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IN THIS ISSUE

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PROJECT SPOTLIGHT

Permeable Pavement Use and Research at Hannibal Parking Lot in Kinston, NC

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Background

Over the past several years, stormwater runoff has been diagnosed as a severe problem in the United States, beginning with the creation of the NPDES Phase I Program in the mid-1990's. However, efforts to address stormwater runoff have been researched and developed since the middle of the twentieth century. In North Carolina, stormwater runoff has been an issue since the 1940's, triggered by massive flooding along the Roanoke River. In addition to flooding, most states began addressing erosion and subsequent sedimentation in the early 1970's. Both problems are linked to development. Traditional building has led to massive areas of impervious surfaces, such as roofs and parking lots. These impervious areas tend to be interconnected and result in increased downstream flooding and erosion.

Simultaneously, the American appetite for mobility has enabled a pavement revolution. More roadways and parking lots have been constructed to accommodate vehicles. Traditionally, parking and driving surfaces are impervious by necessity. Large parking lots are constructed to allow for peak volume days. These lots contribute to downstream flooding and erosion because nearly all stormwater runs off. Many of these areas service traffic infrequently. One challenge facing engineers is to convert areas of low use from impervious to pervious surfaces to help reduce the amount of runoff. Some of these surfaces include driveways, firelanes, overflow parking, walkways, and even small parking lots that receive daily traffic.

Initial attempts at using permeable pavement in North Carolina and other states have been hindered primarily by maintenance issues. Permeable pavement cannot simply be placed in standard fashion, receive no maintenance and still be expected to remain permeable over a long period of time. Careful engineering design and site selection were also lacking in initial applications, causing North Carolina to suspend any credit for using permeable pavement.

EDITOR'S NOTE

With the issuance of EPA's Phase II stormwater rules, communities across the country will be required to develop stormwater management plans and implement best management practices to reduce and/or treat stormwater runoff. This issue of *NWQEP NOTES* features a research project underway by North Carolina Cooperative Extension and the City of Kinston on pervious pavement. A parking lot was installed with concrete and grass pavers, and has been monitored over the past two years. Results from this study, as well as from similar research conducted in other parts of the United States, show that permeable pavement can be successful at reducing stormwater runoff, but requires at the very least proper engineering design, maintenance, and site selection.

As always, please feel free to contact me regarding your ideas, suggestions, and possible contributions to this newsletter.

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Kinston, NC, Study Site

In 1998, North Carolina passed a relatively far-reaching set of stormwater standards, included as part of the Neuse River Rules, requiring 10 cities and 5 counties to implement best management practices (BMPs) to treat stormwater runoff. The size and need of BMPs is dictated in great part by the amount of impervious surfaces. If parking lots could be constructed to infiltrate rainwater, designers would have another tool with which to approach development, and the burden on communities to install BMPs for treating stormwater runoff could be reduced.

One of the cities affected by the new stormwater standards is Kinston, in eastern North Carolina. The City of Kinston volunteered to host a permeable pavement demonstration and research site. The selected site in Kinston was considered to be ideal for a permeable parking lot for several reasons. The lot was to be used by city employees for daily parking and was therefore not considered to be a high use area. The lot would be built on a large bluff along the banks of the Neuse River, with an in situ soil (Kalmia) hydraulic conductivity of 8 inches per hour, and no sign of a seasonally high water table within 5 feet of the surface. Also, due to the site's location downtown, the likelihood of having automobiles track soil into the lot and creating a maintenance problem was very low.

Parking Lot Design

The permeable parking lot was designed by students from N.C. State University's Civil Engineering Department as a senior project. The final design included 26 stalls, 20 of which were constructed using a concrete block paver, turfstone,™[1] and the other 6 utilized a plastic grid paver donated by RK Manufacturing.™ Figure 1 shows the parking lot immediately following completion. Figure 2 shows the lot during construction.

