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KANSAS: HIGH-QUALITY WATER FROM SMALL POTWS

Operators draw on outside help—and deploy their own expertise

At many publicly owned treatment works (POTWs) across the United States, staffs have made low-cost modifications and operational changes to reduce effluent nutrient discharges. EPA's **National Study of Nutrient Removal and Secondary Technologies** investigates similar optimization efforts, and this fact sheet, one product of that study, describes some specific successes at the Clay Center and Concordia, Kansas POTWs.

In their optimization work, the Clay Center and Concordia operators drew on free, hands-on, onsite technical help from the Kansas Rural Water Association (KRWA) and the Kansas Department of Health and Environment (KDHE).

The Clay Center and Concordia staffs actively engaged with this assistance, reducing nutrient discharges and showing that investment in staff training coupled with operational changes provides nutrient load removal benefits.

Neither Concordia nor Clay Center POTW was originally designed to remove nutrients. But their 2015 National Pollutant Discharge Elimination System (NPDES) permits required them to modify operations to achieve one of two annual average effluent nutrient goals for total nitrogen (TN) and total phosphorus (TP):

- TN 10 mg/L and TP 1.0 mg/L
- TN 8.0 mg/L and TP 1.5 mg/L

These conditions were similar for many POTWs across Kansas.

Clay Center POTW

The Clay Center POTW has a design capacity flow of 0.715 million gallons per day (MGD) and an average daily flow of 0.34 MGD. The plant includes preliminary treatment, a primary clarifier, an oxidation ditch, a secondary clarifier, and UV disinfection. The oxidation ditch has two rotors, one each on the east and west ends, as well as dissolved oxygen (DO) sensors at both ends. All process control is manual.

Clay Center staff (left to right): Ron Richardson, Ed Hedberg, Raymond LaVisse, Kent Hessling

Operators began by installing new rotors with variable-speed drives to experiment with aeration cycling. They added a baffle to the west side of the ditch, creating an anoxic zone for denitrification (nitrogen removal) followed by an anaerobic zone for biological phosphorus removal. To enhance phosphorus removal, they added fine bubble diffusers just before the secondary clarifier: this gave polyphosphate-accumulating organisms (PAOs) enough oxygen to retain TP throughout clarification. When they added a second baffle following the first, TP effluent concentrations dipped below 1 mg/L at first (though that performance did not last). Polyaluminum chloride is added for emergency polishing. The Clay Center plant now surpasses both TN permit goals. Meanwhile, monthly energy costs at the plant have decreased from $5,600 before optimization to $2,500 afterward.

Clay Center staff studied nutrient removal and took meticulous daily notes as they made these changes, making it much easier to assess their impacts.

Clay Center POTW Monitoring Data

	Effluent TN Concentration (mg/L as N)	Effluent TP Concentration (mg/L as P)
Pre-optimization Average (June 2014–November 2016)	16.32	3.46
Post-optimization Average (December 2016–February 2020)	3.24	1.63*
Percent Removal	80%	53%

*While this cumulative average is above the TP goal, annual average TP concentrations decreased post-optimization and are now consistently below 1.5 mg/L.

Concordia POTW

The Concordia POTW has a design capacity flow of 1.35 MGD and an average daily flow of 0.4 MGD. The plant includes preliminary treatment, an Orbal® ditch system with three concentric ditches, two secondary clarifiers, and UV disinfection. The outermost and middle ditches are operated identically while the innermost ditch is not used. Two blowers aerate the ditch system in summer, one in winter. The outermost ditch has an oxidation-reduction potential (ORP) probe. All process control is manual.

Concordia staff (left to right): Brian Peterson, Paul McGuire, Tom Strecker

Concordia POTW Monitoring Data

	Effluent TN Concentration (mg/L as N)	Effluent TP Concentration (mg/L as P)
Pre-optimization Average (March 2014–March 2015)	16.21	3.58
Post-optimization Average (April 2015–April 2017)	1.37	1.70*
Percent Removal	92%	53%

*While this cumulative average is above the TP goal, annual average TP concentrations decreased post-optimization and are now consistently below 1.5 mg/L.

Concordia staff began experimenting with aeration cycling using a timer to promote nitrification/denitrification and biological phosphorus removal. They found great success with cycles of 60 min on/60 min off, producing monthly effluent TN concentrations typically less than 1 mg/L. They next tried controlling aeration cycling with ORP setpoints but could not get the same effluent quality. So, they went back to timed control, using ORP readings to adjust the length of the aeration cycles. Seasonally, operators add polyaluminum chloride for supplemental phosphorus precipitation when warmer temperatures impede biological removal. Monitoring data show the Concordia plant has surpassed the TN permit goals.

Optimization Opportunities and Benefits

Optimizing existing treatment systems can effectively reduce nutrient discharges from POTWs. Local training, support from regulatory agencies, onsite consulting, and, most importantly, operator ingenuity and enthusiasm enabled these Kansas POTW operators to make the most of existing equipment and reach their nutrient goals. For Clay Center, optimizing also saved energy costs, showing optimization can produce additional benefits beyond improved surface water quality.

Acknowledgements

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For more information, visit epa.gov/eg/national-study-nutrient-removal-and-secondary-technologies