Georgia's
State Water Plan

Summary of Scientific and Engineering Advisory Panel Workshop

October 5-6, 2009
Georgia Tech Conference Center, Atlanta

Charge to Scientific and Engineering Advisory Panel: Advise Georgia Environmental Protection Division on scientific matters associated with the resource assessment components of the State Water Plan.

The Scientific and Engineering Advisory Panel met in a workshop on October 5th and 6th with the following objectives:

- Review and provide input on resource assessment methodologies
  - Identify refinements in methodologies for this and subsequent rounds of regional planning
- Provide input on flow regimes as a factor in assessment of surface water availability
  - Identify processes for addressing instream flow questions
- Provide input on selected benchmarks for groundwater sustainable yield
- Identify elements of a research agenda to inform resource assessments in subsequent rounds of regional planning

The workshop opened with a welcome from Carol Couch, Director of the Georgia Environmental Protection Division (EPD). Gail Cowie, the EPD associate who facilitated the workshop, then reviewed the agenda, noting that there would not be time to fully accomplish the objectives at this workshop. The last task of the workshop would be to discuss the panel's work program and the steps needed after the workshop to progress on the objectives.

Assessment of surface water availability

The first technical session focused on the assessment of surface water availability. The session began with a detailed review of the assessment methodology and description of the modeling tool being used in the assessment, presented by Wei Zeng with EPD. Panel members and EPD associates discussed the use of reported withdrawals and returns from permitted facilities, the state's threshold for water withdrawal permits (100,000 gallons per day), the approach to estimation of agricultural withdrawals, and the way in which returns from onsite sewage management systems are captured in the starting database.

In discussion, panel members addressed the spatial resolution of the modeling tool. The spatial resolution is determined, first, by the distribution of U.S. Geological Survey monitoring gages. The gages with long-term records were used to define 76 basic nodes. A subset of these was selected as planning nodes, the points for assessment of surface water availability. Planning nodes where chosen to be as close to the boundaries of the water planning regions as possible and to avoid separating major withdrawals and wastewater discharges.

EPD staff noted that, in areas where greater resolution is desirable, they have worked with USGS to install new gages. Thirty-two new gages have been installed and data from those gages should be available to inform the second round of regional water planning (expected to start in 2012).

The ways in which the surface water assessment advances beyond current practice were noted in discussion. Development of statewide unimpaired flow data by removing reservoir regulations, net evaporation, and human consumptive water use data from long-term hydrologic monitoring records at 76 USGS gages is one significant change. When work on the surface water assessment began, unimpaired flow data had only been developed for the Coosa, Tallapoosa, Chattahoochee and Flint river basins for the period of 1939 to 2001. The work conducted under the State Water Plan generated data for all 76 basic nodes for the period 1939 through 2007, greatly enhancing the information base for analysis of water resource management and operation of reservoir systems.

In addition, the surface water assessment tool has the capacity to integrate instream flow requirements to the most downstream node in a basin, estimating the contribution needed from upstream sub-basins to meet flow targets downstream. This provides a basis for cumulative assessment of changes in flows that is not provided by site-specific requirements.

Discussion of the flow regime component of the analysis focused on a number of questions, including differences between unimpaired flows and historical or observed flows, differences in flows in regulated versus unregulated basins, flow alterations observed in regulated rivers and the ecological implications of those changes, and the potential for protection of high flows. Changes in the frequency of high flows are likely significant in regulated basins. In the discussion of protection of high flows, EPD staff noted that current water withdrawals are a small proportion of the volume of water seen at high flows, essentially falling well within the observation's margin of error.

The question of high flows and how those have changed relates in some basins to changes in land use and the changes in the hydrograph seen as impervious cover increases. The high storm flows associated with increased impervious cover can degrade aquatic communities because too much water moves into the system too quickly. The linkages between land use and the hydrology and quality of our water resources needs to be considered.

The surface water assessment tool is currently structured to incorporate a flow regime as a factor in determining the amount of water available, expressed in terms of reliability. Panel members discussed tradeoffs between shortfalls in water supply and shortfalls in instream flows, which can be incorporated in the model. The tradeoffs could also be introduced through work with the regional water planning councils. This topic may be addressed further as the panel's work proceeds.

In discussion of flow regimes, panelists recognized that, in other states and countries, different approaches have been taken to determine flow targets or flow requirements that may be more ecologically protective than minimum flow requirements (e.g., percentage changes from high and low flows). Approaches to flow requirements can range from use of one criterion statewide to a more complex approach starting with stakeholder-driven identification of goals and objectives for specific water resources, followed by estimation of the flows likely to support those goals and objectives. A hybrid of these two approaches could also be used.

