Ensuring resources to support a Growing Economy

The state's natural resources provide Georgians with a variety of basic needs. Water resources provide water to drink; support production of goods, food and electricity; and process wastewater.

Land serves many purposes, including production of food, wood and mineral products and support of our growing cities and counties. Air is essential for life and, in addition to harming human health, poor quality air can impair visibility and lessen our enjoyment of the environment around us.

The third objective established for EPD by state law focuses on the use of Georgia's natural resources as a foundation for a strong economy and a rich quality of life, both now and in the future. This objective is closely related to the objectives of protecting human health and sustaining healthy ecosystems. For the most part, progress on the first two objectives will result in progress on the third, and progress on all three will be necessary for Georgia's continued growth and prosperity.

As Georgia's population and economy has grown, the use of resources has also increased and these trends are expected to continue over the coming decades. As demands increase, the ability of some resources to support critical functions may be at risk.

Unfortunately, limited information exists about the capacity of the state's resources or their ability to support economic growth. More demand for water, for example, requires more information about capacity, and studies under the State Water Plan, have begun to fill some of these information gaps.

This chapter focuses on the environmental services that Georgia's natural resources provide to support the state's economy. Table 3.1 lists the indicators selected to assess the capacity of Georgia's resources to provide those services. Indicators focus on the condition of water resources, including water for water supply and the capacity to assimilate pollution as well as lands used for forestry, agriculture and solid waste disposal.

Table 3.1 *Indicators of the condition of the state's natural resources.*

Natural resource	Indicators of condition
Water supply	Total water use
	Per capita water use
	Groundwater levels
Assimilation of pollution	Pollutants in surface waters
	Nonpoint sources of pollution
Working lands	Land used for agriculture and forestry
	Brownfield revitalization
	Land used for solid waste disposal
Air quality	Visibility

As Georgia's population and economy grows, so does its need for water. Water withdrawn from the state's rivers, streams, lakes and aquifers is used for a variety of purposes, ranging from household use to industrial, agricultural and thermoelectric production. The total amount of water used for these purposes is an indicator of the sustainability of Georgia's water supply.

The U.S. Geological Survey (USGS) conducts an extensive evaluation of water use every five years. The most recent USGS analysis covers water use in the year 2005. For the purposes of this report, water use is grouped into five major sectors (see sidebar).

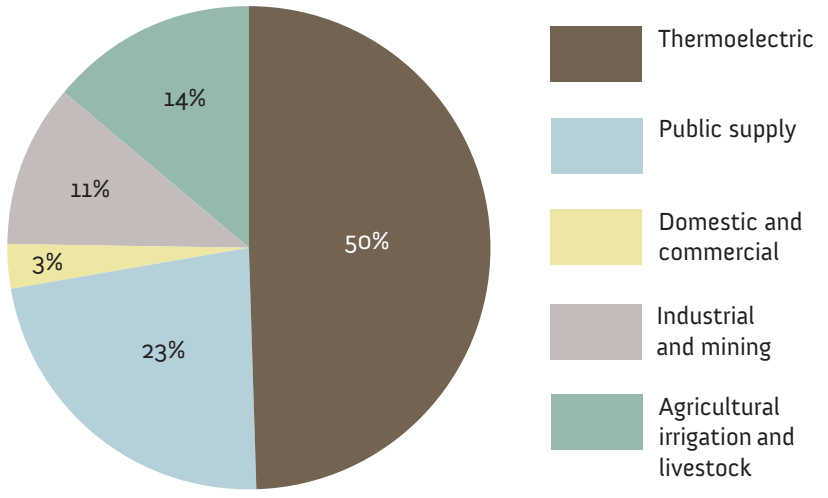
The largest single use of water in the state is for electricity production (Figure 3.1). In 2005, half of all water withdrawn was used in cooling processes associated with the generation of thermoelectric power. There are 15 plants operating on fossil fuels and two nuclear-powered plants in Georgia. In 2005, these 17 plants used an estimated 2.7 billion gallons of water a day.

Water for thermoelectric power production, however, is used differently from other sectors. More then 90 percent of the total water withdrawn for thermoelectric power production is almost immediately returned, usually to the source from which the water came.

The amount returned varies with the type and age of the plant. For some plants, almost all the water used for cooling is returned to the source close to where it was withdrawn. In other plants, water is converted to steam and is consumed in the cooling process (i.e., not returned to the source). For the plants currently operating in Georgia, the estimated amount of water lost through evaporation ranges from less than 1 percent to 70 percent.

The combined water use for public supply, domestic and commercial use, and industrial and mining use accounts for about 37 percent of the total withdrawals in state. For these sectors, the amount of water returned to the source after use varies widely, depending on the specific use.

In the agricultural sector, more than 90 percent of water is used for irrigation. The amount of irrigation water used each year depends on the amount and timing of rainfall. In the past two decades, water used for irrigation has generally accounted for 8 percent to 17 percent of the total water withdrawn. Irrigation water is largely consumed through evaporation or plant use, and little is returned to the water source.



Total = 5,528 million gallons per day

Figure 3.1 *Water use by sector, 2005. Due to rounding, percentages do not total 100. (U.S. Geological Survey)*

Total Water Use

Indicator of the sustainability of Georgia's **Water Supply**

Water in Georgia is used by five major sectors

Public supply. Water withdrawn by public and private water suppliers and delivered for a variety of uses, including domestic, commercial and industrial.

Domestic and commercial. Water from individual water systems, such as wells, withdrawn for self-supplied households and commercial establishments.

Industrial. Self-supplied industries that use water for fabrication, processing, washing and cooling. The largest industrial water users in Georgia are pulp and paper mills, textile industries, chemical manufacturers and mining and mineral industries.

Agricultural. Water used to irrigate crops, large nurseries and golf courses. Also, water used for livestock watering, feedlots, catfish and aquaculture operations, and other livestock farm operations.

Thermoelectric power. Water used in the generation of electric power, primarily for cooling purposes. Excludes water used for hydroelectric production.

Once water is withdrawn, is any returned to the source?

When thinking about current and future use of Georgia's water resources, it is worth noting that the numbers in this report only represent the water that is withdrawn, and say nothing about the amount of water that is returned to the source.

Returning water after it has been used helps support water withdrawals by users downstream and helps maintain the health of aquatic ecosystems.

The loss of water through evaporation or plant use, as happens with much of the water withdrawn for agricultural uses, or through wastewater disposal practices that either delay the return of water or return it to other sources, can affect the ability of that water source to support other water uses.

Sources of water

All of the water used in Georgia comes from the surface water sources in the state's 14 major river systems and groundwater stored in six major aquifers. Surface waters provided 79 percent of the water withdrawn in 2005, and aquifers provided the remaining 21 percent.

Figure 3.2 shows the major water use sectors and the amount of surface water and groundwater that each used in 2005. Among the largest water users, water for thermoelectric production and public supply primarily came from surface water sources. Agricultural irrigation, in contrast, occurs largely through withdrawals from groundwater. Industrial users rely almost equally on surface and groundwater sources.

Some of the state's water sources are more heavily used than others. In 2005, withdrawals from the Chattahoochee and Flint river basins accounted for nearly one-third of all surface water withdrawals in the state. Withdrawals from the Oconee and Ocmulgee river basins also accounted for approximately one-third of the total.

Much of the water withdrawn from these river basins, however, is for thermoelectric use. Looking only at public supply, domestic and commercial uses, withdrawals from surface waters in the Chattahoochee and Flint basins accounted for more than half of the total in 2005. Withdrawals from the Coosa, Ocmulgee and Oconee basins added up to an additional third of the total. All of these basins serve areas of the state that are densely populated and have seen rapid population growth in recent years.

Groundwater withdrawals occur predominantly, but not exclusively, in the southern portion of the state. The majority of groundwater withdrawals — 55 percent in 2005 — are from the Floridan aquifer system, primarily the Upper Floridan aquifer.

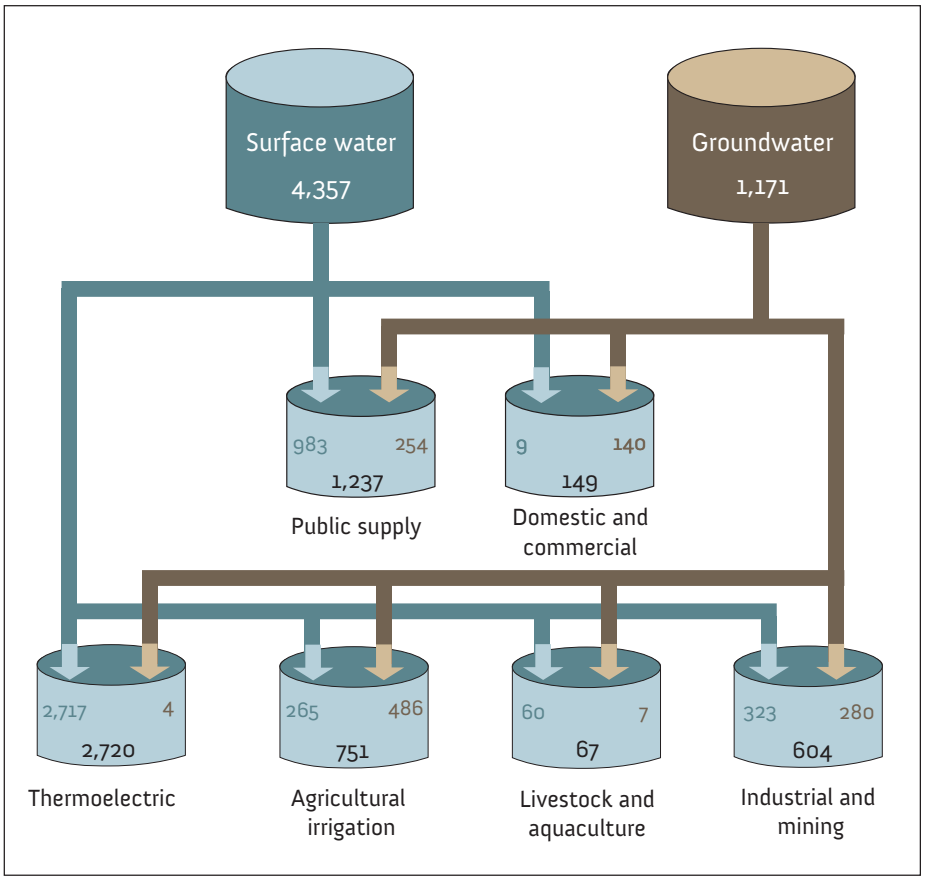


Figure 3.2 *Amount of surface and groundwater used by major sectors in Georgia, 2005 (million gallons per day). Due to rounding, numbers in each category may not add up exactly. (U.S. Geological Survey)*

Trends in water use

The U.S. Geological Survey has tracked trends in water use every five years between 1980 and 2005 (Figure 3.3). Thermoelectric withdrawals were highest in 1980 and were relatively constant through 2000. In 2005, withdrawals for thermoelectric power production dropped, primarily due to retrofits at several plants that decreased water use.

