

Design and Performance of a Pilot-Scale Constructed Wetland Treatment System for Removing Oil and Grease from Oilfield Produced Water

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Pilot-scale experiments were performed to evaluate application of constructed wetland systems to treating simulated oilfield produced water (OPW) containing oil and grease (O&G) at concentrations up to 100 mg/L. The water studied also contained Zn, Ni, and Mn at initial concentrations of 0.50, 0.37, and 5.00 mg/L, respectively. Objectives of the study were: 1) design and build pilot-scale constructed wetland treatment systems (CWTs) to renovate simulated OPW containing O&G and metals; and 2) measure treatment performance of the pilot-scale systems. Specific biogeochemical pathways for treatment of the simulated OPW were targeted in the design of two series of subsurface vertical flow (SSF) wetland reactors planted with *Phragmites australis* (reeds) and a single series of free water surface (FWS) wetland reactors planted with *Typha latifolia* (cattails). The design targeted removal of O&G through oxidation and removal of metals by sulfide formation and sorption. O&G concentration decreased to below the method detection limit (~1.6 mg/L) in SSF and FWS series effluent for targeted influent concentrations of 10, 25, 50, and 100 mg/L. COD removal was consistent with the decrease in O&G concentration; background concentrations of 5-8 mg/L COD were achieved in system effluents. The SSF CWTs achieved a removal efficiency (defined as percent concentration decrease from influent to effluent) of approximately 65 to 99% for metals; the FWS CWTs achieved removal of approximately 40 to 92% for metals. Seven-day static-renewal bioassays with *Ceriodaphnia dubia* and *Pimephales promelas* were performed to assess biological treatment performance of the systems. Prior to treatment, statistically significant (ANOVA) mortality was observed for *C. dubia* and *P. promelas* exposed to 1.56% and 12.5% dilutions of untreated water, respectively. Following treatment in SSF wetland series, no significant mortality was observed in *C. dubia* at 12.5% treated water and *P. promelas* at 25% treated water. These data indicate that pilot-scale SSF and FWS CWTs can decrease concentrations of O&G and selected metals from simulated OPW, and that treatment can increase survival of *C. dubia* and *P. promelas*. Seed germination and early growth studies indicate that a variety of seeds can be germinated and that the treated water can support early growth of food crops, which is encouraging for reuse of OPW following treatment in a CWTs.