Porous Bio-Filters -
Tools to Fight West Nile Virus

The year 2002 brought a disturbing upward trend of West Nile Virus cases to the United States, resulting in more than 232 deaths in 2002, just 3 years since first detected within our borders. This virus is carried by mosquitoes, which thrive in pools of stagnant water – large and small. Large bodies of water can be treated rather easily, by adding predators of the larvae, or chemicals. Small bodies of water – even as small as a cup or coffee can, pose a far greater danger by sheer numbers of container opportunities.

Private landowners have been warned to remove small outdoor containers that can capture rainwater and irrigation, such as tires, pails, etc., and change water frequently in water features, such as birdbaths and fountains. However, there are millions of potential stagnant water containers that lie hidden on private and public lands that have received little notice – catch basins, inlets and manholes that are part of our storm water collection systems.

All of these devices have potential low spots in pipe or within the structure itself, especially catch basins that are designed to capture sediments in pits placed below outfall pipe inverts. All of these devices are designed to allow ready and rapid inflow of water from ground surfaces into the system through large openings in grates or sides of curbs. Air also has unrestricted movement into the system, which allows access by mosquitoes. With 11 to 17 days between runoff events, mosquitoes have an opportunity to place and hatch a new generation of offspring.

Provide Porous Filter Inlets
We can install and retrofit alternative inlet structures that allow water to pass, but not air (at least not free-moving air) – and therefore, mosquitoes. How is this done? By providing a porous filter layer in the path of moving water – 1) at the surface of the inlet, 2) in the middle of the inlet structure, or 3) at the bottom of the inlet structure. The porous filter medium can be soil (sand or gravel), geotextiles, or even “cartridges” of organic materials in proprietary commercial structures. As a general rule, as filter distance from the surface increases, so does the level of maintenance.

Porous Surface Inlet Method
Porous surface inlets include: 1) porous pavements (see Grasspave2 and Gravelpave2); 2) bio-filter swales; 3) surface detention basins – provided water is evacuated within 24 hours; and 4) vegetated roofs – with water evacuated to subsurface storage that has no direct air access. As this paper is dealing primarily with elimination of nesting grounds for disease-bearing mosquitoes, we will focus only upon the first two methods.

The basic concept of porous surface methods is to direct surface runoff to a porous soil filter medium of sand and/or gravel, where the water will then flow vertically very quickly due to the high porosity of these soils. Once passing through this porous filter layer (usually 12 inches thick depending upon pollutants contained in runoff), water can then be recollected and directed to a stormwater distribution system, long term storage, or allowed to continue to percolate into subsoils.

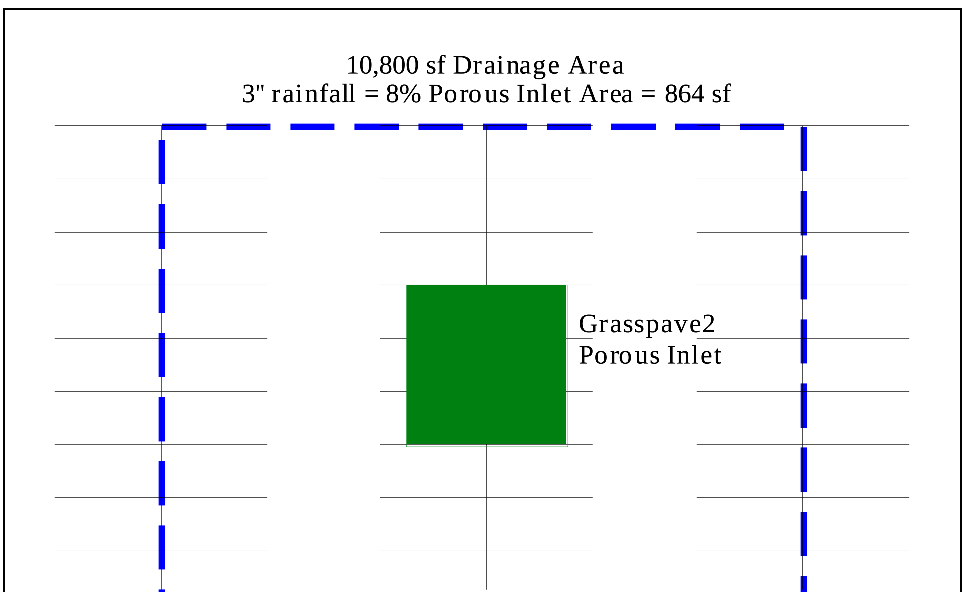
Air can also penetrate deeply into these soils, but not objects as large as mosquitoes. One distinct advantage of porous surface inlets is that pollutants contained in the runoff will be stripped and cleaned by the filter, which can contain high levels of active soil bacteria, and litter or trash will be left on the surface for easy periodic pickup.