Figure 1. Permeable pavement lot at Alice Hannibal Building in Kinston, NC. Far left-hand side of lot is re-inforced grass. Far right-hand side is concrete modular block filled with sand. Lot in foreground is asphalt.

1 The use of specific trade names does not imply product endorsement by N.C. State University.

Figure 2. Parking lot under construction. In foreground, a Turfstone™ concrete block paver layer is laid. Underneath in succeeding order is bedding sand, a permeable fabric and a marl subbase.

Figure 3 shows a cross-section of the concrete block pavement. To carry the expected traffic loading, 8 inches of aggregate was placed to support the block pavers. The aggregate used at this site was marl, an angular ancient seashell stone found along North Carolina's Coastal Plain, most comparable to washed 57 size stone. A permeable geofabric was placed over the aggregate. A two-inch layer of bedding sand was placed over the geofabric. The concrete or plastic block pavers overlay the bedding sand layer. The *concrete block* paver was filled with concrete sand with a very high permeability (hydraulic conductivity greater than 10 inches/hour). The *plastic grid* paver was filled with sandy topsoil to promote grass growth, and Bermuda grass was seeded (see Figure 4). Bermuda grass was selected because of its ease of establishment, drought tolerance, sturdiness to traffic, and relatively low cost. Traffic was prevented from using the plastic grid paver end of the lot until grass establishment.

Total area of the parking lot was 9,340 square feet. The grassy portion of the parking lot (plastic grid pavers) was separated from the concrete and sand portion by a slight "ridge

Figure 4. Bermuda grass roots visible in plastic grid paver.

line" to create two subwatersheds, with the former encompassing an area of 2,620 square feet and the latter 6,820 square feet.

Structural design of the parking lot was determined using the standard Flexible Pavement Method, as noted by AASHTO. The design was based on an Equivalent Single Axle Loading (ESAL) of 275. The soil support value was 6.2 for Kalmia soil. The environmental factor was conservatively set to 1.0, which assumes a good drainage condition with frequent base layer saturation. When determining thickness for the concrete pavement layers, the following strength coefficients were used: concrete block paver with sand fill (0.20), sandy gravel bedding layer (0.07), and gravel subbase (0.14).

Hydraulic analysis of the site identified two potential causes for hydraulic failure (runoff): 1) the gravel subbase would fill with water during a large storm, exceeding infiltration capacity of the underlying soil. Assuming no water exfiltrated the parking lot during the storm, nearly 3 inches of water could be stored in the gravel subbase (35% porosity of 8-inch gravel layer); and 2) intense rainfall that would overwhelm the ability to infiltrate the surface pavement layer. The rainfall intensity thought to cause runoff was 1.6 inches per hour, which is high but not uncommon for some storms in North Carolina.

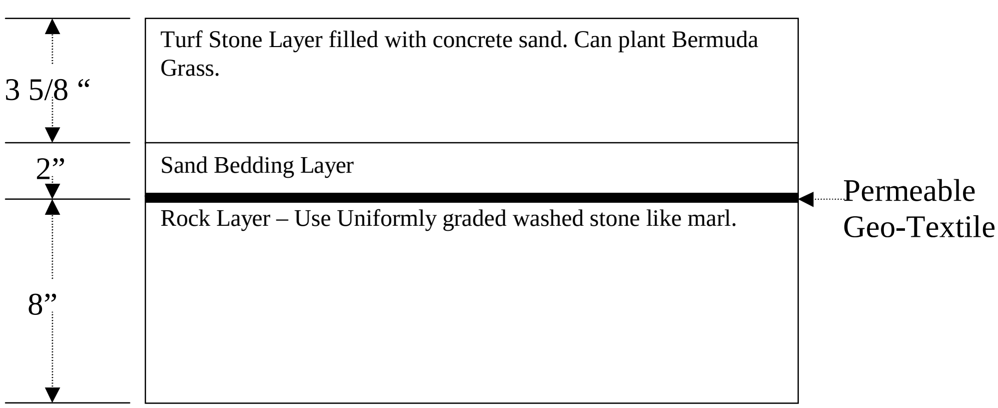

Figure 3. Cross-section of pavement used at Hannibal Parking Lot in Kinston, NC.