Industrial water use declined between 1980 and 2005, with decreases in recent years largely due to more efficient use of water at industrial facilities and a shifting mix of industrial water users.

Agricultural water use declined during the 1980s but increased in the 1990s. Most agricultural water is used for irrigation, which is influenced by rainfall. Irrigation in 2000, a drought year, was 52 percent higher than it was in 1995, a wet year. Increased amounts of water used for irrigation also reflects an increase in the number of acres irrigated, which was 38 percent higher in 2005 than in 1985.

Withdrawals for public water supply steadily increased from 1980 to 2000, with the quantity withdrawn in 2005 roughly equal to that in 2000. By 2005, withdrawals were 62 percent higher than in 1980. As described in the next section, water conservation initiatives appear to be slowing the growth in withdrawals for public supply. But, because increases in population can outweigh the effects of water conservation, the trend of increasing withdrawals may continue as the state's population continues to grow.

Georgia's population and economic growth has raised questions about the long-term capacity of the state's water resources. Assessments of the capacity of individual water sources are currently under development. This information will help create a better understanding of the current and potential impacts of increased withdrawals from the state's water resources.

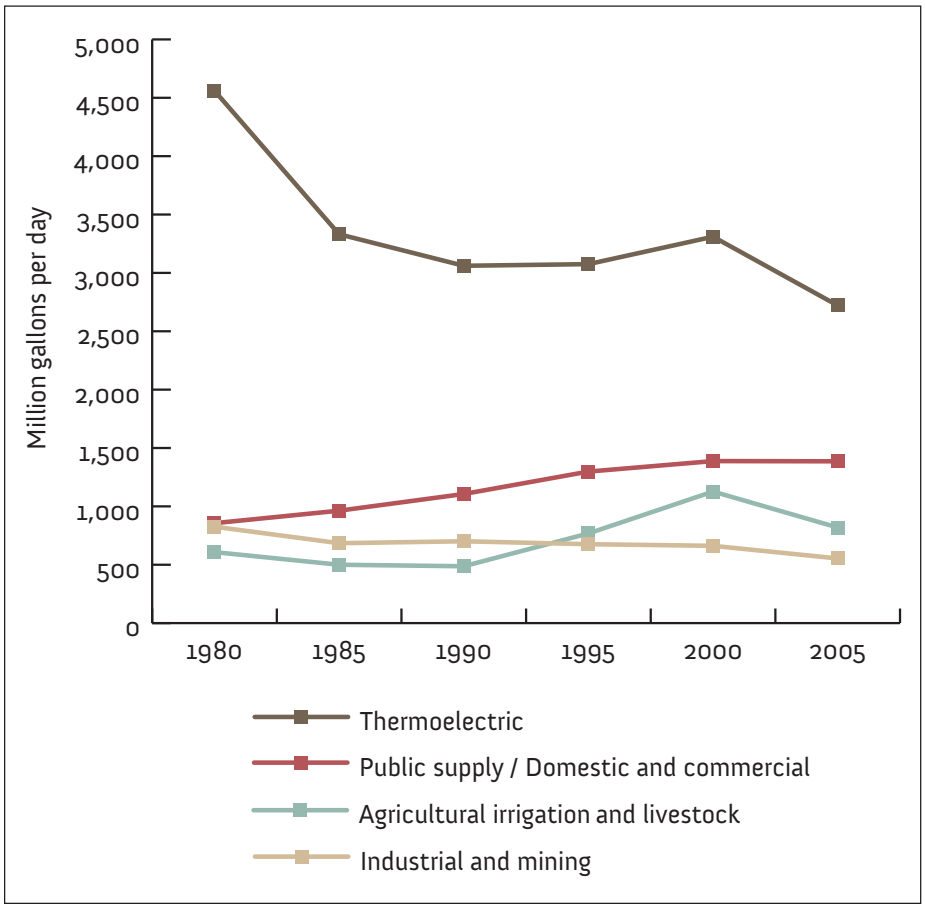


Figure 3.3 *Trends in water use in Georgia, 1980 - 2005. (U.S. Geological Survey)*

Managing competing uses of water

The state's lakes, rivers and streams support a range of uses and provide a variety of benefits to Georgians. Some of these uses occur after water is withdrawn from a water body and transported for use. These are called offstream uses and include water supply for household use, for commercial and industrial purposes, and for agricultural production, among others.

At the same time, Georgia's surface waters provide benefits through uses that occur within the banks of streams, rivers and lakes. These instream uses include dilution and processing of wastewater, navigation, recreation and hydropower production — uses that directly benefit people. Instream uses also include the water needed for fish and wildlife and ecosystem health.

Managing Georgia's waters means taking steps to ensure that water is available, now and in the future, to meet demands for offstream water use while maintaining each water body's capacity to provide instream uses as well.

Per Capita Water Use

Indicator of the sustainability of Georgia's **Water Supply**

Seasonal differences in per capita water use

Residential per capita water use is generally highest during the summer and lowest during the winter. This difference, which is largely due to outdoor water use, can be substantial.

A study of water use in eight representative Georgia communities found that the average per capita water use was 30-67 percent higher in the summer than in the winter. In some communities, residential per capita water use during the summer exceeded 100 gallons per person per day.

Outdoor water use is an area where water conservation practices can be readily implemented to increase the efficiency of residential water use.

Per capita water use is a measure of the efficiency with which households, businesses and industries use water. Greater efficiency in water use can save money for consumers and help meet current and future water demands, while minimizing impacts on the environment.

Per capita use can be calculated a number of different ways. In Georgia, municipal and industrial users who use more than 100,000 gallons per day are required to have a water withdrawal permit. Taking the total amount of water withdrawn under these permits and dividing it by the state's population provides an estimate of overall water use per person per day. This indicator captures changes in population and economic activity.

Table 3.2 shows a consistent decline in overall per capita water use from 2003 to 2007. The decline is due to increased efficiency among industrial water users, restrictions on outdoor watering, and implementation of water conservation practices such as installation of low flow plumbing fixtures and other devices.

Overall per capita water use includes water for residential, commercial and industrial purposes. Measuring residential water use alone provides a more accurate assessment of household progress on water conservation and efficiency. As an alternative to overall per capita water use, EPD recently evaluated residential per capita water use as a measure of water conservation.

Although statewide data are not available, information on residential per capita water use has been collected from representative communities across the state. In 2005, residential water use ranged from 60 to 88 gallons per person per day (Table 3.3). Differences among communities may be due to differences in the accounting of water use, the extent of outdoor water use, and the type and age of the housing stock.

Table 3.2 *Overall water use per person per day (municipal/industrial permits excluding thermoelectric withdrawals). Because methods of calculation differ, these numbers cannot be compared with those for other states. (EPD)*

Fiscal year	Total withdrawals under municipal and industrial permits (gallons per capita per day)
2003	198
2004	192
2005	187
2006	187
2007	185

Table 3.3 *Residential water use in representative public water systems, 2005. (Per capita use is calculated by dividing the gallons per residential account per day by the 2000 U.S. Census household size for the water system; commercial and industrial accounts excluded) (EPD)*

Water system	Daily residential water use per household (gallons)	Daily residential water use per person (gallons)
Douglas	200	78
LaGrange	170	68
Leary	170	65
Macon	220	88
Pickens County	152	60
Reidsville	160	68
Toccoa	145	63
Savannah	211	85

Emerging Issue

Responding to Exceptional Drought

Georgia is currently in a drought of historic severity. By December 2007, more than 99 percent of the state was at some level of drought, with 50 percent of the state experiencing exceptional conditions that are expected to occur only once every 100 years.

Drought conditions led to unprecedented responses from state and local officials and from Georgia citizens. A Level 4 drought, the most severe drought defined by the Georgia Drought Management Plan, was declared in the fall of 2007. This declaration affected much of the northern half of the state and included a mandatory ban on outdoor water use (with limited exceptions).

Reductions in water use in Level 4 drought areas (% change compared to the previous year). (EPD)

	Water use reductions
Nov. 2007	15%
Dec. 2007	13%
Jan. 2008	11%
Feb. 2008	13%
Mar. 2008	14%
Apr. 2008	31%
May 2008	29%
Jun. 2008	20%
Jul. 2008	13%
Aug. 2008	24%
Sep. 2008	18%

From November 2007 through March 2008, water providers in the affected areas also were charged with decreasing water use each month by 10 percent compared to the same period for the preceding year. Because there is not as much water use during cooler months, this extra measure was needed to reduce water use. Local governments and utilities worked to help customers understand water conservation practices as the best way to battle drought and to enforce the ban on outdoor water use. As a result, the reduction target was exceeded each month (see table).

The 10 percent reduction requirement expired March 31, 2008 and was not extended. Outdoor water use restrictions, however, continued. Because outdoor water use is a large portion of water use in spring and summer months, restrictions helped achieve reductions much higher than 10 percent.

