WE&T

water environment and technology

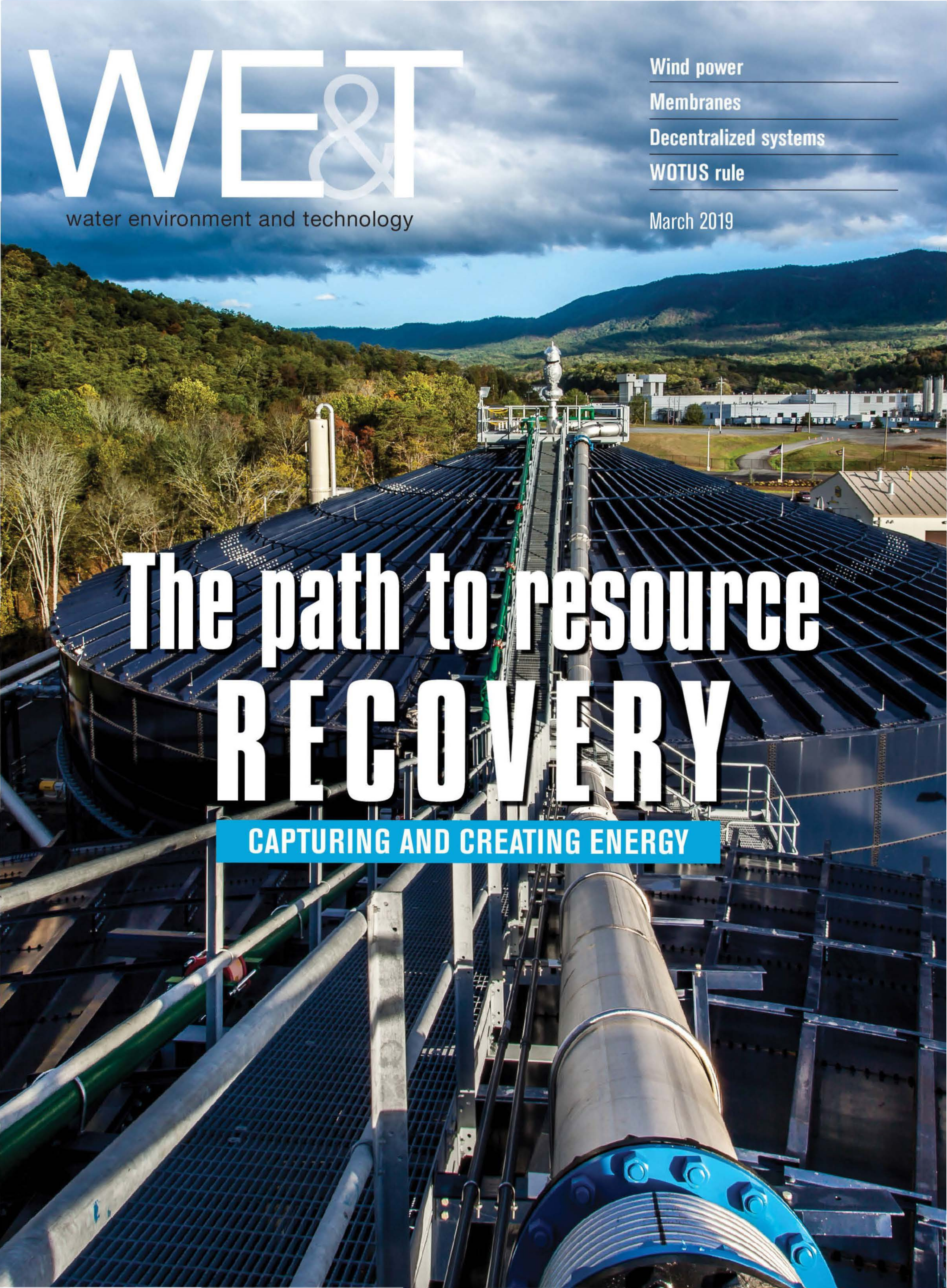
Wind power

Membranes

Decentralized systems

WOTUS rule

March 2019



The path to resource RECOVERY

CAPTURING AND CREATING ENERGY

COOKING

Industrial food processor recaptures energy, water, and nutrients

Michael E. Mecredy, Charles P. Gregory, Asher Benedict, and Jason W. Mullen

In 2014, a food manufacturing facility in the southeast U.S. began the process of replacing its existing wastewater treatment system. After nearly a decade of operation and production increases, the previous system was not capable of keeping up with the demands of current production. Thus, the facility began the process of planning to replace the existing wastewater treatment system with a new system to provide more capacity, reliability, and operational flexibility. The facility also used this upgrade as an opportunity to implement a highly sustainable

The new water resource recovery facility came online in summer 2017 and beneficially uses 100% of the treated wastewater as well as screenings, biogas, and waste biological sludge. Antonio Valdivia/Haskell

UP REUSE

approach targeting beneficial reuse of multiple site-generated waste streams and residuals. The design includes such features as harnessing biogas generated from anaerobic treatment, use of effluent water for routine site activities such as solids press wash water, water reuse and reduction via use of treated effluent for cooling tower makeup, and land irrigation with the balance of the treated effluent. The technologies and methods present at this facility are a case study and example for other industrial facilities seeking to maximize reuse and minimize environmental footprint.

Starting point and goals.

The facility uses an anaerobic contact process to remove biochemical oxygen demand from the screened wastewater. This treatment step also produces biogas that is captured, treated, and reused in the facility. Antonio Valdivia/Haskell

