Potable Reuse – Not a Dirty Word Anymore...

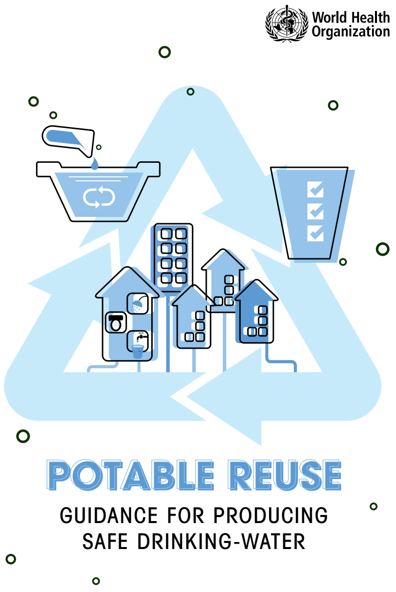
By Jennifer Duffy, P.E.
Jennifer.Duffy@hdrinc.com

As potable reuse becomes a more acceptable concept for the general public and regulations for safely implementing a potable reuse project advance, two new guidance documents were published in 2017. The World Health Organization (WHO) has prepared the Potable reuse: Guidance for producing safe drinking-water, and the U.S. Environmental Protection Agency (EPA) has issued the 2017 Potable Reuse Compendium. (For a basic primer on Potable Reuse, note that the American Water Works Association (AWWA) published Potable Reuse 101: An innovative and sustainable water supply solution in 2016.) The following article briefly summarizes the 2017 documents.

POTABLE REUSE: GUIDANCE FOR PRODUCING SAFE DRINKING-WATER

The WHO guidance describes how to apply appropriate management for the production of safe drinking water from municipal wastewater. Based on increasing interest and development of potable reuse schemes in response to growing pressures on available water resources, WHO determined that drinking-water providers and regulators throughout the world required more guidance to plan, design and operate potable reuse schemes.

The scope of the guidance includes both direct and indirect potable reuse (DPR and IPR). The term *potable reuse* generally refers to both DPR and IPR. The principles described in the WHO Guidelines for Drinking-Water Quality (GDWQ) (WHO, 2017a) apply to potable reuse, but implementation involves consideration of particular issues associated with source water quality and complexity of potable reuse schemes. This document is meant to build upon the guidance provided in the GDWQ and a previous report on potable reuse (WHO, 1975), with additional focus on the quality and protection of source waters, types of treatment processes, additional monitoring considerations, potential use of environmental buffers, engineered storage, and public acceptance. This document does not provide detailed technical design criteria for potable reuse technologies. No new guideline values or principles are introduced.



Terminology is always important, and the WHO guidance document provides a robust definition of terms commonly used in the potable reuse realm.

DEFINITIONS FOR POTABLE REUSE

WASTEWATER is liquid waste discharge from homes and other residential premises, commercial and industrial premises and similar sources, to individual disposal systems or to municipal sewer pipes. It contains mainly human excreta and used water. Wastewater collected in municipal sewerage systems is called municipal wastewater or municipal sewage. In well-operated sewerage systems, contributions of industrial contaminants are reduced by management of industrial waste discharges (e.g. through pre-treatment).

INDIRECT POTABLE REUSE (IPR) represents the planned addition of treated wastewater into water bodies used as sources of drinking-water. The water bodies, which can include rivers, lakes, reservoirs and aquifers, are referred to as environmental buffers. Water containing a proportion of treated wastewater is taken from the environment buffer and further treated to provide drinking-water.

DIRECT POTABLE REUSE (DPR) represents the introduction of treated wastewater (with or without retention in an engineered storage) into a drinking-water supply without prior discharge to an environmental buffer. The treated wastewater may be blended with raw water from a river, lake, reservoir or aquifer immediately before a drinking-water treatment plant; blended with treated water downstream of a conventional drinking-water treatment plant; or introduced directly into a drinking-water distribution system.

UNPLANNED POTABLE REUSE (also known as unacknowledged or defacto potable reuse) represents various descriptions of the long-standing and common practice of producing drinking-water from water sources impacted by wastewater discharges. This is particularly common in river systems serving multiple urban centres where discharged wastewater (treated or untreated) becomes part of the water resource used by downstream centres. Providing that appropriate control measures, including treatment are applied, drinking-water supplies incorporating unplanned potable reuse are capable of producing safe drinking-water.

A number of case studies are also provided to illustrate successful development of potable reuse schemes. The case studies include discussions of potable reuse in:

- Windhoek, Namibia (DPR)
- Orange County, California, USA (IPR)
- Upper Occoquan Service Authority, Virginia, USA (IPR)
- Singapore (IPR)
- Perth, Australia (IPR)
- Big Spring and Laguna Madre, Texas, USA (DPR)
- eMalahleni, South Africa (DPR using acid mine drainage water).

