Balancing Instream and Offstream Uses:
Instream Flows, Surface Storage and Aquifer Management

A Report to
the Georgia Environmental Protection Division

Carl Vinson Institute of Government
University of Georgia
Athens, Georgia
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Fred Tarver, North Carolina Department of Environment and Natural Resources

Tom Woosely, Georgia Environmental Protection Division

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EXECUTIVE SUMMARY

Georgia enjoys a relatively plentiful water supply, yet the availability of our water resources varies both seasonally and regionally. When our natural water complexity is considered with regard to increasing water demands, it becomes apparent that Georgia must approach water management in a thoughtful, comprehensive and coordinated manner based on the best science we have. The following factors, taken together, underscore the need for such a comprehensive approach to water management.

1. **Weather/Climate**: Although Georgia is located in the humid southeastern United States and receives an average of 50 inches of annual precipitation, floods and drought are common and can significantly affect our water resources and how we use them. In fact, in the past two decades, Georgia has experienced the two worst droughts on record and a 100 and a 500-year flood.

2. **Geology/Hydrology**: Georgia encompasses portions of five physiographic provinces that vary in bedrock, soil, and topography, which result in an uneven distribution of water resources. North Georgia generally has more limited surface and ground water resources than south Georgia, which has larger rivers and one of the most prolific aquifer systems in the world. Even with the abundant water resources of south Georgia, pumping too much water from any one place at any one time can result in salt water intrusion or lowering of ground and surface water levels. These problems now face coastal Georgia, an area of high industrial and municipal withdrawals, and southwest Georgia, the agricultural irrigation center of Georgia.

3. **Demographics**: Between 1990 and 2000, the population of Georgia grew by 26.4 percent. This growth is projected to continue so that in the next 25 years, the state's population is expected to approach 12 million people. Population growth is not evenly distributed across the state, exacerbating resource stress caused by greater water demands. Most of the growth in population is expected to occur in the northern part of the state, which has more limited water resources than south Georgia. The second fastest growing region of the state is along the coast, an area faced with salt water intrusion in the Floridan Aquifer, the major water resource of the region.

4. **Economic Growth**: Although Georgia, like the rest of the nation, has been in an economic recession for the past few years, indicators suggest that economic activity is increasing. As our economy grows, demands for water increase to support our expanding industrial and commercial activities.

5. **Federal Laws and Policies**: Federal laws, such as the Clean Water Act and the Safe Drinking Water Act, set national requirements for water resources. In addition, several federal laws affect water resources including the Resource Conservation and Recovery Act, Endangered Species Act, National

Environmental Policy Act, and others. Collectively, these federal laws set parameters within which Georgia must operate. In addition, policies of federal agencies significantly affect Georgia's water resources. For example, the management of federal reservoirs by the U.S. Army Corps of Engineers largely determines flows in rivers, including the Chattahoochee and the Savannah.

6. **Neighboring States**: All of Georgia's major rivers, except those of the Altamaha, Satilla and Ogeechee basins, are shared with neighboring states. The Floridan Aquifer, the major aquifer in south Georgia, is also shared with Alabama, Florida, and South Carolina. Since 1990, Georgia has been in a dispute with Florida and Alabama regarding the management of the waters of two river systems. In addition, Tennessee and South Carolina have voiced concerns over shared water resources.

7. **The Courts**: Increasingly, decisions about water resources are being taken to court. Georgia has been in litigation over ground water use in coastal Georgia, water quality protection, and various other issues. The U.S. Constitution provides the federal courts with a role in resolving interstate disputes, including conflicts over shared water resources. Courts at all levels are becoming increasingly involved, however, in determining how water will be managed in Georgia.

8. **Technology**: Advances in technology have affected how we get water, transport water, treat water, use water, conserve water, and treat wastewater. In fact, technological changes are evident in every aspect of water management. Generally, technology helps us use water more efficiently, but in some cases, it can increase the stress we place on the water system.

9. **Knowledge**: We know a great deal more about our water resources today than we did in past eras. Research has improved our knowledge of how water resources systems work, and what is necessary to have healthy, functioning aquatic systems. Not only have we generated new water-related knowledge and insights, but our ability to communicate this new information has expanded greatly through formal and informal educational programs, the media, and the Internet.

10. **Value of Water**: Water is a valuable resource in many ways. It supports our economy and thus has value in the production of agricultural and industrial products. It has environmental value in that all life is dependent upon water. In addition to water needed to support bodily functions, water provides habitat, nurseries, and refuge for aquatic and terrestrial plants and animals. It has social and cultural value in that our lives are intertwined with water in countless ways. Water provides recreational and aesthetic values. Water not only supports life but it improves the quality of life in myriad ways. Further, growing scarcity of water, whether real or perceived, increases its value for all of these purposes. These factors support the need for a comprehensive approach to managing water resources. The question is whether we have such a water management program in place and, if not, what will it take to create one.

The legal foundation upon which water management in Georgia rests is the set of statutes enacted by Congress and the Georgia General Assembly. Collectively, this body of law has set two general water-related goals for us to meet:

- Protect public health and environmental quality; and

- Meet future needs while protecting aquifers, instream uses and downstream users.

We face significant challenges, however, in meeting these goals. First, inconsistencies and lack of coordination can hamper meeting at least some of our goals. Laws are passed by different legislative bodies at different times, with different motivations, and for different purposes. They are implemented by federal and state agencies with varying degrees of financial, technical, and managerial capacity. Specific water-related decisions reflecting policies and programs are made by local government officials, private sector institutions, and the general public. Assuring coordination and avoiding inconsistencies in such a situation may be desirable but rarely occurs, at least to the extent necessary to fully meet the goals of the statutes.

A second challenge in meeting our water goals is that laws are not static. They reflect the values we attribute to water resources at a particular point in time. These laws also reflect the world as we know it—or can reasonably expect it to become—at the point in time when we conceive them. Congress and the General Assembly can amend these statutes, but they do not always change in lock step with a shift in citizens' goals, aspirations, perceptions, activities, and knowledge related to water resources.

To better address the water challenges we face, the Comprehensive State-wide Water Management Planning Act was passed by the Georgia General Assembly during the 2004 legislative session. This law directs the Environmental Protection Division of the Georgia Department of Natural Resources to develop a comprehensive state water management plan and creates the Georgia Water Council composed of legislators, legislative appointees and agency heads with water-related responsibilities to oversee the development of the plan. The plan is to be provided to the Council in July 2007, for its review and adoption and presented to the General Assembly for consideration in the 2008 legislative session.

The first iteration of the comprehensive water management plan will focus on four key policy objectives:

1. Minimizing withdrawals of water by increasing conservation, efficiency and reuse;

2. Maximizing returns to the basin through reducing interbasin transfers and limiting use of septic tanks and land application of treated wastewater where water quantity is limited;

3. Meeting instream and offstream water demands through storage, aquifer management and reducing water demands; and

4. Protecting water quality by reducing wastewater discharges and runoff from land to below the assimilative capacity of the streams.

These management objectives are interrelated, and policy options may relate to more than one objective. In addition, an option might be appropriate in one situation but not in another. Consequently, the plans should identify a variety of policy options that are consistent with stat and federal laws and usable in different situations. The most appropriate options can then be selected to address the water challenges unique to each river basin and aquifer in the state. The result will be that approaches may vary from region to region depending on water resources and demands, but that all regions will be consistent with the overall state water policy framework.

A series of four reports examines each of the management objectives in terms of current knowledge and policies adopted in other states. As we move through the planning process, the policy options will be considered by various advisory committees, presented at public meetings, and made available on the Georgia Water Council's website (www.georgiawatercouncil.org). The intent is to distribute the information widely and to have as much feedback as possible so that the most effective water management options are identified for use in Georgia.

Meeting Instream and Offstream Needs

Sustainability of water resources is becoming an ever-increasing concern in many parts of the country, especially in metropolitan areas that are experiencing rapid population growth. The challenge of maintaining adequate supplies of high-quality water for both human uses and aquatic ecosystems will necessitate new ways of managing both water supply and water demands. By reducing demands through conservation, efficiency and reuse, sustaining water resources in basins of origin, making efforts to maintain clean water supplies, and providing for effective water management and storage such that demands may be met even during periods of low precipitation, Georgia will help ensure that future generations enjoy the benefits of plentiful, clean water.

Georgia's precipitation, though abundant, does not necessarily occur where and when it is needed such that it meets the demands of both society and natural systems. This variability poses a significant challenge, especially when coupled with the increasing water demands projected in the coming years. Already, Georgia has experienced stresses related to water quantity: saltwater intrusion related to ground water pumping along the coast, decreased river flows that threaten both riverine and estuarine ecosystems, increased agricultural irrigation in Southwest Georgia that may affect ground water levels and river flow, and local water system stresses related to increased domestic water use during times of supply shortages.

As noted in the companion report, *Water Conservation, Reuse and Efficiency*, much can be accomplished by increasing the efficiency with which we use each gallon of water withdrawn from surface and ground water sources. Conservation is the first line of defense against future water crises, but as Georgia's population continues to increase, additional policies for long-term sustainable water provision must be in place to accommodate the associated increase in water demand. Given the overall abundance of water in the state, the issue of storage emerges as a central focus. How will it be possible to spread the water supplies over time and space such that human needs are met while natural systems are kept healthy and continue to provide crucial environmental services upon which we depend?

Long-term sustainability of our water resources will require a holistic approach that considers the natural flow regimes, withdrawals, and storage of surface water as well as ground water withdrawal, ground water-surface water interactions, and conjunctive use of ground and surface water sources. The goal of this report is to provide an array of information offered by academic literature, state and federal guidance documents, and the experiences of other states, as applicable, to inform Georgia's comprehensive water management policy decisions. For the purpose of this report, information is divided into the following topics: instream flow and reservoir policy, ground water withdrawal management, and conjunctive use of ground water and surface water. Policy questions inherent in these topics include the following.

Instream Flow Policies

- What can the state do to move toward more protective minimum flows?
- How should the state define "protective flows?"
- Beyond minimum flows, how do other components of the flow regime support the values we attach to rivers and streams? What policy tools can be used to protect those components of flow?

Reservoir Policies

- Under what conditions should the State of Georgia support the use of reservoirs and for what hydrologic, environmental, or water resource purposes?
- Under what conditions should the state financially support the construction of reservoirs?

Ground Water Withdrawal Management

- How should the State respond when trends show that a ground water resource is stressed?

Conjunctive Use Policies

- Under what conditions are tools such as aquifer recharge and aquifer storage and recovery reasonable options for increasing the availability of water?

The policies adopted by other states are instructive for Georgia as these questions and related policy alternatives are considered in the planning process.

Instream flow policies: The dominant instream flow protection mechanism adopted by other states reviewed is the requirement for specified minimum flows, although these may be expressed as minimum levels at different points in the hydrograph or at different times of the year. These may be based on assimilative capacity (mean annual daily flow, 7Q10, and other thresholds), habitat protection, channel and riparian maintenance, and/or other site-specific considerations. In addition, a variety of water management tools are employed to reduce water withdrawals, including water conservation; demand management; reuse of reclaimed water; using water of the lowest acceptable quality for the purpose intended; limiting interbasin transfers by using water nearest the area of use or application; and using alternative water supply techniques, such as desalination, aquifer recharge, or aquifer storage and recovery.

Permitting conditions are generally used to regulate withdrawals, and permitting may require demand management measures, water use measuring and reporting, and other conditions. Notably, states generally exempt smaller withdrawals from permitting requirements, even though the cumulative effect of many small withdrawals can be as great or greater than a few large withdrawals, and few states make a distinction between consumptive and non-consumptive use in withdrawal permitting. Some states (i.e., Virginia and Oregon) afford, through permitting requirements, a greater degree of protection to certain designated surface water management areas. Conversely, Florida recognizes that certain modified rivers and streams should be exempt from instream flow requirements.

Most of the states surveyed do not formally recognize ground water-surface water interactions in instream flow regulations. Washington allows limits to be placed on ground water withdrawal in order to meet instream flow requirements if a hydraulic connection is demonstrated between the ground and surface water bodies. Florida includes ground water levels as part of its "minimum flows and levels" policy, but ground water withdrawals are not specifically addressed in instream flow criteria.

Reservoir policies: Reservoirs are considered by most states as reasonable water supply alternatives. However, various environmental impacts must be considered before reservoir projects are initiated. Much has been learned in recent years about reservoir influences on instream flow regimes and other aspects of natural systems; accordingly, some states utilize assorted policy mechanisms to minimize adverse environmental impacts.

Reservoir construction and management are regulated through local, state, and federal permits that traditionally focus on public safety and effects on other water uses. However, state policies such as those observed in Florida, North Carolina, Tennessee, Virginia, and Washington may require more extensive evaluations of immediate and long-term environmental impacts. In order to adequately assess such impacts, permit applicants must consider reasonable alternatives to a proposed reservoir, the anticipated effects of each option, and the opportunity to mitigate adverse consequences. Theoretically, an extensive consideration of direct and cumulative impacts on local resources and associated natural systems improves the management capacity of total water resources within a river basin.

Extended evaluation criteria may include: impacts on local flora and fauna; alterations of natural flow regimes and ecosystem functions; short- and long-term diminution of water quality; and influences on habitats connected to riparian areas. Policy strategies that address these issues can include extensive permitting requirements, mandated inter-agency regulatory coordination, and regional water resource planning. The selected strategies play an integral role in the viability of reservoir alternatives as well as location availability. Reservoir alternatives and locations, then, are limited to the stringency of environmentally related policies and the opportunities to mitigate adverse impacts.

Ground Water Withdrawal Policies: Based on the states surveyed, ground water use is managed predominantly through permitting requirements for large withdrawal amounts, typically 100,000 gallons per day or greater. Some states designate special zones for more restrictive management where ground water resource sustainability is threatened by overuse, reduced recharge, or both. Within these zones, ground water withdrawals generally must be permitted, and some states require additional management strategies and tools such as conservation measures and/or the requirement for developers to obtain a certificate of sufficient water supply to assure that proposed withdrawals can be sustained long-term.

Conjunctive Use Policies: Although states appear to increasingly acknowledge the connectivity between ground water and surface water sources and to encourage conjunctive use, it is not common to find specific mechanisms for conjunctively managing water use. Artificial recharge of ground water (AR) and aquifer storage and recovery (ASR) are becoming more common across the country as conjunctive use tools, with up to 2000 wells estimated to exist in the U.S. Ninety percent of these are concentrated in 10 states: California, Colorado, Florida, Idaho, Nevada, Oklahoma, Oregon, Texas, South Carolina, and Washington, although several other states are developing or expanding existing artificial recharge and/or ASR programs. (USEPA 1999)

Most ASR wells are used to maximize water availability, especially for equalizing periods of abundant precipitation with periods of high demand. Projects are generally permitted individually based on local hydrogeologic conditions and water supply needs. Following detailed analysis of the potential for a well, permits are commonly issued for an initial pilot project. Upon completion of successful pilot projects, evaluations are performed to determine whether to permit ongoing operation. Permit applications typically require detailed information, including the hydrogeologic characteristics of the aquifer to be used for storage; the chemical compatibility of native ground water and injected water; water treatment planned; recharge and recovery rates and other operational information; and environmental impacts, including impacts to the supplying stream or aquifer.

As noted earlier, Georgia has already experienced stresses related to water quantity; however, a comprehensive approach that includes demand and supply management for both surface and ground water resources will help ensure that even during periods of low precipitation, future generations will have plentiful, clean water.

Chapter 1

INTRODUCTION

Georgia is a complex state when it comes to water resources. Couple this natural water complexity with increasing water demands, and it becomes apparent that Georgia must approach water management in a thoughtful, comprehensive and coordinated manner based on the best science we have. To meet the challenges before us, we will need to adopt new measures to conserve water, return more water to the streams, help us balance off stream and instream water needs, and protect water quality. The following factors, taken together, underscore the need for such a comprehensive approach to water management.

1. **Weather/Climate**: Although Georgia is located in the humid southeastern United States and receives an average of 50 inches of annual precipitation, floods and drought are common and can significantly affect our water resources and how we use them. In fact, in the past two decades, Georgia has experienced the two worst droughts on record and a 100 and a 500-year flood.

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it improves the quality of life in myriad ways. Further, growing scarcity of water, whether real or perceived, increases its value for all of these purposes.

These factors support the need for a comprehensive approach to managing water resources. The question is whether we have such a water management program in place and, if not, what will it take to create one.

The legal foundation upon which water management in Georgia rests is the set of statutes enacted by Congress and the Georgia General Assembly. These statutes relate both directly and indirectly to our water resources. Statutes are implemented through a series of rules, policies, and programs by various departments of federal and state governments. One must look to the statutes themselves for either explicit or implicit expression of our goals for managing water resources. These "goals" (i.e., the outcomes we seek to achieve) reflect best how we collectively, as citizens of the United States and of Georgia, value the attributes of our water resources.

The laws that express our goals vary. Some laws reflect the broader goals of Americans and were passed by Congress. Federal statutes, such as the Clean Water Act, Safe Drinking Water Act, Endangered Species Act, Coastal Zone Management Act, and others, identify overarching goals that have been embraced, to varying degrees, by Georgia statutes. By enacting state laws that are at least as stringent as the federal laws, the state is able to receive primacy, or the responsibility to implement federal policies and programs in Georgia. The primacy mechanism applies to environmental laws administered by the U.S. Environmental Protection Agency (USEPA), such as the Clean Water Act and the Safe Drinking Water Act. Primacy, however, does not apply to all laws. For example, the Endangered Species Act is administered exclusively by the U.S. Fish and Wildlife Service. If there is sufficient change in collective American values or goals relating to water resources management, Congress adds to or amends federal laws to reflect this change; the State of Georgia alone cannot alter the federal requirements.

Some state statutes are Georgia specific and not driven by federal directives. State statutes include the Erosion and Sedimentation Control Act, Safe Dams Act, Georgia Planning Act, the Coastal Marshlands Protection Act, and others. In addition, states have the authority to determine how water should be allocated to various water users. Georgia has enacted legislation establishing permitting requirements for withdrawals of over 100,000 gallons per day of surface and ground water. These laws were enacted by the Georgia General Assembly and reflect goals and values of Georgians. Together, these federal and state statutes serve as the foundation for our water management programs.

Collectively, this body of law has set two general water-related goals for us to meet.

- Protect public health and environmental quality; and
- Meet future needs while protecting aquifers, instream uses and downstream users.

We face significant challenges, however, in meeting these goals. First, inconsistencies and lack of coordination can hamper meeting at least some of our goals. Laws are passed by different legislative bodies at different times, with different motivations, and for different purposes. They are implemented by federal and state agencies with varying degrees of financial, technical, and managerial capacity. Specific water-related decisions reflecting policies and programs are made by local government officials, private sector institutions, and the general public. Assuring coordination and avoiding inconsistencies in such a situation, while desirable, rarely occurs, at least to the extent necessary to fully meet the goals of the statutes.

A second challenge in meeting our water goals is that laws are not static. They reflect the values we attribute to water resources at a particular point in time. These laws also reflect the world as we know it—or can reasonably expect it to become—at the point in time when we enact them. Congress and the General Assembly can amend these statutes, but they do not always change in lock step with a shift in citizens' goals, aspirations, perceptions, activities, and knowledge related to water resources.

Problems Resulting from Uncoordinated Water Management

Some examples of the need for a more comprehensive, thoughtful, and coordinated approach to water management may be instructive.

- **Protecting Water Quality**: Our efforts to meet water quality standards have focused primarily on reducing contamination through controlling discharges from industries and municipalities. We have accomplished a great deal nationally and in Georgia by reducing pollutants that enter our waterways through these industrial and municipal wastewater discharges. Streams, rivers, and lakes across the country are cleaner today than they were when the Clean Water Act was passed in 1972. However, as we reduced the contaminant load from these point sources, and as our knowledge of the affects of nonpoint sources (e.g., runoff from land) increased, land use changes were outpacing our efforts to address resultant nonpoint sources.

  Georgia's Erosion and Sedimentation Control Act, passed in 1975, only addresses runoff from certain construction activities. It does not deal with the direct relationship between post-construction land use and nonpoint pollution; nor does it address the broad array of nonpoint pollutant types—such as nutrients, heavy metals, and synthetic organic compounds—that enter our waterways as a result of post-construction land-use practices. The Act also assigns responsibilities to multiple state agencies and to local governments who wish to implement the requirements within their jurisdiction.

  In the effort to render our waters safe and healthy, the federal government, through its executive and judicial branches, recently has increased its focus on controlling nonpoint sources as a pollution management tool. Both the USEPA and the Georgia Environmental Protection Division (EPD) have worked to control stormwater discharges. Since the first flush of stormwater carries most of the nonpoint pollutants to streams, collecting and/or otherwise treating this stormwater can help improve water quality. Additionally, the federal court system has required USEPA, and by extension EPD, to develop total maximum daily loads (TMDLs) in order to bring those streams that do not meet water quality standards into compliance with the Clean Water Act.

In Georgia, there are over 6,000 miles of streams that have been assessed that do not meet water quality standards; most of these impairments are due to nonpoint source pollution. To improve coordination of the nonpoint source control efforts, the Georgia General Assembly enacted House Bill 285 in the 2003 legislative session. This statute better aligns erosion and sedimentation control requirements under state law with stormwater control requirements under the federal Clean Water Act. This legislation will result in better coordination, but to be truly effective, the efforts of federal, state, and local governments, as well as private land owners, must work in concert to protect our waterways from nonpoint pollution.

- **Maintaining Healthy Aquatic Systems**: Achieving and maintaining healthy aquatic systems was built into our statutory foundation for water management in the 1970s when the Clean Water Act made it a national goal to have "fishable" and "swimmable" waters. The term "fishable waters" implies a healthy aquatic habitat that supports fish. Additionally, the Clean Water Act declares that "[t]he objective of this Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters." To restore and maintain the biological integrity of our waterways, Congress intended that this federal water quality law protect healthy aquatic communities. So too, the Endangered Species Act was designed to protect both terrestrial and aquatic species.

  To obtain primacy for implementing the provisions of the Clean Water Act in Georgia, the Georgia Water Quality Control Act, first passed in the 1950s and amended in the 1960s, was again amended by the General Assembly to incorporate federal requirements for healthy aquatic systems. Thus maintaining the biological integrity of Georgia's waters was incorporated as a goal for the state. Although the Georgia General Assembly enacted the Georgia Endangered Wildlife Act and the Wildflower Preservation Act in 1973, these laws are much narrower in scope than the federal Endangered Species Act that, as noted above, does not have a primacy provision. Consequently, the goal to have healthy aquatic systems has been in place at the federal level and, to a lesser extent at the state level, since the 1970s. That goal has not changed.

  What has changed over the past few decades is our understanding of what is required to achieve that goal. In 1972, when the Clean Water Act was passed, it was anticipated that improving water quality would enable us to have healthy aquatic systems. Now, it is clear that we also must maintain sufficient stream flow—as well as flow patterns that mimic the natural flow regime—in order to maintain healthy communities of fish and other aquatic organisms.

The Supreme Court of the United States has determined that states have retained the authority to allocate water to users within their borders. The Georgia General Assembly enacted the Georgia Groundwater Use Act in 1972 and amended the Georgia Water Quality Control Act in 1977 to provide for a water allocation system that requires major water users to obtain water withdrawal permits from EPD. Before issuing a withdrawal permit, EPD evaluates water withdrawal permit applications to determine if the withdrawal will have an unacceptable adverse impact on the water resource or other water users.

For surface water withdrawals, EPD formerly used annual 7Q10 (e.g., the annual average of a stream segment's 7-day low flow, with a frequency of occurrence of once in ten years) as the standard with which to determine if, after a withdrawal, a sufficient amount of water would be left in the stream for instream uses. Through the 1990s strong scientific evidence was developed that annual 7Q10 was not a sufficient amount of water to maintain a healthy aquatic system. In 2001, the Board of Natural Resources adopted an interim instream flow policy designed to increase the amount of water remaining in streams—after withdrawals—for instream uses, but that change still may be insufficient. As our knowledge improves, new management actions may be necessary to meet our goals. We also may find it necessary to consider changing our goals to reflect our new knowledge.

- **Integrating Water Quality and Quantity Management**: As more water is withdrawn from streams and less is returned, the capacity of the streams to assimilate wastewater discharges decreases. There is simply less water available to dilute pollutants. Currently a number of streams and rivers in the state are above or approaching their limits for assimilating wastewater—not to mention limitations on their ability to meet off stream water demands for public supply, industrial uses, thermoelectric power production, and agricultural irrigation. Similarly, large withdrawals of ground water along the coast have allowed salt water to intrude into the aquifer upon which most coastal residents depend. Meeting our demands for water while ensuring sufficient water is left in the stream to meet instream needs and in the aquifer to maintain hydrologic balance is a significant challenge that will require greater coordination than we currently have.

- **Integrating Surface and Ground Water Management**: Flow in streams during drought periods comes largely from ground water. This is true throughout the state, but it is even more significant in karst areas where dissolvable bedrock (i.e., limestone, dolomite) is at or near the surface. In Georgia, this includes both the southwest and northwest portions of the state. In the lower Flint River basin, it has been estimated that—over an extended dry period—every gallon of water withdrawn from the Floridan Aquifer decreases the amount of ground water that

> seeps into streams by 0.6 gallons. This is a high irrigation region of the state, therefore, large withdrawals of ground water during dry periods may have a significant impact on the amount of water in streams. Similarly, large withdrawals of ground water along the coast have resulted in decreases in artesian pressure that reduces ground water discharge to wetlands and streams in portions of this area. To avoid surface water problems relating to inadequate flows, it is increasingly necessary to consider the potential impacts of ground water withdrawals on streams, lakes, and estuaries.

When water management values, statutes, rules or programs change in an uncoordinated fashion, there is an inevitable conflict between our goals/aspirations and the rules/policies/programs that seek to achieve them. Here in Georgia, "new values" have largely grown out of lessons we have learned: 1) by programmatically implementing "old" rules and policies; and 2) from vast leaps forward in the state of our knowledge regarding the physical, chemical, and biological functions of our water systems. Generally, we have addressed these conflicts between "old" programs and "new" values in an issue-by-issue, piece-meal fashion through the legislative process, followed by "fixes" to individual rules and programs. A more comprehensive approach is rarely an option due to the cost in time and resources.

A New Opportunity

An opportunity to comprehensively address water management concerns began with the creation of the Joint Comprehensive Water Plan Study Committee and the Water Plan Advisory Committee during the 2001 legislative session of the Georgia General Assembly. Legislation, based on this effort, was passed in the 2004 legislative session and reflects the most recent articulation of a water vision and guiding principles for water planning in the state. The General Assembly incorporated the study committee's overall vision for Georgia's water resources as the state water management goal in the Comprehensive State-wide Water Management Planning Act:

> Georgia manages water resources in a sustainable manner to support the state's economy, to protect public health and natural systems, and to enhance the quality of life for all citizens.

This vision encompasses the concept of sustainability that has never been articulated in earlier goals. It also recognizes the interrelationship of the economy, environmental quality, and quality of life.

Additionally, the study committee identified nine principles to guide the development of the state-wide comprehensive water management plan. These guiding principles were incorporated in the Act:

1. Effective water resources management protects public health, safety and welfare of Georgia's citizens.

2. Water resources are managed in a sustainable manner so that current and future generations have access to adequate supplies of quality water that supports both human needs and natural systems.

3. All citizens have a stewardship responsibility to conserve and protect the water resources of Georgia.

4. Water management efforts recognize that economic prosperity and environmental quality are interdependent.

5. Water quality and quantity and surface and ground water are interrelated and require integrated planning as well as reasonable and efficient use.

6. A comprehensive and accessible database is developed to provide sound scientific and economic information upon which effective water management decisions can be based.

7. Water resource management encourages local/regional innovation, implementation, adaptability and responsibility for watershed and river basin management.

8. Sound water resources management involves meaningful participation, coordination and cooperation among interested and affected stakeholders and citizens as well as all levels of governmental and other entities managing and/or utilizing water.

9. Periodic revisions of the plan are required to incorporate new scientific and policy insights, as well as changing social, economic, cultural, and environmental factors.

The General Assembly has thus created a framework for developing Georgia's first comprehensive state-wide water management plan by providing a vision/goal for water management and guiding principles for developing the plan.

The planning process must:

1. evaluate water trends and conditions to determine the types of challenges that we face now or will face in the future;

2. evaluate our legal/management structure (i.e., statutes, rules, programs, policies) to address those challenges;

3. identify gaps and other weaknesses in our water management approach; and

4. identify options for addressing these gaps and weaknesses and the benefits and drawbacks of each option.

The plan will initially focus on four interconnected water management objectives:

1. Minimize withdrawals of water by increasing water conservation, efficiency and reuse;

2. Maximize returns to the basin of origin by managing interbasin transfers, the use of on-site sewage disposal systems, and land application of treated wastewater where water quantity is limited;

3. Meet instream and off stream demands for water through efficient surface storage, aquifer management and reducing water demands (see number 1); and

4. Protect water quality by reducing pollutant loadings from discharges and runoff from the land to ensure the assimilative capacity of the streams is not exceeded and aquatic life is not impaired.

These policy objectives are complementary, with the overall goal to maximize the amount of water available for both humans and natural systems such that our water resources are sustained in a healthy balance within each river basin and aquifer. In order to achieve this goal, an overarching focus must be on preserving instream flows and ground water levels. Instream flow ranges should be protective of water quality, aquatic ecosystems, and the legal responsibility to provide adequate flows for downstream users. Ground water levels should be maintained to prevent salt water intrusion and adverse impacts to surface water flows and to sustain long-term use of the aquifer.

The first objective, to minimize withdrawals through conservation, efficiency, and reuse, will help reduce the need for increased water supplies as our population and water demands grow. Making better use of the available water is usually the least costly alternative for meeting water demands. Water conservation is certainly not a new concept, but its practice should be stressed in order to better meet both instream and offstream demands for water.

The second objective, to maximize returns to the basin of origin (and thus help maintain adequate instream flow in each river basin) focuses on reducing interbasin transfers and judiciously using septic tanks and land application of treated wastewater. Each of these may be useful water management tools, but without careful management, they may threaten the balance of water resources in the basin of origin. Interbasin transfers may be necessary and desirable in some instances, but the benefits to the importing basin must be weighed against the instream and offstream costs to the exporting basin. Septic tanks are important for protecting water quality in rural areas, however, as proliferation of septic tanks has accompanied sprawling suburban growth, how much of the residential water supply is being returned to its basin of origin? Finally, land application of treated wastewater can be beneficial if used to irrigate land where potable water might otherwise be used, but as a wastewater discharge tool, its benefits should be examined relative to the costs of direct discharges of treated wastewater.

The third objective, meeting offstream water needs during seasonal shortages while maintaining instream values, emphasizes the need to balance human water demands with the needs of aquatic systems. Reservoirs provide valuable water storage for municipal, agricultural, industrial, and commercial needs, but they come with monetary and environmental costs that must be considered. Ground water is often connected to surface water systems and must be managed to help preserve instream flows as well as to sustain ground water quality and quantity over time. Conjunctive use of surface water and ground water, such as aquifer recharge and aquifer storage and recovery (ASR), can provide seasonal and year-to-year storage options that should be weighed with other options in terms of storage utility and environmental integrity.

The fourth management objective, protecting water quality by reducing wastewater discharges and runoff from land to below the assimilative capacity of the streams, is related to the previous management objectives in that the greater the instream flow, the greater the assimilative capacity of streams. While the other management objectives focus generally on managing water quantity, which affects water quality, this objective focuses rather on mechanisms that can be used to reduce direct and indirect discharges.

As stated above, these management objectives are interrelated and need to be considered in a comprehensive manner. To do so will require that a variety of policy options be available and that, from these available options, the most appropriate ones be selected to address the water challenges unique to each river basin and aquifer in the state. The result will be that approaches may vary from region to region depending on water resources and demands, but that all regions will be consistent with the overall state water policy framework.

A series of four reports examines each of the management objectives in terms of current knowledge and policies adopted in other states. As we move through the planning process, policy options will be considered by various advisory committees and be presented at public meetings and made available on the Georgia Water Council's website (www.georgiawatercouncil.org). The intent is to distribute the information widely and to have as much feedback as possible so that the most effective water management options are identified for use in Georgia.

Meeting Instream and Offstream Needs

Sustainability of water resources is becoming an ever-increasing concern in many parts of the country, especially in metropolitan areas that are experiencing rapid population growth. The challenge of maintaining adequate supplies of high-quality water for both human uses and aquatic ecosystems will necessitate new ways of managing both water supply and water demands. By reducing demands through conservation, efficiency and reuse, sustaining water resources in basins of origin, making efforts to maintain clean water supplies, and providing for effective water management and storage such that demands may be met even during periods of low precipitation, Georgia will help ensure that future generations enjoy the benefits of plentiful, clean water.

