two new special conditions are being included during NPDES permit renewals for all facilities larger than 3785 m^3/d (1 mgd). These conditions require permit holders

- to prepare phosphorus removal optimization plans and
- to conduct feasibly planning in anticipation of future changes to their existing phosphorus limits.

The optimization plans are being required to ensure that sufficient steps are being undertaken to reduce nutrients discharge with existing infrastructure. The plans focus on means of implementing source reductions of phosphorus loading to facilities and methods for increasing the level of phosphorus removal by the facilities.

The influent sources of phosphorus, such as industrial or commercial users, should be identified, and a plan developed to reduce significant contributions. This can be accomplished through a combination of pretreatment program tools or encouragement of best management practices. The plans should include an examination of the existing facilities at the WRRF and evaluate opportunities to provide a greater level of nutrient treatment within the existing footprint without undertaking major facility upgrades. This should include operational changes and low-cost modifications to the existing facilities.

The feasibly studies are being required to ensure that permit holders proactively plan and prepare for future phosphorus limits. The studies will examine effluent phosphorus limitations of 1 mg/L, 0.5 mg/L, and 0.1 mg/L. The studies should identify the capital and operational costs for providing each of these three levels of phosphorus removal on a monthly average, seasonal average, and an annual average basis.

The preparation of these plans provides both the clean water utility and IEPA with an appreciation for what improvements will be required, the required time for implementation, and total costs for meeting any future proposed permit limits.

Illinois has taken a big step forward in improving the quality of its water by addressing excessive nutrients. By engaging all of the stakeholders, water professionals have obtained a more balanced view of the issue, one that considers all sources of nutrients and identifies the best opportunities for mitigation.

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Fighting drought on several fronts

Diversified water supplies can help better cope with water limitations

Challenges related to water stress have mainly concerned arid and drought-prone regions, but based on recent trends in climate variability, population growth, and intensifying global water demand, the struggles of ensuring water supply are becoming more widespread. These concerns are placing greater significance on sustainable water management approaches that can reduce water scarcity risks and contribute to more reliable water supplies.

A prime example of how supply distributions have spurred actions to develop more resilient water systems is California, where persistent dry conditions have caused one of the most severe multiyear droughts in the state's history. Now 5 years long, California's water crisis, which includes the lowest ever-recorded snowpack in 2015, spurred Governor Jerry Brown that year to issue an executive order mandating a 25% reduction in the amount of water consumed statewide in urban areas.

Although water supply conditions improved in 2016, November data from the U.S. Drought Monitor still showed that extreme to exceptional drought remained deeply entrenched across 43% of the state.

With the threat of drought conditions continuing into 2017 and beyond, California has placed greater emphasis on making regions and communities more self-reliant through the pursuit of diversified water supplies.

"Diversification will play a huge role in the future of California's water system, but it's important that it be done in a non-prescriptive way – depending on the region, the most viable options can be very different," said Newsha Ajami, director of Urban Water Policy with Stanford University's Water in the West.

In developing regional water management strategies, Ajami said municipalities and water utilities should prioritize solutions that incorporate an integrated approach. "By managing water resources in a more holistic and collaborative way, we can maximize our opportunities and better control costs," she said.

Examples of different initiatives in California that reflect an integrated and sustainable methodology to managing water supplies are currently under way.

Economic model helps cope with water scarcity

As a future mechanism to help conserve freshwater supplies and maximize water reuse opportunities, researchers at the University of California (Riverside) have developed an

economic model that demonstrates how flexible wastewater treatment processes can be optimized to produce cost-effective irrigation water. These flexible processes blend varying levels of treated effluent to meet and surpass various water quality requirements.

In the study, "Wastewater Reuse for Agriculture: Development of a Regional Water Reuse Decision-Support Model (RWRM) for Cost-Effective Irrigation Sources," researchers Kurt Schwabe, David Jassby, and Quynh Tran found that blending effluent from various treatment processes could produce water with nutrients that are beneficial to specific crops, thus reducing fertilizer costs and increasing the affordability of recycled wastewater.