With our standard materials used for Grasspave2 and Gravelpave2 porous pavements and bio-filter swales, rapid infiltration rates allow the filter area to be smaller than the source runoff surface. Actual porous filter areas will depend upon the design rainfall rate to be captured (see table below).

Porous Filter Inlet Area to Runoff Area

Assume Filter Section Percolation Rate of 36 inches per hour (.05 cf/min/sf)

Rainfall Rate-in / hr	Runoff Area to 1 Filter Area	% Filter Area	Rate-cf / min / sf
1.0	36.0	3%	0.0014
1.5	24.0	4%	0.0021
2.0	18.0	6%	0.0028
2.5	14.4	7%	0.0035
3.0	12.0	8%	0.0042
3.5	10.3	10%	0.0049
4.0	9.0	11%	0.0056
4.5	8.0	13%	0.0063
5.0	7.2	14%	0.0069
5.5	6.5	15%	0.0076
6.0	6.0	17%	0.0083
6.5	5.5	18%	0.0090
7.0	5.1	19%	0.0097
7.5	4.8	21%	0.0104
8.0	4.5	22%	0.0111
8.5	4.2	24%	0.0118
9.0	4.0	25%	0.0125
9.5	3.8	26%	0.0132
10.0	3.6	28%	0.0139
10.5	3.4	29%	0.0146
11.0	3.3	31%	0.0153
11.5	3.1	32%	0.0160
12.0	3.0	33%	0.0167

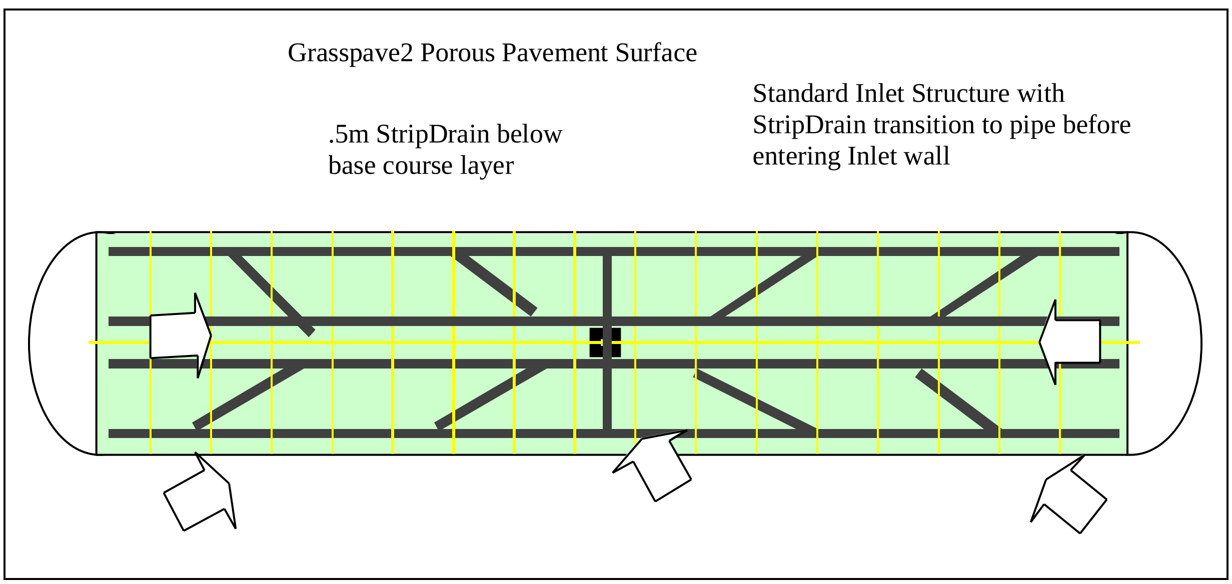


Subsurface Capture & Conveyance

Once water has passed through the porous filter surface (leaving behind litter, debris, and pollutants), water will enter the void spaces of the porous media – which is usually calculated to be from 25% to 35% of the section volume. For small rainfall events there may be enough storage volume in the porous media to prevent further flow out of the media. For larger events (rainfall volumes that exceed media storage capacity), excess water must be provided a means of escape to prevent backup and surface flooding.

Some sites may be blessed with very porous sand or gravel subsoils, which will allow uninterrupted continuous vertical flow. Most sites however, will likely require some form of subsurface catchment and conveyance layer, such as our Draincore2 system. Draincore2 provides a 1 inch high structure with free flowing water capability between rings equal to flows greater than 4" diameter pipe spaced 12" on center. With a crush resistance greater than 200 psi, porous base course can be placed directly over Draincore2 and support heavy truck axle loads. (See illustrations on Page 4 below).