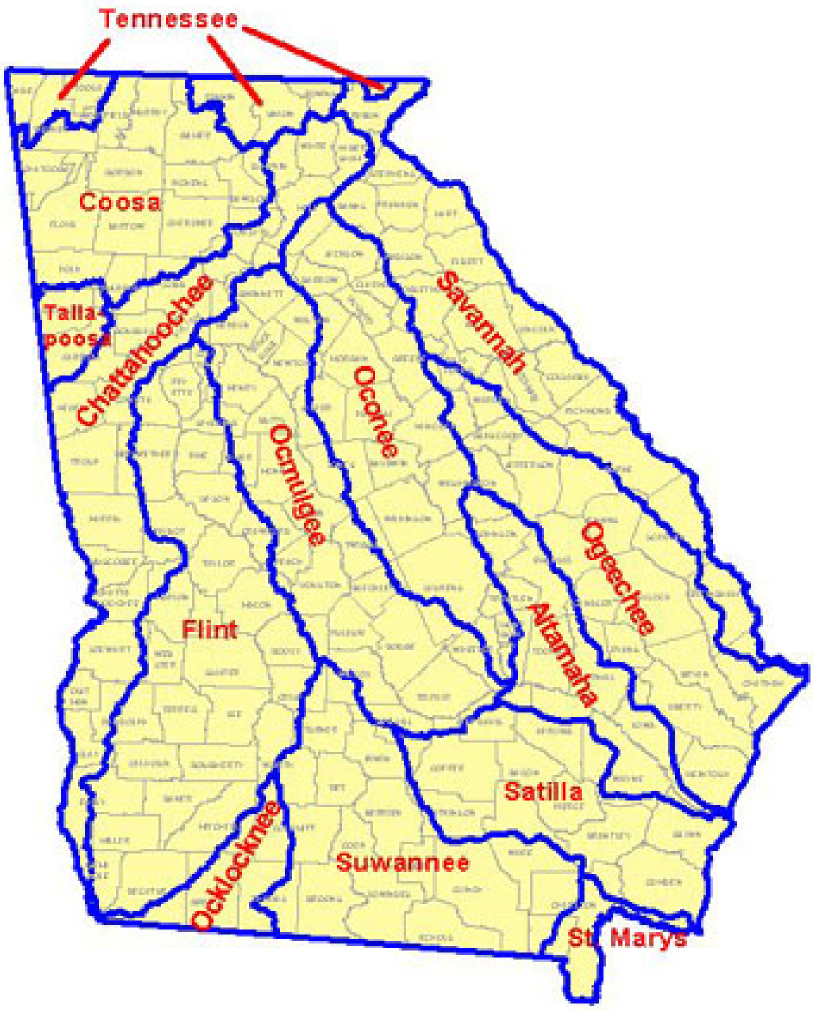
Georgia's precipitation, though abundant, does not necessarily occur where and when it is needed such that it meets the demands of both society and natural systems. This variability poses a significant challenge, especially when coupled with the increasing water demands projected in the coming years. Already, Georgia has experienced stresses related to water quantity: saltwater intrusion related to ground water pumping along the coast, decreased river flows that threaten both riverine and estuarine ecosystems, increased agricultural irrigation in Southwest Georgia that may affect ground water levels and river flow, and local water system stresses related to increased domestic water use during times of supply shortages.

As noted in the companion report, *Water Conservation, Reuse and Efficiency*, much can be accomplished by increasing the efficiency with which we use each gallon of water withdrawn from surface and ground water sources. Conservation is the first line of defense against future water crises, but as Georgia's population continues to increase, additional policies for long-term sustainable water provision must be in place to accommodate the associated increase in water demand. Given the overall abundance of water in the state, the issue of storage emerges as a central focus. How will it be possible to spread the water supplies over time and space such that human needs are met while natural systems are kept healthy and continue to provide crucial environmental services upon which we depend?

Georgia's Water Resources

Major rivers in Georgia originate within or along the state's boundaries, and the headwaters of many of the river basins are located in the Piedmont, where limited source water and population pressures contribute to drought vulnerability (Mohamoud, Draper). Georgia's 14 major river basins are the Altamaha, Chattahoochee, Coosa, Flint, Ochlockonee, Oconee, Ocmulgee, Ogeechee, Satilla, Savannah, St. Mary's, Suwanee, Tallapoosa, and Tennessee. (See Figure 1.) Because several of the rivers that originate in Georgia flow along or beyond our borders, interstate cooperation has become an important element in regional and state water planning.

Figure 1. Georgia's River Basins



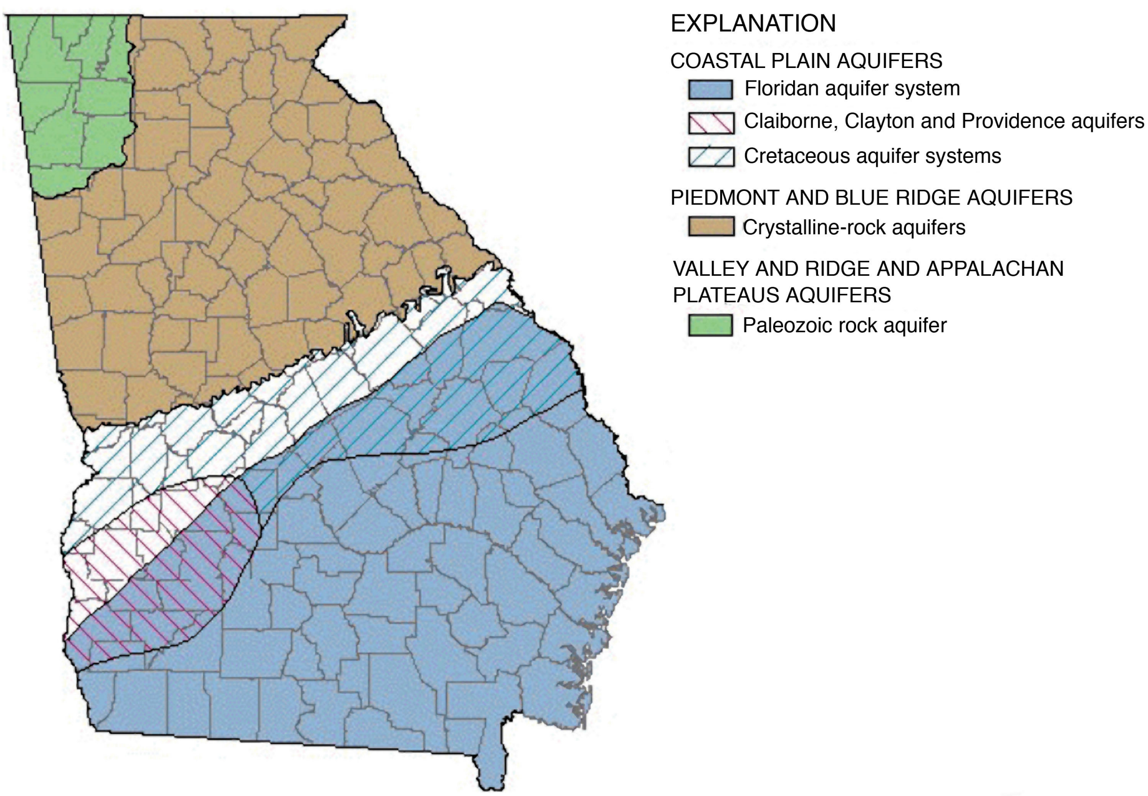
Source: Summit to the Sea Program, University of Georgia

Ground water has historically been managed less than surface water, largely because its quantities, movement, and other dynamics remained a mystery prior to modern monitoring and modeling techniques. Until evidence began to show the vulnerability of ground water quantity and quality, ground water withdrawals were tied directly to property and were generally taken for granted. However, ground water has several characteristics that make it uniquely valuable in terms of water management:

- Generally high quality;
- Large storage capacity; and
- Widespread availability.

Because of geological differences above and below the Fall Line, there are significant differences between these two general areas of the state in the amount of ground water available for human use. In the northern half of the state, wells typically produce from 12 to 15 gallons per minute (gpm), while in the southern half of the state, wells typically produce 1,000 to 1,200 gpm. (Oke 2003) Although there are relatively high producing wells in north Georgia, particularly in the Valley and Ridge province, the northern half of the state is generally dependent on surface water for most of its water supply, while the southern half of the state relies primarily on ground water.

Figure 2. Georgia's Aquifers



Source: U.S. Geological Survey

The Importance of Instream Flows

Free-flowing streams offer a number of ecological benefits that are often taken for granted in decision making processes that focus on providing water resources for municipal, agricultural, industrial, and thermoelectric uses. However, there has recently been dramatic growth in the economic analysis of environmental benefits and costs of water management options. (Westcoat et al., 2003, p. 231**)** These *ecosystem services* as well as other instream values provided by river systems are now commonly being considered in the water management decision-making process. Unfortunately, many of these services are difficult to quantify with precision, contributing to an overestimation or underestimation of their value.

Cowie et al. (2002) point out four major services provided by free-flowing streams:

1. Channel maintenance and sediment transport;

2. Waste assimilation and maintenance of water quality;

3. Habitat for diversity of aquatic animals; and

4. Maintenance of riparian zone function.

To this list could be added many cultural, recreational, and aesthetic values. Each of these services takes place along the entire reach of a stream or river and its tributaries. Additionally, each of these has a significant affect on conditions in estuaries. Without adequate stream flow, estuaries are deprived of fresh water and nutrients, affecting estuarine habitats and, in turn, the ocean food chain. Thus, the health of our coastal ecosystems and the seafood industry they support is dependent on the inflow of freshwater.

Surface Water Withdrawals

Streams, rivers, and lakes are important water sources for a variety of uses, but large withdrawal quantities may affect instream flows. Relatively small amounts of water withdrawn during periods of normal precipitation typically are of little consequence, while more significant withdrawals, especially during times of water shortage, can have far-reaching consequences, such as the following.

- Economic: Decline in fisheries – along the coast, there has been a general decline in crab, shrimp, and other shellfish populations in river and coastal estuaries that may be attributable at least in part to upstream water withdrawals (CDM 2001).

- Habitats and ecosystems: Reduced flows may have affects far downstream. Estuaries without adequate inflow of fresh water become increasingly saline, which causes changes in the types of species that can survive. Estuaries also may not receive adequate nutrients and sediments that provide the foundation for the estuarine food web and replenish coastal zones naturally eroded by wave action. Although research to date is inconclusive, it appears that the marsh grass dieback experienced in the coastal areas during the 1998-2002 drought was caused indirectly by increasing salinity associated with lower inputs of freshwater. (Alber et al. 2002)

- Water quality: Reduced flows result in a more concentrated load of pollutants in rivers and estuaries, potentially affecting human health.

- Recreational use: Reduced flows limit opportunities for boating, swimming, fishing, and other recreational activities.

Surface Water Storage

Reservoirs are constructed lakes designed to store water, usually created by damming a stream or river channel. Alternatively (and far less often), they may be constructed apart from a channel and are filled by runoff, ground water seepage, or pumping from surface or ground water sources. “Onstream” or “mainstem” reservoirs are impoundments on larger rivers, while “offstream” reservoirs are generally located apart from the channel. Reservoirs located on tributaries are often supplemented with water pumped from larger rivers. (Cowie, et al., 2002)

Reservoirs range from small farm and aesthetic ponds to large Corps of Engineers lakes. They serve a variety of important purposes, including flood control; water supply storage for municipal, industrial, and agricultural use; hydroelectricity production; navigation; water quality protection; and aesthetic and recreational use. Most reservoirs, even if constructed to fulfill one primary purpose, tend to serve multiple objectives.

Current reservoir planning in Georgia is generally in response to the need for additional water storage for use during times of drought and in anticipation of population increases. In general, a water supply reservoir in northern Georgia is designed to supply approximately 100 to 200 days of system demand. (Mathis, 2003)

The U. S. Environmental Protection Agency’s National Inventory of Dams, which includes dams larger than six feet in height, lists 4,436 dams in Georgia, the highest density of dams in the Southeast. (Cowie, 2002, Sutherland) With few natural lakes, however, Georgia has an estimated total of 68,000 to 70,000 reservoirs. Many of the smaller reservoirs—approximately 50,000—were constructed during the 1950s as part of a U.S. Department of Agriculture program to assist farmers in securing reliable water supplies. (Davis, 2003)

Pumped Storage

An option for increasing the yield of a reservoir is pumped storage. This is generally done for one of two reasons: for water supply or for increasing hydroelectric capacity. If a large stream flows near a reservoir of interest, water from that stream may be pumped into the reservoir during periods of adequate flow. Similarly, hydroelectric dams can, in some cases, pump water back into the reservoir from downstream during periods when electricity from the facility in not needed (or when electricity is cheap). This augments the flows that naturally drain into the reservoir and may eliminate the need for additional reservoirs in a given region.

Construction and Operation of Reservoirs

Because of the wide variety of social and environmental impacts of large dams, a general consensus has evolved that reservoir construction should be avoided if there is a better alternative for providing dependable water supplies. (Mathis, 2003) The nature and extent of their influence on river systems depends on the type, size, and location of reservoirs, the distance between them, the way they are managed (individually and as a system) in terms of water releases, and other factors. Construction and operation of reservoirs may result in the following changes.

- Reservoirs disrupt natural water level fluctuations, including flood events and low flows, and average flows are typically diminished by water withdrawals from reservoirs. This causes changes to aquatic habitats and to the ability of a stream or river to assimilate waste.

- Reservoirs disrupt sediment transport. This may have localized benefits (such as trapping sediments resulting from poor land practices upstream), but it generally results in habitat degradation, downstream erosion, and loss of property downstream.

- Continuous flows from headwater streams to estuaries are broken by dams, limiting migration of fish and other aquatic species to river segments between reservoirs. (When structural measures were taken to facilitate fish passage on the Snake River in the Pacific Northwest, they failed to prevent decline of endangered salmon stocks, leading to a conflict over decommissioning large upstream dams in the late 1990s. (Westcoat, et al., 2003, p. 179)

- By disturbing natural low flows and high flows, reservoirs alter the composition of downstream riparian zones. Floodplains deprived of the nutrients provided by flood waters become less fertile over time.

- Temperature, turbidity, and other water qualities of water downstream from a reservoir are different than in the water upstream of a reservoir, resulting in a less hospitable habitat for native aquatic species, which have adapted to the natural cycles and varying conditions of the river.

- Evaporative loss from reservoirs is greater than from free-flowing streams, resulting in a net loss of water from the river system.

- Native fish that depend on flowing water habitats cannot survive reservoir conditions, while fish stocked in reservoirs may prey on native species that adapt to the reservoir habitat.

- Reservoirs may have a secondary impact in that the additional water storage they provide encourages growth and development. This, in turn, may result in increased impervious surfaces that are associated with nonpoint pollution and stormwater management problems.

- Cumulative impacts have escalated as large dams have become part of comprehensive river basin development programs. Development of large dams and associated diversions and uses from the Colorado River has cumulatively increased salinity conditions in the lower basin and delta environments. (Westcoat, et al., 2003, p. 181) Similar salinity increases have been observed in the estuarine environments of the Georgia coast. (Alber)

The Nature of Ground Water

An aquifer can be defined as a water-bearing layer of permeable rock, sand, or gravel. Depending on its geologic composition and the size of its particles, fractures, or solution channels, an aquifer can store and transmit varying amounts of water. When an aquifer consists of sedimentary material such as sand, sandstone, or limestone, water passes through relatively quickly, whereas zones of clay and silt tend to restrict water movement and may serve as confining layers. Water may also pass through more consolidated material by way of cracks or channels. Aquifers are generally referred to as either “unconfined” or “confined,” depending on the ability of the aquifer to be recharged by the percolation of precipitation. Ground water movement is generally quite slow and ranges from less than one inch per year to many feet per day.

Ground Water Interactions and the Affects of Withdrawals

The interaction between ground water and surface water depends on the geological structure of the area. In some areas, ground water discharges into streams and rivers and can be solely responsible for surface flows during periods of low precipitation. (According to the American Groundwater Trust, 40 percent of all flow in U.S. rivers and streams originates as ground water.) In other areas, and at other times, streamflow may contribute to ground water resources. Where aquifers are confined by layers of impermeable rock or low-permeability materials, recharge may take place many miles away in “recharge zones” where permeable layers or cracks are exposed to surface water bodies or water that infiltrates from soil layers.

Ground water withdrawals in many parts of the United States and in parts of Georgia are threatened by withdrawals in excess of recharge rates. A number of problems can arise when this occurs, including land subsidence, reduced surface water flows and shrinking wetlands (and associated changes to aquatic ecosystems and ecosystem services), saltwater intrusion, and well pressure reduction.

Georgia’s Aquifers

Georgia’s aquifers are a complex system including the surficial aquifer system, the Floridan aquifer system, the Brunswick aquifer, the Southeastern Coastal Plain aquifer system, the Piedmont and Blue Ridge aquifers, and the Valley and Ridge and Appalacian aquifers. The system is dominated by the Floridan aquifer, underlying an area of about 100,000 square miles in South Carolina, Georgia, and Florida. Its occurrence in Georgia comprises much of the area below the Fall Line. The Floridan is one of the most productive aquifers in the world and supplies about four times as much water as the Biscayne, the second most used aquifer. (Campbell et al.)

The Floridan aquifer is composed of limestone and dolomite, carbonate rocks which dissolve easily when exposed to surface waters. Rainwater absorbs carbon dioxide as it passes through the atmosphere, which forms a weak acid called carbonic acid that dissolves the limestone and dolomite of the aquifer, creating enlarged pores and channels in the rock. If the sedimentary rock is near the land surface, this results in a topography referred to as "karst," characterized by sinkholes, caves, springs, and other features caused by dissolution. Where the Floridan aquifer lies close to the surface in areas of southwestern Georgia and central Florida, sinkholes and springs are common.

The Floridan aquifer is recharged along its upper edge in Georgia (which lies generally along the Fall Line), in the panhandle of Florida, and in two areas of northern and central Florida. Water in the aquifer is believed to flow southeastward in Georgia and South Carolina, south in the Florida panhandle, and in all directions from the recharge zones in central Florida. (Ibid)

Most of the Floridan aquifer can be divided into the Upper Floridan and the Lower Floridan. The Lower Floridan aquifer is separated from the Upper Floridan by a confining layer that varies in thickness, from a thin or absent confining layer to one of about 1000 feet thick. Where it exists, it restricts movement of water between the two zones. The Upper Floridan contains freshwater in Georgia, South Carolina, and most of Florida (along the Florida coast and below lake Okeechobee, it becomes more saline). The Lower Floridan aquifer contains water that ranges in salinity, but generally is more saline than the Upper Floridan. In southern Florida, it becomes brackish.

Other significant aquifers in Georgia include the following.

- The Cretaceous aquifer system of the Coastal Plain is a major source of water in the central part of the state, consisting of sand and gravel and confining layers of clay and silt that locally separate the aquifer into two or more aquifer formations. (Kundell, Tyson)

- The Upper and Lower Brunswick aquifers are located in the southeastern corner of the state. These intermediate aquifers are generally confined and although they are not a major source of water, they provide ground water in some of Georgia's coastal communities.

- The Claiborne aquifer is an important source of water in part of southwestern Georgia. Generally confined, it provides municipal water supplies for Dougherty, Crisp, and Dooly counties, as well as irrigation water. (Tyson)

- The Clayton aquifer is another important source of water for part of southwestern Georgia, providing water for municipal use, especially in Albany, and for irrigation. (Ibid)

- The surficial aquifer lies close to the surface and is generally recharged readily by rainwater.

- The Piedmont and Blue Ridge provinces, located in Georgia's Piedmont and mountains, consist of metamorphic rocks overlain by weathered materials including clay, rock, sand, and boulders. Here, water is stored in rock fractures and in the pore spaces and fractures in the weathered materials. Although quantities of water stored are relatively small, deep wells may produce substantial amounts of water. (Campbell et al. and Kundell)

- In the Valley and Ridge Province of Northwest Georgia, a complex geologic history has created layers of shale, slate, dolomite, limestone, quartzite, and sandstone. Of these, dolomite, limestone, and sandstone are the most water-bearing. Compression forces from the southeast led to a buckling of rock layers that resulted in significant variations of water yield from one location to another. (Kundell)

Meeting Instream and Offstream Needs: Opportunities and Challenges

The goal of this report is to provide an array of information offered by academic literature, state and federal guidance documents, and the experiences of other states, as applicable, to inform Georgia's comprehensive water management policy decisions. Georgia is one of the most rapidly growing states in the nation, and effective water management will be necessary to keep pace with that growth while maintaining water quality and sustaining natural systems. Water demands and water availability vary from one region of the state to another, however, and one-size-fits-all water management is not appropriate. In addition, new information is available regarding the importance of natural flow regimes, the cumulative effect of reservoirs, and the interactions between ground water and surface water, and this information should be considered in developing policy to sustain adequate water supplies for instream and offstream uses.

A number of policy questions relate to meeting offstream needs while maintaining instream values.

Instream Flow Policies

- What can the state do to move toward more protective minimum flows?

- How should the state define "protective flows?"

- Beyond minimum flows, how do other components of the flow regime support the values we attach to rivers and streams? What policy tools can be used to protect those components of flow?

Reservoir Policies

- Under what conditions should the State of Georgia support the use of reservoirs and for what hydrologic, environmental, or water resource purposes?

- Under what conditions should the state financially support the construction of reservoirs?

Ground Water Withdrawal Management

- How should the State respond when trends show that a ground water resource is stressed?

Conjunctive Use Policies

- Under what conditions are tools such as aquifer recharge and aquifer storage and recovery reasonable options for increasing the availability of water?

Chapter 2

TRENDS IN INSTREAM FLOW AND RESERVOIR SCIENCE AND POLICY

Instream flow is essentially the amount of free-flowing water in a river or stream. Adequate flow is needed to support the hydraulic and geomorphic structure of rivers and streams, to assimilate wastes, and to sustain aquatic habitats. Instream flow protection is closely related to reservoir management because water stored in and withdrawn from reservoirs directly affects downstream flows. As we develop new water management policies, they should reflect our increasing knowledge of the importance of maintaining natural flow regimes and the affects of reservoirs, individually and cumulatively, on river systems.

For the purpose of this report, policy for protecting instream flows and for managing reservoir releases is examined separately, where possible, from policies regarding the construction and placement of regional water supply reservoirs. In some instances, however, there is a degree of redundancy between these two aspects of surface water management because of their interrelated nature. The policy questions related to these topics are the following:

- What can the state do to move toward more protective minimum flows?

- Beyond minimum flows, what components of the flow regime support the values we attach to rivers and streams? What policy tools can be used to protect those components of flow?

- Under what conditions should the State of Georgia support the use of reservoirs and for what hydrologic, environmental, or water resource purposes?

- Under what conditions should the state financially support the construction of reservoirs?

Instream Flow Trends and Policy Principles

Although instream flow science is a relatively young discipline, the needs of natural systems in terms of stream flow have become better understood in recent years due to advances in flow assessment and modeling techniques. The field has also become increasingly interdisciplinary as biologists, ecologists, hydrologists, water resource managers, and policy makers have recognized the need for greater integration and cooperation. Many states have now adopted policies that limit water withdrawals in the interest of upholding the goals of protecting the physical, chemical, and biological integrity of rivers and streams, established by the Clean Water Act and other legislation.

The “assimilative capacity” refers to the amount of pollution and/or nutrients that a stream or river can receive while meeting water quality standards and without causing harm to aquatic habitats. The assimilative capacity is related to the amount of water in a stream, as well as the temperature and dissolved oxygen content. In general, the greater the quantity of water, the greater the dilution of wastes. The Total Maximum Daily Load (TMDL), the maximum amount of a pollutant a water body can contain without violating water quality standards, is based in large part on the amount of water available to assimilate wastes.

Until recently, the focus of instream flow policy has been on maintaining a minimum base flow that allows streams to assimilate waste, typically based on such parameters as the 7Q10, or the lowest continuous flow over a 7-day period that is expected to occur within a 10-year interval. Research conducted since the early 1990s has illuminated the importance of maintaining a more natural flow regime that includes higher flows and flood events as well as seasonal and annual variations in magnitude. The focus has also shifted from protection of a small number of threatened or endangered species to protection of entire ecosystem functions, including stream channel and floodplain dynamics.

The basic question remains, “How do flow patterns and amounts of flow at different times relate to the ability of a river to maintain healthy biotic systems, good water quality, and intact ecosystem functions while meeting human needs such as public supply, irrigation, recreation, and hydropower generation?”

The term “safe yield,” sometimes referred to as “sustainable yield,” was originally coined to apply to ground water. The American Water Works Association (AWWA) defines the safe yield of a well as the amount of water which can be withdrawn annually from a ground water system without producing undesired results such as permanent lowering of the water level. (Grigg, p.427) The term has increasingly been used to apply to surface water withdrawals, yet no formal definition encompasses all types of surface water use. If used to apply to diversion from a river or stream, safe yield depends on whether instream flow requirements have been established. If used to apply to withdrawals from a reservoir, it depends on the amount of storage available in the reservoir. In a handbook of drought management, the AWWA defined safe yield for a reservoir as the amount of water that can be withdrawn from storage in a specified interval of time (usually during a dry period or drought). (Ibid) The concept of safe yield might also be applied to an entire system of streams and reservoirs. Water managers must take care in its application because definitions of safe yield can potentially ignore interactions between surface and ground water and among existing withdrawals.

A report released by the National Research Council of the National Academies in 2005, *The Science of Instream Flows: A Review of the Texas Instream Flow Program*, includes a useful description of current trends and principles of a “state-of-the-art” instream flow program.

> State-of-the-art instream flow programs will strive to preserve whole ecosystems, mimic natural flow regimes, include riparian and floodplain systems in addition to the stream channel, take an interdisciplinary approach, use a variety of tools and approaches in technical evaluations, practice adaptive management, and involve stakeholders. [An effective] instream flow program will encompass technical evaluations in biology, hydrology and hydraulics, physical processes, water quality, connectivity, and non-technical aspects of stakeholder involvement and goal setting.

The authors enumerate seven principles of instream flow programs, based on components from the Instream Flow Council's Instream Flows for Riverine Resource Stewardship (2002) and Postel and Richter (2003).

1. Preserve whole functioning ecosystems rather than focus on single species.

2. Mimic, to the greatest extent possible, the natural flow regime, including seasonal and inter-annual variability.

3. Expand the spatial scope of instream flow studies beyond the river channel to include the riparian corridor and floodplain systems.

4. Conduct studies using an interdisciplinary approach. Instream flow studies need hydrologists, biologists, geomorphologists, and water quality experts all working together. Experts can come from academia, public, and private sectors.

5. Use reconnaissance information to guide choices from among a variety of tools and approaches for technical evaluations in particular river systems.

6. Practice adaptive management, an approach for recommending adjustments to operational plans in the event that objectives are not being achieved.

7. Involve stakeholders in the process.

The authors also point out that the inclusion of both technical and non-technical components are important for avoiding untenable situations. "The most scientifically valid instream flow recommendations will not be implemented if it violates a permitting process, is out of compliance with water quality regulation, or lacks public support in the river basin."

Lamb (1995) offers guidance for the development of a state-wide instream flow program in *Criteria for Evaluating State Instream-Flow Programs: Deciding What Works,* According to Lamb, an instream flow program should be evaluated in terms of five basic elements: public confidence, certainty, proper administration, expense, and outcome.

- *Public confidence*, essentially the belief that the instream flow program will achieve desired results, is heightened by public awareness and involvement in the process.

- *Certainty* entails whether the instream use is guaranteed over a long period of time or if protection is fleeting. A successful instream flow program establishes clear and infrequently imposed conditions under which streamflow protection will be altered.

- *Proper administration* means that the goals and measures of an instream flow protection program are clearly delineated. Administrative rules are especially important in the absence of clear statutory guidelines. "Without such guidelines, agencies are likely to encounter conflicts over purpose while lacking the tools to make necessary judgments. The conflict has been described as a competition between established out-of-stream and instream uses that will result in legal challenges and political battles."

- The *expense* of protecting instream flows depends on the complexity of a state's instream flow issues. "In water-rich states where there is little controversy, the outlays may be minimal because streamflow standards can be established using a relatively inexpensive methodology, such as a percentage of the annual hydrograph." Three methods are identified for determining how much spending is appropriate for a state program:

    - cost comparison with other states;

    - percentage of the water administration budget; and

    - cost per unit length of protected stream.

  A combination of approaches is recommended, including the cost per unit length of protected stream method along with one of the other methods.

- *Outcome* answers the question, "How are things down on the creek?" An effective program may protect stream integrity in terms of habitat, recreational use, and preserving flows for downstream use. This can be measured in a variety of ways, including stream miles protected, number of stream segments protected, percentage of total stream miles protected, and percentage of flows remaining in stream.

Approaches for Maintaining Adequate Flows

Maintaining minimum flow levels is vital to sustaining aquatic ecosystems and water quality, yet variability of flows has been recognized as another necessary component. Reservoir managers are increasingly being called upon to regulate releases from dams in a way that more closely approximates the river's natural flow regime. The current challenge facing scientists and water managers is to determine more precisely how much water can be removed from any given stream, and with what timing, without having adverse impacts on both water quality and aquatic and riparian ecosystem functions.

A number of approaches have been developed for determining adequate flow levels, which Freeman (2005) places into one of three basic categories: standard-setting, incremental, or hydrologic variability. Standard-setting approaches establish minimum flows intended to protect one or more biological functions in streams. Incremental approaches use analysis of one or more instream variables in relation to flow to assess alternative flow management scenarios. Hydrologic variability uses daily flow records to characterize natural variation and prescribes river flow targets that protect natural levels of variability within these parameters.[1] According to Freeman, "no single method of setting flow requirements is likely to address adequately the flow needs for ecological sustainability balanced with human uses. Combinations of approaches tailored to meet the issues in specific stream systems may provide workable, scientifically supportable approaches."

Instream Flow Methodologies Developed by Federal Agencies

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) published the Interim Regional Policy for New England Stream Flow in 1981 to help establish guidelines for "aquatic base flows." Much progress has been made since its publication regarding the science of instream flows; nevertheless, the document provides useful information. In it, the USFWS recommended an evaluation of the minimum chemical, physical, and biological conditions required to support aquatic life and wildlife in stream environments, and recommended specified season-specific base flows for New England states. The FWS does not have the authority to require these levels, but their recommendations can be used by state authorities when reviewing water resource development projects in the New England area." (CDM 2001) Similar guidelines may be useful for establishing flow regimes in Georgia.

Federal Laws and Regulations Related to Instream Flows and Reservoirs

The National Environmental Policy Act of 1969 (NEPA) and its implementing regulations require federal agencies to evaluate the potential impacts of proposed federal projects that are likely to result in direct, indirect, or cumulative impacts to the environment. Through either an Environmental Impact Statement or an Environmental Assessment, proposals for legislation and other major Federal actions affecting the

[1] For an assessment of these approaches and a description of specific methods of deriving instream flow requirements, please see Freeman's "Some Pros and Cons of Alternative Methods of Defining Instream Flow Requirements," published in the *Proceedings of the 2005 Georgia Water Resources Conference*, Volume I, 2005.

quality of the environment must be accompanied by a detailed statement by the responsible official, which include the following:

- The environmental impact of the proposed action;
- Any adverse environmental effects which cannot be avoided should the proposal be implemented;
- Alternatives to the proposed action;
- The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
- Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Included under NEPA are federal agency projects as well as projects that require permitting or significant funding by a federal agency. However, many projects that affect stream flow are not covered under NEPA, particularly those that entail cumulative impacts. Cumulative ecological impacts are assessed only on stream and river projects that require federal permits, such as those related to the Clean Water Act or the Rivers and Harbors Act (see requirements below), and effectively include only large projects that discharge dredged or fill material into waters of the nation. (Davis 2003) Agricultural and silvicultural activities are exempt from environmental impact assessments, and in practice, small projects do not undergo assessments (Ibid).

The Clean Water Act (CWA) contains several provisions that relate to stream flow, including Section 313, which requires states to establish water quality standards to be approved by the U.S. Environmental Protection Agency (USEPA). These standards consist of assigning a designated use for each waterway, along with criteria for meeting that designated use. The Supreme Court has ruled (P.U.D. No. 1 of *Jefferson County v. Washington Department of Ecology*, 511 U.S. 700, 1994) that states may include minimum instream flow requirements in a certification issued under Section 401 of the Clean Water Act (water quality certification) to the extent that they are necessary to enforce a designated use contained in a state water quality standard. (Howett and Rogers 2003)

Regarding reservoir construction, CWA Section 404 contains requirements for the disposal of dredge or fill material into "waters of the U.S.," which is synonymous with "navigable waters" and includes adjacent wetlands. Such activities are not prohibited by Section 404, but require a permit from the Corps of Engineers. Permitting requirements include avoidance, reduction, and mitigation measures. The Act also requires that water supply reservoir projects must include needs documentation with an associated population forecast. Efficient water use and effective water conservation measures are assumed to be in place. (Bernstein et al. 2003)

The Rivers and Harbors Act of 1899, Section 9, states that it is unlawful to construct a dam, bridge, dike, or causeway across any navigable water of the U.S. without Congressional consent and approval of plans by the Chief of Engineers and the Secretary of the Army. Where the structure would be built across waterways that lie wholly within a single state, the legislature of that state may approve its construction after approval by the Chief of Engineers and the Secretary of the Army.

The Federal Power Act of 1920 authorizes the Federal Energy Regulatory Agency (FERC) to issue licenses for the construction, operation, and maintenance of dams, reservoirs, and other structures included in hydropower projects. Where such structures affect the navigability of waters of the U.S., however, approval is required by the Chief of Engineers and the Secretary of the Army. The Act also assigns responsibility to the USFWS to review the environmental impacts of hydropower projects that require a license from the Federal Energy Regulatory Commission (FERC), and authorizes USFWS to provide requirements for fish passage and make other recommendations for protection and enhancement of wildlife resources. Such requirements and recommendations result in conditions that FERC includes in hydropower licenses. (USFWS, 2005) (See description of FERC licensing requirements, below.)

The Dam Safety and Security Act of 2002, addresses dam safety and security by giving the Federal Emergency Management Agency (FEMA) authority for coordinating federal programs and initiatives for dams and the transfer of federal best practices in dam security to the states. Included in the Act are provisions for the development and maintenance of a national dam safety information network and the development of a strategic plan that establishes goals, priorities, and target dates to improve the safety and security of dams in the United States. This Act continues activities of the National Dam Safety Program, established by the Water Resources and Development Act of 1996, including grants to the state dam safety programs; training for state dam safety staff and inspectors; and technical and archival research.

The Endangered Species Act (ESA) protects federally designated threatened and endangered species, along with any habitat deemed necessary for their survival. Section 7 of the ESA requires federal agencies to consult with the USFWS or the National Marine Fisheries Service (NMFS) if their activities jeopardize the existence of an endangered or threatened species or its critical habitat. This section applies only to federal actions, thus if there is no federal actor, this section does not apply. It also applies to *proposed actions* and not to existing structures or activities that may jeopardize species habitat.

Section 9 of the ESA prohibits the “take” of an endangered species. “Take” is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.” Section 9 and its implementing regulations define a taking to include disrupting normal behavioral patterns and modifying or degrading habitat such that it results in killing or injuring endangered wildlife. According to the NMFS, this can occur by removing water or altering stream flow to the extent that it “impairs spawning, migration, feeding or other essential behavior patterns.” (Ibid.)