These reductions reflect outstanding water conservation efforts by Georgia citizens along with savings due to outdoor watering restrictions. They demonstrate that water providers, businesses and citizens can and will respond when threats to water supplies become critical. And, some of the water conservation practices, like installing low flow plumbing fixtures and other devices, will contribute to long-term water efficiency.

Saving water through energy conservation

Water conservation is just one way to contribute to the sustainability of Georgia's water supply — energy conservation contributes as well. Energy use and water use are closely connected, and reducing the use of one often reduces the use of the other.

In Georgia, 60 percent of the state's electricity comes from coal-fired generation. According to the Sandia National Laboratory, coal generation requires 25 gallons of water for each kilowatt-hour of generation. The Sandia researchers conclude that consumers may use as much water indirectly, in electricity use, as they use directly, by taking showers and watering lawns.

Georgia released its State Energy Strategy in December 2006. The Strategy's policy objectives include minimizing the impacts of energy production on water supply and water quality. Research conducted to support development of the Strategy found that increasing energy efficiency in Georgia would save a substantial amount of water.

Using cost-effective, energy efficiency measures in Georgia could save 159 million gallons per day by 2015 — almost as much as the 2005 daily water use in all of Fulton County, as estimated by the U.S. Geological Survey.

To read the Georgia Energy Strategy go to http://www.gefa.org/Index.aspx?page=93#a4.

Groundwater Levels

Indicator of the sustainability of Georgia's **Water Supply**

The amount of water sustainably available from individual water sources is finite, and, for sources of groundwater, water withdrawals can contribute to declining groundwater levels.

In some aquifers, when the water level goes down, the amount of water available for our use is reduced. Groundwater levels provide an additional indicator of the sustainability of Georgia's water supply.

Twenty-one percent of the water used in Georgia in 2005 came from groundwater. Figure 3.4 shows the primary aquifers that supply groundwater in Georgia.

Persistent declines in groundwater levels have been observed in three of Georgia's principal aquifers: the Clayton and portions of the Cretaceous and the Upper Floridan. Water levels in representative wells in each of these aquifers are shown in Figure 3.5 on page 61.

The Cretaceous aquifer is in central Georgia. The water level at a representative well in Washington County has fallen about 30 feet since the mid 1980s (Figure 3.5a). This decline represents more than 6 percent of the height of water in the aquifer before water levels dropped due to groundwater withdrawals in the area.

The Clayton aquifer is found in southwest Georgia. The Clayton is a relatively small aquifer with a small recharge area, which limits the rate at which the aquifer is replenished by rainfall. The water level at a Randolph County well in this aquifer has fallen more than 40 feet since the mid-1960s (Figure 3.5b). This represents about 17 percent of the height of water in the aquifer that would have been available before withdrawals in the area began to affect water levels.

Falling water levels have increased the cost of withdrawing groundwater from the Clayton aquifer. Water levels also have not recovered, indicating that the withdrawals have exceeded the aquifer's ability to replenish itself. EPD has not issued new withdrawal permits for the Clayton aquifer since the mid-

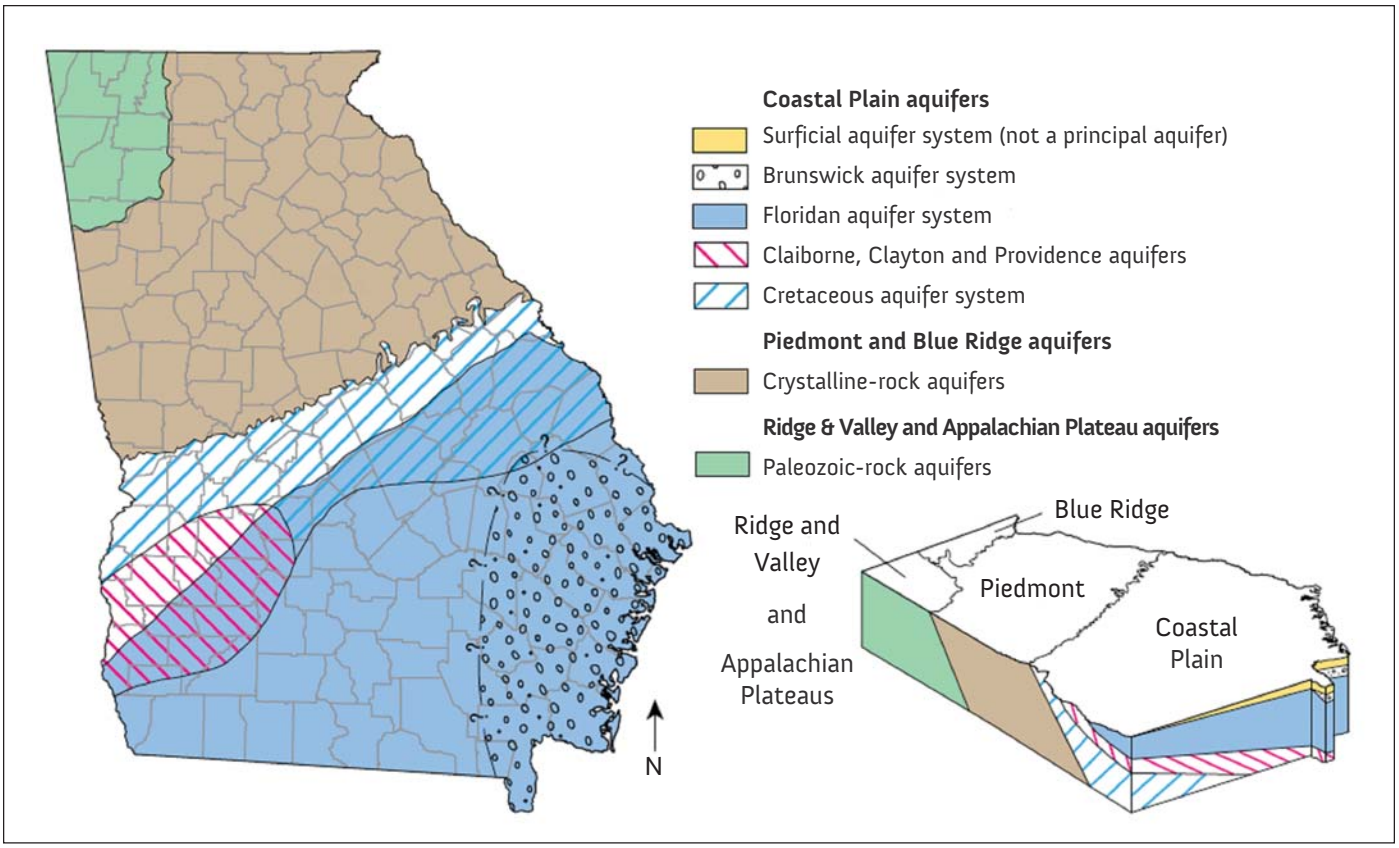


Figure 3.4 *Georgia's principal aquifers. (U.S. Geological Survey)*

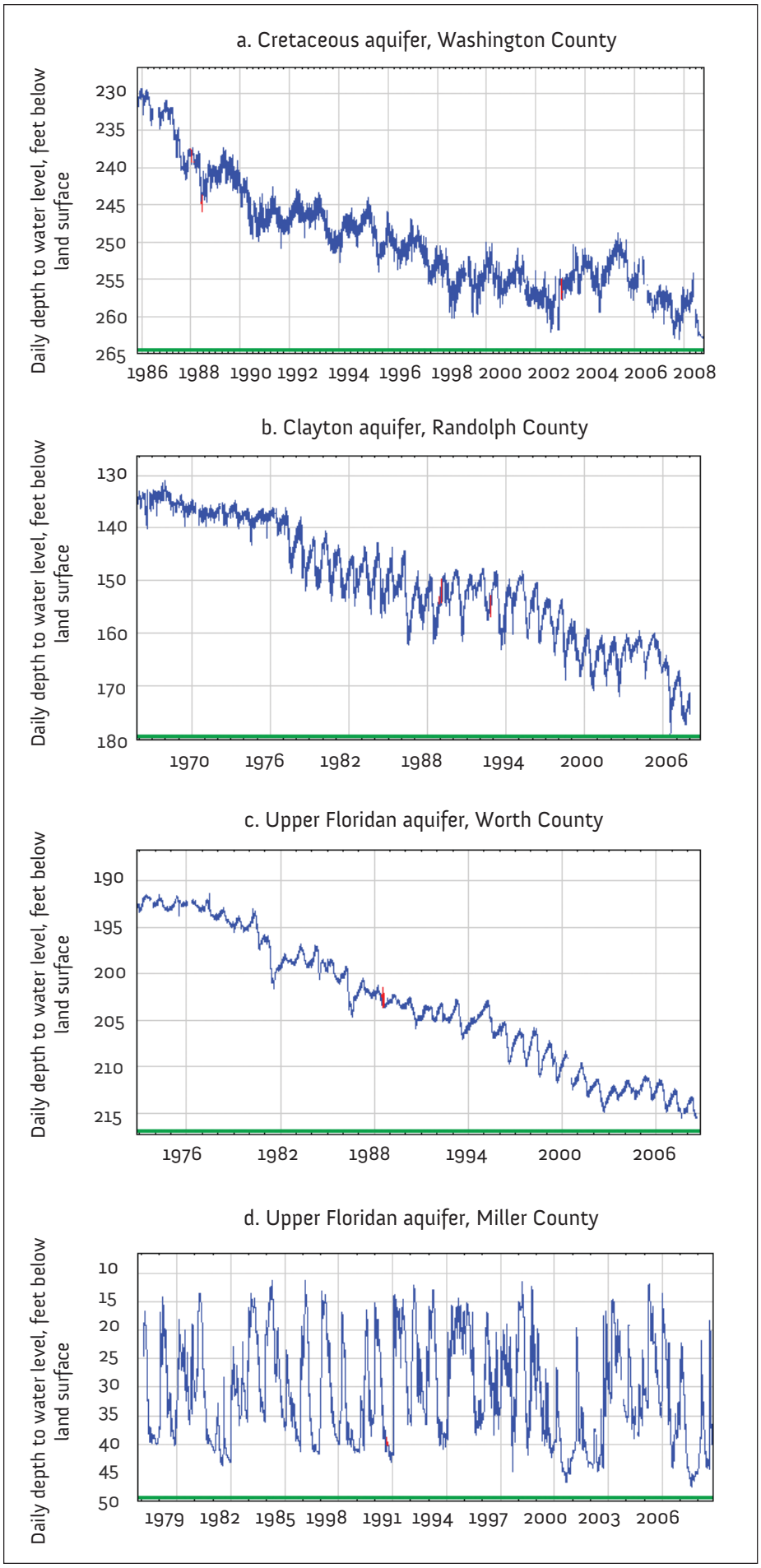


Figure 3.5 *Groundwater levels in selected wells (blue lines indicate measured levels; red indicates estimated water level). (U.S. Geological Survey)*

How is groundwater replenished?

