Using the Q7, 10 as an Indicator of the Affect of Urbanization on Low Flow

Katie Blansett
kblansett@watershedconcepts.com

Arthur Miller, Ph.D., P.E.
amiller@watershedconcepts.com
Overview

- Review of terms
- Regulations (MD, PA, NJ) – Infiltration
- Data results for 3 gages
  - Results for 4 additional gages
- Trends and causes
- Implications -
Base flow

Sustained flow of a stream in the absence of direct runoff.

Natural base flow is sustained largely by ground-water discharges.
Q7-10

- **7-day, 10-year low flow**

- 10-year recurrence interval of the lowest mean discharge for 7 consecutive days
  - Or the 7-day low flow with a 10% chance of occurring each year.

- No influence of stormwater runoff
Surface runoff is minimal in an undeveloped site, but dominates the water balance at a highly impervious site.
Annual hydrologic cycle for an undisturbed acres in the Pa Piedmont region

Representative altered hydrologic cycle for a developed acres in the Piedmont region.
“Filtration of runoff and removal of pollutants by natural surface and channel vegetation is eliminated by storm sewers that discharge runoff directly into waterways. Increases in impervious area can also decrease opportunities for infiltration and reduce stream base flow and groundwater recharge. Reduced base flows and increased peak flows produce greater fluctuations between normal and storm flow rates, which can increase channel erosion and adversely impact aquatic organisms and habitats. Reduced base flows can negatively impact the hydrology of adjacent wetlands and the health of biological communities that depend on these base flows.”
Summary of Stormwater Infiltration/Recharge Regulations

**New Jersey**
100 percent of the difference between the site’s pre- and post-development 2-year runoff volumes be infiltrated.

**Maryland**
Annual groundwater recharge rates shall be maintained by promoting infiltration through the use of structural and non-structural methods. At a minimum, the annual recharge from post-development site conditions shall mimic the annual recharge from pre-development site conditions.
### Pennsylvania

**Volume Control Guidance 1**

Do not increase the post-development total runoff volume for all storms equal to or less than the 2-year, 24-hour event.

Existing (pre-development) non-forest pervious areas must be considered meadow (good condition) or its equivalent.

20% of existing impervious area, when present, shall be considered meadow (good condition) in the model for existing conditions for redevelopment.

**Volume Control Guideline 2**

Stormwater facilities shall be sized to capture at least the first 2” of runoff from all contribution impervious surfaces.

At least the first 1” of runoff from new impervious surfaces shall be permanently removed from the runoff flow.

Wherever possible, infiltration facilities should be designed to accommodate infiltration of the entire permanently removed runoff; however, in all cases at least the first ½” of the permanently removed runoff should be infiltrated.
Gage Locations

Legend

- Gages with long period of record for analysis
- Streams
- Roads

Watershed Concepts – A total water resource
Monocacy River at Jug Bridge near Frederick

7-Day Minimum Flow, Monocacy River

\[ y = 0.235x - 372.7 \]

\[ R^2 = 0.020 \]

Minimum 7-Day, 10-Year Flow, Monocacy River

\[ y = 0.163x - 270.1 \]

\[ R^2 = 0.020 \]
Potomac River at Hancock

**7-Day Minimum Flow, Potomac River**

- Flow (cfs) vs. Period of Record (1932-2005)
- Equation: $y = 2.232x - 4104$, $R^2 = 0.294$

**Minimum 7-Day, 10-Year Flow, Potomac River**

- Flow (cfs) vs. Period of Record (1932-2005)
- Equation: $y = 4.285x - 7993$, $R^2 = 0.430$

**Minimum 7-Day, 10-Year Average Flow, Potomac River**

- Flow (cfs) vs. Period of Record (1932-2005)
- Equation: $y = 4.746x - 8923$, $R^2 = 0.522$
Youghiogheny River near Oakland

1. 7-Day Minimum Flow, Youghiogheny River
   - Equation: \( y = 0.170x - 319.4 \)
   - \( R^2 = 0.082 \)

2. Minimum 7-Day, 10-Year Flow, Youghiogheny River
   - Equation: \( y = 0.193x - 373.6 \)
   - \( R^2 = 0.271 \)

3. Minimum 7-Day, 10-Year Flow Average, Youghiogheny River
   - Equation: \( y = 0.281x - 537.5 \)
   - \( R^2 = 0.477 \)
Why?

Consumptive Uses?

Precipitation?
Precipitation

Precipitation data from NOAA, National Climatic Data Center. Climate at a Glance, Annual Precipitation, Maryland
http://climvis.ncdc.noaa.gov/cgi-bin/cag3/hr-display3.pl
Overlay of Data
Double Mass Curve

- Method to check the consistency of a record of data
- Plot of the cumulative figures of one variable against the cumulative figures of another variable or against the cumulative computed values of the same variable for a concurrent period of time
- Will plot a straight line as long as the data are proportional
- A break in the slope:
  - A change in the constant of proportionality between the variables
  - The time at which a change occurs in the relation between the two variables


Watershed Concepts – A total water resource
Double Mass Curve

- A break in the slope:
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Double Mass Curves

Monocacy River

\[ y = 0.002x + 13.13 \quad R^2 = 1 \]

Potomac River

\[ y = 0.002x + 86.88 \quad R^2 = 1 \]

Youghiogheny River

\[ y = 0.002x - 2.738 \quad R^2 = 1 \]
Crabtree Creek near Swanton

7-Day Minimum Flow, Crabtree Creek

7-Day, 10-Year Minimum Flow, Crabtree Creek

7-Day Minimum, 10-Year Average Flow, Crabtree Creek
Fishing Creek near Lewistown

7-Day Minimum Flow, Fishing Creek

7-Day, 10-Year Minimum Flow, Fishing Creek

7-Day Minimum, 10-Year Average Flow, Fishing Creek
Savage River near Barton

7-Day Minimum Flow, Savage River

Minimum 7-Day, 10-Year Flow, Savage River

Minimum 7-Day, 10-Year Average Flow, Savage River
Marsh Run at Grimes

**7-Day Minimum Flow, Marsh Run**

- Equation: $y = -0.041x + 85.40$
- $R^2 = 0.101$

**7-Day, 10-Year Minimum Flow, Marsh Run**

- Equation: $y = -0.067x + 134.6$
- $R^2 = 0.763$

A reservoir upstream?
References


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