2022 Mid-Continent Transportation Research Symposium
Ames, Iowa
September 14–15, 2022
intrans.iastate.edu/events/midcon2022/

Evaluation of In-Channel Sediment Basin Performance Using Large-Scale Testing Techniques

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Abstract

The Iowa DOT is required to develop stormwater pollution prevention plans (SWPPPs) to minimize the risk of downstream pollution emanating from highway construction, as specified in the National Pollutant Discharge Elimination System General Permit No. 2 (NPDES Permit). The Iowa DOT commonly employs temporary sediment control basins to detain sediment from stormwater runoff before discharge. Sediment basins can be effective in capturing sediment if properly designed and implemented. The current Iowa DOT temporary sediment control basin standard specifies constructing an earthen dam across a conveyance channel to create an impoundment favorable for sedimentation, which is dewatered through a perforated riser pipe and auxiliary spillway. Results from the 18-SPR1-001 erosion and sediment control field monitoring project indicated that the installed and monitored temporary sediment control basins provided negligible turbidity and total suspended solids reduction when comparing inflow and discharge samples. Enhancements to the current design of sediment control basins could provide improved performance and reduce the sediment load discharged from Iowa DOT managed sites. Researchers at the Auburn University - Stormwater Research Facility examined the performance of an in-channel sediment basin design in response to several structural and chemical treatments to emulate an installation in an existing roadside conveyance channel. To quantify sediment retention and water quality performance, treatments were evaluated through large-scale, controlled flow and sediment introduction testing. Treatments included: (1) geotextile lining, (2) a floating surface skimmer, (3) porous flow baffles, (4) an upstream forebay, and (5) application of flocculant. Sediment retention was reported as high as 96% by weight when an upstream forebay, geotextile lining, surface skimmer, and surface were used as a system and 98% when flocculant was added to the basin. The sediment retention can be compared to 76% capture when only a geotextile liner was used. When flocculant was applied, turbidity reduction increased by 42%, and discharge turbidities were consistently below 100 NTU during dewatering periods. Flocculant reduced the captured D₅₀ particle size by four times, on average, indicating that flocculant aids in the capture of fine-sized soil particles, which may decrease the required footprint for installation, required storage volume, and detention times in basins. In addition to experimental testing, a spreadsheet-based tool was developed to aid in implementing in-channel sediment basins and in the design of structural and chemical components that enhanced sediment capture and turbidity reduction. This research indicates that in-channel sediment basins are effective with proper design, installation, and maintenance. Improved sediment basin designs are expected to minimize sediment-laden discharge. It is anticipated that an in-channel sediment basin design may be adopted as an alternative basin design outside of Iowa due to minimized land easement and use of existing infrastructure contributing to decreased costs.