater recharge to get the greatest benefit from water recycling. There is no reason to believe IEUA will not continue to employ this strategy, thereby limiting the volume of recycled water available for groundwater recharge.

g. The Panel supports IEUA's conservative approach in not forecasting limited imported water in the RWC Management Plan and relying on the use of underflows in forecasts for meeting the RWC. If IEUA expects to forecast imported water in the RWC running averaging, more definitive information would be required on how the forecast will be determined and how it will be resolved should imported supplies not be available for recharge.

4. Diluent Water

a. There are three main sources which currently qualify as diluent water that can be diverted to recharge basins beside recycled water: imported water (e.g., untreated State Project Water); storm water runoff during rain events and snowmelt from the San Gabriel Mountains; and local runoff from urban areas during rain events and dry weather flows**.** In addition to these three sources, natural recharge of the Chino Basin occurs by natural infiltration from the San Gabriel Mountains that provides a fourth source of diluent water that is not currently accounted for. This water is referred to as underflow.

b. Quarterly groundwater monitoring data provided by IEUA for the period from April 1 through June 30, 2009, include monitoring results for 33 monitoring wells: one well upgradient of a spreading basin; 3 wells crossgradient of spreading basins; and 29 wells downgradient of spreading basins. With a few exceptions that are considered to be non-representative of the local groundwater, the water quality data indicate that the

groundwater met drinking water primary and secondary maximum contaminant levels. Additional data on specific constituents of concern from research conducted on the IEUA groundwater recharge project by consultants indicate that the groundwater does not contain levels of those specific constituents that would be hazardous to health. Although water quality for the underflow alone (without potential mixing with recharged diluent water or recycled water) is sparse, it appears that the underflow conforms to the water quality requirements specified in the most recent California Department of Public Health (CDPH) Groundwater Recharge Reuse Draft Regulation (dated August 5, 2008).

c. The CDPH Groundwater Recharge Reuse Draft Regulation contains nitrogen requirements that can be met in the recycled water or recharge water (recharge water is defined as either recycled municipal wastewater or the combination of recycled municipal wastewater and diluent water that is applied at a groundwater recharge project). The intent is to allow diluent water to be used to meet nitrogen requirements in the mix of the two waters. While the nitrogen levels in the IEUA recycled water after SAT comply with the limits specified in the CDPH Groundwater Recharge Reuse Draft Regulation, the native groundwater has relatively high nitrogen levels in some of the monitoring wells. Thus, if underflow is to be used as diluent water and the mix of the waters exceeds the nitrogen limits specified in the CDPH Groundwater Recharge Reuse Draft Regulation, it is unclear whether CDPH would consider this to be a violation of the draft recharge regulations. It behooves IEUA to consult with CDPH on this matter.

d. The Panel finds that the quantity of underflow from the Chino Basin aquifer is capable of providing sufficient diluent water to meet the required RWC. The amount of underflow available to contribute to the RWC varies at different recharge sites or clusters of recharge sites and should be determined at each site (See Section 5 below).

e. It is unclear from review of the CDPH draft groundwater recharge regulations as to the point of compliance with the RWC limit. The Panel recommends that IEUA contact CDPH to confirm that the RWC can be met at a potable water extraction well if it is proposed to meet the RWC limit at that point.

5. Calculating Underflow as a Source of Diluent Water

a. The Panel recommends that underflow contribution to be credited as diluent water should be based on a Darcian calculation of groundwater flow through the uppermost permeable layer in the vicinity of the basins. The effective area of groundwater recharge in the vicinity of a recharge basin should include the footprint of the site's basin(s), plus an appropriate buffer zone surrounding the basin(s) to account for the lateral spreading of the groundwater mound beneath the basins.
b. The Panel has the following recommendations regarding calculation of the underflow as a source of diluent water:
    - The cross-sectional area of groundwater flow should be based on transects normal to the limiting flow lines. The limiting flow lines represent groundwater flow paths that are not under the influence of the recycled water spreading basin(s).

Groundwater flow lines are normal to the lines of equal groundwater elevations in the specific area of the basin(s) in question (see Section 2.d).