Construction

Special precaution was taken during construction of the permeable parking lot by the City of Kinston's engineering staff. Limited compaction was allowed during construction. Rollers were not used on the site. The only compaction occurred with the loading and spreading of aggregate. City staff were able to level the bedding layer by using fire hoses, giving the top paver layer an appearance of being nearly perfectly flat. Finally, after the parking lot was completed and allowed to settle for a few weeks, sandy soil was respread across the lot to fill in settled pockets.

Total construction cost for the permeable parking lot was minimized through the use of inmate labor and donated materials. If the project had not been supported by an N.C. State University Extension Grant, construction costs would have run approximately 25% more than a standard asphalt parking lot. However, if the lot proves effective at infiltrating rainfall, a smaller retention pond size and drainage network would be required than if the lot remained impervious. The end result could be that total costs of a permeable lot are at least comparable and may be less than a standard non-permeable lot under certain conditions.

Monitoring Runoff

Both the concrete block paver and plastic grid paver subwatersheds drain to small 5' by 5' concrete-lined basins, designed to temporarily store water. Each concrete catch basin prevents horizontal seepage from the parking lot; only surface flow enters. In the corner of each temporary runoff storage basin is a 2' by 4' metal box divided in half by a v-notch weir, forming two 2' by 2'chambers (see Figure 5).

Figure 5. Weir box before installation. Note three holes which allow water to enter from the bottom, establishing a still area into which a flume stick can be installed. The presenter's hand is directly over the v-notch weir.

The first chamber contains 3 holes set at the bottom, which force water to enter and rise, plus a flume stick. During a runoff event, this chamber fills with water, which flows over the v-notch weir into the second chamber. Once the water flows over the weir, it exits from the back of the second chamber via a 4" drainage pipe, which surfaces into a grassy field 65 feet from the back of chamber. In a very intense rainfall event, it is possible that the pipe's outfall could become submerged, causing a backup of stormwater and an artificial water level rise in the weir box. This could cause flow over the weir to be retarded, leading to erroneously high runoff measurements. This scenario probably occurred at the site and will be discussed in the next section.

To determine the amount of water running off the parking lot, measurements are taken every 2 minutes during a storm using a flume stick data recorder (Figure 6). The height of water over the nape of the v-notch weir is measured, giving the flow rate. Flow rates are estimated as the average of the 2-minute time intervals. By multiplying the flow rate by the two-minute interval, the volume of runoff is calculated. Summing these values during the length of the entire storm determines the total volume of water to leave the site.

Figure 6. Installation of flume stick in weir box. The height of water over the nape of the weir is used to determine volume of runoff from the parking lot.

In order to determine the effectiveness of the parking lot in reducing runoff, actual runoff volumes are compared to potential runoff volumes. To determine potential runoff volume, rainfall is measured using a tipping bucket rain guage from Global Water.™ The precipitation measurement site is on the rooftop of the adjoining Hannibal building with the rain guage approximately 100 feet from the parking lot basin. By multiplying rainfall by watershed area, the potential volume of runoff is found. Rainfall measurements are taken every 15 minutes during an event.

Results

Monitoring began in June 1999, with runoff examined from all storms producing at least 0.50" of rainfall, and will continue through July 2001. A 2-hour lag between events divides events into multiple storms. Since June 1999, over 48 storms produced at least 0.50 inches of rainfall, 19 of which produced 1.00” or greater. Some of these storms will be long remembered in North Carolina by their first names, including Dennis, Floyd, and Irene.

Monitoring results indicated that of the 48 rainfall events, runoff from the concrete paver parking lot occurred with only 11 of the storms (less than 25% of total storms). This departs greatly from a generally accepted notion that runoff will still occur from a permeable lot. Table 1 lists all the storms from July 1999 through March 2001, with at least 0.50” of rainfall and their associated runoff amounts.

