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RESEARCH
SERVICES SECTION

TECHNICAL SUMMARY

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PROJECT COST:
$114,000

Investigators used solar panels to effectively power the winter monitoring equipment at the ponds.

Water Quality Performance of Dry Detention Ponds with Under-Drains

What Was the Need?

Developing highways and urban areas can reduce the ability of ecosystems to accommodate storm water. Runoff management remains a critical aspect of effective transportation systems because storm water carries metals and organic solids that can damage watersheds and downstream water sources.

A study described in report 2005-49A, "Impact of Alternative Storm Water Management Approaches on Highway Infrastructure: Guide for Selection of Best Management Practices—Volume 1," identified wet retention ponds, dry detention ponds, rain gardens and dry swales as the best methods for managing storm water runoff. Effective management removes pollutants, reduces downstream flooding and increases the amount of time that it takes for storm water flow rates to peak, after which flooding may occur.

Wet retention ponds store runoff for extended periods and allow pollutants to settle out, while dry detention ponds allow water to drain out and leave the pollutant-carrying sediment behind. Dry ponds cost 25 percent to 40 percent less to build than wet ponds, and the benefits of dry ponds over wet include elimination of algae growth, drowning risk, bad odors and mosquito breeding areas; dry ponds also offer easier maintenance access. To recommend the use of dry ponds over wet, however, Mn/DOT still needed to know how effectively dry ponds remove pollutants from water headed downstream through under-drains.

What Was Our Goal?

This investigation sought to monitor drainage and pollutant removal performance at dry detention ponds with under-drains in Minnesota. A deeper understanding of dry detention pond performance will lead to better design of storm water management methods and would improve the ability of Mn/DOT and local transportation engineers to protect water sources and more fully satisfy federal clean water regulations.

What Did We Do?

Researchers set up monitoring cabinets with equipment for measuring water temperature, flow rate and water pollution levels at three dry detention ponds. Two ponds were Mn/DOT facilities near Mankato, and the third was a Carver County pond.

Monitoring equipment included inlet and outlet devices for sampling flow, as well as gauges and instruments in the monitoring cabinets. Data was collected from May 2004 to early August 2005; this included 12 storm events at the Carver County site. Researchers compared results to findings of studies from around the country.

What Did We Learn?

This research found that dry detention ponds with under-drains can be effective in managing storm water. Performance observations included:

- One of the Mankato-area ponds performed poorly due, in part, to poor under-drain design. Water pooled continuously, vegetation at the fringes of the pond died, and soil conditions were anaerobic.
- Despite a poor outlet pipe configuration, the other Mankato pond drained better.
- The Carver County pond drained more slowly than its 48-hour design target, draining for an average of five days per storm; following the first two storms monitored,

continued

"Wet ponds present some maintenance difficulties. We feel dry ones are a good solution to wet pond problems. Monitoring data gave us something to work with, but we would have liked to see more design guidance from this study."

–Scott Morgan,
Mn/DOT District 7
Hydraulics Engineer

"This study helps Mn/DOT get credit for dry detention ponds with under-drains as a pollution prevention device. The data showed our monitoring device was fairly good at monitoring total suspended solids and phosphorus."

–John Gulliver,
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The dry detention ponds investigated drained, in most cases, far slower than the 48-hour drainage target for which they were designed. Sediment and under-drain design were the principal culprits of the drainage problems.

drainage required more than 17 days. Silty clay loam at pond bottom may have reduced filter effectiveness. Low plant growth also suggested slow drainage.

- Erosion problems presented the potential for surrounding soil to enter the ponds.

Investigators noted that the meters used to measure storm water flow performed poorly, and that solar panels worked well at powering winter sampling equipment.

Pollution monitoring showed that the ponds were effective at retaining suspended solids, moving 88 percent of total suspended solids from storm water runoff.

Low concentrations of pollutants were found in the influent at Carver County, suggesting the site may not have been ideal for evaluation. Specific pollutant measurements at this pond following storm events showed that it performed within an acceptable range of national averages in concentration-based retention efficiencies, an important measure of pollutant removal. Investigators found:

- The Carver County pond retained 39 percent of suspended solids compared with national averages of 50 percent.
- The pond retained 15 percent of total phosphorus compared with 29 percent nationally.
- The pond retained an average of 3 percent of dissolved phosphorus, at levels ranging from 18 percent to 60 percent, compared with the national average of 14 percent.

What's Next?

This research provided performance information about dry detention ponds with under-drains, and so improved knowledge of best management practices. A key insight gained was that selecting the appropriate soil and location of the under-drain is crucial to its performance.

The study showed that monitoring can work, but is expensive and time-intensive, and the results of this monitoring do not apply well to other sites. A subsequent four-level approach to assessment (which forms the basis of the Assessment of Stormwater Best Management Practices manual) recommends that the goal of an assessment first be identified, and then an appropriate level chosen: visual inspection, capacity testing, synthetic runoff testing and monitoring.

This Technical Summary pertains to Report 2006-43, "Water Quality Performance of Dry Detention Ponds with Under-Drains," published December 2006. The full report can be accessed at http://www.lrrb.org/PDF/200643.pdf.