The case studies demonstrate a diversity of approaches and settings, and include coastal and inland schemes, IPR with groundwater and surface water buffers, and DPR using wastewater or drain water as source waters. In the case of Singapore and Perth, the potable reuse schemes are part of multiple source systems, including traditional water supplies and desalination, showing that combinations of sources can increase resilience.

The selection of a treatment train for a specific potable reuse scheme must be carefully evaluated by each community. Irrespective of which treatment combination is selected, safety will depend on meeting health-based targets identified for microbial, chemical and radiological quality through application of multiple-barrier processes, along with online or frequent operational monitoring to ensure consistent and reliable operation. The multiple-barrier approach ensures that performance failure at a single barrier should not lead to significant failure to remove microbial or chemical contaminants. As such, the multiple-barrier approach may be most effective when processes with diverse modes of operation and removal mechanisms are employed. Examples of the treatment trains used in the case study projects are illustrated on page 4.

The WHO document reviews protocols for system assessment and source control, as well as the development of health-based water quality targets and safety plans. Acknowledging that potable reuse schemes are typically complex, proponents are advised to have sufficient resources and capabilities for successful implementation. Availability of appropriately trained and skilled operators is an essential requirement.

Other key issues and associated conclusions of the WHO document include:

- Wastewater contains high concentrations of enteric pathogens. As a result, production of microbially safe drinking water requires setting relatively high performance targets (default targets: minimum 8.5-log reduction of enteric bacteria, 9.5-log reduction of enteric viruses and 8.5-log reduction of enteric protozoa). These do not represent guideline values but, rather, have implications in identifying control measures and, in particular, combinations of treatment processes.

- While there tends to be greater interest in constituents of emerging concern, such as pharmaceuticals and personal care products, the concentrations are generally low and rarely warrant setting new guideline values. The guideline values described in the GDWQ (WHO, 2017a) are sufficient in most circumstances. Where source water surveys indicate a potential for elevated levels of a chemical without a guideline value (e.g., due to poorly managed discharges from manufacturing facilities), screening values could be developed as part of investigations into potential risks and the need for implementation of additional control measures.

- Control measures should be applied from collection of wastewater to the delivery of drinking water. Control measures need to be validated particularly where operational monitoring is relied upon for demonstrating ongoing performance of treatment processes.

- While operational monitoring follows the principles described in the GDWQ, continuous monitoring linked to Supervisory Control and Data Acquisition (SCADA) systems with automatic alarms for deviation from critical limits will be common.

- The content of regulations should be consistent with those developed for other types of drinking-water supply. Development of a single set of regulations for drinking water, including potable reuse, should be considered.

EXAMPLES OF POTABLE REUSE SCHEMES

MONTEBELLO FOREBAY, CALIFORNIA, USA	Secondary WWTP[1]	Chlorination	Media filtration	Soil-aquifer treatment	Chlorination	Potable water			
WINDHOEK, NAMIBIA	Secondary WWTP[1]	Pre-ozonation	Dissolved air flotation	Media filtration	Ozonation	Activated carbon	Ultra-filtration	Potable water	
ORANGE COUNTY, CALIFORNIA, USA	Secondary WWTP[1]	Chlorination	Micro-filtration	Reverse osmosis	AOP (UV/H_2O_2)	Aquifer retention	Chlorination	Potable water	
SINGAPORE	Secondary WWTP[1]	Micro-filtration	Reverse osmosis	UV	Reservoir storage	DWTP[2]	Potable water		
UOSA[3] VIRGINIA, USA	Secondary WWTP[1]	Lime	Media filtration	Activated carbon	Chlorination	Reservoir storage	DWTP[2]	Potable water	
WULPEN, BELGIUM	Secondary WWTP[1]	Chlorination	Ultra-filtration	Reverse osmosis	UV	Soil-aquifer treatment	Potable water		
BIG SPRING, TEXAS, USA	Secondary WWTP[1]	Sand filtration	Chlorination	Micro-filtration	Reverse osmosis	AOP (UV/H_2O_2)	On-pipe blend lake water	DWTP[2]	Potable water
PERTH, AUSTRALIA	Secondary WWTP[1]	Ultra-filtration	Reverse osmosis	UV	Aquifer retention	Potable water			

[1] Secondary treatment usually based on activated sludge and in most examples includes nutrient reduction.
[2] DWTP= Drinking-Water Treatment Plant.
[3] UOSA= Upper Occoquan Service Authority.