The facility's previous system also showed a commitment to sustainability and included several sustainable components. These included

- effluent discharge via land application
- beneficial reuse of anaerobic biogas as boiler fuel,
- primary screenings – that is, vegetable waste, grains, etc. – management via cattle feed, and
- land application of biological residuals.

But with the new treatment system, the facility sought to improve upon its infrastructure and meet more critical success factors. These new goals include

- compliance assurance without limitation of production,
- reliability and redundancy,
- water reuse in non-food-contact applications,
- future-capable,
- zero odor at property boundary, and
- continued commitment to sustainability.

Starting with conceptual level engineering in 2014, the new water resource recovery facility (WRRF) became a reality in summer 2017 when it began operation. The WRRF is unique as it beneficially uses 100% of the treated water (approximately 30% reused with the balance being land applied) as well as screenings, biogas, and waste biological sludge.

Screening, primary treatment, and biogas

The WRRF's primary function is to reduce nitrogen, phosphorus, and biochemical oxygen demand (BOD) loading at the land application system. The WRRF was designed for the loading conditions presented in Table 1 (p. 28).

The WRRF includes screening, equalization, anaerobic contact with dissolved air flotation separation, and a biological nutrient removal (BNR) activated sludge process with membrane bioreactor (MBR) solids separation. The BNR processes include biological phosphorus removal, denitrification, and nitrification. A portion of the MBR permeate is returned to a reuse header while the balance flows by gravity to an effluent holding pond prior to land application. Figure 1 (p. 28) presents a block flow diagram of the WRRF.

The screening process consists of

Biogas from the anaerobic contact process passes through a desulfurization unit to remove hydrogen sulfide prior to being blended with natural gas and used to fire boilers. Antonio Valdivia/Haskell