Maintenance was perfomed on the parking lot in mid-August 2000, with a street sweeper scarifying the surface and removing a small portion of the soil. Since the maintenance operation, a total of 0.10” of runoff has left the parking lot. Therefore, it is recommended that permeable parking lots be maintained at least once per year to ensure the highest level of permeability in the pavement.

Date	Precipitation (in)	Runoff (in)	Runoff (%)	Date	Precipitation (in)	Runoff (in)	Runoff (%)
8-Jul-99	0.6	0	0	19-Jun-00	0.81	0	0
15-Jul-99	2.67	0.5	0.19	22-Jun-00	0.66	0	0
24-Jul-99	1.23	0	0	12-Jul-00	0.83	0	0
14-Aug-99	0.84	0	0	15-Jul-00	1.65	0.55	0.33
27-Aug	0.74	0	0	21-Jul-00	0.64	0	0
30-Aug-99	0.89	0	0	25-Jul-00	1.8	0.89	0.49
5-Sep-99	4.84	1.54	0.32	31-Jul-00	0.58	0	0
16-Sep-99	14.53	14.2	0.98	16-Aug-00	1.46	0.34	0.23
21-Sep-99	0.82	0	0	27-Aug-00	0.59	0.06	0.1
28-Sep-99	2.56	1.56	0.61	28-Aug-00	0.64	0	0
17-Oct-99	4.33	4.11	0.95	30-Aug-00	1.2	0	0
26-Nov-99	0.5	0	0	31-Aug-00	1.1	0	0
10-Jan-00	0.63	0	0	3-Sep-00	0.51	0	0
24-Jan-00	1.4	0	0	5-Sep-00	1.37	0	0
30-Jan-00	0.76	0	0	18-Sep-00	1.26	0	0
12-Feb-00	1.14	0	0	23-Sep-00	1.48	0	0
14-Feb-00	0.53	0	0	19-Nov-00	0.82	0	0
3-Mar-00	2.84	0	0	25-Nov-00	0.7	0	0
21-Mar-00	0.58	0	0	4-Feb-01	0.54	0	0
18-Apr-00	0.57	0	0	17-Feb-01	0.58	0	0
28-Apr-00	0.69	0	0	22-Feb-01	0.6	0	0
23-May-00	1.8	0.38	0.21	4-Mar-01	0.82	0	0
28-May-00	0.98	0.33	0.34	22-Mar-01	1.27	0	0
4-Jun-00	0.51	0	0	29-Mar-01	0.66	0	0

Table 1. List of Precipitation Events of at least 0.50” and their associated runoff amounts at the Alice Hannibal Public Works Building permeable parking lot in Kinston, NC from July 1999 through March 2001.

An example of runoff from a specific event can be shown by its hydrograph (see Figure 7). On September 4 and 5, 1999, Hurricane Dennis passed near Kinston, resulting in nearly five inches of rainfall at the Hannibal Building. The hydrograph for this storm shows the amount of runoff leaving the facility and is plotted against the associated rainfall. Typically, the volume of runoff for such a large storm would be comparable to the volume of rainfall, with the area under the rainfall curve about the same as the area under the runoff curve. As evidenced by the hydrograph in Figure 7, this is certainly not the case with Hurricane Dennis and the permeable parking lot.

Another important point regarding the hydrograph is to note that runoff is not based on total volume of rain fallen, but on rainfall intensity. Only very intense rainfalls produce runoff at the Kinston parking lot site. The majority of runoff from Hurricane Dennis was produced during a 15-minute period averaging a rainfall intensity of 1.70 inches per hour. The same was true with a 0.98” rainfall event in May 2000. While the total amount of rainfall was substantially less than many of the storms monitored, most of this rain came in a 15-minute period.

