

# TIMELY INFORMATION

## Agriculture & Natural Resources

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### Surfacewater Withdrawal for Sustainable Irrigation

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Agriculture in Alabama may be generally categorized as 'rain-fed.' That is, crop production relies primarily on rainfall to supply water required for plant growth and development. Although Alabama averages 55 inches of rain each year, there is a difference between when the rain occurs and when crops most need water. A majority of the rain falls during the winter months, which means that crops are vulnerable to drought stress during the growing season.

A study was conducted at Auburn University to evaluate the feasibility of withdrawing and storing high water flows in streams generated during winter rains (December-April) for use during the growing season (Srivastava, et al. 2010). The need to balance water withdrawal and stream functions is critical.

Streams require a variety of flows of water to remain healthy and to provide for in-stream functions such as habitat. Stream flow can be described as base flow (amount of water between rainfall events) and storm flow (amount of water during and immediately after precipitation). Life cycles of many in-stream and streamside plants and animals are timed with both base and storm flows. Therefore protection of both base and storm flows are critical for a stream to remain healthy.

Since Alabama receives most of its rainfall during winter months, researchers hypothesized that if water is withdrawn during winter months and is stored in off-stream reservoirs, withdrawn water can be used for irrigation during growing season. Researchers used the Soil and Water Assessment Tool (SWAT) model

(Neitsch et al., 2002) to simulate water withdrawal in first through third order headwater streams in the Big Creek watershed in Mobile County, Alabama. Since protection of low flows, high flows, and average

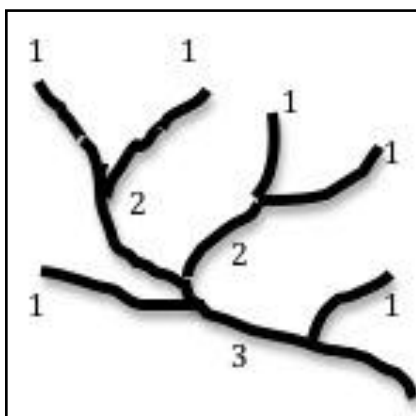
*Generalized winter water withdrawal approach to protect stream low flows, high flows, and average flows:*

- No water withdrawn when the flow for the day drops below the 25<sup>th</sup> percentile of daily flows.
- Water withdrawn when the flow is greater than the 25<sup>th</sup> percentile, but less than the 95<sup>th</sup> percentile (does not allow for dropping below 25<sup>th</sup> percentile).
- 10-15% of total daily flow withdrawn when flow is greater than 95<sup>th</sup> percentile.

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flows in streams are important, researchers used the in-stream flow guidelines developed by the U.S. Fish & Wildlife (USFWS) and U.S. Environmental Protection Agency (USEPA) for the Alabama-Coosa-Tallapoosa (ACT) and Apalachicola-Chattahoochee-Flint (ACF) River Basins (USFWS and USEPA, 1999). From these detailed guidelines, general water withdrawal approach was developed and used for this study (see Text Box). This general approach ensured that, after winter water withdrawal, the flows meet the USFWS and USEPA in-stream flow guidelines.

Decisions for water withdrawal should be made on a daily basis and may use tools such as a stream flow forecasting system or the development of a rating curve to adjust pumping rates. In the southern states, stream flow forecasting is currently being done for large rivers by the Southeast River Forecast Center (SERFC) for flood control purposes (<http://www.srh.noaa.gov/serfc/>). Similar forecasting tools can be used for water withdrawal for irrigation. For more information on stream flow forecasting or rating curves, visit [www.wcc.nrcs.usda.gov/factpub/intpret.html](http://www.wcc.nrcs.usda.gov/factpub/intpret.html) or <http://ga.water.usgs.gov/edu/streamflow3.html>.



First order streams are the first channels in a river network that carry water year round. They are small in size and have small watersheds. A watershed is the area of land that drains to a waterway such as a stream or river. When two first order streams meet they become a second order stream. When two second order streams flow together they become a third order stream, and so on until the river system meets an ocean. This stream classification system was developed by Strahler (1952) and is used to describe general stream characteristics (Fig 1).

Figure 1 Strahler Stream Order

According to this study, an average of 11% of the watershed area of a first order stream can be irrigated from the water that is withdrawn during winter months and still maintain ecological in-stream flows. Similarly, an average of 10% of a watershed for second and third order streams may be irrigated from water withdrawn and stored during the winter months while sustaining critical in-stream flows. Of note is that the watershed area associated with a third order stream is larger than a second order stream which is larger than a first order stream. The area of land that may be sustainably irrigated will differ each year depending on the amount of precipitation. During wet years, more water may be withdrawn and more land area irrigated as compared to dry years that place a greater stress on stream systems and limit the volume of water available for withdrawal.

There is evidence that ENSO (El Niño Southern Oscillation) (<http://www.elnino.noaa.gov/>) is strongly linked to precipitation patterns in the Southeast and may be used to predict water available for withdrawal

during winter months. For example, La Niña winters tend to be warmer and dryer than normal in the Southeast. If back-to-back dry years occur, it is likely that withdrawal would not be feasible or sustainable suggesting that surface water should not be entirely relied upon for irrigation. In places where feasible, surface water should be supplemented with groundwater for irrigation during dry years.

## References

- Neitsch SL, Arnold JG, Kiniry JR, Williams JR, King KW (2002). Soil and Water Assessment Tool (SWAT) Theoretical Documentation, Version 2000. USDA-ARS Grassland, Soil, and Water Research Laboratory, Temple, TX. [www.brc.tamus.edu/swat/](http://www.brc.tamus.edu/swat/). Accessed 1 December 2007
- Srivastava, P, Gupta AK, Kalin L (2010). An ecologically-sustainable surface water withdrawal framework for cropland irrigation – a case study in Alabama. (In press).
- Strahler AN (1952). Dynamic basis of geomorphology. Geological Society of America Bulletin, 63, 923-938.
- U.S. Fish & Wildlife Service and U.S. Environmental Protection Agency (USFWS and USEPA) (1999). Instream flow guidelines for the ACT and ACF basins interstate water allocation formula. Enclosure to letter dated October 25, 1999, from J.H. Hankinson, EPA Regional Administrator, and S.D. Hamilton, USFWS Regional Director, to L. Thomas, ACF Federal Commissioner. 14 pp ? appendices