For Georgia, state policy defines two instream flow criteria: 1) the annual seven-day, ten-year low flow (annual 7Q10[1]) is used in water quality permits as the critical low flow condition and 2) the monthly ten-year low flow (monthly 7Q10[2]) is specified in the Board of Natural Resources interim instream flow policy to protect seasonal variability in low flows at new or expanded withdrawal facilities and below some reservoirs.[3]

In addition to the criteria defined by state policy, the regional water planning councils may identify additional instream flow objectives. For example, some councils may be interested in exploring flows to support recreational uses or fisheries. The regional goals that are currently under development are expected to provide a starting point for this exploration. The process may require translating from regional goals to identify flows or flow statistics that are likely to support those goals, an area where the panel could provide input.

In discussion, panel members noted that addressing additional objectives would likely require specifying flow needs at locations other than the planning nodes. Panelists also recognized that it is not clear what can be inferred about upstream ecological conditions from a flow regime defined for a sub-basin node. Because the 76 gages that serve as nodes tend to be on larger rivers, flow conditions at the many smaller tributaries upstream of each node are uncertain. Questions related to flow regimes and instream flows were flagged as topics for further discussion after the workshop.

Assessment of assimilative capacity

The next session focused on assessment of assimilative capacity in the state's surface waters. The session again opened with a detailed review of the assessment methodology and description of the modeling tools being used in the assessment, presented by Liz Booth with EPD. Assessments of assimilative capacity will evaluate dissolved oxygen levels in relation to the water quality standard for dissolved oxygen. For some areas of the state, assessments will also evaluate nutrient and chlorophyll levels and compare those with the water quality standards that have been adopted to date.

Unlike the surface water assessment, evaluation of water quality and assimilative capacity requires use of several different kinds of models. The steady state models GA DOSAG and GA ESTUARY, and the hydrodynamic model GA RIV-1, are being used to model dissolved oxygen levels in rivers, streams and estuaries. The watershed model LSPC and lake and estuary models EFDC and/or WASP are being used to model dissolved oxygen, nutrients, and algae levels.

EPD associates presented information on the dynamics of biological oxygen demand in the water column and in sediments. Discussion addressed incorporation of nonpoint source loading in the watershed and estuary models and specific methods for estimating sediment loading. Panelists noted that, although they provide a starting point, the measures of assimilative capacity were limited in their ability to characterize water quality more comprehensively (e.g., in contrast to measures of biotic integrity).

---

[1] The lowest stream flow for seven consecutive days that would be expected to occur every ten years.

[2] The lowest stream flow for seven consecutive days in each month that would be expected to occur every ten years.

[3] While the Board's instream flow policy includes options other than the monthly 7Q10, use of those options to date has been infrequent. There are also a number of permitted water withdrawal facilities that are "grandfathered" and do not have instream flow requirements.

Relationships between sediment, phosphorus, and chlorophyll dynamics in lakes were also discussed. It was noted that these relationships are complex in systems with large amounts of sediment input, that depletion of oxygen deep in lakes may result in internal loading of phosphorus, and that sediment-associated phosphorus can move downstream.

Although the models are still under development, the calibration results to date were presented in some detail. EPD associates and panel members discussed what results qualify as a good calibration and explored the factors that can make calibration of water quality models difficult.

The extent of monitoring data is one factor that determines the quality of the calibration. Modeling results for specific parameters (e.g., dissolved oxygen) should be compared to monitoring data for those parameters. In water bodies where more monitoring has been done, estimation errors may be lower and, therefore, modeling results can be used with greater certainty. Panelists also noted that development of empirical relationships between modeled parameters, monitoring results for those parameters, and more comprehensive measures of water quality is another factor that would contribute to the quality of the calibration. Each of the resource assessments will help identify areas where more monitoring would be valuable.

Panel members emphasized the importance of quantifying estimation errors or uncertainty as well as the challenge in communicating what that means to the end users of the models. They agreed to provide advice on how to quantify estimation errors and to review the technical reports on the water quality assessments to provide feedback on this topic. In subsequent discussion, they agreed that the panel should look at estimation errors or uncertainty for all of the resource assessment models.

Land use trends and land use change scenarios

The third technical session focused on historical land use trends and modeling of future land use change scenarios. Liz Kramer with the University of Georgia presented information on land use trends between 1974 and 2005. She also described modeling that is currently underway to explore future scenarios for conversion of land to urban land cover and conversion between other land use classes. This modeling will produce theoretical scenarios or alternatives and results should not be interpreted as specifications for land use planning.

In discussion, panel members asked specific questions about the way growth is distributed in the model, the relationship between different land covers and water use, and the accuracy with which the models describe the growth seen in the past. They also discussed the connections between land use and the assessments of surface water availability, groundwater availability, and assimilative capacity.

For the watershed models that evaluate assimilative capacity, changes in urban cover will be used to derive inputs for assessment of future assimilative capacity conditions. For some of the groundwater models discussed below, changes in urban cover can affect recharge components. For the surface water assessment, the flow data from monitoring gages reflects the effects of historic change in land cover. As the surface water model currently stands, it does not incorporate results of future land use scenarios. Work is underway on a pilot project to revise the surface water assessment tool to incorporate this information for the Oconee-Ocmulgee-Altamaha basins.