- The transects between the limiting flow lines should be drawn considering both groundwater flow directions in the vicinity of the recharge basins, as well as groundwater flow directions in downgradient extraction wells.
- The hydraulic conductivity for the Darcian underflow calculation should be representative of the uppermost aquifer materials in the vicinity of the transect's cross-sectional area.
- The hydraulic gradient for the Darcian calculation should be representative of the groundwater elevations in the area of the transect.
- The total underflow through the transect's cross sectional area should be calculated from the product of the cross sectional area of the uppermost aquifer layer below the transect, the hydraulic conductivity in the vicinity of the transect, and the hydraulic gradient in the vicinity of the transect.
- If the transect is located hydraulically downgradient from the recharge basin, the recharged water should be subtracted from the total calculated underflow to arrive at the underflow volume to be credited as diluent water.
- If the transect is located hydraulically upgradient from the recharge basin, the transect should be outside of the influence of the recharge mound in order for the calculated underflow to represent diluent water.

c. Use of a Darcian method of estimating groundwater underflow is a conservative and accurate method when used with existing data and parameters from the calibrated Chino Basin groundwater flow model. The recommendation to exclude underflow outside the limiting flow lines and to exclude underflow in deeper aquifers is a conservative approach to identifying the fraction of total groundwater underflow to include as diluent water in the RWC running average.

d. A check on the diluent underflow contribution at downgradient wells that capture recharged water may be made considering well production rate, upstream basin recharge, and respective underflow contribution from the uppermost permeable layer.

6. Extending the RWC to 120 Months

a. The RWC limit is a subjective requirement intended to provide an additional degree of public health protection against chemical constituents of concern (and, perhaps, unidentified health-significant constituents) by reducing their concentration via dilution of the recycled water with diluent water. It may also have some value during early implementation of an SAT project to provide assurance that the recharge of recycled water does not result in the mobilization of contaminants already present in the subsurface or the formation of new contaminants by chemical reactions or other means in the aquifer.

b. From a toxicological/health effects standpoint, dilution required by the RWC has limited objective value in reducing potential health effects resulting from exposure to chemical contaminants. Since guideline values such as MCLs are developed applying substantial

factors, the presence of twice the MCL can add little in the way of risk. In cases where a carcinogenic chemical is detected, de minimus risk levels are set so low, typically at one additional cancer case per 10,000 to 1,000,000 population, doubling this risk does not result in a meaningful difference when the background lifetime cancer risk is considered (i.e., between 1-in-3 to 1-in-4 lifetime risk). This is not to argue against the conservative nature of such guidelines, but to point out that a doubling of the risk is not measurable at such levels and is a trivial issue that cannot be reasonably characterized as adding public health benefits. The RWC is not an effective public health strategy; it is more important to ensure that chemicals that present potential health risks do not get to the aquifer. While it is difficult to state with certainty that all such compounds are removed because of analytical limitations, a well-designed and proactive source control program (which IEUA has) is far more important than a RWC consideration. A second effective public health measure is to confirm that specific compounds of varying chemical and physical properties are removed by SAT as well as relying upon general measures of system performance (e.g., TOC). Thus, the complexity and uncertainties associated with attempting to characterize the likely RWC add little value from a public health standpoint. At present, its major value is as a tool to trigger reviews of changes in system operations. On the other hand, if the RWC is eliminated, another trigger should be available for review of projects as they change operations.

c. The original allowable RWC averaging period of 60 months does not require actual mixing of the recycled water and diluent water at the point of recharge. It is intended to result in the RWC being met as an average over 60 months. Given potential drought conditions, agencies should be allowed to recharge recycled water during periods when diluent water is not available as long as the RWC is met at the end of 60 months. The Panel found no data to indicate that the RWC averaging period of 60 months is the maximum time period beyond which health protection would be compromised. Based on data reviewed relating to recycled water quality before and after SAT, diluent water quality, and the Recycled Water Management Plan, the Panel finds that extending the RWC to 120 months would not compromise the current level of public health protection.

d. Using intrinsic tracers to verify the RWC at potable water extraction wells will provide further assurance that extending the RWC averaging period to 120 months is equivalent to current practices. In addition, the use of intrinsic tracers to verify the use of conductivity and/or major ion chemistry for estimating RWC will allow IEUA to confirm RWC estimates throughout the groundwater basin.

APPENDIX A: Panel Biographies

JAMES CROOK, Ph.D., P.E. (Panel Chair)
Environmental Engineering Consultant (Boston, Massachusetts)

Jim Crook is an environmental engineer with more than 37 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 Public Health's 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 has served on several advisory panels and committees convened by the National Academy of Sciences, 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. He is a registered professional engineer in California and Florida.