Unlike Section 7, which applies only to federal agencies, Section 9 applies to any actors and to existing activities and facilities.

The Fish and Wildlife Act of 1956 and the Fish and Wildlife Coordination Act of 1934 also express the will of Congress to protect the quality of the aquatic environment. Any federal agency that proposes to control or modify any body of water must first consult with the USFWS or the NMFS, as appropriate. The Fish and Wildlife Coordination Act seeks to protect and propagate game and fur-bearing animals, including important aquatic species. Amendments passed in 1946 to prevent the loss of wildlife resources, required consultation of the FWS and state fish and wildlife agencies for any proposed water impoundment or diversion by a public or private agency under federal permit or license.

The Wild and Scenic Rivers Act of 1968 established the National Wild and Scenic Rivers System in order to preserve the nation's "outstandingly remarkable, freeflowing rivers." Section 7(a), requires that no federal department or agency may provide financial assistance, license, or otherwise assist in the construction of a water resources project that would have a direct and adverse impact on the values established for that river.

Federal Permitting Requirements for Reservoirs

The U.S. Army Corps of Engineers (USACOE) permitting is required for the construction of a dike or dam in a navigable water of the U.S., pursuant to Section 404 of the Clean Water Act, Section 9 of the Rivers and Harbors Act of 1899, and federal permitting regulations (33 CFR Parts 320, 323, and 325). The term "navigable waters of the U.S." means those waters of the U.S. that are subject to the ebb and flow of the tide shoreward to the mean high water mark and/or are presently used, or have been used in the past, or may be susceptible to use to transport interstate or foreign commerce. The term "dike or dam" means, for the purpose of Section 9, any impoundment structure that completely spans a navigable water of the U.S. and that may obstruct interstate waterborne commerce.

The Assistant Secretary of the Army (Civil Works) decides whether an authorization for a dam or dike will be issued for an interstate navigable waterway, with consideration of recommendations by the district engineer for conditions to be imposed on the instrument of authorization. For intrastate dams and dikes, district engineers are authorized to decide whether an authorization will be issued. When making recommendations or authorization decisions, the district engineer considers comments received in response to a public notice, environmental documentation required under NEPA, and will possibly conduct a public meeting. Final approval for permitting is required under Section 9 of the Rivers and Harbors Act of 1899: Congressional approval is required to issue permits for such projects on interstate waterways, and appropriate state legislative approval is required for those on intrastate waterways. (33 CFR Part 321)

Permit applications for dam or dike construction must contain detailed descriptions of activities that include dredging and discharge of dredged or fill materials into the waters of the U.S. or transport for discharge into ocean waters. If the activity involves the construction of an impoundment structure, the applicant may be required to demonstrate compliance with dam safety criteria or that the structure has been designed and reviewed by qualified professionals. Depending on the nature and location of the project, the district engineer may require water quality certification (under Section 401 of the Clean Water Act), and/or consistency with the Coastal Zone Management Act, the National Historic Preservation Act, the Endangered Species Act, and coordination with state or federal entities as appropriate.

Types of permits issued for USACOE projects take a variety of forms. Individual (standard) permits are issued for specific projects or, for projects expected to have minor individual or cumulative impacts on the environment, letters of permission may be issued. General permits may be issued to allow a specific type of activity to take place over a period of time if certain conditions are met. General permits may be regional or national and are in effect until they automatically expire or are modified, suspended, or revoked.

The Federal Energy Regulatory Commission (FERC) is an independent agency that, among other energy-related responsibilities, regulates non-federal hydropower dams in the U.S. by issuing licenses and relicensing existing projects. The licensing process includes consulting with stakeholders, identifying environmental issues, and preparing environmental documents such as Environmental Assessments or Environmental Impact Statements. The traditional FERC licensing process takes place in two stages: the applicant's pre-filing process, which includes holding a public meeting, consulting with federal and state agencies, and conducting relevant scientific and economic studies; and the application process, which includes formal environmental scoping and issuance of the Environmental Assessment or Environmental Impact Statement. (The latter is required for large and complex projects). These reports must be in compliance with NEPA. The Commission then makes a decision on whether the proposed project is in the public interest, and the license generally includes conditions designed to ensure public safety and environmental protection. FERC also inspects the construction and maintenance of hydropower projects for the term of their license.

The **Tennessee Valley Authority (TVA)** built a number of reservoirs in the southeast, mainly for flood control, including two in Georgia: the Nottely and the Blue Ridge reservoir. The last reservoir to be constructed by TVA was in 1980, and there are presently no plans to augment the existing reservoirs. (Poppe)

The **Natural Resources Conservation Service (NRCS)** has provided technical assistance and helped finance the construction of many small lakes and farm ponds. These ponds are exempt from Section 404 permitting requirements under most common conditions pursuant to the Clean Water Act (§404 (f)(1)). (Brown)

Instream Flow Policy in Other States

Many states have or are in the process of developing some form of instream flow protection. The following states were chosen because their programs had characteristics that provide particularly useful policies and practices for Georgia to consider. The presentation of state programs and policies is not meant to be all-inclusive, as states other than these may employ useful instream flow policies as well.

Florida

Florida's general water supply policies include the promotion of water conservation, demand management, reuse, and the use of water of the lowest acceptable quality for the purpose intended; development of local and regional water resources that avoid water transfers across district boundaries; the use of water from sources nearest the area of use or application; protection of existing and future water supply area; and development of alternative water supplies, including reuse and stormwater and industrial wastewater recycling, desalination, aquifer recharge, and aquifer storage and recovery.

Minimum flows and levels (MFLs) are required by Florida Statutes and adopted as rules (Chapter 40C-8, Florida Administrative Code) by Florida's five water management districts. Minimum flows and levels apply to decisions affecting water withdrawal permit applications, declarations of water shortages, and assessments of water supply sources. Within specified sections, or for the water management district as a whole, the Department of Environmental Protection (FDEP) or the water management district establishes minimum flows for all surface watercourses and minimum levels for ground water and for surface water (which may include lakes, wetlands, and estuaries). Florida Administrative Code makes no reference to thresholds regarding size of water bodies in terms of minimum flows and levels.

Each year, water management districts are required to submit to FDEP for review and approval a priority list and schedule for the establishment of minimum flows and level within the district. The priority list is based on the importance of the waters to the state or region and the existence of or potential for significant harm to the water resources or the ecology of the state or region. All scientific and technical data used to establish minimum flows and levels is subject to independent scientific peer review.

Minimum flows and levels are expressed as multiple flows or levels defining a minimum hydrologic regime, unless reservations implemented to protect fish and wildlife or public health and safety provide equivalent or greater protection. Statutory language also requires that if the existing flow or level is below, or is projected to fall within 20 years below, the established MFL, FDEP or the Governing Board of the water management district must "expeditiously implement a recovery or prevention strategy" which includes the development of additional water supplies and other actions.

Although water management districts are required to establish instream flows and levels for each water body, Florida's instream flow policy allows for exclusions in the establishment of instream flows, embodied in the following statutory language:

> The Legislature recognizes that certain water bodies no longer serve their historical hydrologic functions. The Legislature also recognizes that recovery of these water bodies to historical hydrologic conditions may not be economically or technically feasible, and that such recovery could cause adverse environmental or hydrologic impacts. (F.S. 373.0421 (1)(b)

St. John's River Water Management District

Because Florida's water management relies significantly on work done through its five water management districts, it is instructive to include district policies as well as state-wide policies. In the St. John's River Water Management District, which lies in the northeast area of the state, minimum flows reflect a temporal hydrologic regime that will prevent harm to water resources or ecology. Flows are categorized as:

- Minimum infrequent high (associated with flooding);
- Minimum frequent high;
- Minimum average;
- Minimum frequent low;
- Phased restrictions (at which a water shortage is declared); and
- Minimum infrequent low (as experienced during extreme drought).

In establishing minimum surface water levels and flows, specific numerical values are established for each water body and for each regime type above, including water level (in feet), flow (in cubic feet per second), duration (in days), and return interval (in years).

As of 2005, three of the five water management districts (South Florida WMD, St. John's River WMD, and Southwest Florida WMD) have adopted specific minimum flows and levels. All of the water management districts have scheduled the establishment of minimum flows and levels.

Massachusetts

The Water Management Act authorizes the Department of Environmental Protection (MDEP) to determine safe yield by a water source. Safe yield has been defined by Massachusetts as the volume of water that can be removed from a surface water or ground water source without unreasonable damage to the water resource. Recent research has offered improved guidance on instream flow needs, and the MDEP has adopted more restrictive guidelines than first adopted in 1986. In 2004, MDEP adopted the Water Management Permitting Policy, which increased standards and demand management controls for new permits. New permits, as well as modified or renewed permits, must now meet specific conditions for per-capita water use, limits on unaccounted-for water, summer limits on withdrawals, streamflow thresholds that trigger mandatory limits on nonessential outdoor water use, reporting requirements, and streamflow monitoring.

New Hampshire

The New Hampshire Department of Environmental Services (NHDES) has the responsibility and authority to maintain flow to support instream public uses in 14 rivers designated by the Rivers Management and Protection Act (RSA 483), enacted in 1990.

Twelve years later, in 2002, the New Hampshire legislature enacted legislation (Chapter 278, Laws of 2002) that calls for a pilot program for instream flows on two of the 14 designated rivers: the Souhegan River and the Lamprey River. Both of these pilot projects have been funded, and management plans for the rivers are to take effect no later than October 1, 2007.

In May, 2003, in order to provide structure to the pilot programs and future instream flow protection, NHDES adopted Instream Flow Rules (ISFRs) (Chapter Env-Ws 1900). These specify standards, criteria, and procedures by which a protected minimum instream flow will be established and enforced. The first step under the program is an instream flow study that identifies and catalogs stream resources and instream public uses and identifies appropriate methods to establish recommended instream flow levels. Based on documents, reports, studies, and instream surveys, NHDES prepares a recommended scientifically-based protected instream flow, subject to public notice, hearing and comment. Once a protected instream flow is established, NHDES is required to prepare a Water Management Plan, which includes a conservation plan, a water use plan, and a dam management plan.

North Carolina

Instream flows are regulated in North Carolina in several ways: through dam construction and management regulations, the Capacity Use program, and public water supply permitting.

Under the Dam Safety Act, minimum releases are required for both large and small hydroelectric projects. Permits issued by the Department of Environment and Natural Resources (NCDENR) are predicated on site-specific stream flow studies, and instream flow monitoring is generally required for both water withdrawals and dam releases. Minimum flows on stream reaches affected by dams are based on mean annual daily flow, 7Q10, habitat designation, hydrologic characteristics, and other factors. Results of the process yield one of the following release requirements:

- No minimum release from dam is required;

- Minimum release should be equal to the 7Q10 of the stream;
- Minimum release is determined from regression equations provided in the statute; or
- Minimum release is determined by site-specific study.

Another important regulatory tool is the Water Use Act of 1967, which allows the Environmental Management Commission to establish and regulate water withdrawals in Capacity Use Areas (CUAs) where aggregate uses of surface water or ground water threaten the sustainability of the resources or where water use in an area requires coordination to protect the public interest. (N.C. Statute § 143-215.11 et seq.) Within Capacity Use Areas, ground water withdrawals of more than 100,000 gallons per day require a permit from the Division of Water Resources, and surface water or ground water withdrawals of more than 10,000 gallons per day require annual registration.

For construction of new public water supply facilities or withdrawal increases of more than 1.0 million gallons per day, the Public Water Supply Section of the N.C. Division of Environmental Health requires an Environmental Assessment and Finding of No Significant Impact. Specific to instream flows related to hydroelectricity production, a Certificate of Public Convenience and Necessity must be issued by the North Carolina Utilities Commission prior to the construction of a hydroelectric generating plant.

Oregon

Oregon's instream flow regulations are among the oldest in the nation. In 1955, the legislature passed the Minimum Perennial Streamflow Act, which authorized the Oregon Water Resources Board (now divided into the Water Resources Commission and the Water Resources Department) to establish minimum streamflows sufficient to support aquatic life and minimize pollution. Research done during the 1960s produced a series of reports that made recommendations for instream flows needed to support salmon populations. However, most of the protection afforded by the Act was for major rivers and larger streams, and smaller streams were left with little or no protection. Adopted flow levels were later found to be inadequate, as well, especially during summer months when demands are high and flows are critical for fish.

The Instream Water Rights Act was enacted in 1987 to supplement the perennial flow law. It allows water flowing in a river to be protected by an "instream water right," equal in standing to water rights for irrigation and development. The state holds these rights in public trust so that the instream rights cannot be supplanted by new rights. New out-of-stream water uses may be approved only when there is more water in the stream than is already allocated to existing water rights. With Water Resources Board approval, water may also be reserved by a state agency for future economic development needs.

Related to the Instream Water Rights Act, Oregon's Instream Leasing Program provides a mechanism for voluntary allocations to instream use. Water users may lease their water rights to instream use for up to five years, and may renew leases an unlimited number of times. This arrangement benefits water rights holders that may be at risk of forfeiting their water rights due to non-use. Leases may be individual or pooled (for instance, by several landowners within an irrigation district), and may be split-season leases such that water is used for its authorized purpose for part of the year and for instream use during another part of the same year. A portion of the water right can otherwise be leased only if it can be defined as a portion that irrigates a distinct tract of land. A water user cannot simply use less water than usual and lease the remainder.

The State Scenic Waterway Act, designed to protect instream flows in certain rivers, mandates that the highest and best use of water in designated rivers is to provide for fish, wildlife, and recreation. Rather than attempt to turn back time, the Act recognizes and permits most existing uses so that status quo is maintained. The only specific activity prohibited by the Act is the construction of dams for the development of impoundments.

Oregon's Allocation of Conserved Water Program, authorized by statute in 1987, allows a water user who conserves water to use a portion of the conserved water on additional lands, lease or sell the water, or dedicate the water to instream use. The law requires at least a portion (25 percent) of the conserved water to be reserved for instream use.

Texas

In 1997, Senate Bill 1, commonly referred to as the "Water Bill," established a state water planning process in Texas and set the stage for instream flow provisions. The first state plan, based largely on regional plans, was completed in 2002. Senate Bill 2, passed in 2001, in part amended § 16.059 of the Texas Water Code to include specific provisions for instream flow data collection and evaluation. The latter legislation directs the Texas Commission on Environmental Quality, the Texas Water Development Board, and the Texas Parks and Wildlife Department, in cooperation with other appropriate governmental agencies, to "jointly establish and continuously maintain an instream flow data collection and evaluation program." It also requires the agencies to "conduct studies and analyses to determine appropriate methodologies for determining flow conditions in the state's rivers and streams necessary to support a sound ecological environment."

In October 2002, the three agencies signed a Memorandum of Agreement (MOA) to define a procedure for the completion of instream flow studies and called for a Programmatic Work Plan which was finalized in December 2002. Six priority study sites were identified by the agencies, and instream flow studies at these priority sites are to be completed by December 31, 2010.

Texas Statutes also require that specific quantities of water be reserved for instream use and for release to bays and estuaries, applicable to reservoirs on which construction began after September 1, 1985.

> Five percent of the annual firm yield of water in any reservoir and associated works constructed with state financial participation under this chapter within 200 river miles from the coast, and to commence from the mouth of the river thence inland, is appropriated to the Parks and Wildlife Department for use to make releases to bays and estuaries and for instream uses, and the commission [on Environmental Quality] shall issue permits for this water to the Parks and Wildlife Department under procedures adopted by the commission. (Texas Statutes § 16.1331)

The Commission on Environmental Quality may also require the Water Development Board to pay the amount necessary for all maintenance and operating costs associated with storage and release of water appropriated for the health of any bay or estuary system. (Texas Statutes § 16.1341)

Virginia

Virginia's Surface Water Management Act of 1989 establishes authority for the State Water Control Board to designate surface water management areas. The Board may, at its own discretion or upon petition by a city, county, town, or any state agency, initiate the designation of a surface water management area if there is evidence to indicate that a stream has substantial instream values, low flows threaten important instream uses, or if current or potential offstream uses are likely to exacerbate low flow conditions to the detriment of instream values.

Within surface water management areas, water withdrawal permits are required, with certain exceptions, for any consumptive use of water in excess of 300,000 gallons in any single month that commenced after July 1, 1989. (Code of Virginia § 62.1-243) Permit conditions may include maximum amounts that may be withdrawn, times of the day or year during which withdrawals may occur, and requirements for voluntary and mandatory conservation measures.

In addition, in authorizing permits, the Board is required to prioritize among types of users: Class I (domestic, including public water supply), Class II (new uses, not existing as of July 1, 1989, including instream uses such as habitat protection, waste assimilation, and offstream uses such as agriculture, power generation, and commercial and industrial uses), and Class III (new uses including recreation, navigation, and cultural and aesthetic values). Class I uses are given the highest priority, with Class II and III uses in decreasing priority respectively, and the Board may impose restrictions on one or more classes of beneficial uses. (9VAC25-220-120 (B))

Outside of surface water management areas, surface water withdrawal certificates are required. These are issued by the State Water Control Board with similar application requirements as for water withdrawal permits. Specific requirements may include water conservation or management plans. (9VAC25-220-250 et seq.)

Washington

Washington statutes give the Department of Ecology the exclusive authority and responsibility to regulate instream flows. Under the state's prior appropriation system of water allocation, an instream flow rule established by the Department is essentially a water right for fish and other instream resources.

Rules are specifically established for all or parts of a river basin for which instream flows are established. Protection of instream flows applies to both surface water and to ground water that is hydraulically connected with the surface water. Ground water withdrawals must not affect the flow of any surface water body. (RCW 90.44.030)

In addition to minimum instream flows, establishment of flow levels may include the protection of the frequency and duration of a range of ecological flows. This is accomplished by establishing a maximum amount of water that can be withdrawn from the stream above the instream flow levels, using hydrologic data to determine the amount of water that may be withdrawn without affecting flows needed for channel and riparian maintenance. Instream resources may also be protected by establishing year-round or seasonal closures. A closure is a finding by the Department of Ecology that no water is available for future uses. Closures may be established by rule as an alternative to setting flow requirements (especially for small streams), or may be used in conjunction with flow requirements.

The following statutes provide the foundation for protecting the state's instream flows.

- The 1967 Minimum Water Flows and Levels Act (Ch. 90.22 RCW) established a process for protecting instream flows, including provisions that the Department of Ecology must develop a state water plan. The Act also ensures that the establishment of minimum flows "in no way affect existing water and storage rights and the use thereof," but that new rights for diversion or storage are subject to regulations establishing flows or levels.

- The Water Resources Act of 1971 provided for the development of the Water Resources Management Program (173-500 WAC), which established 62 Water Resource Inventory Areas (WRIAs). The WRIAs typically define the boundaries of watersheds. The Act also authorizes the Department of Ecology to reserve waters for future beneficial uses, and establishes clear standards for instream flow protection.

- Construction Projects in State Waters (75.20 RCW) established the Hydraulic Permit Application program for permitting activities that will use, divert, obstruct, or change the natural flow or bed of any fresh or salt water in the state.

- The Watershed Planning Act (90.82.005 RCW), passed in 1998, authorizes local governments and other entities within each Water Resource Inventory Area to evaluate water quantity issues and make plans to meet future water needs, including instream flow components.

Summary of Instream Flow Policies in Other States

The dominant instream flow protection mechanism adopted by other states reviewed is the requirement for specified minimum flows, although these may be expressed as minimum levels at different points in the hydrograph or at different times of the year. These may be based on assimilative capacity (mean annual daily flow, 7Q10, and other thresholds), habitat protection, channel and riparian maintenance, and/or other site-specific considerations. State governments and regional entities often work in partnership in developing flow requirements. In addition, a variety of water management tools are employed to reduce water withdrawals, including water conservation; demand management; reuse of reclaimed water; using water of the lowest acceptable quality for the purpose intended; limiting interbasin transfers by using water nearest the area of use or application; and using alternative water supply techniques, such as desalination, aquifer recharge, or aquifer storage and recovery.

Permitting conditions are generally used to regulate withdrawals, and permitting may require demand management measures, water use measuring and reporting, and other conditions. Notably, states generally exempt smaller withdrawals from permitting requirements, even though the cumulative effect of many small withdrawals can be as great or greater than a few large withdrawals, and few states make a distinction between consumptive and non-consumptive use in withdrawal permitting. Some states (i.e., Virginia and Oregon) afford, through permitting requirements, a greater degree of protection to certain designated surface water management areas. Conversely, Florida recognizes that certain modified rivers and streams should be exempt from instream flow requirements.

Most of the states surveyed do not formally recognize ground water-surface water interactions in instream flow regulations. Washington allows limits to be placed on ground water withdrawal in order to meet instream flow requirements if a hydraulic connection is demonstrated between the ground and surface water bodies. Florida includes ground water levels as part of its “minimum flows and levels” policy, but ground water withdrawals are not specifically addressed in instream flow criteria.

Reservoir Construction and Operation

Instream flow policy normally deals with the management of flow regimes within natural water courses such as rivers and streams. Balancing withdrawals and inputs is the conventional method for ensuring that adequate flows are maintained for instream and offstream needs at each point along the course. The presence of a reservoir, however, raises new issues for managing flow regimes and protecting natural systems.

A primary characteristic of reservoir dams is the creation of interruption to natural flow regimes (Davis, et al., 2002). Efforts to store water for public supply, hydroelectric capacity, navigation, flood protection, or recreational uses jeopardize the availability of flows for downstream purposes. As noted earlier, impoundments also flood aquatic habitats and obstruct the passage of migratory species. Consequently, reservoir construction and operation require unique policy considerations in addition to those of conventional instream flow issues.

The purpose and ownership of reservoirs can vary greatly. Who constructs a reservoir, its intended functions, and the potential environmental impacts largely determine the overall size and operational strategies utilized as well as which legal requirements apply. Dam constructors and operators assume liability for complying with relevant statutes and regulations. This compliance entails the cost of designing and operating dams in a manner which satisfies legal requirements and meets the intended reservoir functions.

These factors must be considered in answering the following policy questions about reservoir construction and management: 1) What are the alternatives for siting and constructing new reservoirs to minimize adverse impacts on flow regimes and natural systems while also ensuring resource adequacy; and 2) What are the alternatives for managing existing reservoir operations to provide enough flow for natural systems and downstream needs while also protecting a sufficient quantity for intended reservoir uses?

Policy Trends

Many current policies regarding reservoir construction and operation are limited to considerations of public safety; changes to landscapes and significant species; minimum outflow requirements to protect downstream water quality; and minimum outflow requirements to meet downstream demand for water supply. However, some researchers and regulators recognize other significant influences reservoirs may have on river system characteristics.

As described in previous sections, the definition of “adequate flows” for natural systems is gradually being determined as site-specific research is conducted. Flow requirements are typically established for each water body using monthly 7Q10 or other low flow parameters; dam operators are required to release these minimum flows, but are fairly unrestricted to the methods employed. Beyond necessary quantities for sustained water quality and habitat protection, some scientific studies stress the importance of variation and intensity in natural flow regimes. Reservoir releases can be managed to mimic seasonal fluctuations (i.e., low and high flows) which are essential to aquatic- and floodplain-community dynamics (Davis et al., 2002; Duncan & EuDaly, 2003; Irwin & Freeman, 2002; Meyer et al., 2003). Moreover, shifting dam operations from creating extreme wet and dry periods to providing minimum continual flows can improve river system continuity (TVA, 2004).

Another emerging issue of concern is the secondary and cumulative impacts that multiple reservoirs and other activities have on a river basin system. Cumulative impacts are defined in the National Environmental Policy Act (40 C.F.R. § 1508.7) as, “the impact[s] on the environment which [result] from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency…or person undertakes such other actions." Beyond the alteration caused by just one dam, a collection of dams on the main stem or tributaries imparts considerable influence on water flow and whole-ecosystem connectivity. Human use behavior is subject to change relative to the presence of a reservoir as well, which can pose further stresses on reservoir water quality. Each of these factors has profound implications for managing water quality and aquatic community health, both now and in the future.

As understanding of river system dynamics increases, reservoir management policies that more effectively balance natural system needs with stakeholder and assimilative capacity demands become imperative.

Reservoir Construction Criteria

A variety of decisions must be made relative to the construction of new reservoirs, and these decisions relate to the initial and ongoing costs, the effectiveness in terms of water storage and other purposes, and the environmental impacts of reservoirs. Following is a list of issues that are typically included in the decision-making process regarding new reservoir construction:

- Reservoir construction costs, including:
  - Land acquisition,
  - Design and construction,
  - Environmental mitigation, and
  - Other costs;
- Topography, geology, and soils as they affect potential reservoir yields;
- Stream flow;
- Wetland impacts and water quality concerns;
- Existing reservoirs;
- Affects on existing development;
- Demand for increased water supply; and
- Dam safety criteria.

The World Commission on Dams identified five "decision points" related to reservoir construction (Westcoat et al, 2003, p. 184):

- Needs assessment;
- Selecting alternatives;
- Project preparation;
- Project implementation; and
- Project operation (which includes monitoring and ex-post evaluation)

Each of these decision points offers an opportunity for mitigating changes brought by reservoirs. Needs assessments determine whether future water demands warrant the development of additional water sources. Selecting alternatives entails choices between reservoir construction and other source water options, such as conjunctive use, ground water recharge techniques, water conservation, and others. Project preparation and implementation can determine the parameters under which the dam and reservoir function over many years, including size and storage capacity, operational costs, and environmental impacts. Project operation includes management issues such as managing for flood control, domestic water supply provision, and releases for instream flow protection and other downstream water needs.

The USEPA offers more specific guidance for reservoir decision-making. The agency developed a list of factors it considers for reservoir projects, based on Clean Water Act Section 404 (b)(1) guidelines (USEPA, Region 4).

1. Clearly stated project purpose that can be used for an alternatives analysis (includes needs analysis, population projections, and design criteria).
2. Full alternatives analysis, including:
    a. All alternatives to meet project purpose;
    b. Alternative reservoir locations (main stem, small tributary with pump storage, diked upland lagoon);
    c. For water supply reservoirs look at alternatives of ground water, surface water without an impoundment, combined use of all water sources, purchase of water.
3. Avoidance (selection of least damaging practicable alternative).
4. Minimization**:**
    a. Reservoir is minimum size necessary for project purpose (for water supply reservoirs, this includes utilization of 75 percent of reservoir volume);

b. Water conservation and/or wastewater reuse programs to minimize demand;

c. Coordination with wastewater discharge (i.e. discharge upstream of reservoir);

d. Staging of impoundment (fill to levels as needed);

e. Adjustment to location of dam and pool level for minimal impacts;

f. Dam designed to reduce downstream flow and water quality impacts, spill ways artificial aeration, variable depth penstocks;

g. Region wide planning process for maximum efficiency of use including integration with wastewater and storm water management programs; and

h. Accurate long range planning for best facility and avoidance of need for additional reservoirs for same applicant.

5. Full disclosure of all potential impacts (some of which USEPA independently determines):

a. Accurate description of all wetland, stream and upland habitats to be filled, flooded or cleared at maximum (not just average) pool level;

b. Stream impacts described by stream order and in linear feet;

c. Description of pre-impoundment flows and water quality (including flow loss due to increased evaporation from a reservoir, significant for small streams);

d. Presence of any 303(d) listed or outstanding resource waters;

e. For pump storage reservoirs, need to include stream withdrawal impacts in analysis;

f. Threatened/endangered species and species of concern, including migratory fishes;

g. Upstream and downstream discharges and withdrawals;

h. Potential for reservoir eutrophication (may include modeling of nutrients);

i. Potential for reservoir aquatic weed problems;

j. Potential for reservoir volume loss due to sedimentation;

k. Archeological and historical resources (COE/State Historical Preservation Office usually does this);

l. Presence of waste sites (old dumps, oxidation ponds, etc.);

m. Human impacts (local opposition, relocations, and condemnation);

n. Pre-delineation reductions of jurisdictional areas (such as draining of beaver ponds);

o. Cumulative impact issues (historical wetland/stream loss in watershed);

p. Impacts of related facilities (For a water supply reservoir, include treatment plants, distribution lines, and storage facilities. Approval under separate nationwide permits is not appropriate if facilities are dependent on main project.)

q. For new water supply reservoirs, consider wastewater treatment capacity issues;

r. Secondary impacts from development made possible by reservoir (additional fills);

s. Loss of flood plains and flood storage capacity;

t. For large projects, sophisticated environmental assessment methods should be used; and

u. Also for large projects, environmental impact statement may be needed (COE does or overviews third party preparation.

6. Measures to minimize all impacts:

a. Guaranteed levels of downstream dissolved oxygen, temperature, flow quantity and periodicity;

b. Dam operation and release plan based on monitoring to simulate natural conditions;

c. Erosion and sediment control plan during construction;

d. Air quality and noise reduction during construction;

e. Reservoir maintenance plan - includes any maintenance dredging and disposal;

f. Shoreline buffers/set backs/restrictions on development (with enforcement);

g. Fish passage structures if appropriate;

h. Relocation of species of concern (i.e. gopher tortoises, plants);

i. Restrictions/guidelines on recreational uses;

j. Reservoir destratification measures prior to release; and

k. Development and implementation of a watershed management/source water protection plan including measures/ability/willingness to protect reservoir watershed.

7. Compensatory mitigation for loss of wetlands and streams:

a. Reported in acreage for wetlands, linear feet for streams;

b. Covers all impacts from maximum pool level;

c. Stream mitigation can include watershed level actions;

d. Mitigation credit for upland buffers around reservoirs generally not acceptable;

e. At least 50 percent of compensatory mitigation should be other than preservation;

f. Mitigation must be described in detail prior to issuance of any permit and strongly encouraged prior to permit application;

g. Firm options on acquisition of mitigation areas;

h. Wood duck boxes are not wetland enhancement (and need annual maintenance);

i. Monitoring plans for mitigation areas; and

j. Permanent protection for mitigation areas (including protection from use for utility lines; conservation easements preferred over restrictive covenants).

In summary, the USEPA provides guidance in three fundamental categories of factors: analysis of alternative water supplies and/or demand reduction measures that may make reservoir construction unnecessary; analysis of alternative locations of reservoirs so that negative impacts are minimized; and disclosure and minimization of impacts resulting from reservoir construction and operation. Each category is important in terms of protecting instream flows and sustaining water resources. Demand reduction and water delivery improvements can reduce the need for additional water supplies. Alternative sources may be found through reuse of reclaimed water, conjunctive use programs (including ground water recharge and aquifer storage and recovery), and ground water development. Effective siting analysis may reduce the long-term local and cumulative impacts of the reservoir. Finally, design and operational criteria affect instream and offstream water supplies downstream from the reservoir. A noteworthy element in the criteria is the guarantee of downstream levels of dissolved oxygen, temperature, flow quality, and periodicity.

Selecting Reservoir Locations

The process of selecting a reservoir location is often a function of public safety and environmental regulation compliance as well as technical and political feasibility. Although governed by state and federal policy, locating possible reservoir sites is primarily a bottom-up process initiated by local governments or other entities. Once a reservoir is deemed the best alternative for meeting water demand, entities must select locations that:

- Are capable of meeting the technical demands of water storage;
- Do not pose unnecessary risk to public safety;
- Do not cause excessive environmental impacts; and
- Are most cost-efficient.

Reservoir Policy in Other States

Assuming that reservoirs will play a role in providing water storage in states where surface water is a significant source of public water supply, the most important policy consideration is how to site reservoirs so that they have the least possible impact on natural systems and allow sufficient water for downstream use and assimilative capacity. States may steer site selection by providing suitability parameters in their safety and environmental laws or by designating potentially viable water-development locations in future supply plans. Federal policy also directs site selection through an alternatives analysis process required by § 404 of the Clean Water Act (CWA; 33 U.S.C. 1251 et seq.), a decision review process in NEPA, and provisions in the Endangered Species Act, which may affect site selection if federally threatened or endangered species are present. Guided by these state and federal parameters, a site selection process will identify the most feasible location alternatives. The following summaries indicate how selected states guide reservoir site selection through state-level mechanisms.

Florida

The State of Florida employs several mechanisms to guide the selection of reservoir locations. The first mechanism, Regional Water Supply Plans, are required by each water management district to quantify and compare current and projected water supply with current and projected demand within a twenty-year period. Plans are to be developed in areas where current water supplies are considered inadequate “to supply water for all existing and future reasonable-beneficial uses and to sustain the water resources and related natural systems for the planning period." These plans must include alternatives for meeting water demand and may list reservoir site alternatives. How sites are selected in this process may be influenced by factors such as established minimum flows and levels (MFLs) and ecological values of riparian and wetland habitats. Established MFLs provide an early reference as to which sites have available water for new allocations. Local governments or other entities are not obligated to select any of the alternatives identified in regional plans, however.

The second mechanism is the statutory standard for project assessment criteria for activities in surface waters and wetlands. In determining whether a project is contrary to the public interest, the following criteria are evaluated:

1. Whether the activity will adversely affect the public health, safety, or welfare or the property of others;

2. Whether the activity will adversely affect the conservation of fish and wildlife, including endangered or threatened species, or their habitats;

3. Whether the activity will adversely affect navigation or the flow of water or cause harmful erosion or shoaling;

4. Whether the activity will adversely affect the fishing or recreational values or marine productivity in the vicinity of the activity;

5. Whether the activity will be of a temporary or permanent nature;

6. Whether the activity will adversely affect or will enhance significant historical and archaeological resources; and

7. The current condition and relative value of functions being performed by areas affected by the proposed activity.

Even if some criteria are not met, permits may still be granted if applicants can appropriately mitigate adverse environmental impacts and clearly justify such impacts for the benefit of public interest.