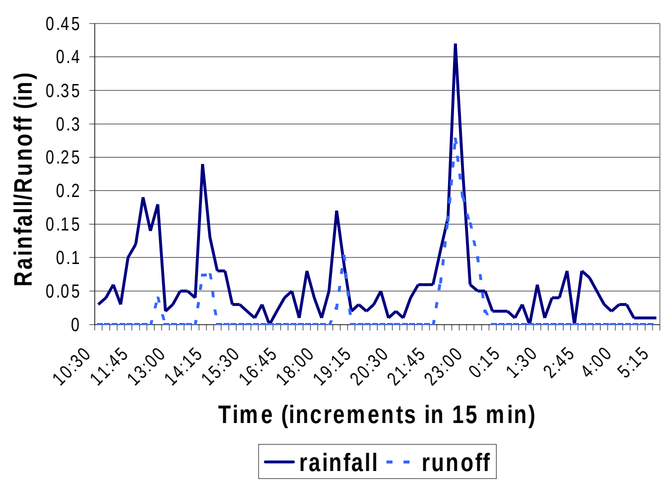

Figure 7. Rainfall and runoff per area of Turfstone and Sand Permeable Parking Lot at the Alice Hannibal Parking Lot in Kinston during Hurricane Dennis, Sept. 4, 1999 - Sept. 5, 1999.

Runoff Coefficients

One way of describing the amount of runoff is with *rational method* runoff coefficients, ranging from 0 to 1.0. A rational coefficient of 1.0 reflects a situation where every drop of rainfall runs off a surface, such as with a sloped rooftop. In cases where every drop of water passes through or infiltrates a surface, the rational C is roughly 0. Perhaps the best examples of this in the Southeast and Mid-Atlantic are sand dunes at the beach.

Two general methods were used to estimate the rational runoff coefficient for the parking lot studied in Kinston. With *Method I,* the percentage of rainfall from each individual storm that runs off is averaged. This was done using all storms of at least 0.50" of rainfall and again for all storms of at least 1.00" of rainfall. As long as the precipitation event meets a minimum standard (0.50" or 1.00"), it is weighted similarly. A runoff coefficient from a 2.67" rainfall event carries the exact same weight as does one from a 1.00" event.

Method II gives weight to rainfall amounts. The runoff from a 2.67" rainfall event is 2.67 times more "important" than a 1.00" event. Method II will inherently yield higher rational coefficients, as larger volume storms produce runoff more easily than smaller storms.

Table 2 describes rational coefficients based on either Method I or II and on whether the minimum amount to be considered for analysis is 0.50" or 1.00." As shown in Table 2, the rational runoff coefficient for the concrete block pavers ranges from 0.10 to 0.35, depending upon the method used to calculate.

During Hurricane Floyd on September 16, 1999, the pipe outlet became submerged. This resulted in incorrect runoff measurements as described above. While Kinston staff claim to have not seen any runoff from the parking lot during Hurricane Floyd, runoff most likely did occur. However, the amount of runoff measured is artificially high due to the submerged outlet. To show the importance of the storm and the probable error in measurement, the Rational C is calculated both inclusive and exclusive of Hurricane Floyd's 14.53 inches of rainfall and 14.20 inches of runoff.

The authors believe it is reasonable to assign a rational runoff coefficient ranging from 0.15 to 0.30 for this particular application of permeable pavement.

Research on permeable pavement conducted in other parts of the United States has shown both similar and other results. A study in the Tampa Bay area of Florida found rational coefficients ranging from 0.20 to 0.40. In Washington State, the ability of permeable pavement to filter pollutants was tested, indicating that sizeable percentages of many metals were removed, however, nutrient removal by the pavement was limited at best.