An aquifer is a geologic formation, such as crystalline bedrock, limestone or sand, that can store and release significant quantities of groundwater. The addition of water to an aquifer is called recharge.

Shallow aquifers receive most of their water from rainfall. Rain sinks downward through open pores and fractures in soil or bedrock and slowly moves into deeper parts of an aquifer. Deeper, buried aquifers – also called confined aquifers – are recharged by leakage from adjacent aquifers and by rainfall where the aquifer is at or near the surface. Aquifers that meet the surface also may be recharged by water from streams and rivers.

Groundwater recharge occurs all over Georgia. The most significant areas of recharge are found in northwest Georgia, in areas just below the Fall Line that runs across the central part of the state, in southwest Georgia, and in river valleys throughout the Coastal Plain.

Water in an aquifer is always moving from recharge areas to discharge areas. Depending on aquifer characteristics, groundwater may move rapidly (hundreds of feet per day) or slowly (an inch or less per day). Some of the water in the Upper Floridan aquifer has been underneath Georgia for thousands of years.

Aquifers discharge naturally to springs, lakes, wetlands and streams, which helps maintain stream flow during dry periods. Some also discharge to the Atlantic Ocean and the Gulf of Mexico. Groundwater pumping removes water from an aquifer and is a type of discharge. When discharge exceeds recharge, water levels will decline.

Recovery of groundwater levels in Camden County

In Camden County in southeastern Georgia, groundwater withdrawals from the Upper Floridan aquifer have supplied the Durango Paper Company, the cities of Kingsland and St. Marys, and the Kings Bay Naval Submarine Base. By 2002, Durango was withdrawing groundwater at a rate of about 35 million gallons per day (mgd) with the cities and naval base withdrawing an additional 5 mgd.

These withdrawals caused water levels in the area to decline to about five feet below sea level. When the paper company stopped withdrawing water in late 2002, water levels recovered within weeks to elevations of about 30 feet above sea level.

The quick recovery of water levels indicated that total groundwater withdrawals of 40 mgd did not exceed the sustainable yield of the Upper Floridan aquifer in Camden County.

1990s to protect this resource for those who currently rely on it.

The third aquifer showing persistent declines, the Upper Floridan, is the most significant in terms of water use. The Floridan aquifer system underlies much of south Georgia and is a principal source of water for people, businesses and farms across the region.

Agricultural irrigation is the largest use of groundwater in the southern half of the state. With the introduction of center-pivot irrigation systems in the mid-1970s, the Upper Floridan aquifer became the primary source of irrigation water in southwest Georgia and water level monitoring in this region show impacts to the aquifer.

At some wells in the Upper Floridan, water levels have fallen continuously since the 1970s. For example, water levels at a well in Worth County have dropped about 20 feet (Figure 3.5c). While the cause of the declines cannot be determined definitively, a variety of factors — including an increase in the number of irrigated acres and a shift to crops, like cotton, that require more water — may have contributed. In some areas, increased water use for nonagricultural purposes may also have contributed.

Declining water levels, however, have not been observed in all wells in the Upper Floridan aquifer. For example, at a well in Miller County, the overall trend in water levels has remained the same since the 1970s, although levels have varied seasonally by 25 feet or more (Figure 3.5d). And, in some areas, levels have rebounded after withdrawals decreased (see sidebar).

The wells in Worth and Miller counties highlight how different areas of the aquifer can respond differently based on the rate at which groundwater is replenished and the way in which it is used for irrigation. Much is unknown about why water levels fall or stay the same and it is difficult to predict long-term changes in water levels in response to withdrawals.

Regardless of the cause, water levels in some wells in the Floridan aquifer have dropped steadily and sharply since the 1970s. These declines show that there are impacts from the use of groundwater from the aquifer. If declines in water levels accelerate or become more extensive, future generations may not be able to get as much water from the Floridan aquifer system as is currently used in southwest Georgia and other parts of the state.

Backgrounder

Managing the Use of Stressed Water Sources

In two areas of the state, water withdrawals have not just affected water levels in the water source. They have also led to other impacts. In coastal Georgia, groundwater withdrawals have affected water quality in parts of the Upper Floridan aquifer. In southwest Georgia, groundwater withdrawals contributed to decreases in the amount of water in tributaries of the Flint River. As a result, EPD has restricted use of some water sources in these areas.

Georgia's coastal region, along with adjoining areas in South Carolina and Florida, rely heavily on the Upper Floridan aquifer as a major source of water for municipal and industrial uses. In two areas, pumping of groundwater has contaminated the aquifer with saltwater. This phenomenon, known as saltwater intrusion, occurs when seawater is drawn into the aquifer, contaminating wells. It can also occur when brackish water is drawn into the aquifer from other geologic formations. Saltwater intrusion affects the long-term viability of the Upper Floridan as a water source.

Recent scientific studies have shown Glynn County is vulnerable to saltwater intrusion due to pumping on the Brunswick peninsula. Chatham County and parts of Effingham, Bryan and Liberty counties overlay a cone-shaped area of lowered water levels that exceeds 100 square miles and extends into South Carolina. This cone of depression is caused by groundwater pumping in Georgia and South Carolina and contributes to the spread of saltwater in the aquifer under Hilton Head Island. These areas now face limitations on use of the Upper Floridan aquifer and water users must look to other sources to meet increasing demands for water.

Pumping for agricultural irrigation has increased significantly in **southwest Georgia's** lower Flint river basin since the 1970s. The onset of drought in 1998 raised concerns about the impact of irrigation withdrawals on low flows in the Flint River and some of its tributaries.

In response, EPD initiated detailed studies of groundwater-surface water interactions in this basin. In 2006, EPD adopted a plan to manage water withdrawals to protect stream flow. The plan limits water use in specific watersheds within the river basin. In 13 of the small watersheds in the lower part of the basin, irrigation withdrawals from the Upper Floridan aquifer have been capped at current levels. Fourteen small watersheds face restrictions on additional withdrawals from the Upper Floridan. Other sources of water will have to be used to meet additional demands for irrigation and other water uses.

To learn more about the Coastal Georgia Permitting Plan for Managing Saltwater Intrusion, go to: http://www1.gadnr.org/cws

To learn more about the Flint River Basin Plan, go to: http://www1.gadnr.org/frbp/index.html

How do we know if there is enough water to meet our needs?

Understanding how water is used provides only one piece of the puzzle needed to determine if our water resources can meet the needs of the current and future generations. EPD also must assess how much water is available, since there are limits on the amount of water that individual sources can supply.

Growth of the state's economy and population brings increased demand for water and an increased need for water to assimilate or process pollution. Managing Georgia's water resources to meet these needs will require better information on the long-term capacities of the state's waters. Currently, information on this is limited.

The provisions of Georgia's State Water Plan, adopted in 2008, are intended to help address this gap. Over the next two years, EPD will conduct resource assessments to determine the amount of surface water and groundwater available to support current and future water use. Other assessments will determine the capacity of surface waters to process or assimilate pollution.

Pollutants in Surface Waters

Indicator of the capacity of Georgia's waters to **Assimilate Pollution**

Monitoring more miles of streams and rivers

The number of stream and river miles evaluated for water quality has steadily increased since 1992.

Increasing the number of river miles evaluated has allowed EPD to identify a larger number of stream segments where water quality standards are violated. However, the percentage of assessed river miles where one or more standard is violated, and the percentage that meet water quality standards, have remained fairly constant.

Since the late 1990s, between 57 percent and 61 percent of the river miles assessed each year violated one or more standard. Between 39 percent and 43 percent of the river miles assessed each year met all water quality standards.

In addition to supplying the state with water, Georgia's surface waters also perform another critical function – assimilating pollution. Water bodies have a natural ability to process – or assimilate – most pollutants in a way that prevents harm to aquatic life or humans who come in contact with the water. This ability, called assimilative capacity, not only protects human health and sustains healthy ecosystems, it is also critical to the long-term support of a growing economy.

There is a limit, however, to the amount of pollutants a water body can assimilate. When the total amount of pollution from point and nonpoint sources exceeds that limit, the quality of the water is reduced and water quality standards may be violated (see page 11). The extent to which standards are violated is one indicator of a limited capacity to assimilate increases in treated wastewater – a capacity necessary to support continued population and economic growth.

Violations of water quality standards are assessed and reported every two years. Figure 3.6 shows the statewide trend since 1992. The percentage of the total miles of river and streams that have been assessed has steadily increased, reaching 20 percent in 2008. The proportion of assessed miles that meet water quality standards, and the proportion where standards are violated, have remained relatively constant. In 2008, 39 percent of miles assessed fully met the standards.

Water quality in the state's lakes and estuaries is also evaluated on a two-year cycle. In 2008, 400,528 acres of lakes were assessed, equaling 94 percent of the state total. Of the acres assessed, 53 percent fully met water quality standards, a slight decline from the 2006 figure of 59 percent.