Florida's third mechanism is the Environmental Resource Permit (ERP) and the wetland resource permit (for the panhandle region only). These permits are administered by the Department of Environmental Protection or applicable water management district and are required in addition to or in conjunction with a federal 404 permit. Permitting evaluations are based on a proposed activity's potential to "adversely affect fish, wildlife, listed species, and their habitats" (FDEP, 2002) as well as public safety and water quality considerations. In addition to primary impacts, the ERP process evaluates the secondary and cumulative impacts of proposed actions. Secondary impacts are those actions or actions that are very closely related and directly linked to the activity under review that may affect wetlands and other surface waters and that would not occur but for the proposed activity. Cumulative impacts are residual adverse impacts to wetlands and other surface waters in the same drainage basin that have resulted or are likely to result from similar activities that have been built in the past, that are under current review, or that can reasonably be expected to be located in the same drainage basin as the activity under review.

St. John's River Water Management District

Because Florida's water management relies significantly on work done through its five water management districts, it is instructive to include district policies as well as state-wide policies. Each water management district has clearly outlined criteria for a proposed activity assessment under the Environmental Resource Permitting process. The St. John's River Water Management District's criteria can be found in the *Applicant's Handbook: Management and Storage of Surface Waters* (2005). This handbook includes the requirements and criteria for evaluating ecological values of wetland or other surface water areas as well as the proper processes for eliminating, reducing, and mitigating adverse environmental impacts. Direct impacts are evaluated through a comparison of pre-activity hydrologic conditions, hydrologic connection, aquatic area uniqueness, location relevant to surroundings, and wildlife utilization with the likely post-activity conditions. Proposed activities must not adversely affect the quantity, quality, or related beneficial uses of a water body.

Applicants must provide reasonable assurance that secondary impacts caused by the proposed activity will not violate water quality standards of the respective water body or adversely impact certain state listed species. Future phases of a proposed activity or anticipated future activity as a result of the proposed activity will be evaluated for potential to cause adverse secondary impacts.

Assessment of cumulative impacts is conducted at the level of each application. If a single project is determined to protect water quality standards and adequately mitigate for the lost ecological functions, then it is determined to have no "unacceptable cumulative impacts." However, if a project will adversely impact water quality standards or ecological functions without full mitigation in the same drainage basin, then the applicant must ensure that unacceptable cumulative impacts will not result from the conjunctive effects of both the proposed and other activities within the same drainage basin.

North Carolina

Reservoir sites in North Carolina are largely determined by technical feasibility in terms of a location's capacity to provide adequate water storage or flood control and avoid adverse impacts on water quality and related environments. For most reservoir projects, impact analyses are considered through the federal 404 permitting process and through North Carolina Environmental Policy Act procedures.

North Carolina has a distinctive assessment process that allows projects to be screened for feasibility and compliance issues before large investments are made into the construction process. The pre-application, or scoping, phase enables potential applicants to openly discuss intended actions and possible regulatory inhibition with the Department of Environment and Natural Resources. Conclusions of this phase could play a role in site selection depending on the resolve and financial capacity of an applicant. Moreover, the scoping phase identifies any need for in depth analysis and documentation based on minimum thresholds set in the State Environmental Policy Act (SEPA). If an environmental assessment (EA) or an environmental impact statement (EIS) is required, applicants must submit a draft version for review by each division within NCDENR. After a comment period and satisfactory application adjustment by the applicant, the environmental document is sent to the State Clearinghouse for dissemination among all applicable state agencies. This final review and comment period addresses SEPA compliance and any additional revision requirements. Lastly, NCDENR forwards the final iteration to the State Clearinghouse for review of a Finding of No Significant Impact (FONSI) or a Record of Decision (ROD) under an EA or EIS, respectively.

If an assessment of the previous criteria determines no significantly adverse impact would occur as a result of the proposed action, then submission of a FONSI is the final requirement. However, if such an assessment determines the action will result in a significant impact, a full EIS must be written.

Tennessee

The Tennessee Division of Water Pollution Control (TDWPC) employs an extensive permitting program pursuant to § 401 of the federal CWA and the Tennessee Water Quality Control Act of 1977 (T.A.C. § 69-3-108(b)(1)). Non-federal reservoirs typically require a general or individual state permit for the alteration of any state water and may also require a Safe Dams permit from the Division of Water Supply and a federal 404 permit. The former permits are generically called Aquatic Resource Alteration Permits (ARAP) and may be granted if applicants adequately justify the need for a proposed project, identify alternatives for meeting the need, select the least environmentally detrimental alternative as practicable, and mitigate for adverse environmental impacts.

Directives in state rules enable reservoir siting to occur through two distinct processes. The first requires an open public notice and comment period. This may place extra feasibility constraints on some project sites due to political acceptance or a willingness to protect personal property rights; consequently, certain locations may be quickly excluded. Secondly applicants are required to utilize practicable alternatives that result in no net loss when available. If the nature of a water body is so unique that insufficient mitigation opportunity exists, the permit is subject to denial by TDWPC. Minimal mitigation opportunity further restricts location alternatives for applicants.

Virginia

Virginia requires localities and regions to develop Regional Water Supply Plans similar to Florida. Through a process outlined in administrative rules, the Water Control Board and the State Health Commissioner assist local governments in assessing the deficits of current and projected water supplies and identifying practicable alternatives for meeting current and future demand. Emphasis is first placed on meeting needs through demand-side management and increasing the utilization and efficiency of existing regional water sources.

If construction of a new water source is necessary, then projects such as a water supply reservoir must adhere to the rigors of the federal 404 and Virginia Water Protection (VWP) permitting processes. For applicants to obtain a VWP permit, the proposed action must protect beneficial instream uses. Beneficial uses as defined by § 62.1-44.15:5 of the Virginia Code include, but are not limited to, “the preservation of instream flows for purposes of the protection of navigation, maintenance of waste assimilation capacity, the protection of fish and wildlife resources and habitat, recreation, cultural, and aesthetic values” as well as domestic and other existing uses.

The VWP permit criteria, in conjunction with 404 avoidance, and minimization and mitigation requirements, drive the site selection process. Practicable reservoir locations emerge through a methods analysis for meeting water demand and preventing adverse environmental impacts. As a result, financial and technical feasibility become the influential factors in reservoir site selection.

Washington

The State of Washington exhibits a unique policy climate in terms of reservoir utilization and regulation. Many reservoir projects have been developed across the state since its inception, and a report released by the Water Storage Task Force (2001) further accentuated the importance of water storage projects for future public, economic, and environmental welfare. The report outlined key principles of reservoir use in the state, including pros and cons between storage methods; policy and regulatory considerations; and environmental concerns.

It is the policy of the state to provide adequate water supplies for instream and off-stream beneficial uses; to encourage the impoundment of excess available water; to utilize and protect water resources for maximum net benefits; to encourage multiple use projects versus single use; and to give full consideration of surface storage in a cost-efficiency analysis of alternatives. Storage alternatives analyses are expected to consider public water supply system plans; supply-related issues identified in watershed plans implemented under the Watershed Management Act of 1998; and consistency with the other elements in land-use plans implemented under the Growth Management Act.

The State Environmental Policy Act of 1971 (SEPA) requires responsible state agencies to prepare an Environmental Assessment or Environmental Impact Statement for state actions that are likely to cause adverse environmental impacts. Washington’s SEPA entails several unique features compared to other states. One feature is that the assessment criteria also apply to non-project actions such as policies, plans, or programs that may create an adverse impact through subsequent actions or implementation. Another feature is the eligibility of some projects to provide documentation in phases due to the nature of their development. Feasible assessments should be conducted and reported at the earliest possible time. Finally, cumulative impact analyses are to be conducted at a comprehensive planning scale (in coordination with the Growth Management Act) and also within individual project EISs. This enables agencies and local governments to evaluate the potential impacts of single and collective projects across time. However, agencies responsible for drafting an EIS are only responsible for considering the cumulative impacts of their respective project.

Reservoirs are subject to extensive permitting requirements, including water rights and withdrawal permits; state Hydraulic Project Approval, the Shoreline Substantial Development Permit, the Coastal Zone Management Certification, as well as the federal 401 Water Quality Certification, the 404 dredge and fill permit, and an individual work permit pursuant to the Rivers and Harbors Act. Large reservoirs are required to obtain a Dam Safety Construction Permit, and a Water Quality Modification Permit is generally required to address turbidity, chemical, and other temporary impairments to water quality during construction. (Through the Joint Aquatic Resources Permit Application (JARPA), multiple permits can be applied for in a single application submission.)

Lastly, the Washington Department of Fish and Wildlife may require or recommend mitigation for actions that cause a loss in habitat value or function for fish and wildlife. WDFW may recommend mitigation in permits issued by other agencies, but may *require* mitigation in permits for which they are the sole decision-maker.

Summary of Reservoir Policies in Other States

Reservoirs are considered by most states as reasonable water supply alternatives. However, various environmental impacts must be considered before reservoir projects are initiated. Much has been learned in recent years about reservoir influences on instream flow regimes and other aspects of natural systems; accordingly, some states utilize assorted policy mechanisms to minimize adverse environmental impacts.

As described in previous sections, reservoir construction and management are regulated through local, state, and federal permits that traditionally focus on public safety and effects on other water uses. However, state policies such as those observed in Florida, North Carolina, Tennessee, Virginia, and Washington may require more extensive evaluations of immediate and long-term environmental impacts. In order to adequately assess such impacts, permit applicants must consider reasonable alternatives to a proposed reservoir, the anticipated effects of each option, and the opportunity to mitigate adverse consequences. Theoretically, an extensive consideration of direct and cumulative impacts on local resources and associated natural systems improves the management capacity of total water resources within a river basin.

Extended evaluation criteria may include: impacts on local flora and fauna; alterations of natural flow regimes and ecosystem functions; short- and long-term diminution of water quality; and influences on habitats connected to riparian areas. Policy strategies that address these issues can include extensive permitting requirements, mandated interagency regulatory coordination, and regional water resource planning. The selected strategies play an integral role in the viability of reservoir alternatives as well as location availability. Reservoir alternatives and locations, then, are limited to the stringency of environmentally related policies and the opportunities to mitigate adverse impacts.

Chapter 3

INSTREAM FLOW AND RESERVOIR POLICY IN GEORGIA

Instream flow policies are generally the purview of state and local governments (in keeping with overarching federal water laws), while reservoir construction and management regulation tends to be divided between state and federal agencies. In Georgia, the Environmental Protection Division (EPD, Division) of the Georgia Department of Natural Resources (DNR) is the primary agency charged with instream flow protection, through water withdrawal requirements and other programs that ensure compliance with state and federal laws that relate to waterways and their aquatic habitats. Reservoirs are regulated primarily through EPD, the U.S. Army Corps of Engineers (USACOE), and the Federal Energy Regulatory Commission (FERC).

Georgia Statutes Related to Instream Flow and Reservoirs

The **Georgia Water Quality Control Act** (OCGA § 12-5-20 et seq.) declares that water resources of the state shall be utilized prudently for the maximum benefit of the people. It directs the state government to assume responsibility for the quality and quantity of such water resources and the establishment of a water quality and quantity control program:

> In evaluating any application for a permit for the use of water for a period of 25 years or more, the director shall evaluate the condition of the water supply to assure that the supply is adequate to meet the multiple needs of the citizens of the state as can reasonably be projected for the term of the permit and ensure that the issuance of such permit is based upon a water development and conservation plan for the applicant or for the region. Such water development and conservation plan for the applicant or for the region shall promote the conservation and reuse of water within the state, guard against a shortage of water within the state, promote the efficient use of the water resource, and be consistent with the public welfare of the state. (OCGA 12-5-31(h))

The Act gives EPD the authority and the responsibility to regulate the withdrawal, diversion, or impoundment of waters of the state and to require the use of reasonable methods after having considered the technical means available for the reduction of pollution and economic factors involved to prevent and control the pollution of waters of the state. (O.C.G.A. § 12-5-21 (b)) It requires permits for all water withdrawals of more than 100,000 gallons per day on a monthly average, or a reduction of flow below a diversion or impoundment by more than 100,000 gallons per day on a monthly average (with the exception of agricultural permits…some farm impoundments and farm uses such as irrigation are not required to obtain a permit, but the lack of a need for a permit must be verified with EPD).

For transportation construction projects, up to 150,000 gallons per day may be withdrawn without a permit, and water used in the construction and filling of impoundments do not require permitting.

All waters of the state are included in the Act's provisions, including "all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells, and other bodies of surface or subsurface water, natural or artificial, lying within or forming a part of the boundaries of the state which are not entirely confined and retained completely upon the property of a single individual, partnership, or corporation." [2]

Permits may be issued for a term of 10 to 50 years. The Division generally issues permits for 10 to 20 years, with extensions of up to 50 years for public water suppliers. Agricultural permits are not limited in duration and may be transferred with the sale of land without agency approval. With the exception of farm use, permits may be revoked following non-use for two or more consecutive years.

When competing applications are submitted for which water supply is inadequate for both uses, the Act gives preference to application renewals over new applications, and the Director may issue new or modified permits for water use on a prorated or other reasonable basis.

The Georgia Water Supply Act (OCGA § 12-5-470 et seq.) authorizes the Department of Natural Resources to secure projects for providing adequate water for future needs, to supplement present needs of communities in the event of prolonged dry-weather conditions, and to promote the use of the projects for the public good and general welfare.

The **Georgia Dam Safety Act of 1978** (OCGA § 12-5-370) outlines the requirements for constructing and managing dams in order to protect public safety below each dam. Reports of structural and other engineering plans for new dams and operating procedures for existing dams are required to be submitted to EPD for review by a qualified individual. Site reviews and inspections may also be conducted by the state during planning, construction, or operation phases.

This statute only applies to dams, which are defined as "any artificial barrier…which impounds or diverts water and which: (i) is 25 feet or more in height from the natural bed of the stream…; or (ii) has an impounding capacity at maximum water storage elevation of 100 acre-feet or more." The purpose of this act is to ensure that proper criteria for the safe construction, operation, and maintenance of dams are adequately considered to protect public safety as well as to continually monitor and inventory every five years dams in the state.

The **Georgia Environmental Policy Act (OCGA § 12-6-1)** is the state-level version of the National Environmental Policy Act. This procedural legislation requires a state

[2] See following section, "Environmental Protection Division Rules Impacting Instream Flows and Reservoirs for requirements established by the Act as implemented by EPD."

agency to provide an assessment of significantly adverse environmental impacts that a responsible official has determined would result from a proposed governmental action. A proposed government action is defined as “any proposed land disturbing activity by a government agency or funded by a grant from a government agency, any proposed sale or exchange of more than five acres of state owned land, or any proposed harvesting of five acres or more of trees over two inches in diameter at breast height” and includes, among other criteria, dredging, filling, placement of a dam or other obstruction, which is likely to have an adverse environmental impact.

Exempted actions include, but are not limited to, the installation of private farm ponds, nongovernmental actions requiring some form of state authorization, local government actions receiving no more than 50 percent of the funding or more than $250,000.00 from a state agency, and the implementation of rules and regulations by a state agency. An environmental effects report must be submitted to the Director of EPD as well as be publicly released in the counties affected by the proposed state government action. Reports must include:

- The environmental impact of the proposed governmental action;
- Alternatives to the proposed governmental action, including no action;
- Any adverse environmental effects which cannot be avoided if the proposed governmental action is undertaken;
- Mitigation measures proposed to avoid or minimize the adverse impact of the proposed governmental action;
- The relationship between the value of the short-term uses of the environment involved in the proposed governmental action and the maintenance and enhancement of its long-term value;
- The effect of the proposed governmental action on the quality and quantity of water supply;
- The effect of the proposed governmental action on energy use or energy production; and
- Any beneficial aspects of the proposed governmental action, both short-term and long-term, and its economic advantages and disadvantages.

The **Georgia Planning Act of 1989** (OCGA § 12-2-8) provides general authority and guidance for the development of minimum standards which should be considered in the formulation and implementation of local comprehensive plans as pursuant to OCGA § 50-8-2. Through the development of such standards, the statute seeks to inform decisions on “land use in order to protect and preserve [the State’s] natural resources, environment, and vital areas.” Comprehensive plans must include minimum standards for land uses affecting natural resources, mountains, river corridors, water supply watersheds, ground water, and wetlands.

The **Flint River Drought Protection Act** (OCGA § 12-5-540) establishes a drought protection program for the Flint River Basin. It gives the Director of EPD the authority to predict each year whether drought conditions are likely in the Flint River basin, and if so, provide certain options for water use reduction. These options include irrigation reduction auctions which offer irrigators a certain sum of money in exchange for ceasing or reducing irrigation, requiring certain permit holders to cease or reduce irrigation, and changing certain water well standards as they relate to irrigation.

Environmental Protection Division Rules Related to Instream Flows and Reservoirs

Rules for Water Quality Control (391-3-6) implements the Georgia Water Quality Control Act regarding wastewater discharges, water use classifications and quality standards, water withdrawal permitting, and requirements affecting artificial ground water recharge. The most important aspects of the rules in terms of instream flow are included in permitting requirements. For new permits or modifications to existing permits, no permits will be issued by EPD which authorizes the depletion of the instream flow established for withdrawal, diversion, or impoundment of surface water, except for periods of emergency water shortage. As long as the instream flow is available from upstream, the applicant is required to pass instream flow at or immediately downstream of the point of withdrawal. The instream flow is established by the Director of EPD as one of the following:

1. The 7Q10 flow, if no unreasonable adverse effects to the stream or other water users will occur from the withdrawal, diversion or impoundment; or

2. The Non-Depletable Flow, as established by the Director, if probable impacts of the withdrawal, diversion or impoundment would occur to other water users; or

3. Other appropriate instream flow limit, as established by the Director.

The priority for water use, established by statute and by rule, does not include instream flow as a stated priority. The priorities for water use are as follows:

1. Emergency facilities for essential life support measures;

2. Domestic and personal uses, including drinking, cooking, washing, sanitary purposes and all health related activities;

3. Farm uses as defined herein;

4. Industrial uses (including those industries on public water systems);

5. Other uses such as lawn sprinkling, noncommercial car washing, garden watering, etc.; and

6. Outdoor recreational uses.

Specific to reservoirs, Subsection 3-6-.03 (15) of Chapter 391 specifically prohibits the placement of any impoundment on a Primary Trout Water, unless 1) The drainage basin upstream of the impoundment is less than 50 acres and 2) Approval for placing the impoundment in such a place is granted by EPD. This subsection also prohibits the construction of an impoundment on a Secondary Trout Water without approval of EPD.

Rules for Regional Reservoirs (391-6-1) establishes practices and procedures to be followed by DNR in implementing the Georgia Water Supply Act relating to regional reservoir projects. It establishes criteria for selection of reservoir sites and membership criteria for the Project Site Control Advisory Council. Under this rule, DNR must accomplish the following prior to final determination of a site for a regional reservoir project.

- Written notification to each local government which may include any portion of the final project site within its territorial boundaries.

- A reasonable period for each local government which may include any portion of the final project site within its territorial boundaries to review and comment on the written notification by DNR. Consideration of the input received from local governments must be given by DNR prior to selection of the final project site.

- A public hearing, for which reasonable notice must be provided, within the territorial boundaries of each local government which may include any portion of the final project site within its territorial boundaries.

- Establishment of the Project Site Control Advisory Council.

Specific criteria for site selection must comply with Section 404 of the Clean Water Act, the Georgia Safe Dams Act, the Georgia Water Quality Control Act, the Georgia Erosion and Sedimentation Control Act, and other appropriate laws. Consideration is given to current land uses, and the site selection process is to be coordinated with the regional plan of the appropriate Regional Development Centers (RDCs). The site selection process must also conform to DNR standards and procedures pursuant to the Georgia Planning Act, including criteria for protection of freshwater wetlands, ground water recharge areas, and water supply watersheds.

Rules for Dam Safety (391-3-8) provides criteria for dam inventory, construction, operation, and maintenance that are the responsibility of either EPD or the dam owner. The first area, inventory, is the responsibility of EPD pursuant to subsection 3-8-.03. All dams within the state must be inventoried and classified as either Category I or Category II. Category I dams are defined as, "[dams] where improper operation or dam failure would result in probable loss of human life. Situations constituting ‘probable loss of life’ are those situations involving frequently occupied structures or facilities, including, but not limited to, residences, commercial and manufacturing facilities, schools and churches.” Category II dams are defined as, “[dams] where improper operation or dam failure would not expect to result in probable loss of human life.”

The remaining sections and rules of 391-3-8 apply to all dams excluding federally owned or funded dams, FERC licensed dams, Category II dams, small impoundments temporarily built for mining projects, and impoundments smaller than six feet in height regardless of storage capacity or impoundments taller than six feet, but have less than 15 acre-feet of storage capacity.

All new dams subject to the provisions of OCGA § 12-5-370 and these rules must obtain a permit for construction and operation. Permit applicants must submit detailed design and engineering plans, which are evaluated for proper safety measures in each phase. Impoundments must include spillways, respective to dam and reservoir size, capable of discharging adequate volumes of water during high precipitation periods to ensure safety of the public upstream of the dam. Specific guidelines are also included for continued dam maintenance and inspection requirements.

Rules for Environmental Planning Criteria (391-3-16) establishes that elements of the environment that must be considered by local governments in the development of their comprehensive plans. Although not mandatory, the minimum criteria regarding water supply watersheds, groundwater recharge areas, wetlands, river corridors, and mountains must be considered to meet Minimum Standards. Local governments must “identify whether any of these environmentally sensitive areas exist within the local government’s jurisdiction and, if so, assess whether all or part of these minimum criteria should be implemented locally.” Furthermore, local governments are given the authority to implement more stringent standards than set by these rules.

Standards set for water supply watersheds, which also includes reservoirs, pertain to water quality protection. Standards for wetlands involve the mapping and inventory of such areas as well as an evaluation of impacts proposed actions may have on the function or existence of jurisdictional wetlands.

The **Georgia Drought Management Plan**, implemented in 2003, establishes a process for drought preparedness and response, including pre-drought strategies of water conservation and efficiency to be implemented at all times as well as requirements for water management at each of four levels of drought response. Drought responses are shorter-term actions to be implemented during a drought, according to the level of drought severity.

The plan calls for the State Climatologist’s office and EPD to routinely monitor and evaluate stream flows, reservoir levels, precipitation, ground water levels, and other indicators in each of nine climate regions of the state. If any of the drought indicators in any climate region reaches or passes a certain prescribed condition for two consecutive months, the state climatologist and EPD evaluate the possible need for a drought response declaration. Depending on drought indicators, the EPD Director, in consultation with members of the Drought Response Committee (composed of senior members of state agencies and one representative each from the agricultural and business community), declares an appropriate level of response to be implemented at the local level. At the end of a drought, when all of the drought indicators have been at a certain level for a period of four months, an evaluation is conducted to assess whether to decrease the level of response.

Drought responses are primarily focused on limiting outdoor watering and prohibiting certain activities during more severe levels of drought, with the exception of certain commercial uses. At each of four levels of drought response, watering restrictions become more stringent, with level four imposing a complete outdoor watering ban. Prohibited activities at levels three and four include washing buildings and vehicles and using water for ornamental purposes and filling swimming pools.

Pre-drought strategies include guidance to local governments, commercial, and agricultural entities regarding conservation and efficiency measures; encouragement of water re-use, conservation, and water-efficient technologies and best-management practices; and a year-round outdoor watering schedule. (Please see the companion report, *Water Conservation, Efficiency and Reuse*, for more information regarding ongoing water conservation efforts.) The plan also calls for the development of water conservation plans by the DNR water conservation coordinator, local governments, Regional Development Centers (RDCs), and local water supply providers.

Instream Flow Policy

Instream flow regulations are the principle mechanism used by EPD to limit withdrawals such that adequate water remains in streams for aquatic habitat, ecosystem functions, and downstream users. Georgia's first instream flow guidelines were adopted in 1977 following passage of the federal Clean Water Act. These guidelines were based on the 7Q10, the lowest continuous flow over a 7-day period that is expected to occur with an average frequency of once in 10 years, which was established to protect water quality but not protective of aquatic habitats and ecosystem functions.

An initial challenge to the 7Q10 policy came from the Wildlife Resources Division (WRD) of Georgia DNR, who expressed concern in 1994 about the adequacy of EPD's instream flow policy. In December of 1995, WRD published a report entitled *A Recommended Method to Protect Instream Flows in Georgia*. The report's recommendations for flow protection for trout streams, non-trout streams, and regulated streams were substantially more than flows under 7Q10. (Evans et al. 1995)

In 1996, the directors of EPD and WRD brought stakeholders together to review WRD's report, and the team recommended that EPD adopt an interim instream flow policy that allowed water users to select one of three instream flow maintenance options. The agency directors, out of concern that the maintenance options were not backed by site-specific scientific research, elected not to implement the team's recommendations (Caldwell, 2005). As a result, EPD continued to employ the 7Q10 instream flow regulations.

During the 1990s, Georgia's population grew by a record 26.4 percent, and concern continued to grow regarding provision of adequate water supplies to accommodate the growing demand. Since the northern third of the state depends almost entirely on surface water supplies, the reasonable expectation was that existing water supply reservoirs would need to be expanded and new ones built. This prospect further increased concerns regarding EPD's policy. (Ibid)

Prompted by the drought that began in 1998, in March, 2001, the Board of Natural Resources adopted the *Interim Instream Flow Protection Strategy*, which recommends that water users select one of three options:

1. Monthly 7Q10;

2. Mean annual flow options for regulated and unregulated streams; or

3. Flow based on a site-specific instream flow study.

These options will be in place until instream flow guidelines are finalized in 2006. These guidelines apply to municipalities, industrial water users, and non-federal dams. (Agricultural users and federal dams are exempt.) Watershed specific studies, including hydrologic, physical, chemical, and biological aspects of river dynamics, are required prior to finalization of the guidelines. (Davis) Funding for the studies is not yet available, however, and efforts are underway to find potential federal grant opportunities (Caldwell, 2005).

Reservoir Policy

The National Dam Inventory lists 4,435 reservoirs in Georgia that have dams larger than six feet tall (Davis et al., 2002). However, an independent analysis by Davis et al. estimates that 68,000 impoundments of varying size and function exist in Georgia, making it the southeastern state with the highest number of dams. Although a majority of these are small impoundments on private property and do not require legal oversight, many are required to meet some form of statutory and regulatory compliance. The Environmental Protection Division is responsible for dam permitting and reservoir oversight in Georgia, although federal agencies such as the Army Corps of Engineers, Federal Energy Regulatory Commission, and Fish and Wildlife Service may take part in regulatory responsibilities.

Selecting Reservoir Location

Reservoirs construction in Georgia can be initiated by state agencies, local governments, or private entities. The location of regulated reservoirs is influenced by two major factors:

criteria set forth in the Army Corps of Engineers Alternatives Analysis and the inclusion of reservoir site planning in regional water development planning.

It is important to note that building dams on main stem rivers is much more difficult and far less popular now than in previous eras due to higher human population densities and better understood cumulative impacts on river systems. “Off-stream” reservoirs, or small impoundments on main stem tributaries, are more likely to be the preferred alternative for surface water storage, but may require in-flow augmentation via water pumping from a main stem river (Davis et al., 2002).

U.S. Army Corps of Engineers Requirements

The Army Corps of Engineers-Savannah District (USACOE) requires reservoir applicants to conduct two analyses before it will consider granting a 404 permit. First, an applicant must justify the purpose and need for building a reservoir based on current and projected water conditions. The Purpose and Need Analysis must be approved by both EPD and the pertinent Regional Development Center before USACOE will review a 404 application. This initial analysis must include the following information.

- Defined service area. Applicants should define the current and projected service areas for a new water supply project.

- Existing supply. Applicants should describe existing surface and ground water supply sources with the respective amount of current and projected utilization.

- Population projections. Applicants should provide a population projection for the defined service area which includes population size and intended uses (e.g., residential *versus* industrial). The Regional Development Center must approve the criteria and methodology used in such projections.

- Well-defined design criteria. Applicants should utilize appropriate criteria to model demand such as peak monthly flow instead of peak daily flow. Sufficient infrastructure to treat and convey water should also be accounted for.

- Conservation. Applicants should outline provisions for maximizing conservation and reuse of water as well as plans to meet peak demand during drought periods. Plans on how to minimize lost or unaccounted for water must also be included.

- Long-term needs. Applicants should evaluate measures for meeting long-term (20 to 50 year) resource needs.

The second obligation, an Alternatives Analysis, requires applicants to thoroughly review the capacity of various sources to meet water needs. The review of each alternative must include an assessment of the anticipated positive and negative impacts (CWA, § 404). By evaluating which alternatives satisfy defined purpose and need and create the least adverse environmental impacts, a best practicable alternative can be identified. The USACOE requires an analysis of the following source alternatives, which may or may not result in a suitable reservoir location:

Avoidance alternatives:

- No action;
- Water conservation;
- Recycle and reuse wastewater;
- Ground water;
- Purchase water from existing or proposed regional source;
- Request increase withdrawal at existing intake site; and
- Upland constructed flow augmentation reservoir.

Surface water alternatives:

- Traditional reservoir (no pumped storage);
- Construction of several reservoirs;
- River or stream intake system (no storage reservoir);
- River or stream intake with one storage reservoir;
- Construction of several intakes with storage reservoirs; and
- Increase size or yield of existing reservoir.

Minimization alternatives:

- Combine water conservation with applicant's proposal;
- Combine ground water use with applicant's proposal;
- Reduce the size of the reservoir for applicant's proposal;
- Continue use of existing water system with construction of a smaller reservoir; and

- Combine waste water flow augmentation with river intake.

Thirdly, the Regional Reservoir Program was created as a result of the Georgia Water Supply Act of 1989 (O.C.G.A. § 12-5-470) and subsequent EPD rules (391-6-1). Under the program, the Department of Natural Resources is authorized to “secure projects for providing adequate water for the State’s future needs, to supplement present needs of communities in the event of prolonged dry-weather conditions, and to promote the use of the projects for the public good and general welfare.” Within this process, several internal factors effect reservoir site location. These factors include state and federal legal parameters as discussed in previous and following sections (see “Statutory and Regulatory Requirements in Georgia”); consideration for existing land uses; and input from Regional Development Centers, local governments and citizens. Reservoir sites that adhere to legal criteria and are technically and politically feasible may be developed to “maximize water supply yields for multi-jurisdictional communities and to meet any other criteria designated by DNR.” Despite identified regions with increased water supply need, only one project has been allocated money from the Georgia General Assembly and even it has been delayed by water allocation issues (DCA). Realizing the difficulties of constructing new large water supply reservoirs, DNR renamed the program Regional Reservoir and Water Supply Program to increase the scope of regional supply alternatives (CH2M Hill, 2003).

State Regulatory Requirements for Reservoirs

Water supply reservoirs primarily fall under the jurisdiction of EPD. Once a reservoir and its respective location are deemed appropriate, the local government or other entity must submit plans to EPD to begin the permitting process. The following measures may be employed by EPD or other responsible agency to ensure compliance with applicable construction and operation requirements.

- Require local governments to develop Water Supply Watershed Protection Plans and Reservoir Management Plans pursuant to the Georgia Planning Act (GPA) of 1989 (OCGA 12-2-8) and EPD Rules for Environmental Planning Criteria (Chapter 391-3-16). Plans are necessary to ensure sufficient considerations have been given to the protection of natural resources and vital areas of the state.

- Require special approval if a proposed reservoir is to be built on a designated Trout Water of the State. Subsection 15 of EPD Water Quality Control Rules (391-3-6.03) prohibits the construction of an impoundment on Trout Waters of the State, but may allow such action on small headwater areas of Primary Trout Waters and on all Secondary Trout Waters with the approval of EPD.

- Require an NPDES Construction permit pursuant to CWA § 402 (p)(1). State NPDES permits, issued under the Stand Alone Permit GAR100001, require dam constructors to implement certified best management practices for controlling stormwater runoff at construction sites.

- Verify receipt of a CWA § 404 permit from the Army Corps of Engineers for unavoidable dredge or fill actions. Requirements for compensatory mitigation may be outlined in the permit.

- Review the environmental effects report if reservoir is to be constructed by a state agency or an entity receiving more than fifty percent funding or more than $250,000 from a state agency. The responsible official of a state agency must prepare an environmental effects report pursuant to the Georgia Environmental Policy Act (OCGA § 12-6-1) if the responsible official determines the agency's proposed action will produce significantly adverse environmental impacts. Once submitted to EPD, a review will determine if proper procedures were followed in the determination process and whether ample consideration was given to proposed alternatives.

- Establish minimum flow requirements pursuant to the interim instream flow policy (BNR, 2001) and the Georgia Water Quality Control Act (OCGA § 12-5-20 et seq.). This measure is applicable to any non-federal reservoir or storage impoundment effective April 1, 2001. One of the three interim minimum flow options may be selected for implementation. For the monthly 7Q10 option, water supply reservoirs are required at all times to release downstream the lesser of monthly 7Q10 or inflow to the reservoir. The site-specific flow study option may require releases equal to or greater than the monthly 7Q10 alternative based on identified flow needs. Finally, the mean annual flow option requires new applicants for water supply reservoirs to release the lesser of mean annual flow or inflow. In this latter option, releases vary in required percentage of flows based on the time of year. Each of the aforementioned options are minimum requirements to help meet identified natural system needs and established water quality standards.

  EPD will coordinate with dam operators and the WRD as necessary to formulate release flows sufficient for meeting downstream demand, assimilative capacity, and natural system needs. The WRD currently consults EPD as a result of *de facto* policy, but has no authority to mandate flow requirements. As authorized by the Federal Endangered Species Act of 1973 (16 U.S.C. § 1531), the U.S. FWS will play an important role in establishing flow requirements if federally threatened or endangered species are present.

- Require dam owners to obtain a permit pursuant to the Georgia Dam Safety Act of 1978 (OCGA § 12-5-370). Design and engineering plans are evaluated for satisfactory safety measures in the construction and operation phases. Impoundments subject to EPD Rules 391-3-8 must include release structures, respective to dam and reservoir size, capable of discharging adequate volumes of water during high precipitation periods to protect public safety. The permit may also include design methods for ensuring adequate releases that meet downstream flow requirements.