- The success of potable reuse depends on the ability to gain public confidence and trust. Information should be made readily available to the public so they understand the background, context and available options. Key stakeholders, including the media and opinion leaders in political, social and community spheres, should be engaged.

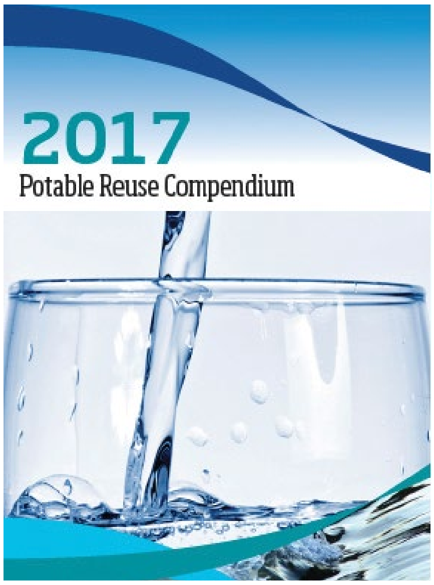
2017 POTABLE REUSE COMPENDIUM

In 2012, EPA published its 2012 *Guidelines for Water Reuse* to serve as a reference on water reuse practices. The document provided information related to indirect potable reuse (IPR), but only briefly described direct potable reuse (DPR). Because of increased interest in pursuing potable water reuse, EPA has issued the 2017 *Potable Reuse Compendium* to outline key science, technical, and policy considerations regarding this practice. This 2017 Compendium supplements the *2012 Guidelines for Water Reuse* to inform current practices and approaches in potable reuse, including those related to DPR. In this Compendium, EPA recognizes the recent water reuse publications from the WHO, the National Research Council of the National Academies of Science, the Water Environment and Reuse Foundation (WE&RF), and the Water Environment Federation (WEF). Specific knowledge and experience are drawn from approaches in existing reuse case studies.

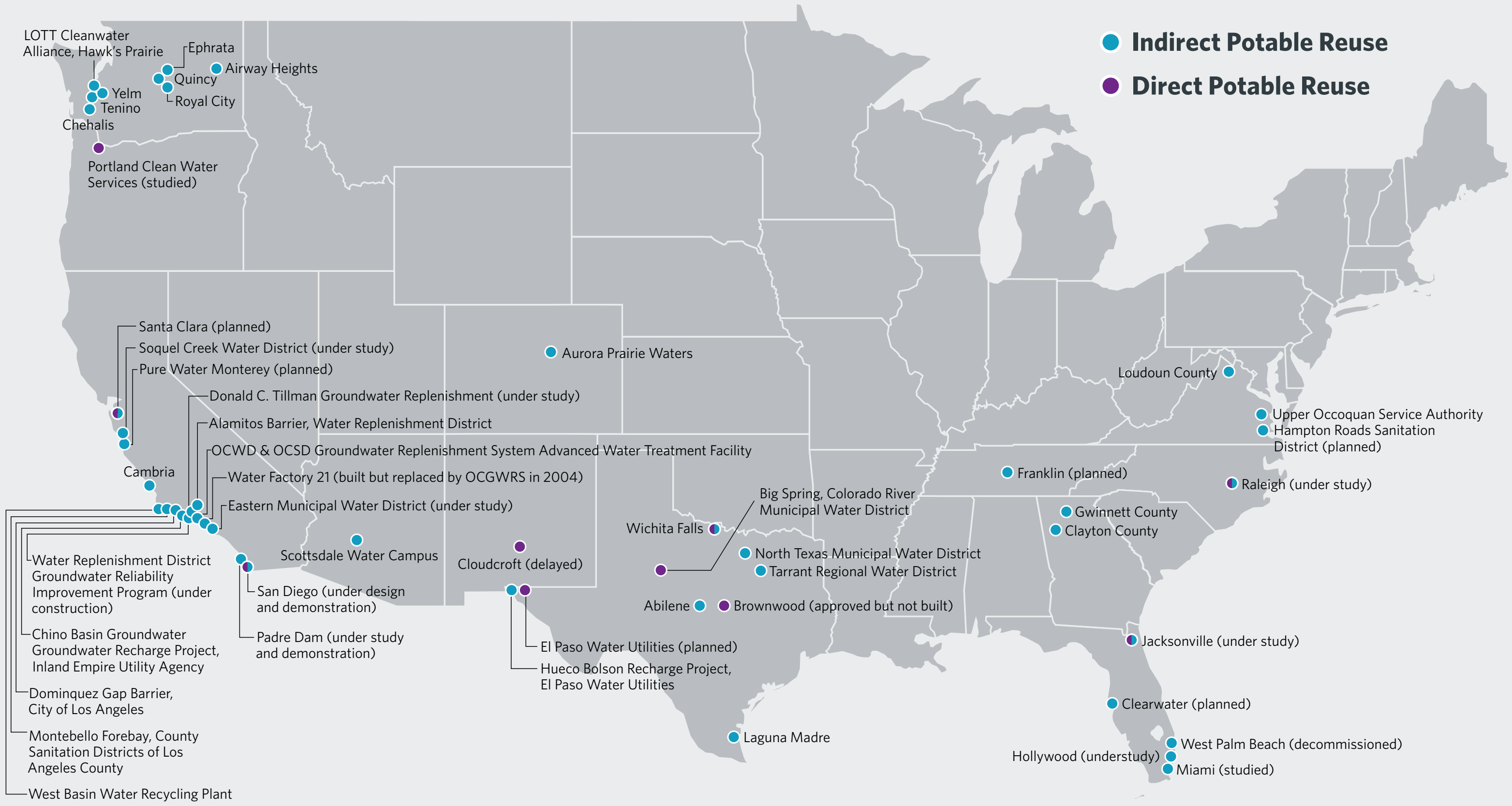
The Compendium discusses the drivers that make potable reuse a viable water supply option, anticipating that potable reuse will grow significantly in the coming decades. The Compendium provides a map of current potable reuse projects in the U.S. as seen on page 5.

