



UPDATES

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Maintenance of Stormwater Treatment Practices

IMPORTANCE OF PARTICLE SETTLING VELOCITY IN BMP DESIGN

Contributed by Eric Hettler (hettl001@umn.edu)
 Funded by Minnesota Pollution Control Agency

Urban runoff contains particles that vary in size from small clays to coarse sands. Some best management practices (BMPs) such as ponds and hydrodynamic separators rely on sedimentation as the primary mechanism to remove these particles. Sedimentation is a function of the settling velocity of particles depends on the particle size and density. In order to ensure accurate design and estimates of performance, it is important to have an accurate measure of the particle settling velocity distribution for particles entering BMPs.

Previous studies have attempted to characterize particle size distribution (PSD) in urban runoff (USEPA 1986, Sansalone et al. 1998, Li et al. 2005), and the reported PSD varies widely. The PSD found by Sansalone et al. is coarser (i.e., larger particles) than the PSD found by Li et al., and the PSD found by Li et al. is coarser than the distribution found by the USEPA (NURP distribution). Nonetheless, practitioners and regulators generally use the NURP distribution for the design of BMPs. Assuming these particles have the same density, the settling velocity will increase as particle size increases.

Figure 1 displays expected solids removal from an underground hydrodynamic separator receiving runoff from a hypothetical impervious watershed assuming the PSD reported by Sansalone et al., Li et al., and the USEPA (NURP distribution). Predicted removal for the coarser distributions (Sansalone et al., Li et al.) is substantially greater than for the commonly used USEPA/NURP distribution. Clearly, an accurate assumption of particle size distribution is essential to the proper design and evaluation of many BMPs.

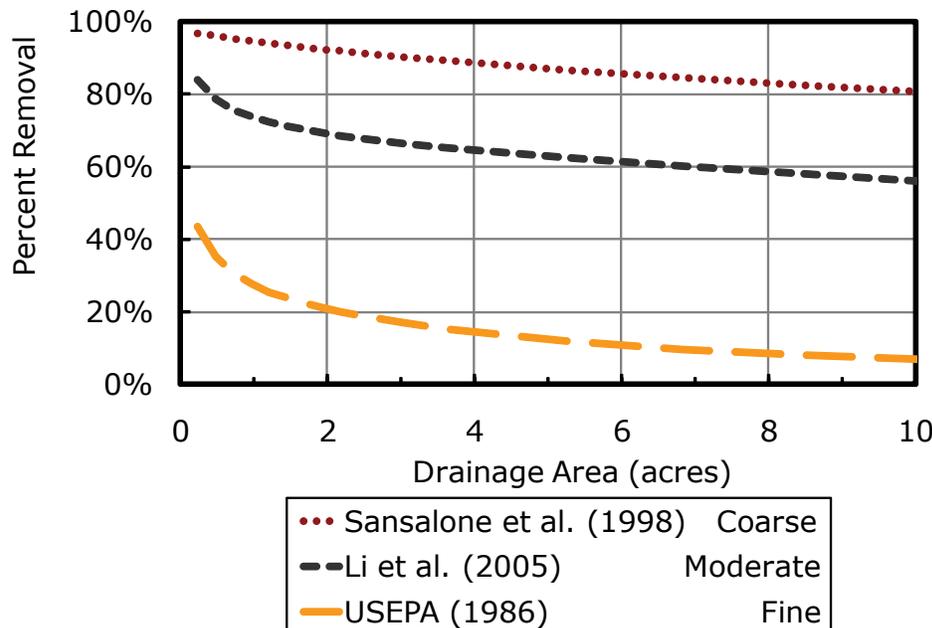


FIGURE 1: Predicted removal from a hydrodynamic separator for a range of particle size distributions. (Courtesy E. Hettler)

WELCOME

Thank you for reading our newsletter! Our purpose is to create opportunities for partnerships which are crucial to our quest for improving the methods for assessment and maintenance of stormwater treatment practices.