Hydroelectric Dams

Federal and non-federal hydroelectric dam construction and operation entail similar steps for the permitting process. However, these dams fall under the jurisdiction of the Federal Energy Regulatory Commission and require a FERC permit in lieu of the Georgia Safe Dams permit. Furthermore, dams constructed by federal agencies or by entities receiving a large portion of funding from a federal agency may necessitate consultation by USFWS and WRD pursuant to the federal Fish and Wildlife Coordination Act (16 U.S.C. § 661). This consultation may address minimum flow establishment or other pertinent issues of natural system needs. Also for such projects, National Environmental Policy Act of 1969 (42 U.S.C. § 4321) procedures are requisite in lieu of Georgia Environmental Policy Act requirements.

Existing Sub-state Water Management Planning Efforts

The Metropolitan North Georgia Water Planning District was developed in response to the growing water demands of Atlanta and surrounding metro counties. Population growth projections show that water demand in the district will almost double by 2030, and the goal of the plan is to "meet projected water demands without compromising environmental or downstream needs." (MNGEPD Water Supply Plan) In 2003, the District developed a District-wide Watershed Management Plan, a Long-term Wastewater Management Plan, and a Water Supply and Water Conservation Management Plan (Water Supply Plan).

Surface water sources supply more than 99 percent of the District's water, the most significant of which is the Chattahoochee River system, which includes Lake Lanier. Including water supply provided by five proposed new reservoirs and reallocation of water storage at Lakes Lanier and Allatoona, the projected supplies will barely meet demands projected for 2030. If conservation measures included in the plan are effective, demands beyond 2030 may be met.

Transfers of both water supply and wastewater are currently allowed between basins within the district but no water is imported into the district. In fact, Senate Bill 130, passed in 2001, specifically prohibits the District from studying or recommending any such interbasin transfers from outside the District.

Current interim instream flow policy does not apply to streams whose flows are determined by the operation of a federal reservoir, such as the Chattahoochee below Buford Dam. Also, the new instream flow policies will not affect existing withdrawal permits, as these permits will be grandfathered. All of the water supply sources included in the water supply plan to meet 2030 needs are grandfathered into the previous instream flow policy, including the five proposed new reservoirs. (MNGWPD Water Supply Plan)

The Water Supply Plan evaluated potential sources of water supply to meet 2030 demands. An aggressive water conservation program and shared water resources among jurisdictions within the District are important components of the plan. The following is a summary of the evaluation of additional supply alternatives.

- Based on the evaluation of all potential water sources, the District is expected to continue to rely heavily on surface water supply sources to meet its future water demand.

- The reallocation of water storage from Lake Lanier and Lake Allatoona will be necessary to guarantee water supply for the District for the next 30 years and beyond.

- Reallocation of water from Lake Lanier and Lake Allatoona far outranks any other supply source in terms of cost, environmental and social impacts, feasibility, and public/intergovernmental acceptance.

- Ground water currently supplies less that one percent of the District's total public water supply and is not likely to provide significant quantities of water supply for the District in the future. However, it may be developed to supplement surface water sources particularly during peak demand periods in parts of the District.

- Indirect potable reuse, or reclaimed water that is returned to water supply sources such as Lake Lanier, directly contributes to meeting future potable demands without encouraging consumptive use such as irrigation.

Potential local and regional sources were ranked according to economic and non-economic evaluation criteria. Economic rankings were based on projected capital an annual operations and maintenance costs. Non-economic rankings were based on factors including the following:

- Present water quality;

- Future water quality;

- Reliability /drought / storage;

- Intergovernmental / regional acceptance;

- Public acceptance;

- Flooding impacts;

- Flow regime alteration;

- Wetlands impacts;

- Threatened and endangered species issue;

- Socioeconomic issues;

- Interbasin transfer requirements; and

- Historic/archeological issues.

To implement the Water Supply and Water Conservation Plan for water supply and treatment, the following actions are planned for securing water supply sources, sharing the water resources within the District, building additional treatment capacity, and organizing facilities for future indirect potable reuse.

- Support reallocation of Lake Lanier and Lake Allatoona for water supply.

- Support permitting and construction of at least five new water supply reservoirs. (Other new reservoirs, if they prove to be feasible and can be permitted, are viewed as consistent with the plan.)

- Construct two new system connections and maintain one existing system connection to allow water resource sharing.

- Construct a new water treatment plant in Walton County.

- Expand 25 existing (or soon to be constructed) water treatment plants.

- Retire four existing water treatment plants.

- Return reclaimed water to Lake Lanier by Forsyth, Gwinnett, and Hall Counties for future indirect potable reuse.

In addition to 25 existing reservoirs in the District, eight additional reservoirs are planned and are in various stages of the permitting process. Five reservoirs are far enough along in the permitting process to be included in the plan’s anticipated water supply for 2030:

- Hard Labor Creek (Oconee Basin),

- Hickory Log Creek (Etowah Basin),

- Lake McIntosh (Flint Basin),

- North Oconee (Oconee Basin), and

- Tussahaw Creek (Ocmulgee Basin).

The other three reservoirs, as of publication of the plan, were not far enough along in the permitting process to predict their eventual construction:

- Glades (Chattahoochee Basin),
- Still Branch Creek (Flint Basin), and
- South Fulton (Chattahoochee Basin).

Recommendations for the Flint River Regional Water Development and Conservation Plan were released in December, 2005, by the Flint River Basin Stakeholder Advisory Committee. The planning effort was launched in response to U.S. Geological Survey studies suggesting that agricultural irrigation was severely affecting flows in the Flint River and its tributaries, especially during times of drought. Also in response to the studies, EPD placed a moratorium on new agricultural withdrawal permits from all surface waters of the entire Flint River Basin and from the Floridan aquifer in southwest Georgia. (Permits continued to be available for the Claiborne and Cretaceous aquifers.) The recommended plan addresses conditions under which the moratorium will be lifted and how to establish a safe yield for ground water and surface water use in the lower Flint River Basin. Upon adoption by the EPD, it will apply to the entire Flint River Basin, from Atlanta to Lake Seminole.

To address current and potential saltwater intrusion into the Upper Floridan Aquifer in some of Georgia's coastal counties, EPD embarked on the Coastal Sound Science Initiative, a seven-year study of ground water movement and use in the coastal region. The study has recently been completed and has quelled, to some extent, concerns that the aquifer would be contaminated by sea water in the short term. Salt water is currently entering the Upper Floridan Aquifer at the northern end of Hilton Head Island, an offshore area northeast of Tybee Island, and on the Brunswick peninsula. Some wells have been contaminated and abandoned on Hilton Head Island and in the Brunswick area. The largest of the three saltwater plumes, at Hilton Head Island, has grown by about six miles since the mid-1960s; however, modeling has shown that under 2000 pumping conditions, many decades will elapse before saltwater intrusion is likely in Floridan aquifer wells in Georgia (Caldwell, 2005). Further research and modeling is underway to better understand ground water dynamics, the extent to which ground water withdrawals affect surface waters, and other issues. With public input (including that gathered at a series of public meetings held in August, 2005), EPD is preparing a plan to manage the water resources of the area.

Chapter 4

TRENDS IN GROUND WATER WITHDRAWAL MANAGEMENT

In south Georgia, ground water is a dominant water source for public supply, domestic, agricultural and industrial use and, as noted earlier, use has strained this resource in some locations. Georgia's aquifer system is recharged largely by rainfall occurring in the major outcrop region south of the Fall Line and in southwest Georgia, and its long-term sustainability is maintained by keeping average withdrawal rates at or below recharge rates. Inadequate ground water levels can lead to reduction of wellhead pressure, land subsidence, sinkholes, and/or salt water intrusion. Instream flows and wetlands are also dependent on ground water in areas of ground water-surface water interaction.

Ground water quantity can be managed with both demand and supply mechanisms. Demand can be controlled through withdrawal permit requirements, well spacing requirements, restricted water use in times of shortage, and other requirements. Supply can be controlled through land use and other regulations that increase natural water recharge, as well as a variety of artificial recharge applications, including aquifer storage and recovery. Monitoring and reporting water use are critical to track how water management efforts are working.

Management tools may also be used to sustain or improve ground water quality. For example, regulations may limit certain activities in an aquifer recharge zone so that there are minimal sources of pollution in the vicinity of a well and so that water is cleansed by the soil through processes of percolation and infiltration. Source water protection programs and wellhead protection programs commonly provide this type of protection. Artificial recharge may also serve a water quality function: reclaimed wastewater or stormwater can be channeled into recharge basins to enhance natural cleansing.

Ground water quantity is often protected on the state level by withdrawal provisions in state statutes and administrative rules. Several states designate ground water zones of special concern, where ground water withdrawals are controlled to a greater degree than other areas of the state. Such designated zones are generally used in one of two ways: as a sole ground water management tool to address existing overdrafts, or in conjunction with a state-wide permitting system designed not only to mitigate existing problems, but also to prevent ground water overdrafts before they begin to cause concern. The basic policy question is how should the State respond when trends show that a ground water resource is stressed.

Federal Laws Related to Ground Water

Ground water is addressed on a federal level through the National Environmental Policy Act (NEPA), the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund law). Each of these statutes primarily addresses water quality rather than quantity issues. Water quality is the focus of the fourth report in this series. Most pertinent to ground water management is the Safe Drinking Water Act, which addresses issues related to artificial recharge of aquifers, discussed below. (See "Federal Regulations Relative to ASR and Artificial Recharge.")

Ground Water Withdrawal Management in Other States

Ground water withdrawal is most commonly controlled by establishing permitting parameters and special management zones.

Arizona

The Arizona Legislature passed the Groundwater Management Act in 1980 to address ground water depletion that had been a growing concern since the 1950s. The Act called for the Arizona Department of Water Resources to implement its provisions and, through the Arizona Groundwater Code (A.R.S. § 45-401 through § 45-704), established four Active Management Areas (AMAs): Phoenix, Pinal, Prescott, and Tucson. The Tucson AMA was divided in 1994 to form a fifth management area, Santa Cruz. The active management areas and the programs they adopt have been quite significant because 80 percent of Arizona's population lives within an AMA. Ground water use is regulated within these areas, and municipal water providers located within AMAs are required to develop and implement conservation programs. Arizona created five management periods, with increasingly stringent water restrictions in each subsequent period.[3]

In addition to the active management areas, the Act established two Irrigation Non-Expansion Areas (INAs), with a third area designated since its passage. Agricultural irrigation in these areas, while not as closely regulated as the management areas, is limited to acreage that has historically been irrigated. Outside of AMAs and IMAs ground water use is limited only by reasonable and beneficial use.

Arizona's Assured Water Supply Program is designed to help sustain the state's economic health by preserving ground water resources and promoting long-term water supply planning within the state's Active Management Areas. Prior to subdividing lands for development, a developer must obtain a certificate of assured water supply, meaning that sufficient ground water, surface water, or effluent of adequate quality will be available to satisfy water needs of the propose water use for at least 100 years. Sufficient ground water means that the proposed withdrawals the applicant will make over a period of 100 years will be of adequate quality and will not exceed in combination with other withdrawals a depth to 1,000 feet or the depth of the bottom of the aquifer, whichever is less. (Bryner et al.)

[3] See the companion report, *Water Conservation, Efficiency and Reuse,* for details regarding the management periods.

California

California's ground water withdrawals are regulated in a variety of ways, most involving voluntary management by a local agency. The Groundwater Management Act provides a systematic procedure for certain local agencies to develop ground water management plans, but does not mandate that local governments develop such plans. The Local Groundwater Management Assistance Act of 2000 provides for funding and implementation of local ground water management plans. To qualify for state funds, ground water plans must include specific components that relate to interagency cooperation, monitoring and management of ground water levels, water quality protection, land surface subsidence, and changes in surface flow or surface water quality that directly affect ground water levels or quality or are caused by ground water pumping in the basin. (§ 10753.7(a)(1)) The funds may be used for feasibility studies, project design, or the construction of conjunctive use projects on a pilot or operational scale (Bryner et al.). Another funding mechanism used for ground water management is the 1985 Water Conservation and Groundwater Recharge Bond Fund, through which the legislature can appropriate money for loans to local agencies for ground water recharge projects (Ibid).

Florida

Florida regulates ground water withdrawals in several ways, primarily through consumptive use permitting, regulated by the state's five water management districts. Ground water levels can be protected by district-established minimum flows and levels, discussed above, however, to date, water management districts have generally established only minimum flows for surface water bodies. In addition, each water management district is required by statute (F.S. §373.0395) to develop a ground water basin resource availability inventory, including but not limited to the following elements:

- A hydrogeologic study to define the ground water basin and its associated recharge areas;
- Site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development;
- Prime ground water recharge areas;
- Criteria to establish minimum seasonal surface and ground water levels;
- Areas suitable for future water resource development within the ground water basin;
- Existing sources of wastewater discharge suitable for reuse as well as the feasibility of integrating coastal wellfields; and
- Potential quantities of water available for consumptive use.

Consumptive use permits (CUPs) are required for all water use beyond specified threshold amounts, with the exception of domestic consumption by individual users. In making permitting decisions, the water districts governing board's considerations include the proximity of the proposed water source to the area of use or application; economically and technically feasible alternatives to the proposed source, potential environmental impacts, and whether existing and anticipated sources of water and conservation efforts will be adequate to meet anticipated future needs.

St. Johns River Water Management District

Because Florida's water management relies significantly on work done through its five water management districts, it is instructive to include district policies as well as state-wide policies. St. John's River Water Management District is almost totally dependent on ground water for its water supply (SJRWMD, 2005). Consumptive use permitting regulations are complex, however, the most common situations that require a permit are if:

- Water is withdrawn from a well that measures six inches or more in diameter;
- Water to be withdrawn is expected to exceed an average of 100,000 gallons per day; or
- Pumping capacity equals or exceeds one million gallons per day.

Because ground water is so important for the district, detailed information is required to develop appropriate management strategies. The district's Division of Groundwater Programs administers the ground water monitoring network, which provides data used to evaluate current resources, identify long-term trends, detect potential problems, and develop management strategies. Planning strategies address the potential impacts of ground water withdrawals to surface water bodies, particularly wetlands.

South Carolina

South Carolina's Ground Water Use and Reporting Act is the most significant feature of the state's ground water policy. It provides legal authority for the Department of Natural Resources to designate Capacity Use Areas, "where excessive ground water withdrawal presents potential adverse effects to the natural resources or pose a threat to public health, safety, or economic welfare, or where conditions pose a threat to the long-term integrity of a ground water resource, including saltwater intrusion." When an area is designated as a Capacity Use Area (CUA), ground water use equal to or in excess of three million gallons per month must be permitted by the Department. In addition, new ground water users are required to issue pubic notice and allow a public comment period.

For ground water use outside of CUAs, well operators must notify the Department of Health and Environmental Control (DHEC) of the intent to construct a well or increase the capacity of existing wells at least 30 days prior to initiating action. Beyond this requirement, reporting of water use outside of CUAs has generally been voluntary. As of January 1, 2001, however, anyone withdrawing three million gallons per month of ground water or surface water must register with DHEC and report that use annually.

North Carolina

An important regulatory tool for ground water management in North Carolina is the Water Use Act of 1967, which allows the Environmental Management Commission to establish and regulate water withdrawals in Capacity Use Areas (CUAs) where aggregate uses of surface water or ground water threaten the sustainability of the resources or where water use in an area requires coordination to protect the public interest. (N.C. Statute § 143-215.11 et seq.) Within Capacity Use Areas, ground water withdrawals of more than 100,000 gallons per day require a permit from the Division of Water Resources, and surface water or ground water withdrawals of more than 10,000 gallons per day require annual registration.

Capacity Use Area No. 1 was established in 1976 and was regulated as such until 2002. It included all or parts of eight counties surrounding a phosphate mine in Beaufort County, where pumping affected ground water levels many miles away. In 2002, the Central Coastal Plain Capacity Use Area was delineated. It encompasses 15 counties where ground water withdrawals are currently being regulated in response to decades of declining aquifer levels.

Texas

Texas is divided into ground water management districts, designated and delineated by the Texas Water Development Board (§ 356.22 T.A.C.). The districts are required by Texas Water Code (§ 36.1071 § 36.1072) to submit to the executive administrator a management plan within two years after the creation of the district (§ 356.3 T.A.C.). Specific and quantifiable management objectives must be established, along with performance standards for each management objective. These goals, standards, and objectives are established by each district based on specific needs of that district. (§ 356.5 T.A.C.)

> "Following notice and hearing, the district shall, in coordination with surface water management entities on a regional basis, develop a comprehensive management plan which addresses the following management goals, as applicable (Texas Statutes § 36.1071):
>
> - Providing the most efficient use of groundwater;
> - Controlling and preventing waste of groundwater;
> - Controlling and preventing subsidence;

- Addressing conjunctive surface water management issues;
- Addressing natural resource issues;
- Addressing drought conditions; and
- Addressing conservation."

Summary of Ground Water Withdrawal Management in Other States

Based on the states surveyed, ground water use is managed predominantly through permitting requirements for large withdrawal amounts, typically 100,000 gallons per day or greater. Some states designate special zones for more restrictive management where ground water resource sustainability is threatened by overuse, reduced recharge, or both. Within these zones, ground water withdrawals generally must be permitted, and some states require additional management strategies and tools such as conservation measures and/or the requirement for developers to obtain a certificate of sufficient water supply to assure that proposed withdrawals can be sustained long-term.

Chapter 5

CONJUNCTIVE USE OF GROUND WATER AND SURFACE WATER

Conjunctive water use is a term used to describe a water supply derived from the complementary use of surface water and ground water. It is generally used to maximize the availability of ground and surface water under conditions that when one resource is limited, the other can, at least for a short period, provide the needed water supply. It also minimizes potential adverse effects of relying on a single source, either surface or ground water. Conjunctive use can take a variety of forms: it may be as simple as having withdrawal points at both surface water and ground water sources, or it may involve artificial recharge applications, including the use of recycled water and/or aquifer storage and recovery, described below. In some circumstances, ground water can be used to supplement surface reservoirs fed by streams. Conjunctive use is becoming more common as scientific investigations reveal interactions between surface water and ground water. The policy question to be addressed is under what conditions are tools such as aquifer recharge and aquifer storage and recovery reasonable options for increasing the availability of water.

Artificial Recharge of Ground Water

Artificial recharge is the planned, intentional introduction of water to an aquifer. Water may be recharged in a variety of ways, including direct injection, surface infiltration (commonly by spreading basins), subsurface infiltration, or land-use or hydrologic modifications that increase natural recharge. Existing aquifers may be recharged, or natural and man-made voids, such as mines or caverns, may be used for water storage. The most common methods of recharge are direct injection (more often used for confined aquifers) and surface infiltration (used generally for unconfined aquifers). Direct injection methods commonly provide more control over the quantity and quality of the water than indirect methods.

The objectives of most artificial recharge projects fall into one of the following categories (Colorado Geological Survey):

- <u>Manage water supply</u>, including short-term water supply management, seasonal storage, long-term storage for drought management, emergency supply, and conjunctive use;

- <u>Meet legal obligations</u>, such as providing augmentation water, supplementing downstream water rights, or facilitating compliance with interstate agreements;

- <u>Manage water quality</u> through the improvement of surface or ground water quality or treated wastewater disposal;

- Restore or protect aquifers by restoring ground water levels, limiting aquifer compaction and surface subsidence resulting from excessive ground water withdrawals, or mitigating saltwater intrusion; or

- Protection of the environment by maintaining wetland hydrology, enhancing endangered species habitat, or controlling the migration of ground water contamination.

Recharge Enhancement in Fractured Rock

As noted earlier, ground water provides most of the public water supply below Georgia's Fall Line, where aquifers provide large quantities of high-quality water. The northern half of the state is underlain by low-permeability rock, and ground water supply there is limited to that which slowly flows through fractures in the rock or pore spaces in the soil. While this is adequate for supplying many private wells, it has limited use for large-scale supply. It is possible, however, that techniques for recharging ground water in fractured rock have potential for increasing the yield in these zones.

The potential for artificial recharge in such aquifers has been tested in Southern Australia and South Africa.[4] Results in Australia showed that injected water may rapidly mix with native ground water and may be transmitted away from the injection well due to relatively high ground water flow through fractures. Nevertheless, additions of fresh surface water were found to improve the ground water resource. (Harrington et al.) A 2001 test of recharging low-permeability fractured rock in South Africa showed that a low yielding aquifer can be recharged at relatively high rates, and that this rate can double the sustainable yield. (Murray et al.)

Concerns About Artificial Recharge Applications

As aquifer recharge and aquifer storage and recovery have become more common, concerns have been raised by some scientists and environmental groups regarding the potential for artificial recharge (and its aquifer storage and recovery applications, described below), to affect the quality of native ground water or the aquifer structure itself, or to affect hydraulically connected surface water bodies. Depending on the characteristics of the native water and the injected water, the native water can be degraded by the introduced water or by disinfection byproducts, and chemical interactions can affect water quality and potentially cause changes in the geologic structure of the aquifer. Another concern is the potential for unintended geologic changes resulting from repeated recharge and withdrawals and the associated changes in subterranean pressure. Among the states that currently employ artificial recharge as a ground water management tool, these and other considerations are a primary aspect of the regulatory program, and recharge activities are generally permitted on a site-specific and carefully monitored basis in order to prevent unintended consequences. Challenges

[4] Potential application has also been considered in Georgia, by the Cobb County-Marietta Water Authority. See Chapter 5.

remain, however, for defining overarching rules and for addressing potential water rights issues related to aquifer recharge.

Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) is a method of storing water from an external source in an aquifer to be withdrawn at a later time for beneficial use. Most of its applications to date have been in permeable sand or limestone aquifers, but it may also serve beneficial purposes in fractured rock zones.

Use of either artificial recharge or ASR has been documented in at least 15 states, pilot systems exist in at least five additional states, and feasibility studies are being conducted in another six states. (AWWA, 2002) Because definitions vary from state to state, published numbers tend to vary, but according to once source (Purdue), the U.S. currently has approximately 1200 documented ASR and aquifer recharge wells, and an estimated total number of 1700 to 2000. About 90 percent of these wells exist in 10 states: Florida (500), Oklahoma (440), California (200), Nevada (110), Texas (67), South Carolina (55), Idaho (48), Oregon (16), Washington (12), and Colorado (9). (Ibid.)

Applications of Aquifer Storage and Recovery

Aquifer storage and recovery is most commonly used for seasonal storage in climates where precipitation does not coincide with water demand. The following purported applications for ASR were identified in a survey of ASR systems and regulatory programs in the U.S. (AWWA 2002):

Maximization of Storage:

- Seasonal storage (to take advantage of seasonal water availability and/or seasonal water demands, e.g. agriculture or tourism);
- Long-term storage (“water banking”);
- Emergency storage; and
- Diurnal storage (night-time storage to meet daytime demands).

Water Quality Management:

- Disinfection byproducts (DBPs) reduction;
- Water quality improvement (e.g. pH, iron and manganese, trihalomethanes, haloacetic acid (HAA), hydrogren sulfide);
- Nutrient reduction in agricultural runoff;

- Soil aquifer treatment of stored water; and
- Stabilization of aggressive water by storage in high calcium carbonate (e.g. limestone) aquifers.

Physical Management of the Aquifer:

- Restoration of ground water levels;
- Reduction of land subsidence;
- Prevention of saltwater intrusion;
- Enhancement of wellfield production;
- Prevention of leakage around salinity barriers; and
- Hydraulic control of containment plumes.

Management of Water Distribution System:

- Maintenance of distribution system flow; and
- Maintenance of distribution system pressure.

Ecological Benefits:

- Conjunctive used with surface water supplies to reduce stream flow diversions from habitat; and
- Temperature control for fish hatcheries.

Federal Regulations Related to ASR and Artificial Recharge

Part C of the Safe Drinking Water Act specifically requires regulation of underground fluid injection through wells and sets forth a series of Underground Injection Program (UIC) regulations. All applications of water artificially recharged into an underground structure, whether later recovered or not, are governed by the USEPA under its Underground Injection Control (UIC) Program Rules. The purpose of the rules is to protect all potential underground sources of drinking water and to prevent degradation of the quality of other aquifers adjacent to the injection zone that may be used for other purposes. The federal regulations divide injection wells into five categories: Classes I through V. Artificial recharge applications are included in Class V, which includes a variety of other injection practices (e.g. chemical waste injection), some of which can pose significant environmental threats. Underground Injection Control regulations allow individual states to implement the UIC program if the state standards are at least as stringent as federal standards. In 19 states, the USEPA directly implement UIC regulations, and in all other states, called Primacy States, state agencies implement and enforce the Class V UIC program (USEPA 1999).

The Safe Drinking Water Act articulates particular authorization requirements for each class of wells. If UIC conditions meet regulatory requirements, wells are authorized by rule and are not required to obtain a permit. Under the UIC program, aquifer recharge and ASR wells are required to submit inventory information and to operate the wells so that drinking water standards are not violated. Owners or operators of all injection wells are prohibited from injecting any fluids that contain contaminants into drinking water source wells if it would cause a violation of a drinking water regulation or cause adverse health effects (Ibid):

> Underground injection control endangers drinking water sources if such injection may result in the presence in groundwater which supplies or can reasonably be expected to supply any public water system of any contaminant, and if the presence of such contaminant may result in such system's not complying with any national primary drinking water regulation or may otherwise adversely affect the health of persons. (SDWA, Part C, paragraph 300H)

In developing the UIC regulations, the USEPA interpreted this statutory language to mean that water must meet primary drinking water standards prior to injection. Depending on the quality of the receiving water, exemptions to this requirement may be made. (Pyne)

Aquifer Recharge and Aquifer Storage and Recovery in Other States

States have taken varied approaches to ASR and aquifer recharge applications. Some states have developed stringent requirements, while others rely largely on federal regulations. Some treat ASR and aquifer recharge identically, since ground water quality is a common concern, while others have specific rules for ASR. If treated wastewater is used for aquifer recharge, state agencies may require permitting under reclaimed water rules. Aquifer storage and recovery wells are permitted by rule in some states, under specified criteria (California, Colorado, Idaho, if less than 18 feet deep, Oklahoma, and Texas), while in other states (Florida, Idaho, if more than 18 feet deep, New York, Oregon, South Carolina, and Washington) ASR wells must be individually permitted. (AWWA)

Florida

Because Florida's topography prohibits the widespread use of surface water reservoirs, ground water management is especially important for sustaining the state's water supplies. Aquifer storage and recovery has been implemented in Florida for more than 20 years, with the first well constructed in 1983 in Manatee County. To date, all ASR facilities in Florida have been designed to provide storage for public supply, and all are required to treat water to primary drinking water standards prior to injection. More recently, ASR has been included in an ambitious and controversial aspect of the Comprehensive Everglades Restoration Plan (CERP), with 333 wells planned to eventually provide water storage needed for ecological restoration of the Everglades system. This is the most extensive ASR project ever proposed worldwide, as part of a $7.8 billion effort.

Florida has more ASR facilities than any other state, with almost 150 wells operated by more than 40 separate water facilities. In addition, a number of facilities have applied for permits, have wells under construction, or are in the testing process. Much of Florida's ASR development is in the southern half of the state, where the Floridan aquifer becomes quite brackish as it dips hundreds of feet below the land surface. It has become an important water management tool in counties where public water supply demands have threatened the sustainability of ground water resources. Use of ASR in Florida has thus far been for the purpose of public water supply storage.

Source water for Florida's ASR facilities is generally either surface water or potable ground water withdrawn from other aquifers, and some facilities use a combination of the two sources. Water injected for future recovery is required to meet water quality standards, and injected water may be treated drinking water, reclaimed water, or water from ground water sources that is pure enough not to require treatment.

Districts are authorized by statute to use ASR for water supply. In general, ASR facility permits are issued for a period of five years, and may be renewed indefinitely. In the mid-1990s, a rule change allowed utilities to operate ASR facilities under a letter of authorization from DEP rather than a permit, under the condition that a facility had conducted enough cycle testing to show that the system is operating as designed and there are no problems with water quality or recoverability. (A cycle is the complete recharge and recovery of a certain amount of water.) A letter of authorization does not expire as long as the facility makes no changes in its operation, but DEP generally requires some level of reporting to ensure compliance with standards.

ASR and Aquifer Recharge in the St. Johns River Water Management District

St. John's River Water Management District (WMD) lies just to the south of Georgia's coastal border and, because of similar topography, water availability, and population pressures, it provides a useful comparison for potential use of ASR in Georgia's coastal region. St. John's River WMD identified the need to use additional surface water in its 2000 water plan, and because of high seasonal variability in both quality and quantity of surface water, the district considers ASR to be a reasonable option. The district has committed $11.82 million for ASR construction and testing for fiscal years 2002-2006. Within the district, the City of Cocoa's ASR wellfield has been operational since 1987 and has expanded its system to 10 wells, and Palm Bay has an ASR well that has been operational since 1989.

ASR projects within the St. John's River WMD can be initiated in one of two ways: the district may solicit development of ASR by a water supply facility in an effort to meet long-term water supply goals, or a water supply facility may initiate an ASR project. The district requires the following tasks of the facility prior to the approval for operation:

- Development of an ASR construction and testing program plan;
- Establishment of objectives and responsibilities;
- Collection of site-specific data and develop preliminary system design;
- Design of ASR pilot system, including well and wellhead facilities;
- Application for regulatory permits;
- Construction, monitoring, and testing of system;
- Startup and training;
- Large cycle operational monitoring and evaluations (to continue during the first two to three years of operation to make necessary adjustments to the sytem); and
- Peer review of ASR team members.

The St. John's River Water Management District has also developed the Central Florida Aquifer Recharge Enhancement Program, a three-phase program for maximizing local recharge to the Floridan aquifer. Phase one involves artificial recharge demonstration projects, which are in progress. In phase two, which has taken place concurrently with phase one, the district evaluates the feasibility of aquifer recharge enhancement approaches such as the placement of storm water and reclaimed water in rapid infiltration basins and naturally occurring closed depressions in upland recharge areas. Phase two work has been completed, and the first phase three (program implementation) projects are underway. Projects are planned for Orange County, the City of Apopka, the City of Orlando, the City of Sanford, and Seminole County.

Oregon

Oregon's conjunctive water use program includes both artificial recharge and aquifer storage and recovery.

Artificial Recharge

"The appropriation of water for the purpose of recharging ground water basins or reservoirs is declared to be for a beneficial purpose." (ORS 537.135) Permits for such appropriation may be granted by the Water Resources Department, subject to the following conditions.

- The applicant must meet standards developed by the Water Resources Commission.

- The water Resources Department determines whether the proposed ground water recharge project would impair or be detrimental to the public interest.

- The supplying stream must have an established minimum perennial stream flow established for the protection of aquatic and fish life. (This requirement may be waived by the Department of Fish and Wildlife if a minimum perennial stream flow is not otherwise required.)

The Oregon Water Resources Department issues permits to appropriate water for artificial recharge projects, and a secondary ground water permit is required to pump the recharged water out of the aquifer. In processing applications for permits, the Department evaluates whether the diversion of water for recharge and the use of recharged water are in the public interest and if the proposed recharge project will yield a net increase in the amount of water available in the aquifer. Water users recharging ground water and using recharged ground water are required to maintain an accounting of the quantities of water stored and used. Water use may not exceed the amount of water injected into the aquifer after accounting for seepage and other losses.

Aquifer Storage and Recovery

Oregon statutes specifically address standards for permitting and administering aquifer storage and recovery:

> "The Legislative Assembly declares that aquifer storage and recovery is a beneficial use inherent in all water rights for other beneficial uses. Aquifer storage and recovery is the storage of water from a separate source that meets drinking water standards in a suitable aquifer for later recovery and not having as one of is primary purposes the restoration of the aquifer." Under the statutory provisions, injection of water into aquifers:
>
> - Shall not be considered a waste, contaminant, or pollutant;
>
> - Shall be exempt from the requirement to obtain a discharge permit or a concentration limit variance from the Department of Environmental Quality;
>
> - Shall comply with all other applicable local, state, or federal laws; and
>
> - May be located within or outside an urban growth boundary in conformance with land use laws. (§ 537.532 (1)) [Urban growth boundaries are used in some parts of Oregon to control sprawling suburban development.]

Under Oregon Administrative Rules, ASR testing programs require a limited license to be issued by the Water Resources Department, and after completion of the testing program of up to five years, the applicant may apply for a permanent ASR permit. Each aquifer storage and recovery limited license or permit must include conditions to minimize, "to the extent technically feasible, practical and cost-effective, the concentration of constituents in the injection source water that are not naturally present in the aquifer." The Water Resources Department may also impose limits on certain constituents in the injection water if, based on valid scientific data, the constituents will interfere or pose a threat to the maintenance of the water resources of the state for present or future beneficial uses.

Tigard, Oregon

The city of Tigard began its ASR program in 2001 with an ASR well at the Canterbury Reservoir Site, and the program's success prompted the city to develop a second well, completed in 2005. Use of ASR enabled Tigard to postpone the construction of additional water storage facilities, reduces strain on surface water sources during summer months, reduces the cost of water provision (as water purchased for ASR injection is less expensive than wholesale water prices during the summer), and provides emergency water supplies. (City of Tigard, 2005)

South Carolina

South Carolina began using ASR in the late 1980s, and wells have now been constructed in Beaufort, Mount Pleasant (a suburb of Charleston), Myrtle Beach, and on Kiawah Island. The City of Orangeburg is conducting a pilot project. The main impetus for using ASR in South Carolina has been the need for seasonal storage. Like Georgia, South Carolina has abundant precipitation, but seasonal and daily peaks, especially in coastal areas with high population growth and tourist demand, typically require expansion of treatment plants to meet increasing water needs. The use of ASR has reduced the need for such expansion and has provided longer-term storage as well, to help prevent water shortages during dry periods.

Legal authority for the use of ASR comes from South Carolina's Underground Injection Control Regulation (R.61-87), which provides authority for the Department of Health and Environmental Control to issue construction and operation permits for ASR wells and other underground injection wells.

Each ASR facility must obtain separate permits from two divisions of DHEC. The Underground Injection Control division issues permits for well construction and, after specified conditions have been met, for operational permits. This permit concentrates primarily on the storage and retrieval process. The Water Supply division issues permits for both construction and operation, focusing on water withdrawal from ground or surface water sources.

