EXPLANATION OF WATER WITHDRAWAL PROVISIONS

Groundwater withdrawal

PennFuture's model ordinance suggests aquifer testing in accordance with Pennsylvania Department of Environmental Protection, Bureau of Safe Drinking Water, Document No. 394-2125-001, *Aquifer Testing Guidance for Public Water Systems*. This document outlines the methodology used for aquifer testing for groundwater withdrawals for public water supplies, which are regulated by DEP. The intent is to determine the sustainable yield of the aquifer, defined as "the amount of water that can be withdrawn from an aquifer without causing an undesired result, such as adverse dewatering of an aquifer, including potential health threats or impacts upon stream uses."[1]

The aquifer test should "adequately define the hydraulic characteristics of the aquifer and well(s)" and provide data that will allow "evaluation of significant potential impacts from the groundwater withdrawal on other water resources."[2] There are several components:

1. **Determination of the hydrogeologic setting**. The hydrogeologic setting refers to the geologic and hydrogeologic conditions that affect the well and are affected by it. It includes the area from which a well's water is drawn (area of diversion) and the area that provides recharge to the aquifer (contributing area). Hydrogeologists model the hydrogeologic setting using data about the aquifer such as location, depth, composition, and ground water flow direction.
2. **Construction of production well and monitoring wells**. The Guidance advises that production wells must be constructed in accordance with DEP standards and that monitoring wells "should be located and constructed to provide the controlled access necessary to characterize the groundwater system during aquifer testing."[3] The document cross-references DEP's *Groundwater Monitoring Guidance Manual* for standards regarding monitoring wells and observation points.
3. **Establishing observation points.** Observation points are points from which data is collected and/or adverse impacts are monitored. They may include monitoring wells, existing wells that are not being pumped during the test, surface water monitoring points, and others. The specific observation points depend on the objectives of the study. The Guidance cross-references other DEP guidance on selection of observation points.[4]
4. **Conducting testing**. The actual pumping test consists of four components: a stepped-rate test, a background test, a constant-rate aquifer test, and a recovery test. The Guidance also provides direction regarding data collection and documentation.
   a. The stepped-rate test is used to determine a sustainable pumping rate for the constant-rate test. It consists of at least three stages of increased pumping lasting at

[1] Pennsylvania Department of Environmental Protection, Bureau of Safe Drinking Water, Document No. 394-2125-001, *Aquifer Testing Guidance for Public Water Systems* 1 (2014).
[2] Pennsylvania Department of Environmental Protection, Bureau of Safe Drinking Water, Document No. 394-2125-001, *Aquifer Testing Guidance for Public Water Systems* 3 (2014).
[3] Pennsylvania Department of Environmental Protection, Bureau of Safe Drinking Water, Document No. 394-2125-001, *Aquifer Testing Guidance for Public Water Systems* 5 (2014).
[4] Pennsylvania Department of Environmental Protection, Bureau of Safe Drinking Water, Document No. 394-2125-001, *Aquifer Testing Guidance for Public Water Systems* 6–7 (2014).

least 100 minutes each, with the last stage being at least the rate of the desired production rate. Drawdown is assessed at each stage, and pumping continues until the well fails to equilibrate or the anticipated production level is reached. Discharge water should be handled in a manner that prevents artificial recharging of the aquifer.

b. The background test assesses any effects from other pumping wells in the area.

c. The constant-rate aquifer test allows for hydraulic evaluation of the aquifer and identifies impacts to other water resources. The production well is pumped—constantly, for 72 hours or more—at the rate indicated by the stepped-rate test and/or the anticipated production demand. The water levels in the production well and at the observation points are measured and recorded at regular intervals. Discharge water should be handled in a manner that prevents artificial recharging of the aquifer.

d. The recovery test starts at the end of the constant-rate aquifer test, when the pump is turned off. Water level recovery in the production well and at the observation points is measured for a minimum of 24 hours or until water levels have recovered by 95 percent of the projected pre-pumping levels.

The data obtained by the aquifer test is then analyzed and interpreted by a professional hydrogeologist to determine the aquifer's sustainable yield, or the amount of water that can be withdrawn without affecting others' wells or harming other water resources. The results of the aquifer test also determine the well's "cone of depression," which is the area that may be impacted by withdrawals from the well.

PennFuture also provides suggested language for pre-construction testing of wells within the cone of depression, for monitoring of wells within this area, and a process for adjudicating claims that the data center has adversely impacted nearby wells. This language is modeled on certain DEP regulations and existing ordinances, as noted in the document.