Violations of water quality standards indicate that the assimilative capacity of these waters has been reached or exceeded. It is difficult or impossible to issue permits for additional discharge of treated wastewater to these waters, a limitation that can hamper economic development.

In the watersheds of water bodies that have reached their assimilative capacities, demand for additional wastewater treatment will have to be met through other means. For wastewater treatment plants and other point sources, this may mean applying treated wastewater to land, reusing the wastewater, or using a technology that completely removes the pollutant that causes the violation of water quality standards. Or, it may require actions to decrease the amount of nonpoint source pollution that reaches the water body.

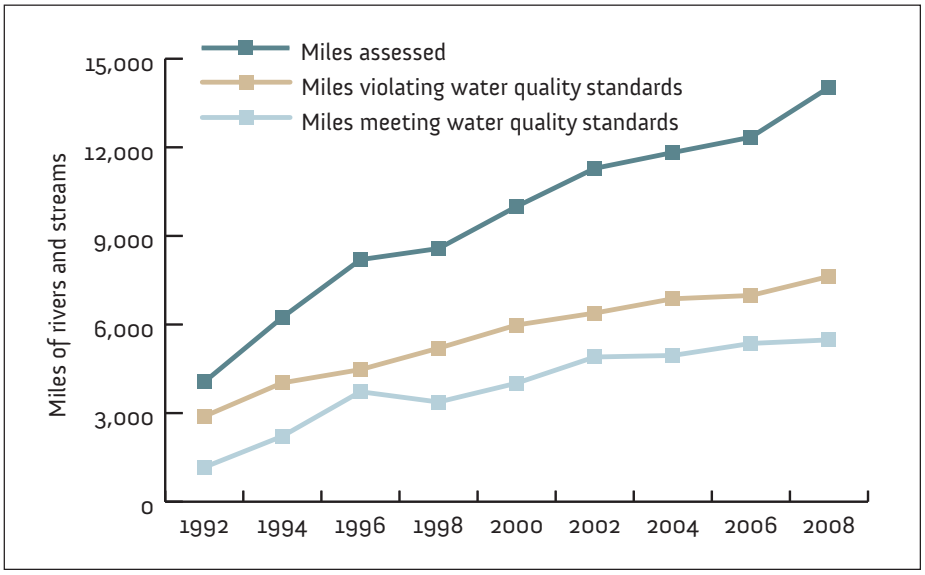


Figure 3.6 *Violations of water quality standards in streams and rivers, 1992 - 2008. Georgia has a total of 70,150 miles of streams and rivers. (EPD)*

Indicators of poor water quality

Tables 3.4 and 3.5 show the major indicators of poor water quality in the state's streams, rivers, harbors, sounds and lakes. Check marks show the indicators of poor water quality that were most common in 2006-2007. Together, the checked pollutants or conditions account for 80 percent of the stream miles or 80 percent of the acres of harbors, sounds and lakes with poor water quality. Factors contributing to poor water quality in the remaining 20 percent of waters include elevated levels of copper and other metals, additional organochlorine compounds, and altered temperature and pH.

Fecal coliform bacteria are a major contaminant in streams and rivers in 13 of the state's 14 major river basins. Poor quality fish and invertebrate communities are major indicators of poor water quality in eight river basins (and the health of fish communities has not yet been evaluated in five river basins).

Mercury in fish tissue is the most common problem in two basins and contributes to violations in several others. Low dissolved oxygen is a major indicator of poor water quality in seven river basins, all in south Georgia.

All violations of water quality standards in harbors and sounds are due to dissolved oxygen. In lakes, the majority are due to organochlorines in fish tissue and high levels of chlorophyll.

Elevated levels of chlorophyll indicate the presence of large amounts of nutrients, which causes growth of algae and aquatic plants. Algae are an important food source for aquatic life, but excessive amounts of nutrients like phosphorus can cause too much plant growth, negatively affecting fishing, recreation and drinking water supplies.

Table 3.4 *Major indicators of poor water quality in Georgia's streams and rivers, 2006-2007. (EPD)*

River basin	Fecal coliform	Poor quality fish and invertebrate communities	Dissolved oxygen	Mercury in fish tissue	Organo-chlorines in fish tissue
Altamaha	✓		✓		
Chattahoochee	✓	✓			
Coosa	✓	✓			✓
Flint	✓	✓	✓		
Ochlockonee	✓		✓	✓	
Ocmulgee	✓	✓			
Oconee	✓	✓			
Ogeechee	✓		✓	✓	
Satilla	✓		✓	✓	
Savannah	✓	✓			
Suwannee	✓		✓	✓	
St. Marys			✓	✓	
Tallapoosa	✓	✓			
Tennessee	✓	✓			

Table 3.5 *Major indictors of poor water quality in Georgia's harbors, sounds and lakes, 2006-2007. Sounds and harbors with poor water quality are found in the Savannah and Satilla river basins. Lakes with poor water quality are found in eight of the state's major river basins. (EPD)*

	Dissolved oxygen	Organochlorines in fish tissue	Chlorophyll
Sounds and harbors	✓		
Lakes		✓	✓

When water quality standards are not met

When water quality standards are violated, EPD must limit the amount of pollutants allowed in the water body. The amount of pollutant allowed is called the total maximum daily load (TMDL), and it is established to ensure that the water body can support its designated uses (see sidebar on page 10 for an explanation of designated uses).

Once the TMDL is established, EPD develops a plan for how the TMDL, and ultimately the water quality standards, will be achieved. Once the water quality standards are met, the state may remove the water body from its list of waters with poor water quality.

The table below shows the amount of water bodies partially or completely removed from this list between 2000 and 2008. Waters that were partially removed now meet at least one water quality standard that was violated in the past. Waters that have been totally removed now meet all water quality standards.

Water bodies removed from the state's list of waters with poor water quality, 2000 - 2008. (EPD)

	Partially removed	Totally removed
River segments (miles)	3,092	1,739
Lakes (acres)	402,374	268,646
Estuarine water bodies (square miles)	281	179

Limits on wastewater discharges

Several areas of the state currently face stringent limitations on additional discharge of treated wastewater, which may constrain growth and development.

High levels of chlorophyll have been measured in Lake Lanier, Lake Allatoona, Carter's Lake and Lake Walter F. George (watersheds shown in green in Figure 3.7). High chlorophyll levels are due to large amounts of phosphorus; any new or increased discharge of treated wastewater would increase the amount of this nutrient.

Until TMDL studies are completed and steps are taken to improve water quality, communities in the watersheds of these lakes will be unable to release additional phosphorus-containing wastewater to the lakes.

Dissolved oxygen levels in the Savannah harbor violate water quality standards. Wastewater released into the lower Savannah River basin (shown in pink on the state's eastern border in Figure 3.7) contains organic matter that requires oxygen to decompose. Because bacteria and other microorganisms consume oxygen during this decomposition, organic matter acts as an oxygen-demanding substance. The consumption of oxygen, in turn, lowers levels of dissolved oxygen in the harbor and new or increased releases of oxygen demanding substances in that part of the basin are prohibited.

The Coosa River at the Georgia-Alabama state line also violates water quality standards for dissolved oxygen. The majority of the Coosa River watershed affects water quality in this segment of the river. As a result, communities in the pink area on the state's western border in Figure 3.7 cannot increase the amount of oxygen-demanding substances going into the streams and rivers that flow into the Coosa.

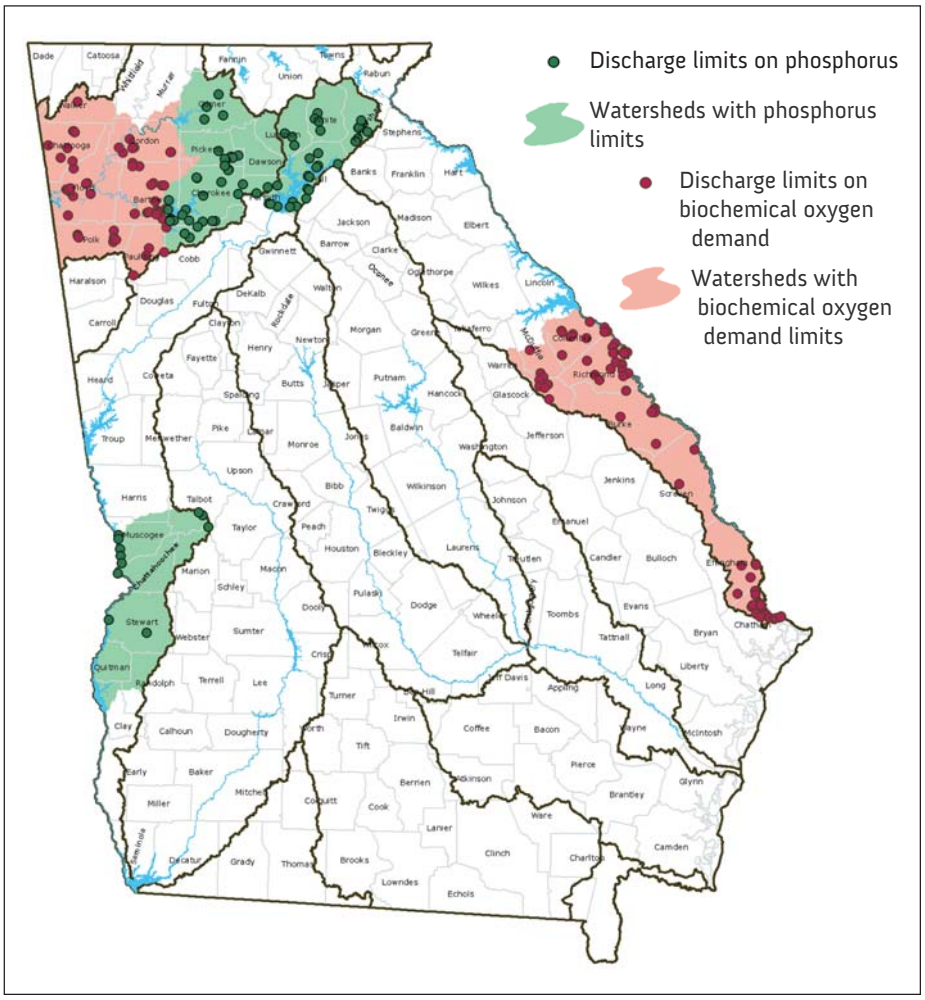


Figure 3.7 *Watersheds with limits on additional wastewater discharges, 2008. (EPD)*

As Georgia's population increases, demands for wastewater disposal also increase. Nonpoint sources of pollution, however, decrease the ability of water bodies to assimilate additional discharges of treated wastewater.