The Department establishes permitting requirements that are specific to each ASR facility. At Beaufort, for instance, the facility was required to submit the following information:

- A water-quality analysis of treated water at the existing plant and native ground water from the Upper Floridan aquifer to determine if any adverse geochemical changes were likely to occur;
- A geochemical computer model to analyze the information above, along with geochemical logs, drilling logs, and cutting descriptions;
- A completed cycle testing program; and
- Information from an observation well, including aquifer transmissivity, storativity, and all raw pumping test data observations and calculations.

Permitting was then subject to the following conditions.

- The chemical, physical, and bacterial quality of the well water must meet USEPA primary and secondary standards or treatment may be required. The water must be evaluated for corrosivity to comply with the Lead and Copper Rule.
- Before an approval to "Place Into Operation" could be issued for the proposed construction, a comprehensive operation and maintenance (O&M) manual was to be developed for all facility processes.
- All required chemical parameters were to be tested, with results shown to be below current maximum contaminant levels established in the federal Clean Water Act. Results must be submitted and approved by DHEC's Water Supply Permitting division prior to final inspection.
- Due to the well withdrawing a mixture of injected water and native ground water, it requires a Capacity Use Permit.

Beaufort-Jasper Water and Sewer Authority

Beaufort-Jasper Water and Sewer Authority, first permitted to operate an ASR well in 1999, operates two ASR wells for recharge and recovery and one well for recovery only. Source water for injection is the Savannah River, which is transported through a 7-mile earthen canal. The water is treated to secondary drinking water standards and stored in the Upper Floridan aquifer. Water is typically injected during October and recovered during the summer months.

Texas

The Texas Commission on Environmental Quality is required by statute (§ 11.153) to investigate the feasibility of storing water in various types of aquifers around the state by encouraging the issuance of permits for demonstration projects for the storage and subsequent retrieval of appropriated water. Upon completion of each pilot project, the Commission and the Texas Water Development Board jointly prepare a report evaluating the success of the project and provide copies of the report to the governor, the lieutenant governor, and speaker of the House of Representatives. The Board must conduct additional studies and investigations, as necessary, to determine the occurrence, quantity, quality, and availability of other aquifers in which water may be stored and retrieved for beneficial use, in the following order of priority (§ 11.155):

1. The aquifers described in Section 11.153;

2. Areas designated by the Commission as "priority ground water management areas;" and

3. Other areas of the state in a priority to be determined by the Board's ranking of where the greatest need exists.

Within the provisions of federal statutes, each district develops its own rules regarding aquifer recharge and ASR. When applying for a permit to store water in a ground water reservoir or subdivision of a ground water reservoir, an applicant must provide a copy of the application to each ground water conservation district. The applicant must cooperate with each district and comply with the rules governing the injection, storage, and withdrawal of water that are adopted by each district that has jurisdiction over the reservoir or reservoir subdivision. (Texas Statutes § 11.154 (a)(1)) In evaluating a project for permit approval, the Commission must consider whether:

- ➢ The introduction of water into the aquifer will alter the physical, chemical, or biological quality of native ground water to a degree that the introduction would:

    - render ground water produced from the aquifer harmful or detrimental to people, animals, vegetation, or property; or

    - require treatment of the ground water to a greater extent than the native ground water requires before being applied to that beneficial use;

- ➢ The water stored in the receiving aquifer can be successfully harvested from the aquifer for beneficial use; and

- ➢ Reasonable diligence would be used to protect the water stored in the receiving aquifer from unauthorized withdrawals to the extent necessary to maximize the permit holder's ability to retrieve and beneficially use the stored water without experiencing unreasonable loss of appropriated water. (§ 11.154(c))

The Commission may also consider a variety of other relevant facts, such as the depth and location of the aquifer, the nature and extent of surface development and activity above the stored water, the permit holder's ability to prevent unauthorized withdrawals, and other specific information.

Hueco Bolson Aquifer Recharge

The Hueco Bolson aquifer provides about 65 percent of the water supply for El Paso, Texas. Since 1985, the city has injected reclaimed water from the Fred Harvey water reclamation plant into a three-mile long series of 10 injection wells, located about a mile from the treatment plant. The reclaimed water must meet drinking water standards before it is injected into the aquifer. Prior to this recharge project, water levels in the aquifer were declining at a rate of two to six feet per year, yet ground water models indicated that in the five-year period after the recharge project began, ground water levels were eight to ten feet higher than they would have been without the recharge. (CDM 2001, p. 7-26, 7-27)

Washington

Aquifer storage and recovery facilities in Washington are authorized by statute. Reservoir Permits (RCW 90.03.370) establishes procedures for the Department of Ecology to assess and permit ASR projects. It allows for standards for review and for mitigation of any adverse impacts of ASR projects to be established by the department by rule. Applicants must initiate project studies for proposed ASR facilities, which are reviewed by the Department. In the 2000 session, the Washington State Legislature expanded the legal definition of "reservoir" to include "any naturally occurring underground geological formation where water is collected and stored for subsequent use as part of an underground artificial storage and recovery project." The statute defines "underground artificial storage and recovery project" as "any project in which it is intended to artificially store water in the ground through injection, surface spreading and infiltration, or other department-approved method, and to make subsequent use of the stored water."

The Department of Ecology assesses projects and issues permits in accordance with Washington Administrative Code 173-157 (Underground Artificial Storage and Recovery), authorized and required by RCW 90.03.370. This rule establishes standards and review of ASR proposals and mitigation of any adverse impacts in the following areas:

- Aquifer vulnerability and hydraulic continuity;
- Potential impairment of existing water rights;
- Geotechnical impacts and aquifer boundaries and characteristics;

- Chemical compatibility of surface and ground waters;
- Recharge and recovery treatment requirements;
- System operation;
- Water rights and ownership of water stored for recovery; and
- Environmental impacts.

Lakehaven Utility District

The Lakehaven Utility District, located in the city of Federal Way, has one operational ASR well that has been operational as a pilot since 1991, and the district is planning as many as 27 additional ASR wells as part of the Optimization of Aquifer Storage for Increased Supply (OASIS) project. The OASIS project is intended to optimize water supplies by storing excess winter water from either ground or surface water sources and making it available when customer demand peaks between May and September. The district is currently drawing water from the Redondo-Milton Channel aquifer, which is relatively shallow and subject to seasonal natural recharge, and injecting water into the sand and gravel Mirror Lake aquifer, considered the storage aquifer. Three wells provide recovery water and one well is a recharge and production (recovery) well. Other potential sources of recharge water are neighboring rivers, the Green and Cedar rivers. If surface water is used for recharge, pre- and post treatment are expected to be required.

Other Conjunctive Use Programs

Recognizing the interrelated nature of ground water and surface water management, some states have developed additional strategies for conjunctive management of water resources.

California

The California Department of Water Resources has implemented, through its Conjunctive Water Management Branch, several integrated programs designed to increase state-wide water supply reliability. The programs include studies of ground water basins, identifying management strategies, and designing and constructing specific conjunctive use projects. The Branch has established partnerships with local agencies, and provides funding for the following:

1. Project management and technical staff to assist in planning processes;
2. Public outreach and policy development to foster information dissemination and program development;
3. Facilitation services to promote stakeholder involvement;

4. Contracts for engineering and hydrogeologic services to conduct feasibility evaluations; and

5. Contracts for drilling services to support data collection efforts and development of monitoring programs.

The conjunctive use program emphasizes partnerships with local agencies and stakeholders to share technical information and costs for developing locally controlled and managed projects. The Branch has partnered with 16 local agency groups, providing them with financial assistance for ground water monitoring, storage, recharge, water banking, and other projects.

Idaho

The Idaho legislature recognizes the hydraulic connection between the Eastern Snake Plain Aquifer and the Snake River and its tributaries, and has included conjunctive administration of surface and ground water in its statutes. House Bills 848 and 849 require conjunctive administration of water rights (under the state's prior appropriation doctrine), and holders of junior priority water rights must provide mitigation to the holders of senior priority water rights from hydraulically connected surface water sources to the extent of material injury caused by water withdrawal and use. Executive Order No. 2004-02 also recognizes the need for conjunctive management of ground and surface waters, and directs the Department of Water Resources, in consultation with the Governor, to develop a long-term management strategy for conjunctive management. Among other requirements, the plan must initiate rulemaking and modifications to existing conjunctive management rules, explore constructing additional storage for surface water, and implement land exchanges or acquisition of federal lands suitable for recharge. Idaho Administrative Code (37.03.11) provides the basis for designation of areas of the state that have a common ground water supply, and establishes procedures for creating new districts as ground water management areas and for granting ground water and surface water withdrawal rights. An area is determined to have a common ground water supply if:

- The ground water source supplies water or receives water from a surface water source;

- Diversion and use of water from the ground water source will cause water to move from the surface water source to the ground water source; or

- Diversion and use of water from the ground water source has an affect on the ground water supply available to persons who divert and use water from the same ground water source.

Oregon

Ground water withdrawals in Oregon are generally regulated under the basin program (See Oregon instream flow summary), under which ground water and surface water are managed conjunctively within river basins. Oregon's Ground Water Act of 1955 authorizes the Water Resources Department to regulate ground water withdrawals based on its hydraulic connectivity with surface water. The Department is required to determine whether wells produce water from a confined or unconfined aquifer. All wells located a horizontal distance less than one-fourth mile from a surface water source that produce water from an unconfined aquifer will be assumed to by hydraulically connected to the surface water source, unless the applicant or appropriator provides satisfactory information or demonstration to the contrary. (OR. ADMIN. R. 690-009-0040(4)).

Basin program rules require that applications for ground water use are examined for the potential for interference with existing wells and with surface water. In order to manage ground water use in areas of concern, the Water Resources Commission may declare certain areas as "Critical Groundwater Areas." These areas are defined by pumpage that exceeds the natural long-term replenishment of the aquifer, and once designated, existing and future withdrawals may be restricted. There are currently six Critical Groundwater Areas in Oregon.(Oregon Water Rights Fact Sheet)

Summary of Conjunctive Use in Other States

Based on the states surveyed, ground water use is managed predominantly through permitting requirements for large withdrawal amounts. Some states designate special zones for more restrictive management where ground water resource sustainability is threatened by overuse, reduced recharge, or both. Although states appear to increasingly acknowledge the connectivity between ground water and surface water sources, it is less common to find specific mechanisms for conjunctively managing water use. Ground water recharge and aquifer storage and recovery are becoming more common across the country as conjunctive use tools, with up to 2000 wells estimated to exist in the U.S. Ninety percent of these are concentrated in 10 states: Florida, California, Nevada, Texas, South Carolina, Oklahoma, Oregon, Washington, and Colorado, although several other states are developing or expanding existing recharge and/or ASR programs.

Most ASR wells are used to maximize water availability, especially for equalizing periods of abundant precipitation with periods of high demand. Projects are generally permitted individually based on local hydrogeologic conditions and water supply needs. Following detailed analysis of the potential for a well, permits are commonly issued for an initial pilot project. Upon completion of successful pilot projects, evaluations are performed to determine whether to permit ongoing operation. Permit applications typically require detailed information, including the hydrogeologic characteristics of the aquifer to be used for storage; the chemical compatibility of native ground water and injected water; water treatment planned; recharge and recovery rates and other operational information; and environmental impacts, including impacts to the supplying stream or aquifer.

Chapter 6

GROUND WATER MANAGEMENT IN GEORGIA

Georgia manages ground water use through the reasonable use doctrine, which basically allows landowners the right to pump ground water from underneath their property to the extent that their use is reasonable relative to other users. In 1972, the state implemented a permit system whereby withdrawals of more than 100,000 gallons per day, on average, require permitting by EPD, with reasonable use as the guide for permitting.

Georgia's ground water resources are generally abundant below the Fall Line; however, overdrafts and periods of drought have brought declines in aquifer levels and, along the coast, saltwater intrusions. It has become clear that, like surface water resources, ground water in Georgia must be managed for long-term sustainability. As ground water modeling and studies of surface water-ground water interactions increase our understanding of hydrogeologic systems, new opportunities become available for managing surface water and ground water in a holistic and systematic manner.

Georgia Statutes and Rules Related to Ground Water Use and Management

The **Georgia Groundwater Use Act of 1972** (OCGA 12-5-90 et seq.), implemented by EPD Rules, Chapter 391-3-2, Groundwater Use, establishes a permitting system for the use of ground water in excess of 100,000 gallons per day. The fundamental policy statement of the act is as follows:

> The general welfare and public interest require that the water resources of the state be put to beneficial use to the fullest extent to which they are capable, subject to reasonable regulation in order to conserve these resources and to provide and maintain conditions which are conducive to the development and use of water resources.

The Act allows the Director of EPD to deny a permit if the proposed use is "contrary to the public interest." (OCGA § 12-5-96(c)(4)) The director must consider the following in evaluating permit applications:

- The number of persons using an aquifer and the necessity of their uses;
- The nature and size of the aquifer;
- The physical and chemical nature of any impairment of the aquifer;
- The probable severity and duration of such impairment;
- The injury to public health resulting from such impairment if not abated;

- The kinds of business or activities to which proposed uses are related;
- The importance and necessity of those uses;
- Any detriment posed by those uses;
- Any reduction of flows in watercourses or aquifers;
- Provisions of a regional water development conservation and sustainable use plan, if available; and
- Other relevant factors. (OCGA § 12-5-96(d))

The act applies to all ground water users. Permit holders, with the exception of permits for farm and individual domestic use, must report quantity, source, and nature of use semiannually to EPD.

The Groundwater Use Act also guides the development of regional water plans:

> The division or a party designated by the division may develop a regional water development and conservation plan for the state's major aquifers or any portion thereof. Such plan shall include water development, conservation, and sustainable use and shall be based on detailed scientific analysis of the aquifer, the projected future condition of the aquifer, and current demand and estimated future demands on the aquifer…Upon adoption of a regional plan, all permits issued by the division shall be consistent with such plan. The term of any permit and all provisions of any permit for which an application for renewal is made prior to the completion of any regional plan shall be extended at least until the completion of such plan. (OCGA 12-5-96(e))

The **Georgia Water Well Standards Act of 1985** (OCGA 12-5-120) provides standards for the construction, operation, maintenance, and abandonment of wells and bore holes. It also requires that all well drillers have a state license.

The **Georgia Water Quality Control Act** (OCGA 12-5-20) gives EPD the authority and the responsibility to regulate the withdrawal, diversion, or impoundment of waters of the state and to require the use of reasonable methods after having considered the technical means available for the reduction of pollution and economic factors involved to prevent and control the pollution of waters of the state." (O.C.G.A. § 12-5-21 (b)) Also authorized by the Act, the Director of EPD may identify underground sources of drinking water, and unless the Director exempts an aquifer or a portion of an aquifer, all aquifers are considered underground sources of drinking water and are protected as such. The Act contains provisions for regulating Class V underground injection wells (used for artificial recharge and aquifer storage and recovery, among other purposes).

Underground Injection Control

Wells constructed for ASR purposes qualify as Class V wells under EPD rules for Underground Injection Control. Applications for constructing and operating a new Class V well must include at least the following:

- Map showing the location of each existing and proposed injection well at the facility;
- Diagram of construction details of existing and proposed injection well(s);
- Proposed or existing injection rate and injection pressure or gravity flow; and
- The chemical, physical, and radioactive characteristics of the fluid to be injected.

An ASR permit may also be subject to special permit conditions required by EPD, such as requirements for well construction and operation, monitoring, and reporting. Permits may be issued for a period of up to 10 years. Standards and criteria for Class V wells include the following:

- Class V injection wells must be sited, constructed, and maintained to ensure that movement of injected fluids will not contaminate an underground source of drinking water;
- Except for remediation wells, the injected fluid cannot contain any chemical constituents that exceed any Maximum Contaminant Levels (MCL) identified in Rule 391-3-5-.18;
- Except for remediation wells, no Class V well may be located within the inner management zone of any wellhead protection area;
- Wells shall be constructed by a licensed well contractor in the State of Georgia in accordance with the provisions of the Water Well Standards Act (1976) and Georgia Laws (1977);
- Well casing must extend at least five feet into the injection zone unless otherwise specified by EPD; and
- The annular space around the entire length of the casing must be grouted and sealed to prevent pollution by surface waters, other formation fluids, or pollutants into the formation above the injection zone.

Wellhead and Source Water Protection

The 1986 Amendments to the Safe Drinking Water Act, Section 1428, provide greater protection for underground sources of drinking water by requiring each state to prepare a

Wellhead Protection Program to be reviewed by the U.S. Environmental Protection Agency. Georgia's program delineates two zones of protection, as follows:

- Within the *Control Zone*, the well owner must control all activities so that there are minimal sources of potential pollution in the immediate vicinity of the well bore. This zone extends outward from the well bore 25 feet for pervious surface materials and 15 feet for impervious surface materials, such as concrete.

- Within the *Management Zone*, certain potential pollution sources are prohibited or certain activities must be performed to comply with rules specified in Chapter 391-3-5-.40. The size of the management zone is typically 500 feet in radius but may vary according to aquifer type, aquifer hydraulic conductivity, pumpage rate, hydrologic province, and proximity to recharge.

Potential ASR Application in Georgia's Fractured Rock Aquifers

In 1990, Cobb County-Marietta Water Authority contracted a feasibility study to assess the potential for using ASR as a water management tool to meet future water demands and to assess how many years ASR could enable the Authority to defer water treatment plant expansion. The evaluation was divided into two phases. The first phase entailed assessment of geologic and hydrologic data; local ground water quality and use data; treated and raw water quality data; and historical water demand data. The consulting firm, CH2M Hill, contracted with HydroVisions of Stone Mountain, Georgia, to complete hydrogeologic studies, and included Layne Atlantic Company in the project team to provide expertise in the use of hydrofracturing as a well stimulation and development technique (CH2M Hill, p. 1-9).

Hydraulic fracturing, or hydrofracturing, is described in the report as a process that involves "propping" open a naturally fractured rock formation with sand to greatly enhance its permeability. "Under controlled pressures and volumes, various sizes of spherical sand and a driving solution are injected into the well and into a defined rock zone. The pressure is then slowly released, creating additional permeability from a much larger drainage area."

The report points out that ground water was not extensively developed as a water source in Cobb County because of a low percentage of high-yielding wells, thus the success of an ASR facility would depend on well location, construction, and/or stimulation techniques that would optimize well yields. Guidance for well siting included the following passage:

> Because groundwater in this area occurs primarily along joints and fractures, intersecting the joints with the well bore is essential to groundwater production. Ideally, the more joints and fractures intersected by the well bore, the greater the reservoir of groundwater available to the well. Cressler et al. (1983) noted increased yields from wells located where topographic features indicate the presence of major joints, and especially joint intersections. Additionally, if a

> saturated layer of unconsolidated soil or sediment was overlying the area where a joint or joint intersection cropped out, a constant recharge supply of groundwater would keep the fractures saturated.

The report later indicates that the same conditions required to make ASR feasible, porosity and permeability, may create conditions detrimental to successful ASR operation:

> Fractures dipping downward from the land surface indicate that groundwater may have a flow path to and from the storage zone. In its worst case, this positive feature theoretically could also serve as a contamination pathway. (However, contamination sources were not expected in the locations proposed for test wells.)

The results of the study indicated that the Authority could potentially use ASR to help meet demands for at least several years without constructing additional treatment facilities, and that after that time, ASR would allow the maximization of additional raw water allocations. The most likely scenario for the use of ASR would be water storage during low-demand periods (November through March) and recovered during high-demand periods (May through July).

Although the first evaluation phase indicated potential for the use of ASR, only the first phase was completed. Further testing of this type of ASR application is not known to have taken place in Cobb County or elsewhere in the state.

Potential for Aquifer Storage and Recovery in the Coastal Plain

Aquifer storage and recovery has most commonly been used in limestone aquifer systems similar to those underlying Georgia's coastal plain. The Floridan aquifer is the aquifer that is generally used for aquifer storage and recovery in Florida and South Carolina, and is the aquifer that has been considered for its use in Georgia. It underlies an area of about 100,000 miles, and is one of the most prolific aquifers in the world. The major recharge zones for the Floridan aquifer are along the upper edge of the aquifer in Georgia and the panhandle of Florida, and two areas of central and north central Florida. The Lower Floridan aquifer is separated from the Upper Floridan by a confining layer that varies in thickness, and this aquifer has been considered for withdrawals as an alternative to the Upper Floridan.

The use of ASR in Georgia's coastal plain was suggested in 1996, when a private company presented a plan for using the technique for municipal water supply. The plan was denied for a variety of reasons, including that a strategy for managing salt water intrusion along the coast had not yet been completed, and the knowledge of ground water science in the region was seen by some to be inadequate to safely implement an ASR program. As a result, legislation that acted as a moratorium prevented the use of ASR in Georgia's Floridan Aquifer in counties governed by the coastal zone management program through 2002, and this was later extended to December 31, 2009. A specific ASR project has not been formally proposed in Georgia since then, but it is recognized that its use will require careful site-specific investigations to protect the high quality of the ground water in the region. (Seerley)

Potential for Other Conjunctive Use in Georgia

Numerous opportunities may exist in Georgia for conjunctive use of ground water and surface water, especially in south Georgia, where both water sources provide relatively plentiful water supplies. Aquifer systems in south Georgia may provide opportunities for seasonal or long-term storage through artificial recharge or aquifer storage and recovery. Conjunctive use may also include complementary use of ground and surface supplies and/or storage of ground water in surface water reservoirs. For example, in a location where ground water pumpage is relatively slow, a farmer may withdraw ground water for storage in a pond that may also be fed by surface water flow, allowing water to be pumped at adequate irrigation rates. Conjunctive use may also afford additional options for using reclaimed water as a tool to extend local water supplies.

Chapter 7

CONCLUSIONS

Georgia enjoys a relatively plentiful water supply, yet the availability of our water resources varies both seasonally and regionally. When our natural water complexity is considered with regard to increasing water demands, it becomes apparent that Georgia must approach water management in a thoughtful, comprehensive and coordinated manner based on the best science we have.

The legal foundation upon which water management in Georgia rests is the set of statutes enacted by Congress and the Georgia General Assembly. Collectively, this body of law has set two general water-related goals for us to meet:

- Protect public health and environmental quality; and

- Meet future needs while protecting aquifers, instream uses and downstream users.

We face significant challenges, however, in meeting these goals. First, inconsistencies and lack of coordination can hamper meeting at least some of our goals. Laws are passed by different legislative bodies at different times, with different motivations, and for different purposes. They are implemented by federal and state agencies with varying degrees of financial, technical, and managerial capacity. Specific water-related decisions reflecting policies and programs are made by local government officials, private sector institutions, and the general public. Assuring coordination and avoiding inconsistencies in such a situation may be desirable but rarely occurs, at least to the extent necessary to fully meet the goals of the statutes.

A second challenge in meeting our water goals is that laws are not static. They reflect the values we attribute to water resources at a particular point in time. These laws also reflect the world as we know it—or can reasonably expect it to become—at the point in time when we conceive them. Congress and the General Assembly can amend these statutes, but they do not always change in lock step with a shift in citizens' goals, aspirations, perceptions, activities, and knowledge related to water resources.

To better address the water challenges we face, the Comprehensive State-wide Water Management Planning Act was passed by the Georgia General Assembly during the 2004 legislative session. This law directs the Environmental Protection Division of the Georgia Department of Natural Resources to develop a comprehensive state water management plan and creates the Georgia Water Council composed of legislators, legislative appointees and agency heads with water-related responsibilities to oversee the development of the plan. The plan is to be provided to the Council in July 2007 for its review and adoption and presented to the General Assembly for consideration in the 2008 legislative session.

The first iteration of the comprehensive water management plan will focus on four key policy objectives:

1. Minimizing withdrawals of water by increasing conservation, efficiency, and reuse;

2. Maximizing returns to the basin through reducing interbasin transfers and limiting use of septic tanks and land application of treated wastewater where water quantity is limited;

3. Meeting instream and offstream water demands through storage, aquifer management and reducing water demands; and

4. Protecting water quality by reducing wastewater discharges and runoff from land to below the assimilative capacity of the streams.

This report is the third of four policy documents to focus on these objectives; specifically on meeting offstream needs while maintaining instream values. Policy questions inherent in meeting offstream and instream uses include the following.

Instream Flow Policies

- What can the state do to move toward more protective minimum flows?

- Beyond minimum flows, what components of the flow regime support the values we attach to rivers and streams? What policy tools can be used to protect those components of flow?

Reservoir Policies

- Under what conditions should the State of Georgia support the use of reservoirs and for what hydrologic, environmental, or water resource purposes?

- Under what conditions should the state financially support the construction of reservoirs?

Ground Water Withdrawal Management

- How should the State respond when trends show that a ground water resource is stressed?

Conjunctive Use Policies

- Under what conditions are tools such as aquifer recharge and aquifer storage and recovery reasonable options for increasing the availability of water?

Long-term sustainability of our water resources will require a holistic approach that considers the natural flow regimes, withdrawals, and storage of surface water as well as ground water withdrawal, ground water-surface water interactions, and conjunctive use of ground and surface water sources. Combined with conservation practices, thoughtful management and storage of ground and surface water resources will ensure that human needs are met while natural systems are kept healthy and continue to provide crucial environmental services.

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APPENDIX A

INSTREAM FLOW POLICY IN SELECTED OTHER STATES

Florida

Minimum flows and levels (MFLs) are required by Florida Statutes and adopted as water management district rules (Chapter 40C-8, Florida Administrative Code) by the governing boards of water management districts. MFLs apply to decisions affecting water withdrawal permit applications, declarations of water shortages, and assessments of water supply sources. (SJRWMD fact sheet)

Florida Statutes 373.042 establishes statewide standards for minimum instream flows and groundwater levels:

1) Within each section, or the water management district as a whole, the department or the governing board shall establish the following:

    a) Minimum flow for all surface watercourses in the area. The minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area.

    b) Minimum water level. The minimum water level shall be the level of groundwater in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources of the area.

    The minimum flow and minimum water level shall be calculated by the department and the governing board using the best information available. When appropriate, minimum flows and levels may be calculated to reflect seasonal variations. The department and the governing board shall also consider, and at their discretion may provide for, the protection of nonconsumptive uses in the establishment of minimum flows and levels.

2) …By November 15, 1997, and annually thereafter, each water management district shall submit to the department for review and approval a priority list and schedule of establishment of minimum flows and water levels for surface watercourses, aquifers, and surface waters within the district. …The priority lies shall be based upon the importance of the waters to the state or region and the existence of or potential for significant harm to the water resources or ecology of the state or region, and shall include those waters which are experiencing or may reasonably be expected to experience adverse impacts.

4) Upon written request to the department or governing board by a substantially affected person, or by decision of the department or governing board, prior to the establishment of a minimum flow or level and prior to the filing of any petition for administrative hearing related to the minimum flow or level, all scientific and technical data, methodologies, and models, including all scientific ant technical assumptions employed in each model, used to establish minimum flow or level shall be subject to independent scientific peer review.

Section 373.0421 recognizes exclusions to the establishment of instream flows and levels, including the following statement:

> The Legislature recognizes that certain water bodies no longer serve their historical hydrologic functions. The Legislature also recognizes that recovery of these water bodies to historical hydrologic conditions may not be economically or technically feasible, and that such recovery could cause adverse environmental or hydrologic impacts. (F.S. 373.0421 (1)(b))

The same section provides that if the existing flow or level in a water body is below, or is projected to fall within 20 years below, the applicable established minimum flow or level, the Department or Governing Board…shall "expeditiously implement a recovery or prevention strategy," which includes the development of additional water supplies and other actions.

<u>Minimum Flows and Levels in Florida Department of Environmental Protection Rules</u>

The Florida Department of Environmental Protection adopted the Water Resource Implementation Rule as a means to provide goals, objectives, and guidance for the development of programs, rules, and plans relating to water resources, based on statutory directives. Among its declarations are the following statements relevant to instream flow and sustainability of water resources:

- It is an objective of the state to protect the functions of entire ecological systems, as developed and defined in the programs, rules, and plans of the Department and water management districts.

- It is a goal of this chapter that sufficient water be available for all existing and future reasonable-beneficial uses and the natural systems, and that the adverse effects of competition for water supplies be avoided.

- The Department and the districts shall take into account cumulative impacts on water resources and manage those resources in a manner to ensure their sustainability.

General policies regarding water supply include the promotion of water conservation, demand management, reuse, and the use of water of the lowest acceptable quality for the purpose intended; development of local and regional water resources that avoid water transfers across district boundaries; the use of water from sources nearest the area of use or application; protection of existing and future water supply areas; and development of alternative water supplies, including reuse and stormwater and industrial wastewater recycling, desalination, aquifer recharge and aquifer storage and recovery.

“In establishing minimum flows and levels [pursuant to Florida Statutes], consideration shall be given natural seasonal fluctuations in water flows or levels, nonconsumptive uses, and environmental values associated with coastal, estuarine, riverine, spring, aquatic, and wetlands ecology, including:

a. Recreation in and on the water;

b. Fish and wildlife habitats and the passage of fish;

c. Estuarine resources ;

d. Transfer of detrital material;

e. Maintenance of freshwater storage and supply;

f. Aesthetic and scenic attributes;

g. Filtration and absorption of nutrients and other pollutants;

h. Sediment loads;

i. Water quality; and

j. Navigation.” (62-40.473(1) F.A.C.)

Minimum flows and levels are to be expressed as multiple flows or levels defining a minimum hydrologic regime, unless reservations implemented to protect fish and wildlife or public health and safety provide equivalent or greater protection. (62-40.473(2) F.A.C.)

Minimum Flows and Levels in the St. John River Water Management District

The St. Johns River Water Management District, located in northeastern Florida, provides a useful example of water management district policies concerning instream flows and ground water levels (MFLs). In its Minimum Flows and Levels rules, the district’s Governing Board is directed to use the best information and methods available to establish limits which prevent significant harm to the water resources and ecology and to consider the protection of nonconsumptive uses, including navigation, recreation, fish and wildlife habitat, and other natural resources. Minimum flows and levels are used as a basis for imposing limitations on withdrawals of surface water and ground water, for reviewing proposed surface water management and storage systems and stormwater management systems, and for imposing water shortage restrictions.

Minimum flows are expressed as a fluctuation regimes that include a series of minimum flows reflecting a temporal hydrologic regime that will prevent harm to water resources or ecology:

- Minimum Infrequent High – an acutely high surface water level or flow with an associated frequency and duration that is expected to be reached or exceeded during or immediately after periods of high rainfall so as to allow for inundation of a floodplain at a depth and duration sufficient to maintain biota and the exchange of nutrients and detrital material.

- Minimum Frequent High – a chronically high surface water level or flow with an associated frequency and duration that allows for inundation of the floodplain at a depth and duration to maintain wetland functions.

- Minimum Average – the surface water level or flow necessary over a long period to maintain the integrity of hydric soils and wetland plant communities.

- Minimum Frequent Low – a chronically low surface water level or flow that generally occurs only during periods of reduced rainfall. This level is intended to prevent deleterious effects to the composition and structure of floodplain soils, the species composition and structure of floodplain and instream biotic communities, and the linkage of aquatic and floodplain food webs.

- Phased Restrictions – the level or flow (based on the past 30 consecutive average level or flow) at which a water use shortage phase (Phase 1-4) is declared and its associated restrictions imposed.

- Minimum Infrequent Low – an acutely low surface water level or flow with an associated frequency and duration which may occur during periods of extreme drought below which there will be a significant negative impact on the biota of the surface water which includes associated wetlands.

In establishing minimum surface water levels and flows, specific numerical values are established for each water body and for each regime type above, including water level (in feet), flow (in cubic feet per second), duration (in days) and return interval (in years).

<u>Current Status of Minimum Flows and Levels Adopted in Florida</u>

As of 2005, three of the five water management districts (South Florida WMD, St. John's River WMD, and Southwest Florida WMD) have adopted by rule specified minimum flows and levels, beginning in 1996. All of the water management districts have scheduled the establishment of minimum flows and levels for a number of rivers, lakes, springs, and in some cases, aquifers, wetlands, and estuaries. For a list of adopted and currently scheduled MFLs in each of the water management districts, please see refer to the *2003 Statewide Water Body Priority List for Establishment of Minimum Flows and Levels*, at http://www.dep.state.fl.us/water/waterpolicy/doc/MFL2003_Web_Version.xls.

Massachusetts

The Water Management Act authorizes the Department of Environmental Protection to determine safe yield by a water source. Safe yield has been defined in Massachusetts as the volume of water that can be removed from a surface water or ground water source without unreasonable damage to the water resource, but how this is determined has become an arguable point. The statutory guidelines are not detailed, but in the review of permit applications, consideration is given to emerging science on the natural variation of streamflow developed by the U.S. Geological Survey (Lamonte). Those guidelines have generally been used in the determination of safe yield since 1986. However, because recent research has offered improved guidance on instream flow needs for water quality and habitat protection, the Department of Environmental Protection has recently adopted more restrictive guidelines. These are reflected in the Massachusetts Water Management Permitting Policy, effective April 2004. (See Department of Environmental Protection Rules, below.)

Department of Environmental Protection Rules

Permitting for water withdrawals is the purview of the Department of Environmental Protection. Permitted withdrawals under the Water Management Act are about 15 percent of the total regulated volume of water withdrawn in the state in an average year. Approximately 85 percent of authorized withdrawals come under the Water Management registration program. Permitted volumes are above, on top of, or in addition to registered volumes. (Lamonte)

With the adoption of the Water Management Permitting Policy in April 2004, the number of permits containing performance standards and demand management controls has increased relative to requirements in previous years. According to the 2004 policy, the Department of Environmental Protection will condition permits relative to basin stress, so that aquatic habitat is protected and a stable water budget is maintained in all basins, especially those most highly stressed. Basin stress is classified in the Stressed Basin Report, published by the Water Resources Commission.