UPDATES is a quarterly newsletter designed to share news, current stormwater research efforts, and contact information related to the development of assessment methods and maintenance education for stormwater treatment practices. It is an outreach effort of a project sponsored by the Minnesota Pollution Control Agency (MPCA) and in cooperation with other agencies and organizations. For information, contact Andy Erickson (eric0706@umn.edu).

STORMWATER ASSESSMENT AND MAINTENANCE PROJECT TEAM:

University of Minnesota

John Gulliver (PI), Civil Engineering
Deb Swackhamer (Co-PI), Water Resources Center
Randal Barnes, Civil Engineering
John Chapman, Bioproducts & Biosystems Engineering
Andy Erickson, St. Anthony Falls Laboratory
William Herb, St. Anthony Falls Laboratory
Raymond Hozalski, Civil Engineering
Omid Mohseni, St. Anthony Falls Lab/Barr Engineering Co.
John Nieber, Bioproducts and Biosystems Engineering
Heinz Stefan, Civil Engineering
Pete Weiss, Valparaiso University

PROJECT MANAGERS & TECHNICAL LIAISONS

C. Bruce Wilson, MPCA
Mike Eastling, City of Richfield
Marilyn Jordahl-Larson, Mn/DOT
Barbara Loida, Mn/DOT
Rhonda Rae, Donohue and Associates, Inc.
Doug Snyder, Mississippi Watershed Management Organization



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MEASURING AND ESTIMATING INFILTRATION RATE WITH THE MPD INFILTROMETER

Contributed by Farzana Ahmed (ahmed262@umn.edu)
Funded by Minnesota Pollution Control Agency

Infiltration is an essential process of many stormwater best management practices (BMPs). However, infiltration rates have great spatial variation, making quantification of infiltration rates challenging. In addition, accumulation of fine particles at the surface can limit the infiltration rate of these practices. Therefore, measurements of the infiltration rate are needed to determine performance, schedule maintenance, and meet regulatory requirements. The Modified Philip Dunne (MPD) Infiltrrometer has been developed as a fast, simple, and inexpensive device to measure the infiltration rate of water into the soil at a number of locations in rain gardens, infiltration basins and trenches, swales, and filter strips. A person with minimal training can obtain the saturated hydraulic conductivity at a number of locations in an infiltration practice, and ultimately calculate the infiltration rates for a variety of storms.

The MPD Infiltrrometer is a falling head device. This infiltrrometer is made of a hollow open-ended cylinder that is pounded two inches deep into the soil. Next, the device is filled with water to a predetermined height; a stopwatch is started when the water level starts to drop, and the water level is recorded over time. An MPD spreadsheet, developed for application in EXCEL, is then used to determine the saturated hydraulic conductivity (K_{sat}) and soil suction (C) based on the water level vs. time data, dimensions of the MPD, and the initial and final moisture conditions.

The spreadsheet minimizes the root mean square (RMS) of the difference between the observed and predicted time increment (Δt), as well as the observed and predicted head increment (ΔH), by adjusting the saturated hydraulic conductivity (K_{sat}) and soil suction (C). The MPD spreadsheet and a set of MPD infiltrrometers will be available for purchase from St. Anthony Falls Laboratory in the summer of 2010.



FIGURE 1: Modified Philip Dunne Infiltrrometer (Courtesy F. Ahmed)

SOIL REMEDIATION AS A STORMWATER BMP

Contributed by Nick Olson

(Contact: John Gulliver at gulli003@umn.edu)

Funded by Minnesota Pollution Control Agency, Three Rivers Park District, and The Center for Urban and Regional Affairs.

Soils in residential developments typically have lower stormwater infiltration rates than the soils they replace. This is due to reduced topsoil depth and increased subsoil compaction as land is reshaped and worked with heavy equipment during development. Loss of infiltration leads to increased stormwater runoff and associated downstream problems of flooding, pollutant transport, and warming stream temperatures.