Assessment of groundwater availability
The final technical session focused on the assessment of groundwater availability. The session began with a detailed review of the assessment methodology and description of the models being used in the assessment, presented by Jim Kennedy with EPD.

The groundwater assessments are designed to evaluate sustainable yields, or the amount of groundwater that can be withdrawn from an aquifer without causing an unacceptable impact. The State Water Plan recognizes that, because evaluating sustainable yields for all the aquifers in the state would be extremely expensive and time consuming, prioritization of aquifers for evaluation is a necessary first step in assessment of groundwater availability.

Aquifers were prioritized based on functional characteristics, evidence of adverse effects due to withdrawals, and projections indicating significant increases in demand. As a result of the prioritization, numerical computer models are being developed for the following aquifers, which are the source of most of the groundwater used in the state, where withdrawals have caused some unacceptable impacts, and where future increases in withdrawal are expected:

- Upper Floridan aquifer in the Dougherty Plain
- Upper Floridan aquifer in Tift County area
- Cretaceous aquifer between Macon and Augusta
- Claiborne aquifer in southwestern Georgia
- Upper Floridan aquifer in the eastern Coastal Plain

Water balance models are being developed for the north Georgia crystalline and Paleozoic rock aquifers where less groundwater is withdrawn.

In discussion, panel members noted that aquifers cross the boundaries of water planning regions, a challenge in planning to protect sustainable yield. They discussed the benchmarks being considered to determine sustainable yield, the goal of managing groundwater use to protect sustainable yield, and the implications of declining groundwater levels for different aquifers.

Groundwater – surface water interconnections in different aquifers across the state were discussed in some detail. Groundwater provides a component of streamflow known as baseflow. This component is generally more significant at low flow conditions. The degree of interconnection and the specifics of the groundwater contribution, however, vary by aquifer.

Groundwater – surface water interconnections are most significant for the Upper Floridan aquifer in the Dougherty Plain (southwest Georgia) and the Paleozoic rock aquifer in northwest Georgia. The groundwater and surface water assessments done for these areas will be closely coordinated, with iterative analyses likely for both assessments. For the crystalline rock aquifer in the Piedmont, potential impacts on streamflow from groundwater use are more limited, due to the hydraulics of the aquifer. There might be localized effects but that impact would not be seen at the planning nodes where the surface water assessments are being conducted. Models of the other prioritized aquifers are currently for confined portions of those aquifers, meaning that there is no direct contribution to streamflow.

Panelists indicated that they would like further exploration of the implications of groundwater contributions to streamflow for the metrics used in the groundwater and surface water assessments. In some areas, for example, there may be value in a metric aimed at baseflow protection as well as metric(s) based on total flow. They also recognized a need for more information on the degree to which the physical/chemical characteristics of rivers in Georgia are controlled by groundwater and the extent to which this varies across the state.

Discussion in the final technical session concluded with an exploration of the linkages between the three resource assessments and their underlying models. Panelists and EPD staff discussed the points of coordination planned for the various models. Points of coordination include use of data from one model as input to another, iterative application of different models, and comparison of results to assess consistency and compatibility. Panelists also began discussion of linkages to consider in future refinement of the models.

Next steps

In the final segment of the workshop, the panel discussed its products and the steps needed to progress on the objectives laid out at the beginning of the workshop. In the short term, the panel will focus on two topics: 1) evaluating flow regimes and instream flows necessary to meet specific objectives, including protection of biological communities and ecosystem processes; and 2) quantifying uncertainty or estimation errors in the resource assessment models. The panel's long-term work program is also expected to address two additional topics: integration of models to evaluate groundwater – surface water interactions and the groundwater contribution to streamflow; and sediment-phosphorus-chlorophyll relationships in reservoirs and their downstream effects.

EPD staff will assist the panel in documenting conclusions or findings on the resource assessment methodologies, flow regimes and processes for addressing instream flow questions, benchmarks for groundwater sustainable yield, and refinements in methodologies recommended for this and subsequent rounds of regional planning. The panel's conclusions or findings are also expected to include elements of a research agenda to inform future resource assessments and to identify topics for which research funding might be sought (e.g., from federal agencies).

Workshop participants

Panel members

David Allan, University of Michigan
Bruce Beck, University of Georgia
Mary Freeman, U.S. Geological Survey
Aris Georgakakos, Georgia Institute of Technology
Wendy D. Graham, University of Florida
Jim Greenfield, U.S. Environmental Protection Agency
Todd Rasmussen, University of Georgia
Brian Richter, The Nature Conservancy
Seth Rose, Georgia State University
Amy Rosemond, University of Georgia

EPD associates and consultants

Carol Couch, EPD
Elizabeth Booth, EPD
Becky Champion, EPD
Gail Cowie, EPD
Jim Kennedy, EPD
Elizabeth Kramer, University of Georgia
Wei Zeng, EPD