Since the adoption of the 2004 policy, the following standards and conditions are included in all new permits, as well as modification and renewal of existing permits:

- Cap on per capita per day residential water use (no more than 65 gallons per capita for high and medium stress basins, and no more than 80 gallons per capita for low stress and unassessed basins);

- Limits on unaccounted-for water (no more than 10 percent for high and medium stress basins, and no more than 15 percent for low stress and unassessed basins);

- Summer limits on withdrawals (limit varies based on prior use);

- Streamflow thresholds that trigger mandatory limits on nonessential outdoor water use, including but not limited to lawn and landscape irrigation;

- Standard and consistent reporting requirements; and

- Streamflow monitoring.

New Hampshire

The Rivers Management and Protection Act (RSA 483), 1990, gives the New Hampshire Department of Environmental Services (DES) the authority and responsibility to maintain flow to support instream public uses in rivers that have been designated by the Legislature for special protection under the Act. Fourteen Designated Rivers were defined in the Act

Fourteen years later, in 2002, the New Hampshire legislature enacted legislation (Chapter 278, Laws of 2002) that calls for a pilot program for instream flows on two of 14 designated rivers: the Souhegan River and the Lamprey River. Both of these pilot projects have been funded, and management plans for the rivers are to take effect no later than October 1, 2007.

In May, 2003, in order to provide structure to the pilot programs and future instream flow protection, the New Hampshire Department of Environmental Services (DES) adopted Instream Flow Rules (ISFRs) (Chapter Env-Ws 1900). These specify standards, criteria, and procedures by which a protected minimum instream flow will be established and enforced. The first step under the program is an instream flow study that identifies and catalogs stream resources and instream public uses and identifies appropriate methods to establish recommended instream flow levels. Based on documents, reports, studies, and instream surveys, DES prepares a recommended scientifically-based protected instream flow, subject to public notice, hearing and comment. Once a protected instream flow is established, DES is required to prepare a Water Management Plan, which includes a conservation plan, a water use plan, and a dam management plan:

- The *conservation plan* identifies potential conservation practices within the Water Management Planning Area and establishes an implementation schedule.

- The *water use plan* uses information in the conservation plan to prepare a report for each water user describing how modifications in water use can meet protected instream flows and includes implementation schedules and an estimate of implementation costs.

- The *dam management plan*, in addition to extensive information about each structure, storage capacity, and operations, includes a report on the impacts of the impoundment and the potential stored water available for release to maintain protected instream flows. DES is required to meet with dam owners to review instream flow requirements and "coordinate negotiations" among dam owners, affected water users, and other applicable interests to achieve water use and dam management that protects both instream flow requirements and existing uses of reservoirs.

North Carolina

Instream flows are regulated in North Carolina in several ways: through dam construction and management regulations, the Capacity Use program, and public water supply permitting.

Under the Dam Safety Act, minimum releases are required for both large and small hydroelectric projects (see Appendix C). Rules adopted by the N.C. Department of Environment and Natural Resources (DENR) (Subchapter 2K, Dam Safety) refine these requirements. Although the rule was developed to determination minimum releases from dams, it is also typically used by applicants for surface water withdrawal (CD&McKee, 2001). Permits issued by DENR are predicated on site-specific stream flow studies, and instream flow monitoring is generally required for both water withdrawals and dam releases.

Minimum flows on stream reaches affected by dams are based on mean annual daily flow, 7Q10, habitat designation, hydrologic characteristics, and other factors. Aquatic habitats are divided into three classes: "poor," "moderate," and "good," determined by fish assemblage ratings, substrate (particle size of the stream bed), cover (shelter of plant materials that overhang stream), and the number and type of macro-invertebrate organisms. Evaluation of hydrologic changes include volume of storage, withdrawals from the impoundment, upstream and downstream hydrologic characteristics of the stream, and downstream point source discharges. Results of the process yield one of the following release requirements:

- No minimum release from dam is required;
- Minimum release should be equal to the 7Q10 of the stream;
- Minimum release is determined from regression equations provided in the statute; or
- Minimum release is determined by site-specific study.

New reservoir sites, and sites where existing minimum flows need revision, are required to develop three levels of minimum releases based on usable water stored in the impoundment. Minimum release in the three levels should increase as stored usable water increases. DENR may at any point review and adjust minimum flows if water quality standards are not met or if aquatic habitats are not maintained under existing minimum flow requirements. Special exceptions are made for circumstances such as the presence of endangered species or fisheries. (CD&McKee, 2001).

Specific to instream flows related to hydroelectricity production, a Certificate of Public Convenience and Necessity must be issued by the North Carolina Utilities Commission (NCUC) prior to the construction of a hydroelectric generating plant. The North Carolina Department of Environment and Natural Resources may review the plans for the proposed project and, if not acceptable, can file a complaint and request a hearing. The Department may also propose conditions for project approval, to be considered by the Utilities Commission.

The Public Water Supply Section of the N.C. Division of Environmental Health requires an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for the construction of a new public water supply facility or a withdrawal increase greater than 1.0 million gallons per day. Studies and operating conditions may be required as part of the EA or FONSI.

Oregon

Oregon manages water use under the prior appropriation doctrine of "first in time, first in right." All water is publicly owned, and users must obtain a permit from the Water Resources Department to use water from any source. The Water Resources Commission has adopted basin programs for all but two of the state's 20 major river basins. The basin programs allow for comprehensive management of the land area, surface water bodies, aquifers, and tributaries that drain into a major river. Within each basin, action by the state legislature or administrative procedures by the Water Resources Commission can close an area to new appropriations.

Oregon's instream flow regulations are among the oldest in the nation. In 1955, the legislature passed the Minimum Perennial Streamflow Act, which authorized the Oregon Water Resources Board (now divided into the Water Resources Commission and the Water Resources Department) to establish minimum streamflows sufficient to support aquatic life and minimize pollution. Research done during the 1960s produced a series of reports that made recommendations for instream flows by month needed to support salmon populations. However, most of the protection afforded by the Act was for major rivers and larger streams, and smaller streams were left with little or no protection. Adopted flow levels were later found to be inadequate, as well, especially during summer months when demands are high and flows are critical for fish. (Backgrounder)

The Instream Water Rights Act was enacted in 1987 to supplement the perennial flow law. It allows water flowing in a river to be protected by an "instream water right," equal in standing to water rights for irrigation and development. The state holds these rights in public trust so that the instream rights cannot be supplanted by new rights. Under the Act, instream allocations may be assigned in one of three ways by the Water Resources Department:

- Existing minimum perennial streamflows were converted to instream rights.
- Three state agencies may apply for instream water: Department of Environmental Quality, Parks and Recreation Department, and Department of Fish and Wildlife.
- Water rights established for other uses, such as irrigation, may voluntarily be leased or permanently transferred.

The Water Resources Department has certified about 1,400 applications, of which about 500 of these were previous minimum perennial streamflows which have been converted into instream water rights. New out-of-stream water uses may be approved only when there is more water in the stream than is already allocated to existing water rights (both out-of-stream and instream), although certain multi-purpose storage projects and municipal or hydroelectric uses may take precedence over an existing instream right. With Water Resources' approval, water may also be reserved by a state agency for future economic development needs. (Backgrounder)

Related to the Instream Water Rights Act, Oregon's Instream Leasing Program provides a mechanism for voluntary allocations to instream use. Water users may lease their water rights to instream use for up to five years, and may renew leases an unlimited number of times. This arrangement benefits water rights holders that may be at risk of forfeiting their water rights due to non-use. Leases may be individual or pooled (for instance, by several landowners within an irrigation district), and may be split-season leases such that water is used for it authorized purpose for part of the year and for instream use during another part of the same year. A portion of the water right can otherwise be leased only if it can be defined as a portion that irrigates a distinct tract of land. A water user cannot simply use less water than usual and lease the remainder.

The State Scenic Waterway Act, designed to protect instream flows in certain rivers, mandates that the highest and best use of water in designated rivers is to provide for fish, wildlife, and recreation. The first river to be protected under the program was the Lower Deschutes, in 1970. During the 1980s several other rivers were designated for protection. (Water Watch) The Oregon Parks and Recreation Department determines whether a river meets the standards of a scenic waterway, and based on the Department's recommendations, the Governor makes official designations. Rather than attempt to turn back time, the Act recognizes and permits most existing uses so that status quo is maintained. The only specific activity prohibited by the Act is the construction of dams for the development of impoundments. Property owners must notify and get approval from Oregon Parks and Recreation for disturbances within a quarter mile on each side of a designated river, such as road building, mining, timber cutting, or home construction. (The New Oregon Trail)

Oregon's Allocation of Conserved Water Program, authorized by statute in 1987, is designed to promote efficient water use to meet current and future instream and out-of-stream needs. The program allows a water user who conserves water to use a portion of the conserved water on additional lands, lease or sell the water, or dedicate the water to instream use. The Oregon Water Resources Department must approve an allocation of conserved water, and the law requires at least a portion (25 percent) of the conserved water to be reserved for instream use. Relatively few applications for the program have been submitted, but interest has increased in recent years as water users have sought to expand supplies and support for streamflow restoration has increased. (Oregon WRD)

Texas

In 1997, Senate Bill 1, commonly referred to as the "Water Bill," established a state water planning process in Texas and set the stage for instream flow provisions. The first state plan, based largely on regional plans, was completed in 2002. Senate Bill 2, passed in 2001, in part amended § 16.059 of the Texas Water Code to include specific provisions for instream flow data collection and evaluation. The latter legislation directs the Texas Commission on Environmental Quality, the Texas Water Development Board, and the Texas Parks and Wildlife Department, in cooperation with other appropriate governmental agencies, to "jointly establish and continuously maintain an instream flow data collection and evaluation program." It also requires the agencies to "conduct studies and analyses to determine appropriate methodologies for determining flow conditions in the state's rivers and streams necessary to support a sound ecological environment."

In October 2002, the three agencies signed a Memorandum of Agreement (MOA) to define a procedure for the completion of instream flow studies and called for a Programmatic Work Plan which was finalized in December 2002. Six priority study sites were identified by the agencies, and instream flow studies at these priority sites are to be completed by December 31, 2010. The three agencies also produced a Technical Overview Document, which details scientific and engineering methodologies for data collection and analysis. The agencies contracted with the National Academy of Sciences to thoroughly review and critique the methodology proposed by the state agencies in these two documents before site specific work begins. The comprehensive instream flow methodology is designed to be generic enough that it may be used at any site in Texas, and includes at least five riverine components: hydrology, biology, geomorphology, water quality, and connectivity. The instream flow studies will go through an intensive process of peer review, including one by an interagency science team, the National Academy of Sciences, and ongoing peer review by river authorities and other water management entities within each basin and subbasin to the degree that they are willing to participate. Results from the studies will be considered by the Texas Commission on Environmental Quality in its review of any management plan, water right, or interbasin transfer. (Texas Statutes § 16.059)

Texas Statutes also require that specific quantities of water be reserved for instream use and for release to bays and estuaries, applicable to reservoirs on which construction began after September 1, 1985:

> "Five percent of the annual firm yield of water in any reservoir and associated works constructed with state financial participation under this chapter within 200 river miles from the coast, and to commence from the mouth of the river thence

> inland, is appropriated to the Parks and Wildlife Department for use to make releases to bays and estuaries and for instream uses, and the commission [on Environmental Quality] shall issue permits for this water to the Parks and Wildlife Department under procedures adopted by the commission." (Texas Statutes § 16.1331)

The Commission on Environmental Quality may also require the Water Development Board to pay the amount necessary for all maintenance and operating costs associated with storage and release of water appropriated for the health of any bay or estuary system. (Texas Statutes § 16.1341)

Virginia

Virginia's Surface Water Management Act of 1989 establishes authority for the State Water Control Board to designate *surface water management areas*. The Board may, at its own discretion or upon petition by a city, county, town, or any state agency, initiate the designation of a surface water management area if there is evidence to indicate that:

- A stream has substantial instream values as indicated by evidence of fishery, recreation, habitat, cultural, or aesthetic properties; and
- Historical records or current conditions indicate that a low flow condition could occur which would threaten important instream uses; and
- Current or potential offstream uses contribute to or are likely to exacerbate natural low flow conditions to the detriment of instream values. (Code of Virginia § 62.1-246)

Prior to the creation of a surface water management area, or the issuance of a permit within one, the Board is required to "consult and cooperate with, and give full consideration to the written recommendations of," the following agencies: the Department of Game and Inland Fisheries, the Department of Conservation and Recreation, the Virginia Marine Resources Commission, the Department of Health, and any other interested and affected agencies. "Such consultation shall include the need for development of a means in the surface water management area for balancing instream uses with offstream uses." (Code of Virginia § 62.1-250)

Within surface water management areas, water withdrawal permits are required, with certain exceptions, for any consumptive use of water in excess of 300,000 gallons in any single month that commenced after July 1, 1989.(Code of Virginia § 62.1-243) Permits are issued for a maximum duration of 10 years. The application for a permit must include, at a minimum, the following information (9VAC25-220-70 (D)(3)):

- The location of the water withdrawal, including the name of the water body from which the withdrawal is being made;

- The average daily withdrawal, the maximum proposed withdrawal, and any variations of the withdrawal by season, including amounts and times of the day or year during which withdrawals may occur;

- The use for the withdrawal, including the importance of the need for this use;

- Any alternative water supplies or water storage; and

- If it is determined that special studies are needed to develop a proper instream flow requirement, then additional information may be necessary.

Permit conditions may include maximum amounts that may be withdrawn, times of the day or year during which withdrawals may occur, and requirements for voluntary and mandatory conservation measures. (Code of Virginia § 62.1-248 (A)) In consideration of whether to issue, modify, revoke, or deny a withdrawal permit, the Board must consider the following factors (Code of Virginia § 62.1-248 (B):

- The number of persons using a stream and the object, extent, ant necessity of their respective withdrawals or uses;

- The nature and size of the stream;

- The types of businesses and other activities to which the various uses are related;

- The importance and necessity of the uses claimed by permit applicants, or of the water uses of the area and the extent of any injury or detriment caused or expected to be caused to instream or offstream water uses;

- The effects on beneficial uses; and

- Any other relevant factors.

In addition, in authorizing permits, the Board is required to prioritize among types of users. The following classification system is used for establishing water use priority (9VAC25-220-120 (B)):

- Class I uses are domestic, including public water supply, and include all existing uses as of July 1, 1989;

- Class II uses are new uses, not existing as of July 1, 1989, and include instream uses, such as protection of fish and wildlife habitat and maintenance of waste assimilation, and offstream uses, such as agriculture, electric power generation, commercial and industrial; and

- Class III uses are new uses, not existing as of July 1, 1989, and include recreation, navigation, and cultural and aesthetic values.

Class I uses are given the highest priority, with Class II and III uses in decreasing priority respectively, and the Board may impose restrictions on one or more classes of beneficial uses. (9VAC25-220-120 (B))

Outside of surface water management areas, surface water withdrawal certificates are required. These are issued by the State Water Control Board with similar application requirements as for water withdrawal permits, and are also issued for a maximum 10-year duration. Specific requirements may include water conservation or management plans. (9VAC25-220-250 et seq.)

Washington

Washington statutes give the Department of Ecology the exclusive authority and responsibility to regulate instream flows: "No agency may establish minimum flows and levels or similar water flow or level restrictions for any stream or lake of the state other than the department of ecology whose authority to establish is exclusive." (RCW 90.03.247) Under the state's prior appropriation system of water allocation, an instream flow rule established by the Department is essentially a water right for fish and other instream resources.

Rules are specifically established for all or parts of a river basin for which instream flows are established. The method generally used by the Department of Ecology and the Department of Fish and Wildlife is the Instream Flow Incremental Methodology (IFIM), described in Chapter 2. Protection of instream flows applies to both surface water and to ground water that is hydraulically connected with the surface water. Ground water withdrawals must not affect the flow of any surface water body. (RCW 90.44.030)

In addition to minimum instream flows, establishment of flow levels may include the protection of the frequency and duration of a range of ecological flows. This is accomplished by establishing a maximum amount of water that can be withdrawn from the stream above the instream flow levels, using hydrologic data to determine the amount of water that may be withdrawn without affecting flows needed for channel and riparian maintenance. Instream resources may also be protected by establishing year-round or seasonal closures. A closure is a finding by the Department of Ecology that no water is available for future uses. Closures may be established by rule as an alternative to setting flow requirements (especially for small streams), or may be used in conjunction with flow requirements. (WDOE)

Washington Statutes Affecting Instream Flows

Washington's instream flow protection began in 1949, when the legislature amended the fisheries code to tie water allocation to the needs of fish and to require consultation between the state agencies managing fish and water. In the 1960s and 1970s, the legislature recognized instream uses of water as beneficial and capable of being statutorily protected.

The 1967 Minimum Water Flows and Levels Act (Ch. 90.22 RCW) established a process for protecting instream flows, including provisions that the Department of Ecology must develop a state water plan, consult with the Department of Fish and Wildlife, and conduct pubic hearings. RCW 90.22.010 states, “The department of ecology may establish minimum water flows or levels for streams, lakes, or other public waters for the purpose of protecting fish, game, birds, or other wildlife resources, or recreational or aesthetic values of said public waters whenever it appears to be in the public interest to establish the same.” The Act also ensures that the establishment of minimum flows “in no way affect existing water and storage rights and the use thereof,” but that new rights for diversion or storage are subject to regulations establishing flows or levels. All regulations establishing flows or levels must be filed in a “Minimum Water Level and Flow Register” of the Department of Ecology.

The Water Resources Act of 1971 established that balancing the uses of water will be generally based on securing “maximum net benefits’ to the people of the state.” The Act provided for the development of the Water Resources Management Program (173-500 WAC), which established 62 Water Resource Inventory Areas (WRIAs). The WRIAs typically define the boundaries of watersheds. The Act also authorizes the Department of Ecology to reserve waters for future beneficial uses, and establishes clear standards for instream flow protection: “Perennial rivers and streams of the state shall be retained with base flows necessary to provide for preservation of wildlife, fish, scenic, aesthetic, and other environmental values, and navigation values. Lakes and ponds shall be retained substantially in their natural condition. Withdrawals of water which would conflict therewith shall be authorized only in those situations where it is clear that overriding considerations of the public interest will be served.”

Construction Projects in State Waters (75.20 RCW) established the Hydraulic Permit Application (HPA) program for permitting activities that will use, divert, obstruct, or change the natural flow or bed of any fresh or salt water in the state. The statute also requires consultation between the Department of Fish and Wildlife and the Department of Ecology before Ecology may set flow requirements.

The Watershed Planning Act (90.82.005 RCW), passed in 1998, authorizes local governments and other entities within each Water Resource Inventory Area to evaluate water quantity issues and make plans to meet future water needs. Watershed planning units may chose to include an instream flow component in their watershed plan, and can propose instream flows to be established by rule by the Department of Ecology. If minimum instream flows have already been adopted by rule for a stream within the management area, the instream flows may not be modified unless members of the local government and tribes on the planning unit unanimously vote to modify those flows. If minimum stream flows have not been established, setting minimum flows is to be a collaborative effort between the Department of Ecology and members of the planning unit.

Washington Water Code (90.RCW) also gives the Department of Ecology exclusive authority to establish flow requirements: “Whenever an application for a permit to make beneficial use of public waters is approved relating to a stream or other body of water for which minimum flows or levels have been adopted and are in effect at the time of approval, the permit shall be conditioned to protect the levels or flows.

APPENDIX B

RESERVOIR POLICY IN SELECTED OTHER STATES

Florida

The State of Florida employs several mechanisms to guide, or rather permit, the selection of reservoir locations. The first mechanism is the Regional Water Supply Plans that, under § 373.0361 F.S., require each water management district to quantify and compare current and projected water supply with current and projected demand within a twenty-year period. Plans are to be developed in areas where current water supplies are considered inadequate "to supply water for all existing and future reasonable-beneficial uses and to sustain the water resources and related natural systems for the planning period." These plans must include alternatives for meeting water demand and may list reservoir site alternatives. How sites are selected in this process may be influenced by factors such as established MFLs and ecological values of riparian and wetland habitats. Established MFLs provide an early reference as to which sites have available water for new allocations. Even so, local governments or other entities are not obligated to select any of the alternatives identified in regional plans.

The second mechanism is the statutory requirements under § 373.414 F.S. for activities in surface waters and wetlands, which delineate proposed project assessment criteria. In determining whether a project is contrary to the public interest, the following criteria are evaluated:

1. Whether the activity will adversely affect the public health, safety, or welfare or the property of others;

2. Whether the activity will adversely affect the conservation of fish and wildlife, including endangered or threatened species, or their habitats;

3. Whether the activity will adversely affect navigation or the flow of water or cause harmful erosion or shoaling;

4. Whether the activity will adversely affect the fishing or recreational values or marine productivity in the vicinity of the activity;

5. Whether the activity will be of a temporary or permanent nature;

6. Whether the activity will adversely affect or will enhance significant historical and archaeological resources under the provisions of § 267.061; and

7. The current condition and relative value of functions being performed by areas affected by the proposed activity.

Even if some criteria are not met, permits may still be granted if applicants can appropriately mitigate adverse environmental impacts and clearly justify such impacts for the benefit of public interest.

Florida's third mechanism, which can be considered the implementing tool of § 373.414 F.S., is the Environmental Resource Permit (ERP) and the wetland resource permit (for the panhandle region only, pursuant to Chapter 62-312 F.A.C.). These permits are administered by the Department of Environmental Protection or other applicable water management district and are required in addition to or in conjunction with a federal 404 permit. Permitting evaluations are based on a proposed activity's potential to "adversely affect fish, wildlife, listed species, and their habitats" (FDEP, 2002) as well as public safety and water quality considerations. Consultation by the state Fish and Wildlife Conservation Commission and relevant federal agencies may be utilized for proposed activity assessment. Other than direct impacts, the ERP permitting process evaluates the secondary and cumulative impacts of proposed actions. These impacts are defined as:

- Secondary. Secondary impacts are those actions or actions that are very closely related and directly linked to the activity under review that may affect wetlands and other surface waters and that would not occur but for the proposed activity. Secondary impacts to the habitat functions of wetlands associated with adjacent upland activities are not considered adverse under the environmental resource permit program if buffers of a certain minimum size are provided abutting the wetlands (with some exclusionary provisions).

- Cumulative. Cumulative impacts are residual adverse impacts to wetlands and other surface waters in the same drainage basin that have or are likely to result from similar activities (to that under review) that have been built in the past, that are under current review, or that can reasonably be expected to be located in the same drainage basin as the activity under review.

St. John's River Water Management District

Each water management district has clearly outlined criteria for a proposed activity assessment under the ERP permitting process. The SJRWMD's criteria can be found in the *Applicant's Handbook: Management and Storage of Surface Waters* (2005). This handbook includes the requirements and criteria for evaluating ecological values of wetland or other surface water areas as well as the proper processes for eliminating, reducing, and mitigating adverse environmental impacts (subsections 12.1 through 12.3). Direct impacts are evaluated through a comparison of pre-activity hydrologic conditions, hydrologic connection, aquatic area uniqueness, location relevant to surroundings, and wildlife utilization with the likely post-activity conditions. Proposed activities must not adversely affect the quantity, quality, or related beneficial uses of a water body.

Applicants must provide reasonable assurance that secondary impacts caused by the proposed activity will not violate water quality standards of the respective water body or adversely impact the nesting and denning sites of certain state listed species. Future phases of a proposed activity or anticipated future activity as a result of the proposed activity will be evaluated for potential to cause adverse secondary impacts.

Assessment of cumulative impacts is conducted at the level of each application. If a single project is determined to protect water quality standards and adequately mitigate for the lost ecological functions, then it is determined to have no "unacceptable cumulative impacts." However, if a project will adversely affect water quality standards or ecological functions without full mitigation in the same drainage basin, then the applicant must ensure that unacceptable cumulative impacts will not result from the conjunctive effects of both the proposed and other activities within the same drainage basin. In theory, the issuance of single activity with no cumulative impacts allows equitable opportunity for similar future activity within the same basin. The single greatest constraint to this opportunity is, however, the availability of adequate mitigation credits within the same drainage basin.

North Carolina

Reservoir sites in North Carolina are largely determined by technical feasibility in regard to a location's capacity to provide adequate water storage or flood control and avoid adverse impacts on water quality and related environments (Electronic communication, Tarver, 2005). For most reservoir projects, impact analyses are considered through North Carolina Environmental Policy Act (G.S. § 113A), or SEPA, procedures and federal 401 and 404 permitting processes. SEPA procedures apply to actions carried out or authorized by a state agency, involve expenditures of public monies or use of public land and have a potential to cause a "detrimental environmental effect on natural resources, public health and safety, natural beauty, or historical or cultural elements, of the state's common inheritance."

North Carolina has a distinctive assessment process that allows projects to be screened for feasibility and compliance issues before large investments are made into the construction process. The pre-application, or scoping, phase enables potential applicants to openly discuss intended actions and possible regulatory inhibition with the Department of Environment and Natural Resources (NCDENR). Conclusions of this phase could play a role in site selection depending on the resolve and financial capacity of an applicant. Moreover, the scoping phase identifies any need for in depth analysis and documentation based on minimum thresholds set in the State Environmental Policy Act (SEPA). If an environmental assessment (EA) or an environmental impact statement (EIS) is required, applicants must submit a draft version for review by each division within NCDENR. After a comment period and satisfactory application adjustment by the applicant, the environmental document is sent to the State Clearinghouse for dissemination among all applicable state agencies. This final review and comment period addresses SEPA compliance and any additional revision requirements. Lastly, NCDENR forwards the final ititeration to the State Clearinghouse for review of a Finding of No Significant Impact (FONSI) or a Record of Decision (ROD) under an EA or EIS, respectively.

The EA is utilized to determine whether a significant environmental impact will occur as a result of the proposed activity. Marks[1] (NCDWQ) outlines information considered in the evaluation of potentially significant impacts, including:

- Project description. Description of all relevant components of project and project site;
- Project need. Description of project to meet stated need of applicant and whether it is some form of facility improvement, consolidation, or upgrade;
- Project service area summary description. Description of geographic area, resources, and parties affected by project;
- Project site plan. Illustration of affected geographic area with demarcation of relevant property characteristics;
- Alternatives analysis. Description of alternatives to project, including no action. Information should include environmental and economic factors and a rationale for selected alternative;
- Existing environmental characteristics of project area. Description of the project site's environment as it exist prior to initiation of action;
- Predicted environmental impacts of project. Description of direct, secondary, and cumulative impacts to environmental characteristics listed in characteristics description; and
- Mitigation measures. Description of methods to be employed for mitigation of direct, secondary, and cumulative impacts. A summary of relevant policies to the action from each effected jurisdiction should also be included.

If an assessment of the previous criteria determines no significantly adverse impact would occur as a result of the proposed action, then submission of a FONSI is the final requirement. However, if such an assessment determines the action will result in a significant impact, a full EIS must be written. This report includes similar information as an EA, but in much greater detail; Mark[2] (NCDWQ) specifically lists these criteria:

- Purpose and need for the project;
- Summary stating major conclusions, areas of controversy, and further issues to be resolved;
- Alternatives to the project, including "no action", with a conclusion supporting the preferred with documentation as follows:

- Comparatively weigh the direct, cumulative and secondary impacts to the affected environment that could result from each alternative,

- Assess the socioeconomic impacts of each alternative, economically quantifiable where possible, and

- Identify the preferred alternative and discuss the reasons for eliminating each of the rejected alternatives;

➢ Mitigation measures as appropriate that were not already included in alternatives;

➢ Site map listing all significant resources potentially affected by the project;

➢ Uncertainty that may exist in the permitting process; and

➢ Federal, state, and local permits to be permitted.

North Carolina Administrative Code subsection 15A NCAC 01C.0103 defines secondary and cumulative impacts rather broadly. However, to adjust for any ambiguity, the Wildlife Resources Commission has issued a guidance memorandum to aide local governments in addressing and mitigating secondary and cumulative impacts of public projects (NCWRC, 2002). Recommendations in this memorandum primarily contain methods to protect headwater and other riparian areas, abate stormwater and sediment pollution as well as methods to manage wastewater and the related infrastructure.

Tennessee

The Tennessee Division of Water Pollution Control (TDWPC) employs an extensive permitting program pursuant to § 401 of the federal CWA and the Tennessee Water Quality Control Act of 1977 (T.A.C. § 69-3-108(b)(1)). Non-federal reservoirs typically require a general or individual state permit for the alteration of any state water and may also require a Safe Dams permit from the Division of Water Supply and a federal 404 permit. The former permits are generically called Aquatic Resource Alteration Permits (ARAP) and may be granted if applicants adequately justify the need for a proposed project, identify alternatives for meeting the need, select the least environmentally detrimental alternative as practicable, and mitigate for adverse environmental impacts to prevent a net loss of wetlands and streams. The TDWPC uses the following factors to determine the value of lost resources and the amount of mitigation required:

➢ Direct loss of stream length, waters, or wetland area due to the proposed activity;

➢ Direct loss of instream, waters, or wetlands habitat due to the proposed activity;

- Impairment of stream channel stability due to the proposed activity;

- Diminishment in species composition in any stream, wetland, or state waters due to the proposed activity;

- Direct loss of stream canopy due to the proposed activity;

- Whether the proposed activity is reasonably likely to have cumulative or secondary impacts to the water resource;

- Conversion of unique or high quality waters as established in Rule 1200-4-3-.06 to more common systems;

- Hydrologic modifications resulting from the proposed activity;

- The adequacy and viability of any proposed mitigation including, but not limited to, quantity, quality, likelihood of long term protection, and the inclusion of upland buffers;

- Quality of stream or wetland proposed to be impacted;

- Whether the state waters is listed on the §303(d) list; whether the proposed activity is located in a component of the National Wild and Scenic River System, a State Scenic River, waters designated as Outstanding National Resource Waters, or waters identified as high quality waters as defined in Rule 1200-4-3-.06, known as Tier II waters; whether the activity is located in a waterway which has been identified by the Department as having contaminated sediments; and whether the activity will adversely affect species formally listed in State and Federal lists of threatened or endangered species; and

- Any other factors relevant under the Act.

Directives in state Rules § 1200-4-7 enable reservoir siting to occur through two distinct processes. The first is set forth in subsection .04-4, which requires an open public notice and comment period. This may place extra feasibility constraints on some project sites due to political acceptance or a willingness to protect personal property rights; consequently, certain locations may be quickly excluded. Secondly, articles in subsection .04-5 require applicants to utilize practicable alternatives that result in no net loss when available. If the nature of a water body is so unique that insufficient mitigation opportunity exists, the permit is subject to denial by TDWPC (Personal communication, Eager, 2005). Minimal mitigation opportunity further restricts location alternatives for applicants.

Virginia

Virginia requires localities and regions to develop Regional Water Supply Plans similar to Florida. Through a process outlined in 9 V.A.C. 25-780, the Water Control Board and State Health Commissioner assist local governments in assessing the deficits of current and projected water supplies and identifying practicable alternatives for meeting current and future demand. Emphasis is first placed on meeting needs through demand-side management and increasing the utilization and efficiency of existing regional water sources.

If construction of a new water source is necessary, then projects such as a water supply reservoir must adhere to the rigors of the federal 404 and Virginia Water Protection (VWP) permitting processes. For applicants to obtain a VWP permit, the proposed action must protect beneficial instream uses. Beneficial uses as defined by § 62.1-44.15:5 of the Virginia Code include, but are not limited to, "the preservation of instream flows for purposes of the protection of navigation, maintenance of waste assimilation capacity, the protection of fish and wildlife resources and habitat, recreation, cultural, and aesthetic values" as well as domestic and other existing uses.

The VPW permit criteria, in conjunction with 404 avoidance, minimization and mitigation requirements, drive the site selection process. Practicable reservoir locations emerge through a methods analysis for meeting water demand and preventing adverse environmental impacts. As a result, financial and technical feasibility become the influential factors in reservoir site selection.

Washington

The State of Washington exhibits a unique policy climate in terms of reservoir utilization and regulation. Many reservoir projects have been developed across the state since its inception and a report released by the Water Storage Task Force (2001) further accentuated the importance of water storage projects for future public, economic, and environmental welfare. The report outlined key principles of reservoir use in the State including pros and cons between storage methods; policy and regulatory considerations; and environmental concerns. The following summary includes most of the policy and regulatory considerations identified in the Task Force report as well as other considerations required by state agencies:

State Water Policies and Planning:

- It is the policy of the State: to provide adequate water supplies for instream and off-stream beneficial uses (R.C.W. 43.83B.010; R.C.W. 43.99E.010); to encourage the impoundment of excess available water (R.C.W. 90.03.255); to utilize and protect water resources for maximum net benefits (R.C.W. 90.03.005); to encourage multiple use projects versus single use (R.C.W. 90.54.020); to give full consideration of surface storage in a cost-efficiency analysis of alternatives (R.C.W. 90.54.180(4)).

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- Storage alternative analyses should consider planning considerations, including: public water supply system plans; supply-related issues identified in watershed plans implemented under the Watershed Management Act of 1998; and specific conditions identified in land-use plans implemented under the Growth Management Act (GMA).

State Environmental Policies and Regulations:

- State Environmental Policy Act of 1971 (SEPA). Under SEPA, responsible state agencies are to prepare an EA or EIS for state actions that are likely to cause adverse environmental impacts. Washington's SEPA entails several unique features compared to other states. One feature is that the assessment criteria also apply to non-project actions such as policies, plans, or programs that may create an adverse impact through subsequent actions or implementation (W.A.C. 197-11-704). Another feature is the eligibility of some projects to provide documentation in phases due to the nature of their development. Feasible assessments should be conducted and reported at the earliest possible time. And finally, cumulative impact analyses are to be conducted at the scale of GMA comprehensive planning and also within individual project EISs. This enables agencies and local governments to evaluate the potential impacts of single and collective projects across time. However, agencies responsible for drafting an EIS are only responsible for considering the cumulative impacts of their respective project (WDE, 2003).

- Joint Aquatic Resources Permit Application (JARPA). Reservoirs necessitate multiple permits for the alteration of water bodies. Potentially required permits may include the state Hydraulic Project Approval, the Shoreline Substantial Development Permit, and the Coastal Zone Management Certification as well as the federal 401 Water Quality Certification, the 404 dredge or fill permit, and an individual work permit pursuant to the Rivers & Harbors Act. Through JARPA, multiple permits can be applied for in a single application submission.