Future Work

North Carolina Cooperative Extension is collaborating with two other municipalities in eastern North Carolina to determine the amount of runoff reduction from various types of permeable pavement, including concrete block pavers, permeable concrete and grass confinement systems. In Wilmington, NC, the site is currently being designed to employ permeable concrete and plastic grid blocks. The watershed area for each pavement type is between 4,000 and 5,000 square feet. Monitoring is tentatively scheduled to begin at the site in Fall 2001, once the parking lot is installed, and will continue through 2003. At the Wilmington site, the seasonally high water table is approximately 4 feet from the surface and the soil is poorly graded fine sand. These site conditions are considered to be sufficient, yet potentially borderline, for permeable pavement applicability.

The second research site was installed in River Bend, NC, in December 2000. Construction of the parking lot was funded in part by a grant from N.C. Division of Water Resources due to the lot's location immediately upstream of a wetland. This lot consists of two types of block pavers with varying gap sizes (46% open space and 12% open space). The gaps are each filled with small granite shavings, which also serve as the bedding material. Since installation of the site, over 12 inches of rainfall has fallen onto the parking lot, with no measurable runoff from the site.

Method Used	Rational C Calculation
Method I with minimum precip. of 0.50"	0.1
Method I with minimum precip. of 1.00"	0.23
Method I, min. precip. of 0.50" excluding Hurricane Floyd	0.08
Method I, min. precip. of 1.00" excluding Hurricane Floyd	0.2
Method II, with minimum precip of 0.50"	0.36
Method II, with minimum precip of 1.00"	0.48
Method II, min. precip. of 0.50" excluding Hurricane Floyd	0.19
Method II, min. precip. of 1.00" excluding Hurricane Floyd	0.28

Table 2. Rational runoff coefficient calculations for the Hannibal Parking Lot by varying methods.

Checklist

A simple guideline is suggested for use by interested installers of permeable pavement in eastern North Carolina, which can also be used in many other areas of the United States. Below are 9 criteria that must be met to ensure a successful and truly permeable pavement.

1. Low Traffic Volume. Exact amount and type of vehicles varies based upon climate and soil, but a standard traffic loading of 30-40 vehicles per day seems to be a reasonably conservative upper limit in eastern North Carolina.

2. Sandy or Loamy Sand In-Situ Soil. Soil must allow for water to exfiltrate the parking lot and must have low shrink-swell potential to ensure long term structural integrity. Any soil tighter than Loamy sand probably fails on both counts.

3. Seasonally high water table no closer than 36” from surface (with 48” preferred). Water tables approaching the lot will not allow water to exfiltrate the parking lot and will cause structural damage to the application.

4. Upstream disturbance not an issue. Clay, silt or other particles can clog the open pores of permeable pavement. Construction upstream of the lot could result in frequent pavement clogging.

5. The site follows proper engineering design. The practice should be designed using accepted flexible pavement design standards. Simply using block pavers or other permeable pavement materials without proper design will not guarantee long term permeability or structural integrity.

6. A washed and angular aggregate base is used. Washed 57 size stone is generally available and acceptable. If standard crusher run is used, the fine particles will clog the pores at the bottom of the pavement. Rounded aggregate encourages rocking of block pavers.

7. Loamy Sand to Gravel used to fill gaps of the block pavers. The principal indicator of how well water can infiltrate the surface of the parking lot is the permeability of the surface layer. Any soil tighter than loamy sand will not allow substantial rainfall intensities to infiltrate the pavement.

8. A proper construction technique is followed. The subbase cannot be compacted as normally done for an asphalt lot. The sand-bedding layer must be properly laid.

9. A maintenance plan is devised and followed. The site will eventually have its surface layer clogged even if properly designed and constructed. A maintenance schedule of sweeping or power washing at least once per year should be implemented for small sites.

For More Information

For more information on permeable pavement design and function, a web-based short course is available through N.C. State University’s Biological and Agricultural Engineering Department. The address is:

http://www2.ncsu.edu/eos/info/bae/cont_ed/pavement_course/index.htm.

The web course has four modules: general overview, structural design, hydraulic and hydrologic design, and construction. The modules are available in both Powerpoint™ and Real Player™ format. The site includes videos of runoff measurement and gives a site overview of Kinston’s permeable parking lot. Fact sheets and worksheets are also available to be printed out in PDF format. The site is best suited for users with computers having a quick internet connection and relatively high memory.