Such a framework could help ease stress on groundwater and surface water sources, which are relied on heavily for crop irrigation water in California, according to Jassby. He is an assistant professor of chemical and environmental engineering. "Although irrigation demand in California is roughly seven times larger than the amount of municipal wastewater produced, that demand could still be reduced by allocating treated wastewater to certain high-value crops grown at the rural–urban interface such as turfgrass, citrus, avocado, and grapevines," Jassby said.

Using reclaimed wastewater for irrigation – particularly on golf courses – already is practiced regularly in California and other arid states, but because of the limited treatment of that water, salinity-related problems can be a reoccurring issue.

"Golf courses that irrigate with treated wastewater will often end up with elevated levels of accumulated salt in the soils, requiring periodic flushing with potable water," Jassby said.

Because of the typical high salt concentrations in treated effluent, the researchers emphasized desalination in specifying the technologies and treatment trains associated with their model. "The idea is to desalinate a small portion of the wastewater and then blend it with secondary effluent," Jassby said. "And, by adjusting the blending ratio, water can be engineered with appropriate nutrient compositions that are matched to specific crop demands at a minimum cost."

Following completion of their study, the researchers are now working with colleagues in Israel toward applying their framework to a regional water supply model.

"The next phase is to see how our research can help water districts evaluate the consequences of different infrastructure projects and better develop water supply strategies based on rising demands over time," said Schwabe, a professor of environmental economics and policy. "We will also consider further lower-cost opportunities to blend certain types of effluent with other water sources, which could help the lower costs of meeting regional water supply needs."

Stormwater capture augments supply

To help bolster the Los Angeles region's water supply and add more resiliency against drought-related risks, the City of Los Angeles recently broke ground on an aquifer recharge facility expansion that will double the amount of stormwater that can be captured at the Tujunga Spreading Grounds. This facility is a 61-ha (150-ac) parcel of permeable soil in the San Fernando Valley that connects to the San Fernando Groundwater Basin.

The $29 million expansion project will enhance the storage and conveyance capacity of the spreading basins. It will include construction of new diversion gates and intake structures to allow the spreading grounds to capture more channel flows.

"The purpose of the project is to both equip the facility to hold higher flood-flow volumes and improve the rate at which water can percolate into the ground," said Marty Adams, senior assistant general manager of the water system with the Los Angeles Department of Water and Power. "Based on climate studies, we expect future storms to be shorter and higher-intensity. As such, the ability to capture more instantaneous water from extreme rain events becomes a very important aspect."

By reconfiguring the spreading basins for enhanced replenishment of the San Fernando Groundwater Basin, the project aims to augment the region's most valuable local water asset that is relied on as a primary source for potable supply, according to Adams. "If we are going to prepare our region for future droughts and reduce our reliance on imported water, more focus needs to be placed on developing water resources locally," he said.

Tailored water reuse

In El Segundo, Calif., the Edward C. Little Water Recycling Facility, which is owned and operated by the West Basin Municipal Water District (Carson, Calif.), helps bolster the region's water supply reliability by producing approximately 282,000 m^3/d (62 mgd) of recycled water. The facility is the only one of its kind to convert secondary wastewater effluent into five different types of tailored recycled water qualities that are utilized for specific end uses.

The "designer" types of water produced include tertiary water for industrial and irrigation uses, nitrified water for cooling towers, pure reverse osmosis (RO) water for low-pressure boiler feed water, ultrapure RO water for high-pressure boiler feed water, and softened RO water that is injected into the West Coast Groundwater Barrier to protect local well water supplies against seawater intrusion.

The recycling facility is a key pillar of West Basin's Water Reliability 2020 program, which is designed to shift water supplies to more locally controlled and reliable sources of water.

– Jeff Gunderson, *WE&T*