How to Incorporate Grasspave2 and Gravelpave2 into Your Runoff Calculations

Performing stormwater drainage design is one of the requirements of a site designer. Recent regulations created and enforced by the EPA require new developments to limit the amount of stormwater that flows off of a newly developed site, to be equivalent to or less, than the flow rate prior to development. The site designer must determine how much water is running off the original site, and compare this to the amount of water expected to flow off the newly developed site. Each site must have a drainage plan designed and certified by a Professional Engineer before construction can move forward.

The permeable nature of Porous Pavement is an attractive feature for the site designer because the Porous Pavement reduces the amount of stormwater runoff, and thus, reduces the amount of water that must be managed on-site. Designers often ask how to take the porous pavers Grasspave2 and/or Gravelpave2 into account when determining their runoff values.

Effective Percent Imperviousness

Porous Pavement, like Grasspave2 and Gravelpave2, is designed to allow stormwater to infiltrate back into the ground as opposed to impervious surfaces with the same function. Grasspave2 and Gravelpave2 reduce the Effective Imperviousness (I_A) of the developed site, thereby reducing the runoff and pollutant load off the site. Effective Imperviousness is defined as the combined effect of the proportion of constructed impervious surfaces to the catchment, and the connectivity of these impervious surfaces to receiving water bodies. Minimizing the Effective Imperviousness of the site helps to retain the post-development hydrology as close as possible to the pre-developed hydrology.

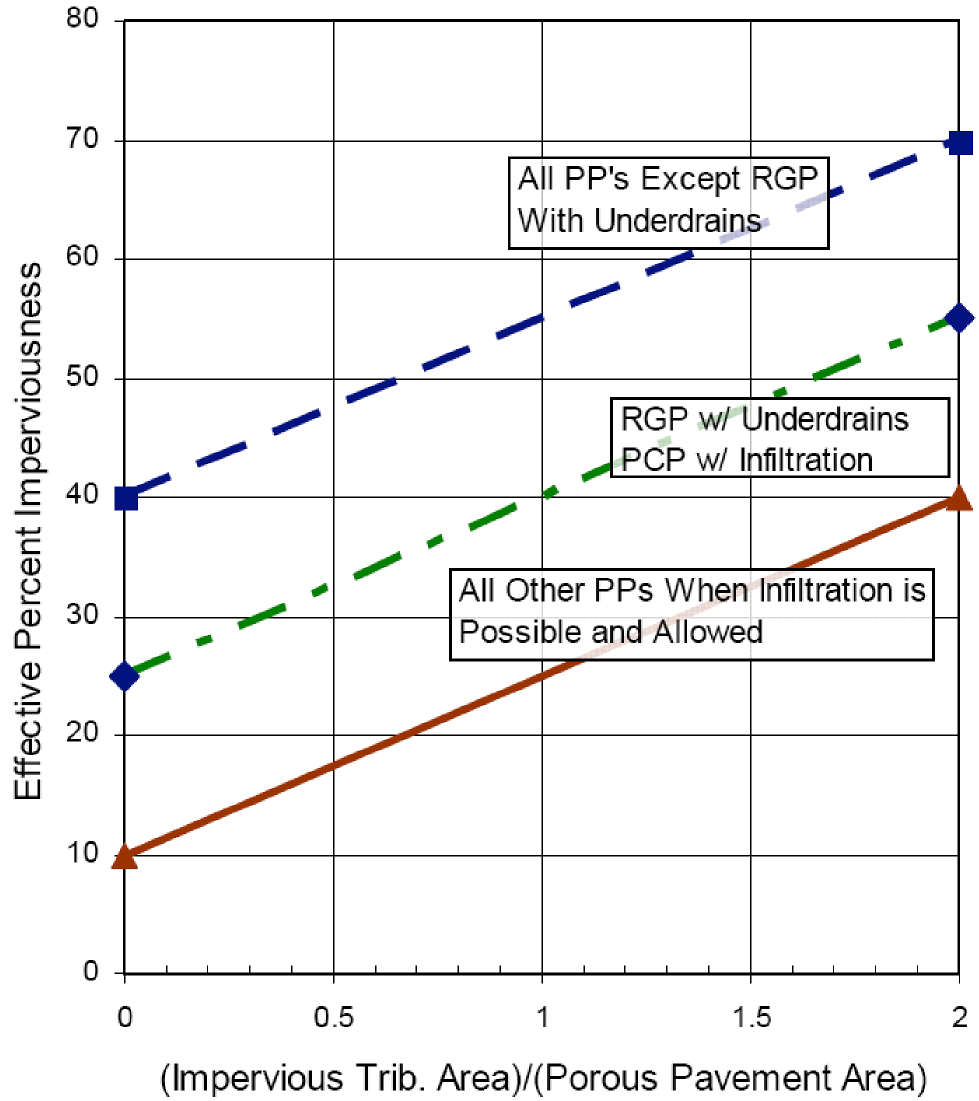
The Urban Drainage and Flood Control District has published a Drainage Criteria Manual (Vol.3) that discusses many Best Management Practices (BMPs) used industry wide to address handling stormwater on-site. Among the Structural BMPs detailed in this manual are Porous Pavements (PPs). This manual has an Effective Percent Imperviousness chart (see page 3) which details Porous Pavements and their use in different circumstances. The x-axis of this chart refers to the tributary area feeding the Porous Pavement area. The ratio of impervious tributary area to the area of Porous Pavement allows the designer to account for a site design where an impervious surface is designed to sheet flow onto a Porous Pavement. On the Chart, the bottom red line applies to all Porous Pavements, besides Porous Concrete Pavement – including Grasspave2 and Gravelpave2 – when site soils allow for infiltration. The green line refers to Grasspave2 (RGP = Reinforced Grass Pavement) used with underdrains or Porous Concrete Pavement with infiltration. The top blue line refers to all Porous Pavement types, besides Grasspave2 or Porous Concrete Pavement, when installed with underdrains. Use of underdrains would be necessary on-site if there are poor draining soils, or other drainage concerns. The on-site geotechnical engineer determines this.

