Research Brief

Wisconsin Highway Research Program
Project 0092-13-03
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Understanding and Complying with the EPA's Storm Water Mitigation Guidelines

Research Objectives

- Evaluate the effectiveness of various BMPs for controlling erosion and sediment discharge based on quantitative measures
- Better understand and comply with the EPA's new construction and development rules
- Help establish appropriate storm water runoff monitoring protocols for WisDOT projects

Research Benefits

- Determined BMPs are generally effective at reducing erosion and turbidity to acceptable levels
- Confirmed automatic monitoring of turbidity is cheaper and easier than monitoring TSS directly
- Confirmed the use of TSS turbidity relations from samples to predict turbidity in runoff events

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Background

In Wisconsin, the Environmental Protection Agency (EPA) delegates the regulation of storm water discharge associated with construction activities to the Wisconsin Department of Natural Resources (WDNR) through the Wisconsin Pollutant Discharge Elimination System (WPDES). Although the Wisconsin Department of Transportation (WisDOT) is exempt from these regulatory requirements, it follows the Wisconsin Administrative Code and a cooperative agreement with the WDNR to address construction site erosion control on its construction projects.

Major components of the erosion control plan that WisDOT follows are non-numeric best management practices (BMPs) that require erosion and sediment controls, but they do not require permittees to monitor turbidity or other measures of pollution. The EPA has not specified numeric limits on pollutants in the past because of technical limitations and prohibitively high costs for businesses; however, as automatic turbidity testing devices become more advanced and less costly, the EPA may revisit imposing numerical limits and mandatory testing. Therefore, there is a need to determine the effectiveness of existing storm water management practices and to develop other measurement strategies.

Methodology

An automated monitoring device was developed to collect time series of turbidity at the outfall locations of five sampling sites. At four sites, grab samples were also collected during or after storm events to quantify typical turbidity and other water quality parameters at various discharge points, specifically; conductivity, pH value and mass concentration of total suspended solids (TSS). Most grab samples were measured onsite with handheld meters, while some samples were taken back to the laboratory to be validated on a benchtop Nephelometer.

Laboratory experiments were also conducted to investigate the relationship between turbidity and the mass concentration of TSS. Soil was taken from the four sites where grab samples were collected and laboratory simulations of runoff were created. The resulting turbidity levels and other parameter measurements were compared to grab samples.

Handheld turbidity monitor used to collect data at runoff site.

"Conventional BMP measures are able to effectively protect soil from erosion, reduce runoff volume and speed and enhance infiltration, thereby reducing the total sediment entering the receiving water body."
– Qian Liao, UW-Milwaukee

Interested in finding out more?

Final report is available at: WisDOT Research website.

Results

Measured turbidity in grab samples during or after storms ranged from 20 to 2,300 Nephelometric Turbidity Units (NTU). These measurements are lower than those reported in the literature at typical construction sites, but comport with the 500 to 2,000 NTU range reported by the National Cooperative Highway Research Program for sites following conventional BMPs. This suggests that conventional BMP measures are able to effectively protect soil from erosion, reduce runoff volume and speed and enhance infiltration, thereby reducing the total sediment entering the receiving water body. However, some samples measured immediately at both sides of BMP controls, such as straw roll ditch checks and silt fences, did not show significant difference in turbidity.

TSS-turbidity relation for runoff from construction sites can be well characterized and predicted by analyzing soil samples collected on-site following a simple laboratory test.

The measured pH values of grab samples ranged from 7.2 to 9.2, and the conductivity values were between 380 and 3,200 μS/cm. No correlations were found among the pH value, conductivity and turbidity for grab samples.

Recommendations for Implementation

WisDOT should continue employing BMPs (minus straw roll ditch checks and silt fences) to keep turbidity to acceptable levels. Sedimentation basins or ponds with flocculation treatment are the only known methods to effectively settle out fine clay or silt sediments, thus reducing the turbidity level even further.

Reconstruction of the turbidity response function and observed statistical correlations suggest that it is possible to develop models to predict the daily maximum turbidity and the total turbidity load of effluent from construction sites for designed storm events. Models of this kind are valuable for future BMPs of WisDOT construction projects as well as for the EPA to evaluate new regulation policies.

If the EPA institutes numeric limits and monitoring mandates, automatic turbidity monitors should be used at appropriate distances from outfall to collect data that can be used to estimate TSS using a calibrated TSS-turbidity relation. This relation estimates TSS with a much simpler turbidity measurement, which allows continuous monitoring of the TSS concentration of effluents from construction sites to be done economically and accurately. Turbidity measured immediately from outfalls will likely be extremely high despite extensive BMP coverage.

This brief summarizes Project 0092-13-03,
"Understanding and Complying with Storm Water Mitigation Guidelines from the EPA"
Wisconsin Highway Research Program