<u>Surface Water</u>

PennFuture's recommended water withdrawal limits and standards are based on studies and models that PADEP uses when evaluating withdrawals for public water supplies.[5] Which standard is best for a given municipality will depend on the watershed and/or physiographic province the municipality is located in and/or the surface water's use designation.

The studies/methodologies are briefly described below:

Nature Conservancy Ecosystem Flow Recommendations

The Nature Conservancy (TNC), in conjunction with river basin commissions, the U.S. Army Corps of Engineers, and others, developed flow recommendations for each of Pennsylvania's major river basins (Susquehanna, Delaware, Ohio, Potomac, and Great Lakes)[6] based on the critical flow needed to protect a variety of plant and animal species, natural

[5] See https://www.pa.gov/agencies/dep/programs-and-services/water/bureau-of-safe-drinking-water/water-allocation/instream-flow

[6] TNC did not make flow recommendations for the Potomac River in the same way as in the other watersheds and it is therefore not included in our suggested provisions.

communities, and key ecological processes within various stream and river types. These studies considered fish, aquatic insects, mussels, reptiles, amphibians, birds, mammals, floodplain and aquatic vegetation, floodplain and channel maintenance, and water quality. The resulting flow recommendations are designed to protect low flows, typical flows, and high flows because each is important to supporting certain life cycles of aquatic life and other ecological functions.

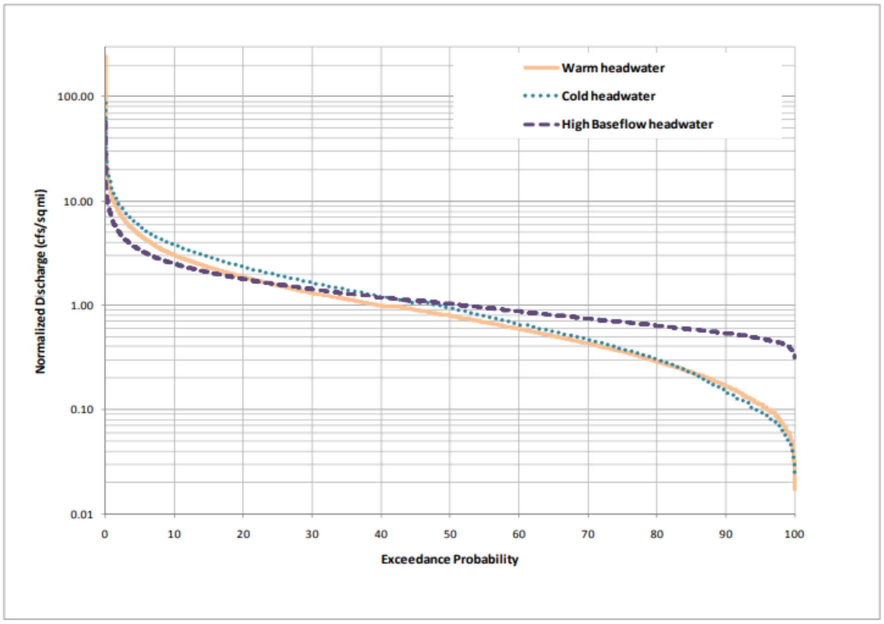
TNC's flow recommendations are tied to flow statistics that can easily be calculated using daily streamflow data from the stream from which withdrawals will be taken, or from a comparable reference stream.

These statistics include:

- The magnitude and frequency of 20-, 5- and 2- year floods;
- Monthly high flow (flow that is exceeded in 10% of the days in the month);
- Monthly median flow (flow that is exceeded in 50% of the days in the month);
- Monthly low flow (flow that is exceeded in 75% or 90% of the days in the month, depending on watershed and stream size); and
- Typical monthly flow ranges (area under monthly flow duration curve between two specified points depending on watershed and stream size)

A flow duration curve is based on many years of flow data collected for the same timeframe and shows the likelihood that a stream's flow will reach or exceed various levels in a typical month or year. An example from TNC's Ecosystem Flow Recommendations for the Susquehanna River Basin is shown below.[7]

[7] The Nature Conservancy, ECOSYSTEM FLOW RECOMMENDATIONS FOR THE SUSQUEHANNA RIVER BASIN 20 (2010).



Normalized annual flow duration curves for cool and cold, warm and high baseflow headwaters and small streams (USGS Gages 01555500, 01550000, 01571500, respectively, 1960-2008)

This annual flow duration curve for certain headwaters and small streams in the Susquehanna River Basin indicates that there is an 80% chance that the flow of the warm headwater stream (yellow line) will exceed 0.3 cubic feet per second (cfs) per square mile of watershed in any given year, and a 10% chance that it will exceed 1.2 cfs.