- Water Rights and Reservoir Permits. Additional permits must be secured from the state for the right to impound water (R.C.W. 90.03.370), withdraw water from an existing or constructed reservoir (average withdrawal permit), or to withdraw water for off-stream storage.

- Other State Permits. Construction of reservoirs with a storage capacity greater than 10 acre-feet require a Dam Safety Construction Permit (§ 173-175 W.A.C.), which ensures the safety of life and property downstream by requiring certain structural standards. Furthermore, a Water Quality Modification Permit must be issued by the Department of Ecology to address turbidity, chemical, or other temporary impairment to a water quality standard created during construction phases.

Environmental Considerations:

- Although some adverse environmental impacts may be mitigated for, others may not possess such potential. This may limit sites available for alteration (i.e., placement of a dam). The presence of endangered species will also affect the suitability of potential locations. If a proposed reservoir will jeopardize a federally endangered specie, then design modifications must be formulated to eliminate risk. Lastly, the Washington Department of Fish and Wildlife (WDFW) may require or recommend mitigation for actions that cause a loss in habitat value or function for fish and wildlife. Pursuant to policy M5002, WDFW may recommend mitigation in permits issued by other agencies, but may *require* mitigation in permits which they are the sole decision-maker.

APPENDIX C

GROUND WATER POLICY IN SELECTED OTHER STATES

Ground Water Withdrawal Management

Arizona

The Arizona Legislature passed the **Groundwater Management Act** in 1980 to address groundwater depletion that had been a growing concern since the 1950s. The Act called for the Arizona Department of Water Resources to implement its provisions and, through the Arizona Groundwater Code (A.R.S. § 45-401 through § 45-704), established four Active Management Areas (AMAs): Phoenix, Pinal, Prescott, Tucson. The Tucson AMA was divided in 1994 to form a fifth management area, Santa Cruz. The active management areas and the programs they adopt have been quite significant because 80 percent of Arizona's population lives within a management area. Groundwater use is regulated within these areas, and municipal water providers located within AMAs are required to develop and implement conservation programs. Arizona created five management periods, with increasingly stringent water restrictions in each subsequent period. (See the companion report, *Water Conservation, Efficiency and Reuse*, for details regarding the management periods.)

In addition to the active management areas, the Act established two Irrigation Non-Expansion Areas (INAs), with a third area designated since its passage. Agricultural irrigation in these areas, while not as closely regulated as the management areas, is limited to acreage that has historically been irrigated. Outside of AMAs and IMAs ground water use is limited only by reasonable and beneficial use.

Assured Water Supply Rules

Arizona's Assured Water Supply Program is designed to sustain the state's economic health by preserving ground water resources and promoting long-term water supply planning within the state's AMAs. Prior to subdividing lands for development, a developer must obtain a certificate of assured water supply, meaning that sufficient ground water, surface water, or effluent of adequate quality will be available to satisfy water needs of the propose water use for at least 100 years. Sufficient ground water means that the proposed withdrawals the applicant will make over a period of 100 years will be of adequate quality and will not exceed in combination with other withdrawals a depth to 1,000 feet or the depth of the bottom of the aquifer, whichever is less. (Bryner et al.)

California

Operating under the prior appropriation doctrine of “first in time, first in right” for surface water withdrawals, California does not administer water rights for ground water. Its ground water withdrawals are regulated in a variety of ways, most involving voluntary management by a local agency. The Groundwater Management Act (Sections 10750-10756 of the California Water Code, AB 3030) provides a systematic procedure for certain local agencies to develop ground water management plans, but does not mandate that local governments develop such plans. The Local Groundwater Management Assistance Act of 2000 provides for funding and implementation of local ground water management plans (§ 10753). To qualify for state funds, ground water plans must include specific components that relate to interagency cooperation, monitoring and management of ground water levels, water quality protection, land surface subsidence, and changes in surface flow or surface water quality the directly affect ground water levels or quality or are caused by ground water pumping in the basin. (§ 10753.7(a)(1)) Ground water management plans may also include components relating to the following (§ 10753.8):

1. Control of saline water intrusion;

2. Identification and management of wellhead protection areas and recharge areas;

3. Regulation of the migration of contaminated ground water;

4. The administration of a well abandonment and well destruction program;

5. Mitigation of conditions of overdraft;

6. Replenishment of ground water extracted by water producers;

7. Monitoring of ground water levels and storage;

8. Facilitating conjunctive use operations;

9. Identification of well construction policies;

10. The construction and operation by the local agency of ground water contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects;

11. The development of relationships with state and federal regulatory agencies; and

12. The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of ground water contamination.

Also related to ground water management is Senate Bill 221, which prohibits approval of subdivisions consisting of more than 500 dwelling units unless there is verification of sufficient water supplies for the project. The requirement also applies to increases of 10 percent or more of service connections for public water systems with less than 500 connections.

Florida

Florida regulates ground water withdrawals in several ways, primarily through consumptive use permitting, regulated by the state's five water management districts. Ground water levels can be protected by district-established minimum flows and levels, discussed above, however, to date, water management districts have generally established only minimum flows for surface water bodies. In addition, each water management district is required by statute (F.S. §373.0395) to develop a ground water basin resource availability inventory, including but not limited to the following elements:

- A hydrogeologic study to define the ground water basin and its associated recharge areas;
- Site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development;
- Prime ground water recharge areas;
- Criteria to establish minimum seasonal surface and ground water levels;
- Areas suitable for future water resource development within the ground water basin;
- Existing sources of wastewater discharge suitable for reuse as well as the feasibility of integrating coastal wellfields; and
- Potential quantities of water available for consumptive use.

Consumptive use permits (CUPs) are required for all water use beyond specified threshold amounts, with the exception of domestic consumption by individual users. The water district's governing board considers the following in making permitting decisions (F.S. §373.223):

- The proximity of the proposed water source to the area of use or application;
- All impoundments, streams, ground water sources, or watercourses that are geographically closer to the area of use or application than the proposed source, and that are technically and economically feasible for the proposed transport and use;

- All economically and technically feasible alternatives to the proposed source, including, but not limited to , desalination, conservation, reuse of nonpotable water and stormwater, and aquifer storage and recovery;

- The potential environmental impacts that may result from the transport and use of water from the proposed source, and the potential impacts that may result from the use of other water sources identified above;

- Whether existing and reasonably anticipated sources of water and conservation efforts are adequate to supply water for existing legal uses and reasonably anticipated future needs of the water supply planning region in which the proposed water source is located;

- Consultations with local governments affected by the proposed transport and use; and

- The value of the existing capital investment in water-related infrastructure made by the applicant.

St. Johns River Water Management District

St. John's River Water Management District is almost totally dependent on ground water for its water supply (SJRWMD, 2005). Consumptive use permitting regulations are complex, however, the most common situations that require a permit are if:

- Water is withdrawn from a well that measures six inches or more in diameter;

- Water to be withdrawn is expected to exceed an average of 100,000 gallons per day; or

- Pumping capacity equals or exceeds one million gallons per day.

Because ground water is so important for the district, detailed information is required to develop appropriate management strategies. The district's Division of Groundwater Programs administers the ground water monitoring network, which provides data used to evaluate current resources, identify long-term trends, detect potential problems, and develop management strategies. Planning strategies address the potential impacts of ground water withdrawals to surface water bodies, particularly wetlands.

South Carolina

South Carolina's Ground Water Use and Reporting Act is the most significant feature of the state's ground water policy. It provides legal authority for the Department of Natural Resources to designate Capacity Use Areas, "where excessive ground water withdrawal presents potential adverse effects to the natural resources or pose a threat to public health, safety, or economic welfare, or where conditions pose a threat to the long-term integrity of a ground water resource, including saltwater intrusion." When an area is designated as a Capacity Use Area (CUA), ground water use equal to or in excess of three million gallons per month must be permitted by the Department. In addition, new ground water users are required to issue pubic notice and allow a public comment period.

For ground water use outside of CUAs, well operators must notify the Department of Health and Environmental Control (DHEC) of the intent to construct a well or increase the capacity of existing wells at least 30 days prior to initiating action. Beyond this requirement, reporting of water use outside of CUAs has generally been voluntary. As of January 1, 2001, however, anyone withdrawing three million gallons per month of ground water or surface water must register with DHEC and report that use annually.

North Carolina

An important regulatory tool for ground water management in North Carolina is the Water Use Act of 1967, which allows the Environmental Management Commission to establish and regulate water withdrawals in Capacity Use Areas (CUAs) where aggregate uses of surface water or ground water threaten the sustainability of the resources or where water use in an area requires coordination to protect the public interest. (N.C. Statute § 143-215.11 et seq.) Within Capacity Use Areas, ground water withdrawals of more than 100,000 gallons per day require a permit from the Division of Water Resources, and surface water or ground water withdrawals of more than 10,000 gallons per day require annual registration.

Capacity Use Area No. 1 was established in 1976 and was regulated as such until 2002. It included all or parts of eight counties surrounding a phosphate mine in Beaufort County, where pumping affected ground water levels many miles away. In 2002, the Central Coastal Plain Capacity Use Area was delineated. It encompasses 15 counties where ground water withdrawals are currently being regulated in response to decades of declining aquifer levels.

Texas

Ground water management districts are designated and delineated by the Texas Water Development Board (§ 356.22 T.A.C.) The districts are required by Texas Water Code (§ 36.1071 § 36.1072) to submit to the executive administrator a management plan within two years after the creation of the district (§ 356.3 T.A.C.). Specific and quantifiable management objectives must be established, along with performance standards for each management objective. These goals, standards, and objectives are established by each district based on specific needs of that district. (§ 356.5 T.A.C.)

> "Following notice and hearing, the district shall, in coordination with surface water management entities on a regional basis, develop a comprehensive management plan which addresses the following management goals, as applicable (Texas Statutes § 36.1071):

- Providing the most efficient use of groundwater;
- Controlling and preventing waste of groundwater;
- Controlling and preventing subsidence;
- Addressing conjunctive surface water management issues;
- Addressing natural resource issues;
- Addressing drought conditions; and
- Addressing conservation."

Conjunctive Use

California

The California Department of Water Resources has implemented, through its Conjunctive Water Management Branch (CWMB), several integrated programs designed to increase state-wide water supply reliability. The programs include studies of ground water basins, identifying management strategies, and designing and constructing specific conjunctive use projects. CMWB has established partnerships with local agencies, and provides funding for the following:

1. Project management and technical staff to assist in planning processes;
2. Public outreach and policy development to foster information dissemination and program development;
3. Facilitation services to promote stakeholder involvement;
4. Contracts for engineering and hydrogeologic services to conduct feasibility evaluations; and
5. Contracts for drilling services to support data collection efforts and development of monitoring programs.

Oregon

Ground water withdrawals in Oregon are generally regulated under the basin program (See Oregon instream flow summary), under which ground water and surface water are managed conjunctively within river basins. Oregon's Ground Water Act of 1955 authorizes the Water Resources Department to regulate ground water withdrawals based on its hydraulic connectivity with surface water. The Department is required to determine whether wells produce water from a confined or unconfined aquifer. All wells located a horizontal distance less than one-fourth mile from a surface water source that produce water from an unconfined aquifer will be assumed to by hydraulically connected to the surface water source, unless the applicant or appropriator provides satisfactory information or demonstration to the contrary. (OR. ADMIN. R. 690-009-0040(4)).

Basin program rules require that applications for ground water use are examined for the potential for interference with existing wells and with surface water. In order to manage ground water use in areas of concern, the Water Resources Commission may declare certain areas as "Critical Groundwater Areas." These areas are defined by pumpage that exceeds the natural long-term replenishment of the aquifer. There are currently six Critical Groundwater Areas in Oregon. (Oregon Water Rights Fact Sheet)

Use and Regulation of ASR/Artificial Recharge

States have taken varied approaches to ASR and aquifer recharge applications. Some states have developed stringent requirements, while others rely largely on federal regulations. Some treat ASR and aquifer recharge identically, since ground water quality is a common concern, while others have specific rules for ASR. If treated wastewater is used for aquifer recharge, state agencies may require permitting under reclaimed water rules.

Florida

Because Florida's topography prohibits the widespread use of surface water reservoirs, ground water management is especially important for sustaining the state's water supplies. Aquifer storage and recovery has been implemented in Florida for more than 20 years, with the first well constructed in 1983 in Manatee County. To date, all ASR facilities in Florida have been designed to provide storage for public supply, and all are required to treat water to primary drinking water standards prior to injection. More recently, ASR has been included in an ambitious, controversial, and possibly essential aspect of the Comprehensive Everglades Restoration Plan (CERP), with 333 wells planned to eventually provide water storage needed for ecological restoration of the Everglades system. This is the most extensive ASR project ever proposed worldwide, as part of a $7.8 billion effort. State legislation was proposed in 2001 to reduce the treatment requirements for recharged water used in this project and possibly others, and this sparked a heated state-wide debate that called into question the water treatment requirements for all ASR facilities.

Florida has more ASR facilities than any other state, with almost 150 wells operated by more than 40 separate water facilities. In addition, a number of facilities have applied for permits, have wells under construction, or are in the testing process. Much of Florida's ASR development is in the southern half of the state, where the Floridan aquifer becomes quite brackish as it dips hundreds of feet below the land surface. It has become an important water management tool in counties where public water supply demands have threatened the sustainability of ground water resources. Use of ASR in Florida has thus far been for the purpose of public water supply storage.

Source water for Florida's ASR facilities is generally either surface water or potable ground water withdrawn from other aquifers, and some facilities use a combination between the two sources. Water injected for future recovery is required to meet water quality standards, and injected water may be treated drinking water, reclaimed water, or water from ground water sources that is pure enough not to require treatment. (Seerley)

Florida's Department of Environmental Protection (DEP) coordinates water quantity and quality efforts throughout the state, and its Water Resources Management division is responsible for establishing standards for drinking water, surface water, and ground water quality. Operating within the parameters of state statutes and policy established by the DEP, Florida's water management districts are required to develop district management plans that address water supply, water quality, and other aspects water management, such as flood control.

District water supply provision is authorized by statute to include ASR: "The governing board [of water management districts] may establish works of the district for the purpose of introducing water into, or drawing water from, the underlying aquifer for storage or supply. However, only water of a compatible quality shall be introduced directly into such aquifer." (§ 373.087 F.S.)

The governing board of each water management district is given exclusive authority for processing and issuing permits for each ASR project within its jurisdiction, and "no construction may begin on a project involving artificial recharge or the intentional introduction of water to any underground formation" except as permitted in Chapter 373 [Water Resources Act of 1972, as amended], without the written permission of the governing board of any water management district within which the construction will take place." The same legislation established that a water management district may "do any act necessary to replenish the groundwater of the district, which may include the following (F.S. 373.106):

- Buy water;
- Exchange water;
- Distribute water to persons in exchange for ceasing or reducing groundwater extractions;
- Spread, sink, and inject water into the underground;
- Store, transport, recapture, reclaim, purify, treat, or otherwise manage and control water for beneficial use within the district; and
- Build the necessary works to achieve groundwater replenishment.

Additional rules apply to inter-basin or inter-district transfers.

In general, ASR facility permits are issued for a period of five years, and may be renewed indefinitely. In the mid-1990s, a rule change allowed utilities to operate ASR facilities under a letter of authorization from DEP rather than a permit, under the condition that a facility had conducted enough cycle testing to show that the system is operating as designed and there are no problems with water quality or recoverability. (A cycle is the complete recharge and recovery of a certain amount of water.) A letter of authorization does not expire as long as the facility makes no changes in its operation, but DEP generally requires some level of reporting to ensure compliance with standards. (Haberfield, Seerley)

ASR in the St. Johns River Water Management District

St. John's River Water Management District (WMD) lies just to the south of Georgia's coastal border and, because of similar topography, water availability, and population pressures, it provides a useful comparison for potential use of ASR in Georgia's coastal region. St. John's River WMD identified the need to use additional surface water in its 2000 water plan, but because of high seasonal variability in both quality and quantity of surface water, the district considers ASR to be a reasonable option. The district has committed $11.82 million for ASR construction and testing for fiscal years 2002-2006 (SJRWMD). Within the district, the City of Cocoa's ASR wellfield has been operational since 1987 and has expanded its system to 10 wells, and Palm Bay has an ASR well that has been operational since 1989.

ASR projects within the St. John's River WMD can be initiated in one of two ways: the district may solicit development of ASR by a water supply facility in an effort to meet long-term water supply goals, or a water supply facility may initiate an ASR project. The district requires the following tasks of facility prior to the approval for operation:

- Development of an ASR construction and testing program plan;
- Establishment of objectives and responsibilities;
- Collection of site-specific data and develop preliminary system design;
- Design of ASR pilot system, including well and wellhead facilities;
- Application for regulatory permits;
- Construction, monitoring, and testing of system;
- Startup and training;
- Large cycle operational monitoring and evaluations (to continue during the first two to three years of operation to make necessary adjustments to the system); and

- Peer review of ASR team members.

The St. John's River Water Management District has also developed the Central Florida Aquifer Recharge Enhancement Program, a three-phase program for maximizing local recharge to the Floridan aquifer. Phase one involves artificial recharge demonstration projects, which are in progress. In phase two, which has taken place concurrently with phase one, the district evaluates the feasibility of aquifer recharge enhancement approaches such as the placement of storm water and reclaimed water in rapid infiltration basins and naturally occurring closed depressions in upland recharge areas. Phase two work has been completed, and the first phase three (program implementation) projects are underway. Projects are planned for Orange County, the City of Apopka, the City of Orlando, the City of Sanford, and Seminole County.

ASR and the Comprehensive Everglades Restoration Plan

ASR in Florida took on state-wide and national importance when it was proposed for use as an important component of the Comprehensive Everglades Restoration Plan (CERP). The federal Water Resources Development Act, signed into law in 2000, approved the CERP for restoration of damaged ecosystems in the Everglades. A great deal of water will be needed to implement the plan, and surface reservoirs are not a feasible option because very little suitable land is available for reservoir construction and because of high evaporation rates. The plan includes a proposed system of 333 ASR wells that will store water in the Upper Floridan aquifer, using surface water withdrawn during wet periods. The scale of this project is unprecedented, with approximately 1.7 billion gallons of water per day projected for underground storage.

The plan to use ASR for Everglades restoration has raised a variety of concerns about the magnitude of the plan, including issues of geological integrity and water quality. Geological issues focused on possible subsurface fracturing cause by repeated injection and withdrawal and the potential alterations of the aquifer's hydrogeologic properties. Water quality became one of the most controversial aspects of the plan, with the proposal to use untreated surface water for injection into the Upper Floridan aquifer. Senate Bill 854 and House Bill 705, referred to as the Aquifer Storage and Recovery Act, sought to reduce treatment requirements for surface water injected into ASR wells. (Seerley)

The impetus for the bills was that the level of treatment required by the Environmental Protection Agency and by Florida law was viewed as being prohibitively expensive for such a large-scale project, and to a lesser extent, that treatment to drinking water standards is possibly undesirable for environmental restoration purposes. Some scientists, environmental groups, and others expressed concerns including whether interactions would occur between untreated water and native ground water, whether the water quality would change during storage, and whether the recovered water would pose public health risks, especially in terms of the fate of microorganisms and endocrine disrupting chemicals. These and other concerns led Governor Jeb Bush to withdraw the legislation. Since this controversy, suggestions have been made to introduce legislation to specifically prohibit the injection of untreated water into Florida's aquifers, but thus far no statutory changes have been made.

Oregon

Artificial Recharge

"The appropriation of water for the purpose of recharging ground water basins or reservoirs is declared to be for a beneficial purpose." (ORS 537.135) Permits for such appropriation may be granted by the Water Resources Department, subject to the following conditions:

- The applicant must meet standards developed by the Water Resources Commission.
- Water Resources Department determines whether the proposed ground water recharge project would impair or be detrimental to the public interest.
- The supplying stream must have an established minimum perennial stream flow established for the protection of aquatic and fish life. (This requirement may be waived by the Department of Fish and Wildlife if a minimum perennial stream flow is not otherwise required.)

The Oregon Water Resources Department issues permits to appropriate water for artificial recharge projects, and a secondary ground water permit is require to pump the recharged water out of the aquifer. In processing applications for permits, the Department evaluates whether the diversion of water for recharge and the use of recharged water are in the public interest and if the proposed recharge project will yield a net increase in the amount of water available in the aquifer. Water users recharging ground water and using recharged ground water are required to maintain an accounting of the quantities of water stored and used. Water use may not exceed the amount of water injected into the aquifer after accounting for seepage and other losses.

Aquifer Storage and Recovery

Oregon currently has 10 ASR projects in development or operation. Oregon statutes specifically address standards for permitting and administering aquifer storage and recovery in Sections 537.531 through 537.534:

> "The Legislative Assembly declares that aquifer storage and recovery is a beneficial use inherent in all water rights for other beneficial uses. Aquifer storage and recovery is the storage of water from a separate source that meets drinking water standards in a suitable aquifer for later recovery and not having as one of is primary purposes the restoration of the aquifer." Under the statutory provisions, injection of water into aquifers (§ 537.532 (1)):

- Shall not be considered a waste, contaminant, or pollutant;

- Shall be exempt from the requirement to obtain a discharge permit or a concentration limit variance from the Department of Environmental Quality;

- Shall comply with all other applicable local, state, or federal laws; and

- May be located within or outside an urban growth boundary in conformance with land use laws. [Urban growth boundaries are used in some parts of Oregon to control sprawling suburban development.]

In addition, “In order to protect the high quality of Oregon’s aquifers for present and future uses, the Legislative Assembly recognizes the need to minimize concentrations of constituents in the injection source water that are not naturally present in the aquifer. Each aquifer storage and recovery limited license or permit shall include conditions to minimize, to the extent technically feasible, practical and cost-effective, the concentration of constituents in the injection source water that are not naturally present in the aquifer.” Concentration limits established by the Department of Human Services and the Environmental Quality Commission may not be exceeded, and if certain constituents exceed 50 percent of the concentration limits, permits or limited licenses can require “technically feasible, practical, and cost-effective methods t minimize concentrations of such constituents.” (§ 537.532 (2), (3)) The Water Resources Department may also impose limits on certain constituents in the injection water if, based on valid scientific data, the constituents will interfere or pose a threat to the maintenance of the water resources of the state for present or future beneficial uses.

Under Oregon Administrative Rules, ASR testing programs require a limited license to be issued by the Water Resources Department, and after completion of the testing program of up to five years, the applicant may apply for a permanent ASR permit. ASR testing program applications must include reports that detail the proposed project, including the proposed source of injection water, maximum diversion rate, maximum injection rates, maximum storage volume and duration, maximum withdrawal rates at each well, and use and amounts of recovered water. Reports must also include details regarding the proposed system design, hydrogeologic information pertaining to the aquifer targeted for storage, quality of source water for injection and native aquifer water, and proposed treatment of injection water.

Upon completion of an ASR testing program, the application process for a permanent ASR permit requires a conference with the Water Resources Department and personnel from both the Department of Environmental Quality and the Oregon Health Division. The purpose of the conference is to discuss the ASR testing results, information needed for the application, and possible constraints on a project. The conference may serve as a point of review for the apparent adequacy of the applicant’s hydrogeologic and other information. (OARS 690-350-0030 (3)) The application for a permanent ASR permit requires information similar to the application required for the testing program, and must address water quality and other issues as applicable, based on testing results. The Water Resources Department is required to allow a 45-day protest period, during which time protests may be filed by any person objecting to the proposed issuance of a permit. The Director of the Department may issue the permit as proposed (upon finding that the project will not be detrimental to the public interest), propose to deny the application, offer the applicant and protester(s) an opportunity to engage in discussions to try and resolve issues of concern, refer to contested case hearing, or refer the application to the Water Resources Commission to address policy matters raised by the application. After issuance, the Director of the Department may modify or revoke the ASR permit under certain conditions.

Tigard, Oregon

The city of Tigard began its ASR program in 2001 with an ASR well at the Canterbury Reservoir Site, and the program's success prompted the city to develop a second well, completed in 2005. Use of ASR has enabled Tigard to postpone the construction of additional water storage facilities, reduces strain on surface water sources during summer months, reduces the cost of water provision (as water purchased for ASR injection is less expensive than wholesale water prices during the summer), and provides emergency water supplies. (City of Tigard, 2005)

South Carolina

South Carolina began using ASR in the late 1980s, and wells have now been constructed in Beaufort, Mount Pleasant (a suburb of Charleston), Myrtle Beach, and on Kiawah Island. The City of Orangeburg is conducting a pilot project. The main impetus for using ASR in South Carolina has been the need for seasonal storage. Like Georgia, South Carolina has abundant precipitation, but seasonal and daily peaks, especially in coastal areas with high population growth and tourist demand, typically require expansion of treatment plants to meet increasing water needs. The use of ASR has reduced the need for such expansion and has provided longer-term storage as well, to help prevent water shortages during dry periods.

Water use in South Carolina is regulated by two state agencies: the Department of Natural Resources (SCDNR) and the Department of Health and Environmental Control (DHEC). SCDNR is responsible for conducting research and water resources planning, and managing wildlife resources, while DHEC develops permitting procedures and processes all permit applications.

Legal authority for the use of ASR comes from South Carolina's Underground Injection Control Regulation (R.61-87), which provides authority for DHEC to issue construction and operation permits for ASR wells and other underground injection wells.

Each ASR facility must obtain separate permits from two divisions of DHEC. The Underground Injection Control division of DHEC issues permits for well construction and, after specified conditions have been met, for operational permits. This permit concentrates primarily on the storage and retrieval process. The Water Supply division issues permits for both construction and operation, focusing on water withdrawal from ground or surface water sources.

The application process for an Underground Injection Control permit must include the following attachments for DHEC review:

- Summary of activities that require a UIC permit;
- Well construction details (surface and subsurface);
- Operational data, including average and maximum rate and volume of injection at each well, average and maximum injection pressures, pumping schedules, and duration of project ;
- Description of monitoring program, including monitoring devices, frequency, sampling protocol, and hydraulic control of injected water;
- Existing state or federal permits;
- Description of business;
- Area of review (radius of ¼ mile);
- Map of wells and area of review;
- Geologic cross-sections and diagrams;
- Name and depth of underground sources of drinking water; and
- Sufficient supporting data to demonstrate hydraulic control over injectate/ ground water computer models.

Beaufort-Jasper Water and Sewer Authority

Beaufort-Jasper Water and Sewer Authority, first permitted to operate an ASR well in 1999, operates two ASR wells for recharge and recovery and one well for recovery only. Source water for injection is the Savannah River, which is transported through a 7-mile earthen canal. The water is treated to secondary drinking water standards and stored in the Upper Floridan aquifer. Water is typically injected during October and recovered during the summer months.

DHEC establishes permitting requirements that are specific to each ASR facility. At Beaufort, the facility was required to submit the following information:

- A water-quality analysis of treated water at the existing plant and native ground water from the Upper Floridan aquifer to determine if any adverse geochemical changes were likely to occur;

- A geochemical computer model to analyze the information above, along with geochemical logs, drilling logs, and cutting descriptions;

- A completed cycle testing program; and

- Information from an observation well, including aquifer transmissivity, storativity, and all raw pumping test data observations and calculations.

Permitting was then subject to the following conditions:

- The chemical, physical, and bacterial quality of the well water must meet USEPA primary and secondary standards or treatment may be required. The water must be evaluated for corrosivity to comply with the Lead and Copper Rule.

- Before an approval to "Place Into Operation" could be issued for the proposed construction, a comprehensive operation and maintenance (O&M) manual was to be developed for all facility processes.

- All required chemical parameters were to be tested, with results shown to be below current maximum contaminant levels established in the federal Clean Water Act. Results must be submitted and approved by DHEC's Water Suppl Permitting division prior to final inspection.

- Due to the well withdrawing a mixture of injected water and native ground water, it requires a Capacity Use Permit.

Texas

The Texas Commission on Environmental Quality is required by statute (§ 11.153) to investigate the feasibility of storing water in various types of aquifers around the state by encouraging the issuance of permits for demonstration projects for the storage and subsequent retrieval of appropriated water. Upon completion of each pilot project, the Commission and the Texas Water Development Board jointly prepare a report evaluating the success of the project and provide copies of the report to the governor, the lieutenant governor, and speaker of the House of Representatives. The Board must conduct additional studies and investigations, as necessary, to determine the occurrence, quantity, quality, and availability of other aquifers in which water may be stored and retrieved for beneficial use, in the following order of priority (§ 11.155):

1. The aquifers described in Section 11.153;

2. Areas designated by the Commission as "priority ground water management areas;" and

3. Other areas of the state in a priority to be determined by the Board's ranking of where the greatest need exists.

Within the provisions of federal statutes, each district develops its own rules regarding aquifer recharge and ASR. When applying for a permit to store water in a ground water reservoir or subdivision of a ground water reservoir, an applicant must provide a copy of the application to each ground water conservation district. The applicant must cooperate with each district and comply with the rules governing the injection, storage, and withdrawal of water that are adopted by each district that has jurisdiction over the reservoir or reservoir subdivision. (Texas Statutes § 11.154 (a)(1)) In evaluating a project for permit approval, the Commission must consider whether:

- The introduction of water into the aquifer will alter the physical, chemical, or biological quality of native ground water to a degree that the introduction would:

    - render ground water produced from the aquifer harmful or detrimental to people, animals, vegetation, or property; or

    - require treatment of the ground water to a greater extent than the native ground water requires before being applied to that beneficial use;

- The water stored in the receiving aquifer can be successfully harvested from the aquifer for beneficial use; and

- Reasonable diligence would be used to protect the water stored in the receiving aquifer from unauthorized withdrawals to the extent necessary to maximize the permit holder's ability to retrieve and beneficially use the stored water without experiencing unreasonable loss of appropriated water. (§ 11.154(c))

In making its evaluation, the Commission may consider all relevant facts, including:

- The location and depth of the aquifer in which the water is stored;

- The nature and extent of the surface development and activity above the stored water;

- The permit holder's ability to prevent unauthorized withdrawals by contract or the exercise of the power of eminent domain;

- The existence of an underground water conservation district with jurisdiction over the aquifer storing the water and the district's ability to adopt rules to protect stored water; and

- The existence of any other political subdivision or state agency authorized to regulate the drilling of wells. (§ 11.154(d))

Hueco Bolson Aquifer Recharge

The Hueco Bolson aquifer provides about 65 percent of the water supply for El Paso, Texas. Since 1985, the city has injected reclaimed water from the Fred Harvey water reclamation plant into a three-mile long series of 10 injection wells, located about a mile from the treatment plant. The reclaimed water must meet drinking water standards before it is injected into the aquifer. Prior to this recharge project, water levels in the aquifer were declining at a rate of two to six feet per year, yet ground water models indicated that in the five-year period after the recharge project began, ground water levels were eight to ten feet higher than they would have been without the recharge. (CDM 2001, p. 7-26, 7-27)

Washington

ASR facilities in Washington are authorized by statute (RCW 90.44.460): “The legislature recognizes the importance of sound water management. In an effort to promote new and innovative methods of water storage, the legislature authorizes the department of ecology to issue reservoir permits that enable an entity to artificially store and recover water in any underground geological formation, which qualifies as a reservoir under RCW 90.03.370, below.

Reservoir Permits (RCW 90.03.370) establishes procedures for the Department of Ecology to assess and permit ASR projects. It allows for standards for review and for mitigation of any adverse impacts of ASR projects to be established by the department by rule. Applicants must initiate project studies for proposed ASR facilities, which are reviewed by the Department. In the 2000 session, the Washington State Legislature passed Engrossed Second Substitute House Bill 2867, which expanded the legal definition of “reservoir” to include “any naturally occurring underground geological formation where water is collected and stored for subsequent use as part of an underground artificial storage and recovery project.” The statute defines "underground artificial storage and recovery project" as “any project in which it is intended to artificially store water in the ground through injection, surface spreading and infiltration, or other department-approved method, and to make subsequent use of the stored water.”

The Department of Ecology assesses projects and issues permits in accordance with Washington Administrative Code 173-157 (Underground Artificial Storage and Recovery), authorized and required by RCW 90.03.370. This rule establishes standards and review of ASR proposals and mitigation of any adverse impacts in the following areas:

- Aquifer vulnerability and hydraulic continuity;

- Potential impairment of existing water rights;
- Geotechnical impacts and aquifer boundaries and characteristics;
- Chemical compatibility of surface and ground waters;
- Recharge and recovery treatment requirements;
- System operation;
- Water rights and ownership of water stored for recovery; and
- Environmental impacts.

In the 2002 legislative session, Engrossed House Bill 2993 simplified the application process for ASR by allowing a single application form to cover both a proposed reservoir and proposed use of water from the reservoir. Applications for an ASR project must contain, at a minimum, the following elements:

- Water rights for the source waters for the proposed ASR project;
- A general description of the physical design of the hydrogeological system prepared by an engineer or geologist registered in the State of Washington;
- A general description of the operational design of the hydrogeolocical system prepared by an engineer or geologist registered in the State of Washington;
- A project plan;
- A data monitoring plan; and
- An environmental assessment and analysis of any potential adverse conditions or potential impacts to the surrounding environment, limited to storage and subsequent use of stored water, that might result from the project.

Lakehaven Utility District

The Lakehaven Utility District, located in the city of Federal Way, has one operational ASR well that has been operational as a pilot since 1991, and the district is planning as many as 27 additional ASR wells as part of the Optimization of Aquifer Storage for Increased Supply (OASIS) project. The OASIS project is intended to optimize water supplies by storing excess winter water from either ground or surface water sources and making it available when customer demand peaks between May and September. The district is currently drawing water from the Redondo-Milton Channel aquifer, which is relatively shallow and subject to seasonal natural recharge, and injecting water into the sand and gravel Mirror Lake aquifer, considered the storage aquifer. Three wells provide recovery water and one well is a recharge and production (recovery) well. Other potential sources of recharge water are neighboring rivers, the Green and Cedar rivers. If surface water is used for recharge, pre- and post treatment are expected to be required.