RICHARD BULL, Ph.D.
Consulting Toxicologist
MoBull Consulting (Richland, Washington)

Since 2000, Richard Bull has been a Consulting Toxicologist with MoBull Consulting, where he conducts studies on the chemical problems encountered in water for water utilities, as well as federal, state, and local governments. Bull is a retired Professor of Pharmacology/Toxicology from Washington State University, where he maintains Adjunct Professor appointments in the College of Pharmacy and the Department of Environmental Science. Formerly, he served as a senior staff scientist at DOE's Pacific Northwest National Laboratory, Professor of Pharmacology/Toxicology at Washington State University, and Director of the Toxicology and Microbiology Division in the Cincinnati Laboratories for the U.S. Environmental Protection Agency. Bull has published extensively on research on central nervous system effects of heavy metals, the carcinogenic and toxicological effects of disinfectants and disinfection by-products, halogenated solvents, acrylamide, and other contaminants of drinking water. He has also served on many international scientific committees convened by the National Academy of Sciences, World Health Organization, and International Agency for Research on Cancer regarding various contaminants of drinking water. Bull received a B.S. in Pharmacy from the University of Washington and a Ph.D. in Pharmacology from the University of California, San Francisco.

JEAN-FRANÇOIS DEBROUX, Ph.D.
Director, Advanced Technologies Group
Kennedy/Jenks Consultants (San Francisco, CA)

At Kennedy/Jenks Consultants, Jean Debroux serves as Director of the Advanced Technologies Group, which was formed to solve technologically challenging problems. Part of this effort includes performing pilot and field studies for regulated and emerging contaminants and evaluates the cost impacts of complying with Safe Drinking Water Act regulations. A water quality expert, Debroux has extensive experience and expertise working with water utilities and research organizations in water treatment and water reuse issues, and is an active member of the WateReuse Foundation, where he serves on the Research Advisory Committee. Debroux received a B.S. in Chemical Engineering from the University of South Florida, and both an M.S. in Environmental Engineering and Ph.D. in Civil Engineering from the University of Colorado, Boulder. In addition, he attended the Environmental Management Institute at Tufts University and has served as a Post Doctoral Research Fellow and Lecturer at Stanford University and as a Research Fellow at Université de Poitiers, France.

DR.-ING. JÖRG E. DREWES
Associate Professor
Colorado School of Mines (Golden, CO)

Jörg Drewes has taught courses as in the Environmental Science and Engineering Division at Colorado School of Mines (CSM) since 2001. He also serves as Director of CSM's Advanced Water Technology Center (AQWATEC), which is dedicated to advancing the research and development of novel water treatment processes and hybrid systems to enable sustainable and energy efficient utilization of impaired water sources to provide potable and non-potable water supplies. Drewes is actively involved in research in the areas of water treatment and non-potable and potable water reuse. Current research interests include treatment technologies leading to indirect potable reuse and the fate and transport of persistent organic compounds in these systems. He has published more than 140 journal papers, book contributions, and conference proceedings, and was recently appointed to the National Research Council Committee on Water Reuse as an Approach for Meeting Future Water Supply Needs. Drewes received a Cand. Ing. (B.S.), Dipl. Ing. (M.S.), and Doctorate (Dr.-Ing.) in Environmental Engineering from the Technical University of Berlin in Germany.

PETER FOX, Ph.D.
Professor, School of Sustainable Engineering and the Built Environment
Arizona State University (Tempe, AZ)

Peter Fox is a Professor in the School of Sustainable Engineering and the Built Environment at Arizona State University (ASU) and serves as the coordinator of Environmental Engineering at ASU. He previously served as Director of the National Center for Sustainable Water Supply, which researched indirect potable reuse at numerous field sites in both Arizona and California. His professional interests include water reuse, biological treatment processes, and combined biological/adsorptive systems. For the last 14 years, he has focused his work on natural treatment systems and water reuse; recently, he has begun to expand his expertise on sustainable water systems to include desalination. Fox served as an Associate Editor of the American Society of Civil Engineering *Journal of Environmental Engineering*, and has published over 100 papers and presentations. He has also served on the National Academy of Science ad-hoc committee to assess Sustainable Underground Storage and was an executive committee member for the development of the national roadmap for desalination and water purification. Fox also authored the groundwater recharge chapter of the Metcalf and Eddy textbook, *Water Reuse*. Fox received a B.S. Chemical Engineering and both an M.S. and Ph.D. in Civil and Environmental Engineering from the University of Illinois.