Effective Imperviousness and the Rational Method
This chart provides critical information to the designer about how to incorporate the Porous Pavements Grasspave2 and Gravelpavc2 into their runoff calculations. Effective Imperviousness directly correlates to the Runoff Coefficient used in the Rational Method. Both values measure the amount of expected runoff using a percentage approach. A Runoff Coefficient of 0.2 means 20% of the stormwater will runoff, while 80% will infiltrate into the ground. An Effective Imperviousness Percent of 20% translates identically. As such, the Urban Drainage chart tells that if there is no tributary area from adjacent impervious surfaces, and the site soils allow for infiltration, Gravelpave2 and Grasspave2 have an Effective Imperviousness of 10%. This equates to a Runoff Coefficient of 0.10. This value (depending on the source of the Runoff Chart) is representative of a lawn area.

Effective Imperviousness and TR-55
Effective Imperviousness also translates into the Curve Numbers used in National Resource Conservation Society's TR-55 hydrology calculation method. As demonstrated above, if there is no tributary stormwater load from adjacent impervious areas, and site soils allow water to infiltrate back into the ground, both Grasspave2 and Gravelpave2 can be considered to have a pervious nature similar to lawns, or open space in good condition. The designer can then select the appropriate Curve Number according to the site's Hydrologic Soil Group from TR-55's Table 2-2a – Open Space in Good Condition. An alternative method for determining the appropriate Curve Number would be to create a composite Curve Number. The composite Curve Number should be computed using TR-55's Figures 2-3 or 2-4 based on the Effective Impervious Area percentage (with CN = 98) given in the Urban Drainage chart and the pervious area Curve Number assuming Open Space in Good Condition.

Conclusion

The use of the Effective Percent Imperviousness Chart developed by Urban Drainage and Flood Control District allows the designer to appropriately incorporate Grasspave2 and/or Gravelpave2 into their drainage plan. Both products have been shown to have a similar runoff profiles as open spaced areas in good hydrological condition. This allows the designer to select the appropriate Runoff Coefficient or Curve Number for their hydrologic soil group, slope, and design storm. Each site has its own special needs and circumstances. As always, the designer should be aware of the assumptions and limitation of both methods, and as such, should use his or her good judgment regarding the applicability of the above values. The chart and tables included in this paper are not intended to replace reasonable and prudent engineering judgment that should permeate each step in the design process.



Notes:
1. Chart applies only to porous pavements described in Volume 3 of the USDCM, Structural MBPs chapter. Not to be used for other types of porous pavements.
2. Apply the "Effective Percent Imperviousness" to the total area that included the area of porous pavement and the tributary impervious area that can be made to flows uniformly onto PP.
3. Use no more than two units of impervious area for each unit of PP. All impervious areas exceeding this ratio shall be treated as 100% impervious in hydrologic calculations, including runoff volumes.
4. Whenever impervious areas cannot be made to run onto the pervious areas in a uniform sheet-flow fashion, identify individual areas and what ratios apply to each and then composite them reating each as a separate area.

Figure PP-1—Interim Recommended Effective Percent Imperviousness for Porous Pavements
(Based on the Ratio of the Impervious Area Tributary to Porous Pavement)

References:

Rational Method:

Runoff Coefficients for Rational Formula:
United States Department of Transportation
Federal Highway Administration
"Urban Drainage Design Manual – HEC 22" – November 1996
"Table 3-1. Runoff Coefficients for Rational Formula"
http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hec/hec22.pdf

Runoff Coefficients for the Rational Formula versus Hydrologic Soil Group (A, B, C, D) and Slope Range:
McCuen, R. Hydrologic Analysis and Design – 3rd Edition
http://www.bossintl.com/download/RunoffCoefficients.html

TR-55:

Table 2-2a from TR-55, Runoff Curve Numbers for Urban Areas
United States Department of Agriculture
Natural Resources Conservation Service
Conservation Engineering Division
"Urban Hydrology for Small Watersheds: Technical Release 55" – June 1996
http://www.cpesc.org/reference/tr55.pdf

Effective Imperviousness Chart:

Urban Drainage and Flood Control District
"Urban Storm Drainage Criteria Manual Volume III" – 2008 latest revision
Section 04 – Structural BMP
http://www.udfcd.org/downloads/down_critmanual_volIII.htm