Using Wetlands for Domestic Wastewater Treatment at the Bridger Bowl Ski Resort

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Treatment wetlands (TW) are a type of wetland engineered specifically to remove pollutants from contaminated waters. TW are used throughout the world for the treatment of stormwater, domestic wastewater, industrial wastewater, agricultural runoff, landfill leachate, acid mine drainage, sludge dewatering and combined sewer overflows. The Montana Department of Environmental Quality and Bridger Bowl Inc. partnered with Montana State University to design, construct and monitor performance for a full-scale pilot TW system to treat domestic wastewater at the Bridger Bowl Ski Area north of Bozeman, Montana. The two-stage vertical flow (VF) TW system treats a portion of the wastewater produced from Saddle Peak and Jim Bridger Lodges during the ski season. The influent chemical oxygen demand (COD) and total ammonium concentration can exceed 1000 mg/L and 200 mg/L-N, respectively. This is due to water conservation measures, coupled with sources being primarily from lavatories and kitchens. Winter treatment of high strength wastewater creates a challenging environment to assess the efficacy of a vertical flow wetland technology. The focus of the research has been to maximize the two-stage VF TW system for total nitrogen removal.

The TW system has been tested in the winter for nitrogen removal since the beginning of operation in 2013. Experiments on the VF wetlands have been conducted over multiple operating schemes by varying the recycle ratio, bed saturation level, hydraulic loading and dosing frequency. Results since 2014 suggest that the second stage is capable of complete nitrification. However, the first stage has not yet achieved complete denitrification. Increasing the saturation levels in the first stage improved total nitrogen removal throughout the 2015-2016 and 2016-2017 ski seasons. Three saturation levels have been assessed: 0.0m, 0.53 m and 0.71m. Average system removal was 93% and 95% for chemical oxygen demand (COD) and 70% and 75% for total nitrogen (TN) in 2016 and 2017, respectively, despite elevated influent concentrations of 930 mg∙L⁻¹ COD and 195 mg∙L⁻¹ TN. In addition, the system converted virtually all influent TN to nitrate. Continuing experiments will further assess the interactions and influence between influent hydraulic load, recycle ratio and saturation level to achieve total nitrogen removal.