Field studies were conducted to measure the practical application and performance of amending soil with tillage and compost under actual conditions. Three different sites (Maple Lakes Park, Lake Minnetonka Regional Park, and French Regional Park) were divided into three plots for comparison:

- **Control:** No remediation was performed
- **Tilled:** Tilled to 24" depth and spaded to a depth of 16" to smooth furrows
- **Compost:** Tilled to 24" depth and spaded with 3" of compost incorporated to a depth of 16"

Each plot has been tested to assess compaction before and after soil remediation with three indicators: saturated hydraulic conductivity, soil bulk density, and soil strength. Saturated hydraulic conductivity (K_{sat}) measures the permeability of the soil under saturated conditions and in general K_{sat} decreases as compaction increases. Soil (dry) bulk density is a measure of the density of the soil which increases as compaction increases. Soil strength is a measure of the resistance to penetration in the soil column, and penetration resistance increases as compaction increases.

Comparison of each site before and after remediation revealed that compost amended plots at all sites had the largest K_{sat} values and were 3.4 to 6.1 times greater than pre-remediation plots (e.g., see figures 1 and 2). Tilled plots had K_{sat} values 1.3 to 2.4 times greater than pre-remediation plots, but were not statistically different from the control plot averages at Lake Minnetonka Regional Park and French Regional Park (not shown).

Bulk densities before and after remediation were similar for the control and tilled plots at all sites. Bulk densities in the compost plots, however, ranged from 0.93 to 1.15 g/cm³, which is a significant improvement compared to the pre-remediation average of 1.4 g/cm³. *(cont'd on page 4)*

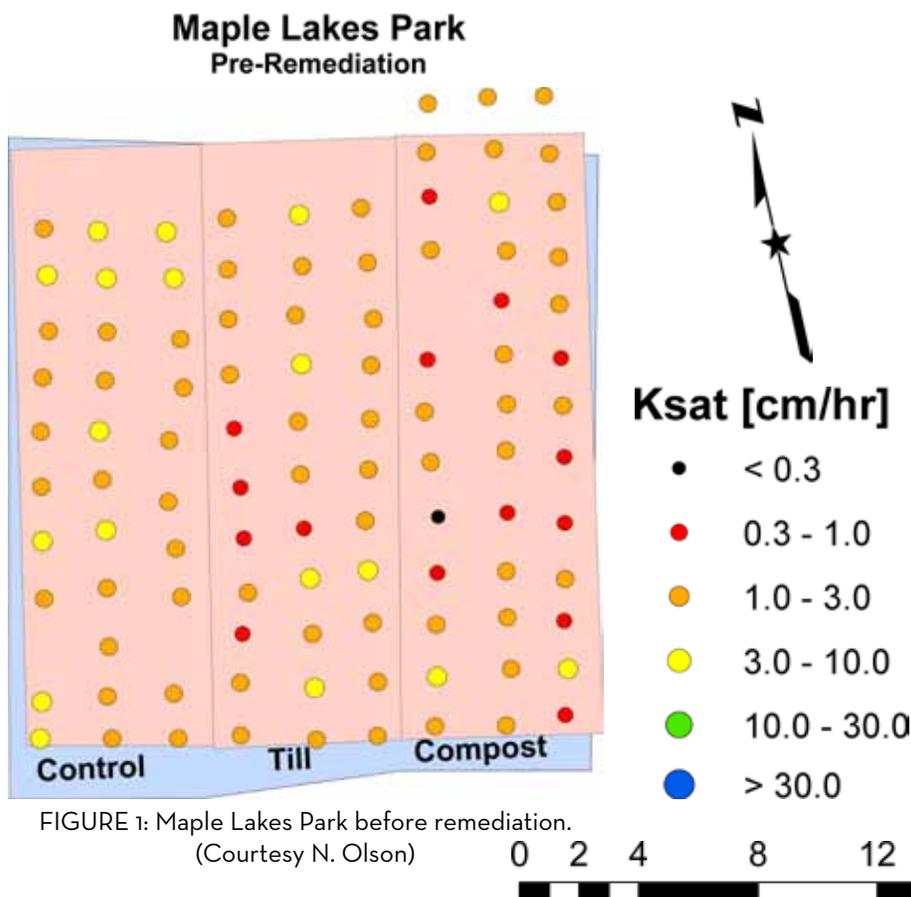


FIGURE 1: Maple Lakes Park before remediation. (Courtesy N. Olson)