The values at each increment of probability are referred to as Px. For example, the stream flow at the 40% exceedance probability is expressed as P40. For the warm headwater stream in the graph above, P40 is 1.00 cfs/sq. mi. This value is sometimes expressed using Q (for quantile) instead of P.

PA/MD Instream Flow Study Model

PennFuture recommends municipalities that are not located in one of the river basins covered by the Nature Conservancy's ecosystem flow recommendations use the standard derived from the PA/MD Instream Flow Study Model.

The Instream Flow Study (IFS) was conducted in 1994 and published in 1998 by PADEP, the Susquehanna River Basin Commission, the Pennsylvania Fist and Boat Commission, and the U.S. Geological Survey. Researchers studied the levels of flow necessary to support all life stages of brook and brown trout in sample naturally reproducing trout streams and extrapolated the results to develop an impact assessment method for determining what flow protection levels are necessary to protect these species in comparable streams. PA DEP uses this model to evaluate instream flow needs and/or passby flow requirements where there are public water withdrawals from the types of streams that were studied. This method is advantageous because it is easily derived from hydrologic records and does not require stream-specific impact analysis studies.

Relevance

The IFS studied streams with the following characteristics, and is therefore applicable only to streams that share them:

- Contains brook or brown trout (wild or stocked)
- Has a drainage area of less than 100 square miles
- Is located in the Ridge and Valley physiographic province or the unglaciated part of the Appalachian Plateau province
- Has a use designation of Cold Water Fisheries, High Quality, or Exceptional Value

How it works

The overarching approach of the IFS is to establish the amount of flow necessary to maintain a suitable amount of habitat for brook and brown trout in all stages of life. The goal is to achieve no net loss of habitat at the stream's **median monthly flow**, which is the average of all daily stream flows for each month measured in cubic feet per second.

Using methods beyond the scope of this summary, researchers quantified the amount of habitat available for each life stage of brook and brown trout (spawning, fry, juvenile, and adult) at various flow levels in each study stream, resulting in a value they call weighted usable area (WUA), expressed in units of square feet per thousand linear feet of stream. These WUAs were then "normalized"[8] for each life stage and flow level by dividing the WUA for that life stage and flow level by the maximum WUA for the same life stage over all stream flows. This results in what is called a normalized WUAs for each life stage and flow level that is expressed as the ratio between the WUA for that life stage and stream flow and the maximum WUA possible for that life stage across all stream flows. To address situations where multiple life stages are present simultaneously in a stream, researchers identified the most limiting normalized WUA of all the life stages present and used that as the normalized WUA for that combination of life stages. Finally, researchers "renormalized" the WUAs for each combination of life stages at each flow level by dividing the normalized WUA by the maximum normalized WUA possible for that combination of life stages across all flow levels. This value is called the renormalized minimum weighted usable area (RMWUA). RMWUA represents a measure of habitat available at a given flow relative to the peak habitat available over the entire range of possible flows on that stream.

In addition to cubic feet per second (cfm), researchers also expressed each flow level in terms of cubic feet per second per square mile of drainage area (csm), percentage of average daily flow, and percentage of annual median flow.

Impact Analysis

Persons proposing withdrawals are to conduct an impact analysis to determine the impact of the withdrawal on the amount of habitat available. Impact analyses are performed on a monthly, seasonal, or annual basis.

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[8] Normalization and renormalization rescale the data to a range of zero to unity, meaning all values will fall somewhere between 0.0 and 1.0. This allows for comparison of habitat values between streams that may vary significantly in terms of absolute size or amount of habitat.

The criterion the researchers developed for habitat loss was "no-net-loss of median monthly habitat." Median monthly habitat is defined as the amount of habitat available at a stream's median monthly flow. The no-net-loss flow is equal to the smaller of the median monthly flow or, if the median monthly flow exceeds the flow at the peak of the RMWUA curve, the flow less than the peak at the same RMWUA.

Passby flow is the flow rate below which no water withdrawal may be taken.

At the end of the day, the researchers came up with the following guidelines based on stream classification, which PennFuture has incorporated into its model ordinance:

- For Exceptional Value and High Quality streams, withdrawal cannot cause annual habitat loss greater than 5%
- For streams classified as Cold Water Fishes and as Class B wild trout streams by the PA Fish and Boat Commission, annual habitat loss cannot exceed 10%
- For streams classified as Cold Water Fishes and as Class C or D wild trout streams by the PA Fish and Boat Commission, annual habitat loss cannot exceed 15%
- In no case shall passby flow be less than $P_{7\text{-}10}$, the lowest seven-day average flow that occurs on average once every ten years.