Based on a report from Bluefield Research (2015), it is estimated that by 2025, municipal utilities' wastewater reuse will increase by 61 percent and require $11 billion of capital expenditures. Potable reuse installations are expected to grow by 25 to 50 million gallons per day (MGD) per year. From craft brewers to upstream oil & gas, industries are also exploring reuse applications to mitigate supply risk, reduce costs, and comply with regulations.

The Safe Drinking Water Act (SDWA) and Clean Water Act (CWA) provide the core statutory requirements relevant to potable water reuse. Wastewater effluent must meet, if not exceed, the CWA requirements, including National Pollutant Discharge Elimination Systems (NPDES) requirements. Subsequently, reused water must meet drinking water treatment



PLANNED AND CONSTRUCTED IPR AND DPR PROJECTS IN THE UNITED STATES AS OF 2017



requirements under the SDWA, including the National Primary Drinking Water Regulations (NPDWRs). While the SDWA and CWA are the federal laws that identify water quality criteria and standards (either in guidance or regulation), regulations specific to water reuse exist only at the state level.

As of the summer of 2017, no state had developed comprehensive, final regulations for DPR; however, North Carolina approved legislation in 2014 allowing limited DPR use with engineered storage buffering and blending with other sources. In 2016, the California State Water Resource Control Board concluded that it is feasible to develop uniform water quality criteria for DPR, a first step in consideration of a state regulation. Some states are developing regulatory approaches for planning, permitting, and implementing risk management strategies to support potable reuse projects. These actions are in response to water supply challenges, population shifts and growth, and increasing interest in providing more resilient water supplies.

The Compendium reviews the constituents of concern in potable reuse water sources, risk assessment and management, treatment technologies, and alternative treatment trains appropriate for potable reuse applications. Subsequent chapters address source control, the use of natural and engineered buffers, epidemiological studies, public acceptance, and costs. The need for training, operating and monitoring specific to potable reuse plants, which require knowledge of both wastewater and drinking water treatment standards, is also discussed.

Case studies from California, Texas, Georgia, Virginia, and Colorado are provided in the Appendix:

- Los Alamitos Barrier Water Replenishment District of Southern California/Leo J. Vander Lans Advanced Water Treatment Facility (IPR)
- Orange County Groundwater Replenishment System Advanced Water Treatment Facility (IPR)
- Gwinnett F. Wayne Hill Water Resources Center, Chattahoochee River and Lake Lanier Discharge (IPR)
- Village of Cloudcroft PURe Water Project (DPR)
- Colorado River Municipal Water District Raw Water Production Facility Big Spring Plant (DPR)
- Wichita Falls River Road WWTP and Cypress WTP Permanent IPR and Emergency DPR Project
- Potable Water Reuse in the Occoquan Watershed (IPR)

HDR staff are actively engaged in reuse-related committee work for AWWA, Water Research Foundation (WRF) and WateReuse Association. We are sitting members on the WRF Research Advisory Committee, the WRF Reuse Issue Area Team, AWWA Biological Treatment Committee, and the AWWA Workgroup for Potable Reuse. **For more information on HDR's Potable Reuse Practice, contact Jennifer Duffy, Water Reuse Practice Lead, at** Jennifer.Duffy@hdrinc.com.