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INFORMATION

National Stormwater BMP Database Update

EPA and the American Society of Civil Engineers began distribution of the National Stormwater BMP Database in 1999. The database provides detailed performance data and design information in a standardized format. Originally available on CD-ROM, the database is now also available on the internet at **http://www.bmpdatabase.org**

The following provides a brief update on developments with regard to the database project. More detail on these items, as well as other periodic project updates, can be found on the website.

1. The ASCE project team has analyzed the perfomance of the 71 BMPs in the initial database release. The performance evaluation can be downloaded in Adobe portable document format (PDF) from the website on a BMP-specific basis. Use the “Online Data Search

Engine" to see these reports. An overall data evaluation report is also available on the "What's New" page.

2. ASCE and EPA are developing a BMP Monitoring Guidance manual consistent with the database protocols. Publication is expected in late 2001. Forms for use in field monitoring activities will be available for downloading from the website.
3. Thirteen new BMP data sets have been posted to the website this month. Several more will be added by early spring 2001 and over 60 new data sets will be added by the end of 2001.
4. The project team is actively pursuing new data for the database and is available to enter your data for you, provided that it meets the database reporting protocols. If you have data that you would like to provide or discuss providing, please contact Jane Clary, ASCE Project Manager, at clary@wrightwater.com.
5. The "Frequently Asked Questions" portion of the website provides information on minor bugs detected in the software, as well as clarifying information of various aspects of the database. We welcome your feedback on both the database and website. Please direct any suggestions to Jane Clary at clary@wrightwater.com.

Center for Watershed Protection New Publications

The Practice of Watershed Protection: Techniques for Protecting and Restoring Urban Watersheds. This reference contains 150 articles on all aspects of watershed protection. Drawn from past issues of Watershed Protection Techniques as well as a wealth of other Center papers and reports, this 800-page book is organized around the eight tools of watershed protection, indexed for easy reference, and introduced by new material from Tom Schueler. Price: $80 (hardcover).

Urban Stream Restoration Practices: An Initial Assessment. This publication assesses the performance of 24 different urban stream restoration practices from sites around the Mid-Atlantic and Mid-west and provides recommendations for improving their application in a variety of urban stream environments. Price: $20.

National Pollutant Removal Performance Database - 2000 - 2nd Edition. The second edition modifies, clarifies, and expands upon the original National Database of BMP Pollutant Removal Performance. This report contains summaries of more than 135 urban pollutant removal monitoring studies. Includes a statistical and graphical comparison of removal rates for six groups of stormwater management practices: ponds, wetlands, open channels, filters, infiltration and on-site devices. In addition, key research gaps in terms of parameters and practices are identified. The report contains a full bibliography. Price $25.

MEETINGS

Meeting Announcements — 2001

MAY

World Water and Environmental Resources Congress 2001, Bridging the Gap: Meeting the World's Water and Environmental Resources Challenges: May 20-24, 2001, Orlando, Florida. Web site: www.ASCE.org/ewri2001.

Delineation of Piedmont and Coastal Plain Jurisdictional Wetlands: May 21-25, 2001, Raleigh, NC. Contact Susan Moore, Forestry Educational Outreach Program, NC State University, Campus Box 8003, Raleigh, NC 27695. Tel: 919-515-3184, Fax: 919-515-6884, email: susan_moore@ncsu.edu.

JUNE

5th International Conference on Diffuse Pollution: June 10-15, Milwaukee, WI. Contact Vladimir Novotny, Institute for Urban Environmental Risk Management, Marquette University, Milwaukee, WI, 53201-1881. Tel: 414-288-3524; Fax: 414-288-7521; email: environment@marquette.edu; web site: www.mu.edu/environment/iwa-page.htm.