The pollutants that enter Georgia's water come from point sources, including releases of treated wastewater, and from stormwater runoff and other nonpoint sources. Over the past three decades, improvements in wastewater treatment technology have decreased point source impacts on water quality. As pollutants from point sources have decreased, the contribution of nonpoint sources has increased.

National studies indicate that nonpoint sources can add a significant amount of pollution to a water body. The total nonpoint source contribution to Georgia waters has not been fully evaluated, but recent lake studies suggest the likely size of the problem.

The water quality standard for chlorophyll is violated in lakes Lanier and Allatoona due to phosphorus levels that exceed each lake's capacity to assimilate the nutrient. This phosphorus comes from wastewater treatment plants and nonpoint sources, such as stormwater runoff from agricultural fields, lawns and paved surfaces.

Recent studies demonstrate that more than 75 percent of the phosphorus entering each lake is the result of nonpoint source pollution, primarily carried by stormwater runoff (Figure 3.8). This contribution consumes a significant portion of each lake's assimilative capacity and is a major cause of water quality standard violations. These violations limit EPD's ability to permit additional releases of treated wastewater into streams in the lakes' watersheds.

Watershed monitoring across the state also highlights stormwater as a source of pollution. Between 1998 and 2005, measurements at 42 locations show that, on average, phosphorus concentrations are three times higher during rainy weather than concentrations in the same streams under dry conditions.

Decreasing pollution from nonpoint sources would help maintain the capacity of Georgia's waters to assimilate treated wastewater, but it is a significant challenge. The many types of nonpoint sources create a complex mix of pollutants, which varies depending on activities on the land. The specific sources of pollutants can also be difficult to determine.

Without changes in what have been standard practices, continued growth is likely to result in more land disturbance, new impervious surfaces and increased stormwater runoff. These changes may increase the amount of pollution that reaches Georgia's streams, unless concerted actions are taken to reduce nonpoint source pollution — actions necessary to protect water quality and maintain assimilative capacity in order to meet future demands for wastewater disposal.

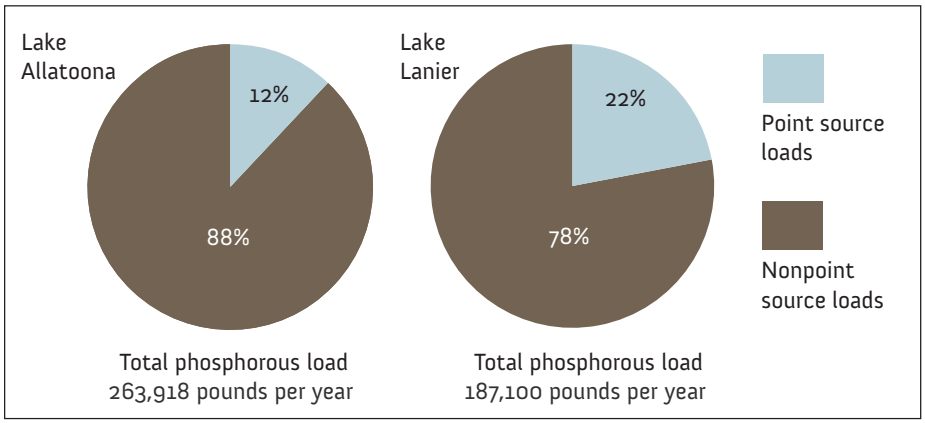


Figure 3.8 *Total phosphorus loads to lakes Allatoona and Lanier (average for 2006 and 2007). (EPD)*

Nonpoint Sources of Pollution

Indicator of the capacity of Georgia's waters to **Assimilate Pollution**

Controlling point source impacts on water quality

Since the early 1970s, local governments and utilities, with financial assistance from the state and federal governments, have made considerable financial investments to decrease the amount of pollution released in treated wastewater.

As a result, the proportion of water quality problems caused by point sources has declined, as has the amount of assimilative capacity used by point sources.

In 1972, wastewater treatment only removed 65 percent of the oxygen-demanding pollutants generated by point sources in Georgia. Within 10 years, the percentage removed had increased to 90 percent and, by 1990, had reached 96 percent (see table below).

Generation and point source discharge of oxygen-demanding pollutants (thousand pounds), 1972 - 1990. (EPD)

	Pollutants generated	Pollutants released
1972	802	283
1982	925	96
1990	1,483	62

Lands Used for Agriculture and Forestry

Indicator of the extent of Georgia's **Working Lands**

What land cover types indicate lands used for forestry and agriculture?

Evergreen forest. Forest composed of at least 75 percent evergreen trees, managed pine plantations and evergreen woodland.

Hardwood forest. Forest composed of at least 75 percent hardwood trees in the canopy and deciduous woodland.

Clear-cut and sparse. Recent clear-cuts, sparse vegetation and vegetation that is common early in the succession from cleared land to forest regrowth.

Mixed forest. Mixed deciduous/coniferous canopies, mixed woodland and natural vegetation in the coastal plain ecoregions, and mixed shrub/scrub vegetation.

Row crops and pastures. Row crops, orchards, vineyards, groves and horticultural businesses. Pasture and non-tilled grasses.

Georgia's economic prosperity, historically as well as today, has relied on the state's land. From the founding of the original colony, Georgians have worked this land to provide food, fiber, wood and other forest products. At the same time, working lands used for forestry and agriculture have provided environmental benefits including habitat for plants and animals and preservation of air and water quality.

The ways in which the state's lands are used changes continuously. Trees are harvested and forests regrow; agricultural lands are put into and taken out of production. Working lands also are converted to different uses.

These changes can be dramatic. As much as 80 percent of the Piedmont, for example, was cleared in the last century. By 2005, 58 percent (6.4 million acres) of the Piedmont had been reforested. Trends in land cover are one source of information on Georgia's changing landscape and the ways its resources are used to support a growing economy.

Trends in five major land cover types — evergreen forest, deciduous forest, clear-cut and sparse land cover, mixed forest, and row crops and pasture — are examined to track the extent of lands used for forestry and agriculture. The first four represent land managed for forest products and the fifth tracks land worked for food and fiber. As in chapter two, we draw on analysis of land cover changes by researchers at the University of Georgia.

It is important to note that this indicator tracks broad changes at the state and ecoregion level in the extent of lands used for agriculture and forestry. It is not assumed that all land in these categories is actively or intensively managed for production.

These categories include lands that are under active management, as well as those that may be used for future production. Whether under active management or not, much of the land in these categories helps to maintain air quality, water quality and natural habitat — all environmental benefits associated with working, vegetated landscapes.

As of 2005, taken together, forest and agricultural land in these five categories covered 76 percent of the state, down from 80 percent in 1974 (Table 3.6). Statewide, the acreage of hardwood forest declined consistently between 1974 and 2005, while the acreage of mixed forest consistently increased (Figure 3.9). The extent of evergreen forest and clear-cut/sparse land cover varied over this period. The acreage of agricultural land generally declined, although an increase was seen in 2005.

Market forces, changes in production technology, incentive programs and financial considerations may all have contributed to changes in the extent of forested and agricultural lands. Some of these factors result in land simply being taken out of production or shifted to a different type of vegetated cover. Others contribute to the conversion of land to more intensive use, including residential and commercial uses.

Table 3.6 *Statewide change in forest and agricultural lands, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Landcover classification	% of state land in 1974	% of state land in 2005	Change in number of acres	Percent change
Hardwood forest	20	17	-1,188,341	-16%
Evergreen forest	27	26	-565,323	-6%
Clear-cut/sparse	5	8	+1,096,935	+58%
Mixed forest	2	3	+475,731	+58%
Row crops and pasture	26	22	-1,596,370	-16%

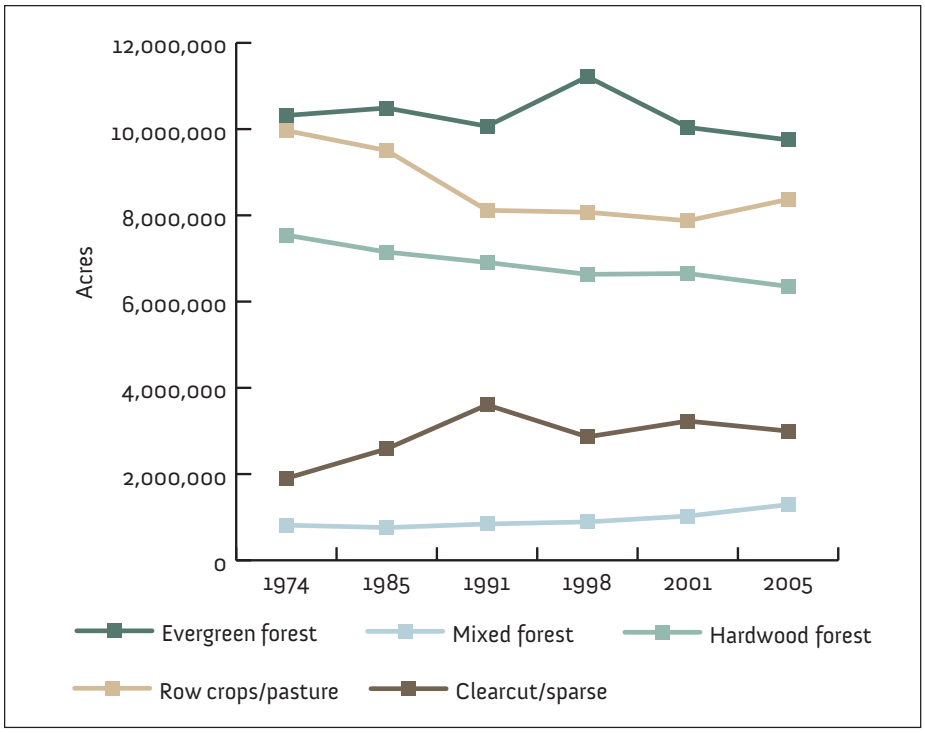


Figure 3.9 *Statewide change in forest and agricultural lands, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Forest lands

Taken together, between 1974 and 2005, the extent of forested land cover in the state declined by just 182,000 acres (Table 3.6). The mix of different forest types, however, changed markedly. Hardwood forest cover declined by 16 percent, a loss of nearly 1.2 million acres. The change in acres of hardwood forest was greater than that seen in the other forest land covers. The majority of these losses were in the Piedmont (Figure 3.10).