Figure 1. Block flow diagram of the new water resource recovery facility

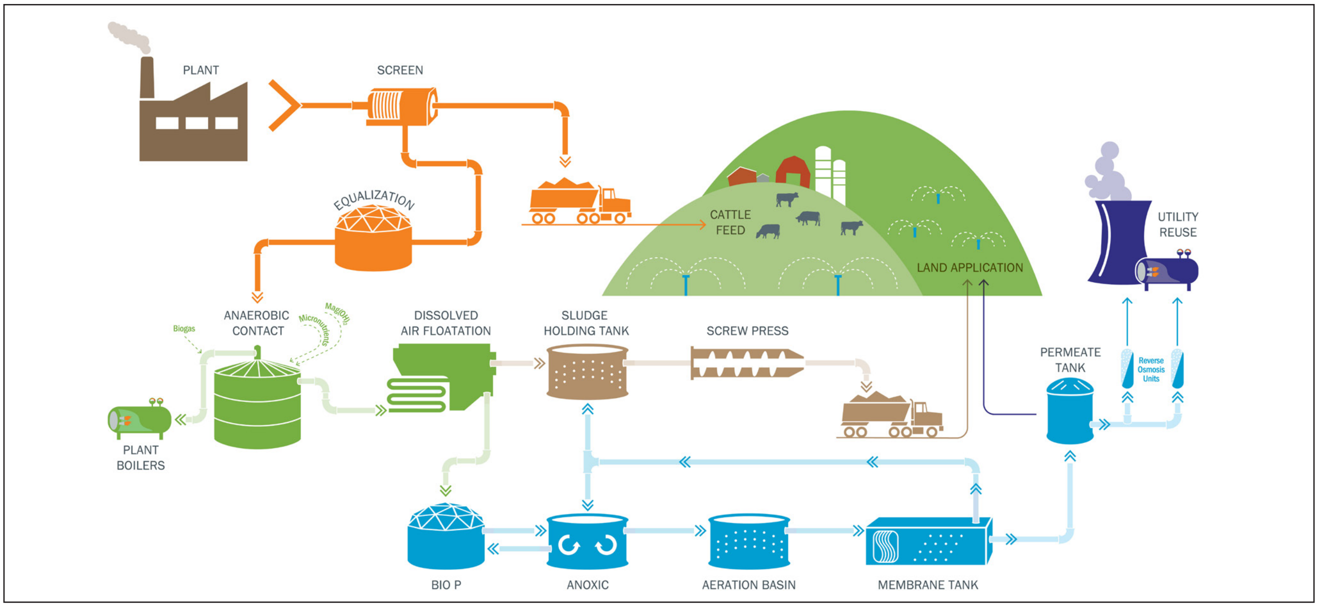


Table 1. Water resource recovery facility design basis

Parameter	Average	Peak
Flow, m^3/d (mgd)	5680 (1.5)	7950 (2.1)
Influent		
Total COD, mg/L	10,800	29,000
TSS, mg/L	6540	28,300
VSS, mg/L	6370	27,600
Total nitrogen, mg/L	190	250
Total phosphorus, mg/L	30	40
Screened influent		
Total COD, mg/L	7790	11,100
TSS, mg/L	1050	1660
VSS, mg/L	1120	1590

COD = chemical oxygen demand.
TSS = total suspended solids.
VSS = volatile suspended solids.

a pair of sidehill screens followed by a rotary drum screen for removal of vegetable waste and grain fragments prior to biological treatment. The fragments are collected and used as a nutritional cattle feed at an off-site cattle facility. On average, 62,300 kg (137,000 lb) of cattle feed is generated weekly from the screenings. Table 2 (p. 29) presents a summary of the nutritional content of the screenings.

After screening, wastewater is pumped to a pair of 4.7-ML (1.25-mg) equalization tanks. The equalization contents are fed to two, 9.5-ML (2.5-mg) anaerobic contact tanks that remove greater than 97% of chemical oxygen demand (COD).

In addition to treating the water, the anaerobic contact process also produces biogas. Average biogas production is approximately 680 m^3/h (400 ft^3/min). The biogas contains approximately 68% methane, 25% carbon dioxide, and 7% other gases with an average hydrogen sulfide concentration of 5000 ppm.