Decision Support Systems for Water Resources Management – American Water Resources Association's Summer Specialty Conference: June 27-30, 2001, Snowbird, Utah. Contact AWRA at 540-687-8390.

JULY

Drinking Water Quality Conference: July 1-2, 2001, Atlanta, Georgia. Sponsored by the National Environmental Health Association. Contact NEHA Headquarters at 720 S. Colorado Blvd., Ste. 970-S, Denver, CO 80246-1925. Tel: 303-756-9090, Fax: 303-691-9490, email: staff@neha.org, web site: www.neha.org.

2001 ASAE Annual International Mtg: Jul 29-Aug 1, 2001, Sacramento, CA. Website: http://asae.org/meetings/am2001/form.html.

Meetings continued on p. 11

AUGUST

Wetlands Engineering & River Restoration Conference 2001: August 27-31, 2001, Reno, Nevada. Sponsored by American Society of Civil Engineers. Contact J. Craig Fischenich, General Conference Chair, Tel: 601-634-3449, Fax: 601-634-4263, email: fischec@wes.army.mil, website: www.asce.org/conferences/wetlands2001.

9th National Nonpoint Source Monitoring Workshop

August 27-30, 2001
Hyatt Regency, Indianapolis, IN
http://www.ctic.purdue.edu/CTIC/NPSCall.html

About the Conference: This workshop will bring together land managers and water quality specialists to share information on the effectiveness of best management practices in improving water quality, effective monitoring techniques, and statistical analysis of watershed data. The workshop will focus on the successes of Section 319 National Monitoring Program projects and other innovative projects from throughout the U.S. The agenda will include three days of workshop sessions/presentations and a one-day field trip. Two half-day workshops will focus on monitoring program evaluation and GIS. Contact Tammy Taylor at taylor@ctic.purdue.edu or call 765-494-9555.

SEPTEMBER

River Basin Management 2001: September 11 – 13,2001, Wales, UK. Contact Susan Hanley, Conference Secretariat at shanley@wessex.ac.uk. Web site: http://www.wessex.ac.uk/conferences/2001/river01/.

OCTOBER

Addressing Animal Production/Environmental Issues: An International Symposium: October 3-5, Research Triangle Park, NC. Contact Dr. Leonard S. Bull, Program Chairperson, Associate Director, Animal and Poultry Waste Management Center, Box 7608, N.C. State University, Raleigh, NC 27695-7608. Tel: 919515-6836; Fax: 919-513-1762; email: Leonard_bull@ncsu.edu; web site: www.cals.ncsu.edu/waste.mgt/.

WEFTEC 2001. Water Environment Federation 74th Annual Conference & Exposition: Oct. 13-17, 2001, Atlanta, GA. Call 1-800-666-0206. If outside the US and Canada, call 1-703-684-2471 or send an email to confinfo@wef.org. Web site: www.wef.org.

Fourth Annual North Carolina Stream Restoration Conference - Stream Repair and Restoration: A Focus on the Urban Environment: October 16-19, 2001, Raleigh, NC. Web site: http://www5.bae.ncsu.edu/programs/extension/wqg/sri/.

NOVEMBER

2001: A Lake Odyssey – 21st International Symposium: November 7-9, 2001, Madison, Wisconsin. Sponsored by North American Lake Management Society.
Web site: www.nalms.org.

American Water Resources Association Annual Water Resources Conference: November 12-15, 2001, Albuquerque, New Mexico. Contact Michael Campana, Conference Chair, University of New Mexico, Water Resources Program, 1915 Roma NE, Albuquerque, NM 87131-1217. Tel: 505-277-5249, Fax: 505-277-5226, email: aquadoc@unm.edu.

Virginia Water Research Symposium 2001 – Protecting Our Water Resources for the Next Generation: Where Do We Go From Here?: November 14-16, 2001, Charlottesville, VA. Contact VWRRC, Virginia Tech, 10 Sandy Hall, Blacksburg, VA 24061. Fax: 540-231-6673; email: water@vt.edu.

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