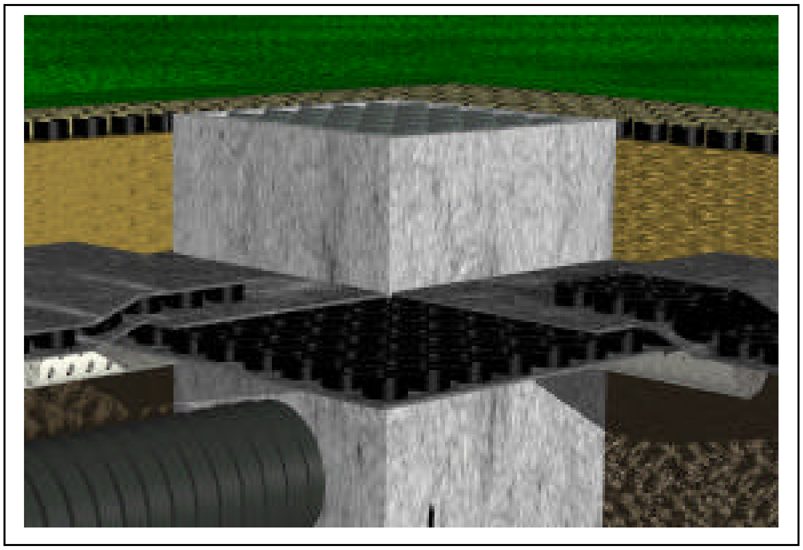
Most porous surface inlets will use Draincore2 with uniform coverage below the entire filter area. However, some project economics may demand placement of DC2 StripDrain (20" wide strips wrapped in geotextile fabric, placed 4' to 6' on center), provided temporary surface flooding in extreme rain events is not an issue.

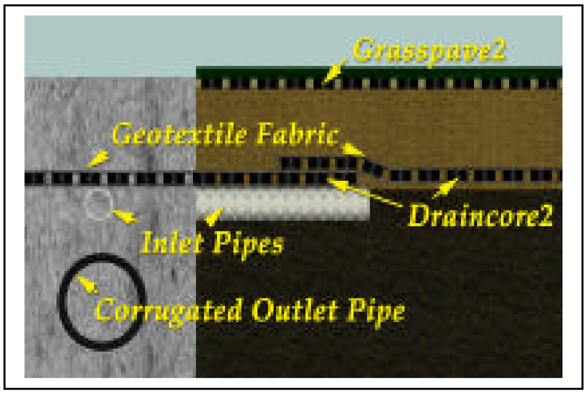


Retrofit Existing Inlet Structures

Even existing facilities may be retrofit with porous surface filters provided certain other site conditions are met. Generally, an area surrounding an existing catch basin, or other inlet structure, (sized per table above), is excavated to depth. The walls of the inlet structure are then modified to allow water to enter the structure at the level of the Draincore2 layer. Geotextile is then placed over Draincore2 and backfilled with porous media to elevations appropriate for either Grasspave2 or Gravelpave2 porous pavements – which finish flush with surrounding hard surface pavement.

When complete, runoff entering the filter area from higher elevations will first flow into the filter cross-section, then into Draincore2, then into the inlet structure (below grade). This process also meets criteria by many communities to treat "first flush" pollutants. If a rain event occurs which is greater than designed for the porous surface inlet filter, excess water will flow across the filter area and into the surface grate which remains from the original inlet structure. Please note that regulations that now require onsite storage of excess runoff will require that outlet pipes be directed to storage devices, such as Rainstore3, prior to release of runoff into surface waters or community sewer systems.





These illustrations show DC2 StripDrain placed around an existing catch basin, with feeder strips extending into the porous surface filter area. Perforated pipe is placed below (one method) to allow water to enter the catch basin below grade. Grasspave2 is shown around the surface grate inlet with porous media between GP2 and DC2.

Stored Filtered Water – Now Use It At Least Once

Once water passes through the porous filter inlet it is sufficiently clean of insects, pollutants, and sediments to allow entry directly into surface water bodies or underground water table. However, most surface soils do not percolate quickly enough for the runoff volumes generated during storms, and EPA regulations require onsite storage with slow release to community sewer systems.

Once we go to the effort of cleaning, capturing and storing rainfall onsite, we should look at creating runoff storage chambers that function as long-term storage devices – which allow at least one domestic use such as irrigation or toilet flushing? Doing so will relieve pressures of growth upon community water treatment capacity, making us better stewards of a critical environmental asset.

The simple construction and modular nature of Rainstore3 will allow consideration and use of multiple storage chambers placed in locations responsive to space available and variable runoff sources (roof, asphalt pavement, service pavement, etc.), which also allows alternative inlet designs responsive to filtration/treatment demands of each source. This decentralized storage system can minimize need for pipe (conveyance) and/or expensive structural filtration devices.

Please refer to our website for additional information related to Rainstore3 storage devices. If any other issues or questions arise, please contact our Technical Support Department for assistance.

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