The facility uses a desulfurization unit to remove hydrogen sulfide from the biogas prior to use. Hydrogen sulfide removed from the biogas is converted to elemental sulfur in the desulfurization unit. The facility is considering using this sulfur for fertilizer.

After treatment, the biogas is sent to the facility's boilers. The boilers accept a blend of treated biogas and a minimum of 25% natural gas.

Biological nutrient removal and water reuse

After the anaerobic contact tanks, the liquid stream passes through a BNR process that includes anaerobic, anoxic, and aerated sections.

The facility plans to reuse upwards of 1140 m^3/d (300,000 gal/d) of treated effluent between production facility utility needs and the WRRF. Previous droughts have limited well water supply to the facility and highlighted the need for additional sources. The WRRF effluent is being used for routine, non-food-contact purposes such as clean up, flushing, solids press wash water, and utility makeup.

A portion of the treated effluent receives further treatment via reverse osmosis (RO). The RO system enables the facility to reuse this water as cooling tower makeup water. The facility is also moving forward with additional non-food-contact uses such as boiler makeup. Table 3 (below) presents a summary of the RO permeate quality.

The remaining treated effluent, along with the RO reject, is land applied on the facility's farmland. The spray irrigation water replenishes groundwater and supports cover crops for onsite cattle grazing.

A reverse osmosis step further polishes a portion of the effluent to enable the water's reuse in cooling towers. Michael Mecredy

Solids treatment

Waste sludge from the anaerobic contact and BNR processes is discharged to a storage tank prior to dewatering. Dewatering of the solids is accomplished using two screw presses that utilize GRAS (Generally Regarded As Safe) polymer for conditioning. Dewatered cake is then land applied as a soil amendment. Solids wasting currently totals approximately 1800 kg (4000 lb) dry per day.

Complete reuse

The beneficial reuse performed at this facility has reduced environmental BOD and nutrient emissions, provided cattle feed, produced biogas fuel, addressed a risk of water shortage, reduced local water table drawdown, and met irrigation demand of cover crops. The WRRF provides a stellar example of treatment and beneficial reuse for industrial facilities.

Michael E. Mecredy *is a senior professional,* ***Charles P. Gregory*** *is a professional,* ***Asher Benedict*** *is a senior staff member, and* ***Jason W. Mullen*** *is a senior director at Brown and Caldwell (Walnut Creek, Calif.).*

Table 2. Nutritional content of screenings

Parameter	Value
Dry matter (DM), %	38
Crude protein, % DM	24
Calcium, % DM	0.31
Phosphorous, % DM	0.34
Magnesium, % DM	0.14
Potassium, % DM	0.57
Sodium, % DM	0.10
Acid detergent fiber, % DM	8.1
Neutral detergent fiber, % DM	16
Iron, ppm	122
Manganese, ppm	18
Zinc, ppm	37
Copper, ppm	9

Table 3. Reverse osmosis permeate quality

Parameter	Value
pH	4.63
Conductivity, µS/cm	176
Turbidity, NTU	0.26
Total organic carbon, mg/L	0.8
Total hardness, mg/L as $CaCO_3$	1.5
Calcium, mg/L as $CaCO_3$	0.78
Magnesium, mg/L as $CaCO_3$	0.67
Sodium, mg/L as $CaCO_3$	63
Potassium, mg/L as $CaCO_3$	22
Iron, mg/L	0.01
Manganese, mg/L	0.001
Aluminum, mg/L	0.005
Barium, mg/L	<0.005
Strontium, mg/L	0.001
Copper, mg/L	<0.002
Zinc, mg/L	0.008
Fluoride, mg/L	<0.02
Chloride, mg/L as $CaCO_3$	28
Bromide, mg/L as $CaCO_3$	0.37
Nitrate, mg/L as $CaCO_3$	34
Phosphate, mg/L as $CaCO_3$	1.6
Sulfate, mg/L as $CaCO_3$	0.81
Silica (SiO_2) as $CaCO_3$	0.2