During this period, the acreage of evergreen forest (primarily managed pine forests) declined after peaking in 1998. Between 1974 and 1998, evergreen forest increased by approximately 439,000 acres. This was followed by a decline of nearly 1.5 million acres and, as a result, the total acreage of evergreen forest declined by 6 percent — approximately 565,000 acres — between 1974 and 2005.

The 1998 peak in evergreen acreage was preceded by a 1991 peak in acreage of clear-cut and sparse lands. In the seven years between the two measurements, trees grew and a portion of the clear-cut/sparse land became evergreen forest.

Between 1974 and 2005, the increase in clear-cut/sparse land was much greater than the other forest-related land covers. Most of this gain was seen in the Piedmont and the Upper Coastal Plain.

During the same period, mixed forest cover increased by more than 475,000 acres statewide. Mixed forest includes evergreen forests mixed with deciduous trees or shrubs, which may occur in previously clear-cut areas. A steady increase in this type of forest resulted in a 58 percent increase in acreage by 2005.

Most of the state's ecoregions lost evergreen forest and gained mixed forest during this time, with the exception of the Lower Coastal Plain. Sixty-six percent of the state's total loss of evergreen forest was in the Piedmont, as was 57 percent of the mixed forest gain.

These changes, however, varied by county. Evergreen forest, for example, increased by more than 25,000 acres in seven counties, while eight counties lost more than 25,000 acres.
The greatest change in evergreen forest cover was in Gwinnett County, where nearly 60,000 acres were lost between 1974 and 2005.

The economic and environmental value of forest and agricultural lands

Agriculture and forestry are among the most important sectors of Georgia's economy. Researchers at the University of Georgia estimate that, in 2006, agricultural commodities produced in Georgia had a total value of $10.4 billion. This includes a value of $663 million for timber, the state's most valuable vegetative crop.

Timber value contributes to the Georgia Forestry Commission's estimate of $16.1 billion in direct economic benefit from the state's forest resources.

UGA researchers also estimate that, in 2006, Georgia's food and fiber industry had a total direct and indirect economic impact of $55.2 billion and provided a total of 366,000 jobs.

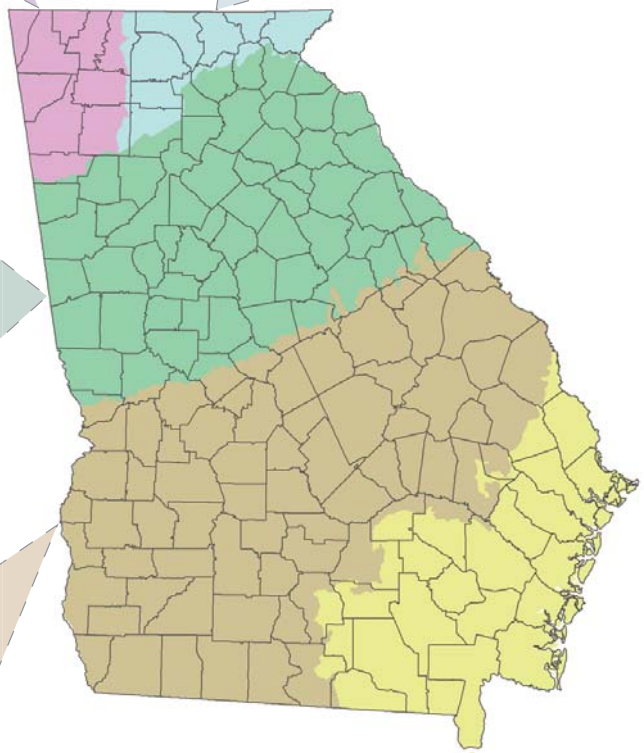
The lands that support this employment and economic impact also provide an array of other benefits. Recreational uses range from hunting to hiking, and income from hunting leases and nature- and agricultural-based tourism helps support local economies.

Proper stewardship of vegetated lands also provides environmental services. Vegetated lands maintain air quality by removing or trapping air pollutants and support water quality by absorbing or breaking down pollutants in stormwater.

They also slow the movement of stormwater, controlling runoff, erosion and flooding. Finally, they can provide critical habitat for plants and game and nongame species of animals.

Ridge and Valley & Southwestern Appalachians	Change in acres	Percent change
Hardwood forest	153,810	22%
Evergreen forest	-149,063	-40%
Mixed forest	57,205	302%
Clearcut/sparse	-67,407	-51%
Row crops/pasture	-191,319	-29%

Blue Ridge	Change in acres	Percent change
Hardwood forest	-60,616	-5%
Evergreen forest	-65,789	-20%
Mixed forest	41,808	268%
Clearcut/sparse	27,185	150%
Row crops/pasture	-46,344	-37%



Piedmont	Change in acres	Percent change
Hardwood forest	-1,147,948	-29%
Evergreen forest	-466,811	-14%
Mixed forest	270,884	238%
Clearcut/sparse	390,868	89%
Row crops/pasture	-390,169	-18%

Upper Coastal Plain (Southeastern Plains)	Change in acres	Percent change
Hardwood forest	-106,802	-7%
Evergreen forest	-21,864	-1%
Mixed forest	106,128	18%
Clearcut/sparse	650,924	88%
Row crops/pasture	-971,771	-15%

Lower Coastal Plain (Southern Coastal Plain)	Change in acres	Percent change
Hardwood forest	-26,784	-18%
Evergreen forest	138,204	6%
Mixed forest	-286	-0.5%
Clearcut/sparse	95,364	17%
Row crops/pasture	3,233	0.5%

Figure 3.10 *Change in forest and agricultural lands by ecoregion, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Agricultural lands

In 2005, row crops and pasture lands in Georgia covered nearly 8.4 million acres. Of the five land cover types considered here, agricultural lands are more extensive than all except evergreen forests.

While agriculture remains a dominant sector of Georgia's economy, the total amount of land in row crops and pasture has declined substantially since 1974 (Table 3.6). In the 15 years from 1974 to 2001, cropland and pasture land declined by more than 2 million acres. Acres of row crops and pastures increased somewhat by 2005, but the loss between 1974 and 2005 still accounted for 16 percent of the state's farmlands.

Part of this decline can be attributed to the Conservation Reserve Program, a federal initiative to remove highly erodible cropland from production. As of 2007, more than 300,000 acres were enrolled in this program, which represents about 19 percent of the decline in acres of row crops and pasture between 1974 and 2005.

Although the Lower Coastal Plain showed a slight gain in row crop and pasture land, all other ecoregions showed a loss in farmlands between 1974 and 2005 (Figure 3.11). Losses in the Upper Coastal Plain alone approached 1 million acres, and substantial decreases in row crop and pasture acreage were also seen in the Piedmont and Ridge and Valley/Southwestern Appalachians regions (Figure 3.10). Fifty percent of the total statewide decline occurred in 23 counties, with each losing more than 25,000 acres.