DENNIS E. WILLIAMS, PH.D., P.G., CHG
President
GEOSCIENCE Support Services, Inc. (Claremont, CA)

Dennis Williams is founder and president of GEOSCIENCE Support Services, Inc., which focuses on groundwater supply, development, management, and protection. He has over 35 years of experience in groundwater hydrology, specializing in groundwater planning, development, and management, with specific emphasis on the groundwater basins of Southern California. In particular, he has consulted to most of the major water districts and agencies in the Southern California area, as well as clients in South America, Europe, and the Middle and Far East. The author of numerous publications on groundwater, Williams is also a part-time research professor at the University of Southern California, where he has taught graduate level courses in geohydrology and groundwater modeling since 1980. Williams received a B.S. in Geology from the University of Redlands and both an M.S. and Ph.D. in Groundwater Hydrology from the New Mexico Institute of Mining and Technology. He is a registered California geologist, a certified hydrogeologist with the State of California, and a certified groundwater hydrologist with the American Institute of Hydrology.

APPENDIX B: Meeting Agenda

NATIONAL WATER RESEARCH INSTITUTE

Independent Advisory Panel
Inland Empire Utilities Agency's
Groundwater Recharge Permit Amendment

Meeting Agenda
February 8-9, 2010

Meeting Location
Inland Empire Utilities Agency
Building B, Anza Room
6075 Kimball Ave
Chino, CA 91708

On-Site Contacts:
Jeff Mosher (NWRI)
Cell: (714) 705-3722
Carolyn Echavarria (IEUA)
Office: (909) 993-1855

Background
In 2009, IEUA received provisional approval from the Santa Ana Regional Board to increase the Recycled Water Contribution (RWC) averaging period for the Chino Basin Recycled Water Ground Water Recharge Program from its current 60-month averaging period to a 120-month averaging period. The purpose of this change is to address the water supply shortage of imported water from the State Water Project needed as diluent water the groundwater recharge basins.

Panel Charge and Meeting Objectives
The NWRI Independent Advisory Panel was formed to monitor, evaluate, and report on IEUA's current groundwater recharge projects and on any possible implications that may result from extending the 60-month averaging period for RWC to 120 months. Specifically, the Panel is charged with:

- Evaluating the change in the calculation period for a running monthly average RWC from 60 months to an extended RWC compliance period for 120 months (including reporting changes for IEUA's annual "Recycled Water Management Plan."
- Reviewing the criteria needed to provide an "equivalent level of public health protection" while operating under the proposed extended RWC averaging period.

Monday – February 8, 2010

8:15 am	**Meeting Begins**	**IEUA (Build. B, Anza Room)**
8:30 am	Introductory Remarks and Meeting Overview	Jeff Mosher (NWRI) Jim Crook (Panel Chair)

8:45 am	Panel Charge and Objectives	Patrick Sheilds, IEUA
9:00 am	*Panel Questions and Discussion*	Jim Crook
9:10 am	Source Control Program	Craig Proctor, IEUA
9:30 am	*Panel Questions and Discussion*	Jim Crook
9:45 am	Soil Aquifer Treatment	Andy Campbell, IEUA
10:10 am	*Panel Questions and Discussion*	Jim Crook
10:30 am	**BREAK**	
10:45 am	Recycled Water Management Plan Reporting	Andy Campbell, IEUA
11:30 am	Overview of WateReuse Study WRF06-018	Jeff Soller
12:00 noon	**WORKING LUNCH**	
12:30 pm	Diluent Water	Andy Campbell, IEUA
1:10 pm	Proposal for Calculating Underflow as a Source of Diluent Water	Andy Campbell, IEUA
2:00 pm	*Open Discussion*	Jim Crook
2:30 pm	**BREAK**	
3:45 pm	Panel-Only Deliberations	
5:30 pm	**Day 1 Adjourns**	

Tuesday – February 9, 2010

8:00 am	Depart for Site Tour of Groundwater Recharge Basins (Turner or Brooks Basin)	Andy Campbell
10:00 am	**Arrive at IEUA**	**IEUA (Build. B)**
10:00 am	Panel-Only Deliberations	Jim Crook
12:00 noon	**PANEL WORKING LUNCH**	
2:00 pm	Panel Open Briefing with IEUA	Jim Crook
3:00 pm	**Day 2 Adjourns**	

APPENDIX C – Meeting Attendees

Panel Members

- *Chair*: James Crook, Ph.D., P.E., Environmental Engineering Consultant (Boston, MA)
- Richard Bull, Ph.D., MoBull Consulting (Richland, WA)
- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, CA)
- Dr.-Ing. Jörg Drewes, Colorado School of Mines (Golden, CO)
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