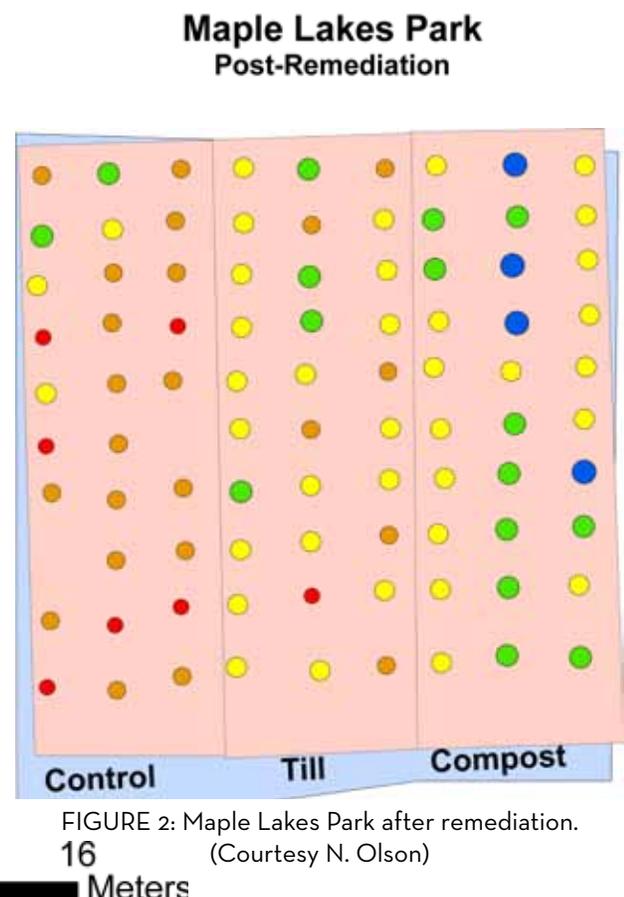


FIGURE 2: Maple Lakes Park after remediation. (Courtesy N. Olson)

SOIL REMEDIATION... (cont'd)

Remediation substantially reduced the soil strength at the surface and significantly reduced soil strength to depths near 12 inches in both the tilled and compost plots. This is a significant improvement when compared to the control plot.

Remediation by tillage alone was ineffective in improving the saturated hydraulic conductivity, even though soil strength was reduced. Spading in compost after a soil has been tilled resulted in increased K_{sat} and reductions in bulk density, both of which improved the soil condition. This is likely due to the ability of the compost to increase the porosity and connected pathways in the soil. The next step in this study will be to assess permeability at French Regional Park and Maple Lakes Park to determine if the compost plots continue to improve (or maintain) the soil permeability.

FIGURE 3: High school research assistant Lanre Adekola takes measurements with a Modified Philip-Dunne Permeameter. (Courtesy N. Olson)



EVENTS CALENDAR

NOTE: Participant travel paid for by the University of Minnesota

May 17-21, 2010: World Environmental & Water Resources Congress (EWRI) (Providence, RI).

- *Enhanced Filtration for Stormwater Phosphorus Removal*

June 9-10, 2010: Stormwater U Education Program (St. Paul, MN) <http://www.extension.umn.edu/stormwater/>.

- *P8 Modeling for Reviewers and Modelers*

August 1-5, 2010: StormCon (San Antonio, TX) -

- *Capturing Dissolved Phosphorus With Iron-Enhanced Sand Filtration*
- *When Do We Need to Replace a Bioretention Practice?*
- *Field Measurement of Particle Settling Velocity*

PUBLICATIONS

1. Erickson, A.J., J.S. Gulliver, J.H. Kang, P.T. Weiss, and C.B. Wilson. (In Press). "Maintenance of Stormwater Treatment Practices," *Journal of Contemporary Water Research and Education*. Accepted 2009.