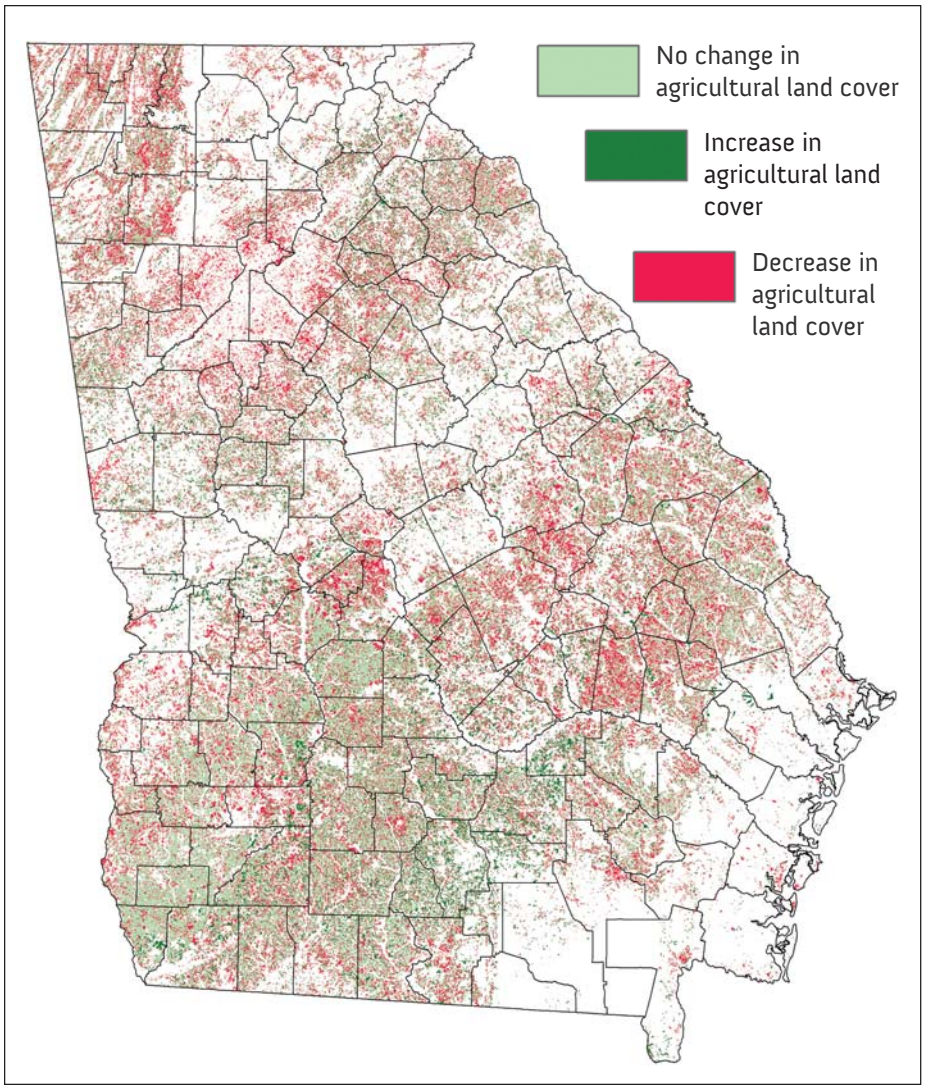


Figure 3.11 *Changes in row crop and pasture lands, 1974 - 2005. (Natural Resources Spatial Analysis Laboratory, University of Georgia)*

Converting land to more intensive uses

Conversion of land to urban land cover can contribute to a decline in forest and agricultural lands and the environmental benefits those lands provide.

Most of the urban land added in Georgia since 1974 has been low-intensity urban cover, such as single-family homes, schools and recreation areas. Increases in this type of land cover are often linked to conversion of agricultural and forested lands.

As described in the previous chapter, between 1974 and 2005, low-intensity land cover in Georgia increased 385 percent, an addition of more than 2.3 million acres. While much of this change occurred near major cities, smaller cities and rural areas also saw substantial increases in this type of land cover.

Of the new acres of low-intensity urban lands, 33 percent were added in the metro Atlanta area. Twenty-six percent were added in Georgia's 14 other metropolitan areas (as defined by the U.S. Census Bureau). The remaining new acres of low-intensity land cover — roughly 40 percent — were added in the 90 counties that lie outside of the state's metropolitan areas.

Brownfield Revitalization

Indicator of the extent of Georgia's **Working Lands**

Reclaiming and reusing brownfields is an alternative to converting forest and agricultural land into developed or urban land. As cities spread, many commercial and industrial properties within them are left abandoned or underutilized because of environmental contamination.

Often, these "brownfield" properties are close to transportation corridors and utilities, and many contain serviceable structures that could house a business or be converted to housing. But until recently, real or perceived environmental liability has caused many potential purchasers to shun these properties in favor of land that has not previously been developed.

Georgia law now encourages the reuse and redevelopment of brownfields throughout the state. Legislation passed in 2002 placed limits on liability for purchasers of brownfields property who voluntarily conduct environmental investigation and cleanup. Tax incentive legislation followed in 2003, creating an opportunity for property tax abatement to offset clean-up costs. Since 2002, 3,241 acres have been enrolled in the brownfield revitalization program (Table 3.7).

Table 3.7 *Acres enrolled and cleaned up under the brownfield revitalization program, 2002 - 2008. (EPD)*

	Acres enrolled	Acres cleaned up
2002	17	7
2003	65	13
2004	157	67
2005	649	178
2006	1,279	339
2007	510	273
2008	564	196
Total	3,241	1,073

The time required to clean up brownfields varies widely, depending on the size of the site, property acquisition and construction schedules and economic factors. By the end of 2008, a total of 281 brownfield properties were enrolled in the program, and cleanup had been completed at 130 of these sites – revitalizing more than 1,000 acres. The cleanup of these properties was completed with private funds, and they are now being put back into productive use (Figure 3.12).

Figure 3.12 *Tivoli Tenside is an apartment complex that opened in Fall 2008 between Atlantic Station and the Westside neighborhood of Atlanta. The before photo (above right) shows how the lot looked before redevelopment. (EPD)*

Land Used for Solid Waste Disposal

Indicator of the extent of Georgia's **Working Lands**

Land is also used for landfills to dispose of solid waste, including municipal solid waste (MSW) and construction and demolition debris (C&D). Currently, EPD has issued permits for landfills on approximately 40,000 acres in Georgia – an area roughly equal to the size of Lake Lanier.

In recent years, the trend has been toward fewer landfills that are much larger and have much greater capacity than those permitted in the past. One result of this trend is that the distance that waste is hauled for disposal has greatly increased.

As of 2007, more than 31 years of capacity remained in municipal solid waste landfills in Georgia (Table 3.8). This estimate is based on the remaining capacity (i.e., the amount of space available to accept waste) in currently permitted landfills and on the current rate of solid waste disposal. This capacity, however, is not evenly distributed across the state (Figure 3.13).

From 2002 to 2007, the years of remaining capacity in C&D landfills in Georgia more than doubled, while the capacity in municipal solid waste landfills remained relatively constant. Since the remaining capacity is based on current disposal rates, it does not account for external factors. For example, permitting new landfills and expanding existing landfills would add capacity, while natural disasters and increased amounts of waste imported from other states would decrease capacity.

Table 3.8 *Years of capacity remaining in Georgia landfills. (EPD)*

	2002	2003	2004	2005	2006	2007
Municipal solid waste (lined and unlined)	27	19	26	29	27	31
Construction and demolition	14	17	26	21	19	29

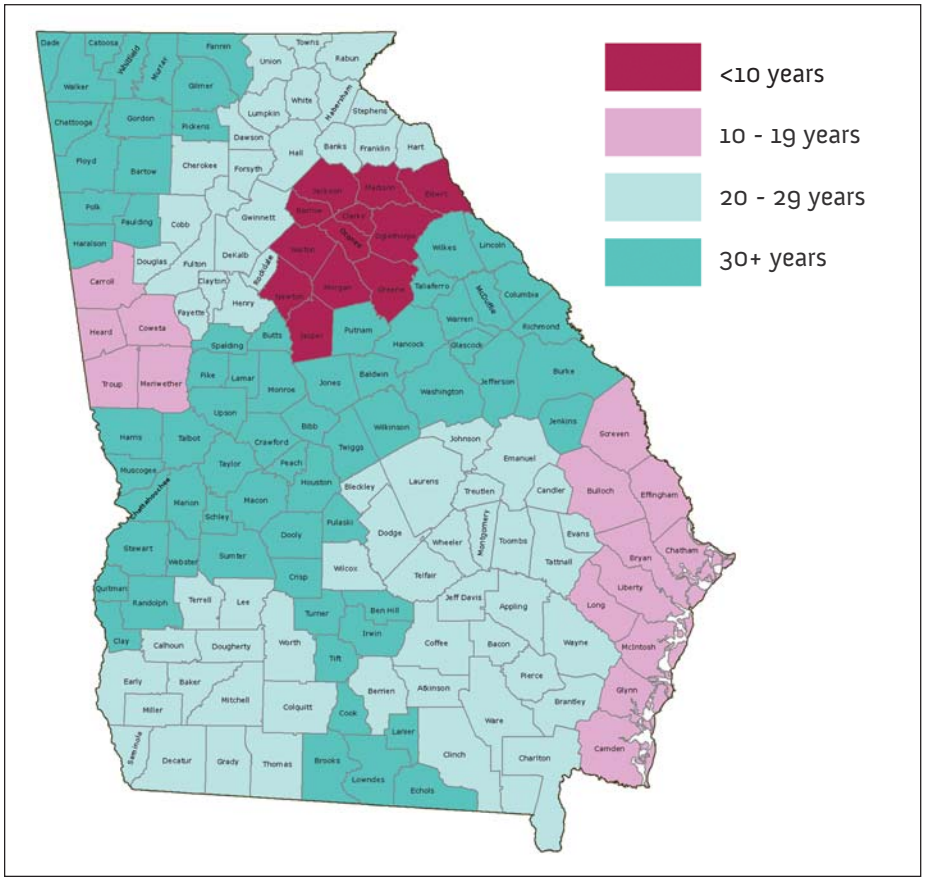


Figure 3.13 *Years of landfill capacity remaining by region, 2007. (EPD)*

Visibility

Indicator of the quality of Georgia's **Air**

Georgia's land provides recreational opportunities and aesthetic value. Unfortunately, these benefits can be impaired by air pollution that decreases visibility.

The list of substances that cause haze and smog includes sulfates, organic matter, elemental carbon (soot), nitrates, dust and water vapor. These substances come from a variety of natural and human-caused sources, including open burning, emissions from internal combustion engines, and emissions from factories and power plants. Aerosols, tiny drops of liquid that form in the atmosphere when certain chemicals react with each other, also contribute to haze.

As a group, the substances that cause haze and smog can impair visibility, harm human health and cause long-term damage to the health of our ecosystems.

In 1948, a visitor to the southern Appalachian mountains in north Georgia could see an average of 93 miles. By 1990, due to air pollution, that distance had dropped to an average of 22 miles.

The images in Figure 3.14 were created using a computer program that simulates air pollution levels. As state and national agencies work toward the federal goal of no human impact on visibility by 2064, this tool will allow scientists to evaluate the effectiveness of different approaches to reducing pollution.

The causes of haze also tend to harm human health. As we make progress in meeting the health-based air quality standards discussed in chapter one, we will also be making strides toward improving visibility.

Figure 3.14 *Visibility levels at Cohutta, GA. These images were created using WinHaze, computer imaging software that simulates air quality differences. (EPD)*