

Effects of Hydraulic Loading On Nitrification and Denitrification Processes in a Two-Stage, Vertical Flow Treatment Wetland at Bridger Bowl Ski Area

Masters Thesis Defense

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Abstract:

A pilot-scale two-stage vertical flow treatment wetland (VFTW) at the Bridger Bowl Ski Area was used to evaluate the influence of hydraulic loading rate on COD removal, nitrification, and denitrification in the system. Hydraulic loading rates ranged from 35.8 cm/d to 59.7 cm/d over system years 2018 and 2019. The system effectively removed COD both years, with removals of 95% and 96% for influent COD concentrations of 555 mg/L and 607 mg/L, respectively. Influent total nitrogen was 141 mg/L in 2018 and 105 mg/L in 2019, and removals were 67% and 54%, respectively. At a hydraulic load rate of 59.7 cm/d, COD removal declined in the first stages and ammonium removal declined in the second stage. At lower hydraulic load rates up to 47.8 cm/d, removal of COD, ammonium and nitrate increased in a consistent pattern with increased mass loading of the respective contaminant suggesting an upper limit between those values. However, the maximum is likely influenced by partial saturation of the first stage and the recycle ratio which were not varied in this study and cannot be completely separated with mass loading of a specific contaminant. A key limiting factor is hydraulic overload to the first stage which limited removal of COD and subsequently interfering with nitrification in the second stage. A multivariate model for ammonium removal in the second stage predicts increased ammonium removal with increasing ammonium load but decreasing COD load. Despite performance variation depending on operational parameters, the system met applicable discharge requirements, reinforcing the ability of a VFTW system to perform secondary wastewater treatment, even for high-strength wastewater and in cold climates.