No. 142, Original

In The
Supreme Court of the United States

STATE OF FLORIDA,

Plaintiff,

v.

STATE OF GEORGIA,

Defendant.

DIRECT TESTIMONY OF ROBERT STAVINS, Ph.D.

October 26, 2016

TABLE OF CONTENTS

Page

I, Robert Stavins, Ph.D., offer the following as my Direct Testimony.

1. I am an expert in environmental and resource economics and public policy. I have been retained by the State of Georgia to offer expert opinions regarding economic information relevant to the *Florida v. Georgia* equitable apportionment action.[1]

2. Economic analysis can inform decisions about the "equitable apportionment" of interstate waters by addressing important questions about the use of water and the implications of proposals to restrict water in one state ostensibly to increase flows to another state. Those include whether the current allocation of resources is reasonable or fair; whether proposals for restricting consumptive water use in ACF Georgia[2] result in benefits in excess of costs; and how the economic consequences of proposals for restricting consumptive water use in ACF Georgia affect different members of society. I discuss these topics in my testimony below.

3. To begin, I describe water use by the Municipal and Industrial ("M&I") and the Agricultural Sectors in ACF Georgia. See Section III, *infra*. I then compare the amount of water used by ACF Georgia with the amount of water available to ACF Florida, taking into account the respective regions' populations and economies. Section IV, *infra*. Next, I estimate the economic costs of the water restrictions proposed by Florida's economic expert, Dr. Sunding,[3] Section VI, *infra*; analyze the economic benefits (if any) of those restrictions, Section VII, *infra*; and assess how the costs to Georgia compare with any benefits to Florida, Section VIII, *infra*.

---

[1] I submitted an expert report in this matter dated May 20, 2016 ("Stavins Report"), a true and correct copy of which is GX-0874. I reference my report several times in this testimony as the source for further details and support for the analyses described herein.

[2] I refer to the Apalachicola-Chattahoochee-Flint River Basin as the "ACF Basin," the Georgia portion of the ACF Basin as "ACF Georgia," and the Florida portion of the ACF Basin as "ACF Florida." See Stavins Demo. 6 for a map of the counties in ACF Georgia and ACF Florida.

[3] Dr. Sunding has submitted three sets of opinions in this matter. These include opinions contained in his original report filed February 29, 2016 ("February Report" or "Sunding February Report"), his second report filed May 20, 2016 ("May Report" or "Sunding May Report"); and his pre-filed direct testimony filed on October 14, 2016 ("Sunding Testimony"). (*See* FX-784 (Sunding February Report) and FX-801 (Sunding May Report).) In addition, Dr. Sunding produced results of additional analysis on June 8, 2016, the day prior to his deposition. (*See* FX-802.) Across these submissions, Dr. Sunding has repeatedly and significantly modified his opinions with respect to the conservation measures he proposes, including their potential costs and potential streamflow impacts. In particular, the Sunding Testimony, which was filed on October 14, 2016, included additional findings and proposed conservation measures, and Florida provided new materials he relied upon in support of his analyses as recently as October 24, 2016. I reserve my right to supplement or modify my testimony after I have had more time to review these new materials and analyses.

I. SUMMARY OF OPINIONS.

4. Based on this analysis and my review of the evidence available to me to date, I conclude that:

- Water is vital to the economy of ACF Georgia and to its large and productive agricultural sector in particular. ACF Georgia is home to more than 5 million inhabitants and supports a $280 billion economy. ACF Georgia is one of the largest producers of peanuts and cotton in the United States. Agriculture alone generated more than $4.7 billion in total revenues in ACF Georgia in 2013 and accounted for nine percent of total Gross Regional Product ("GRP") in the Lower Flint River Basin in 2013.

- ACF Georgia uses only a small fraction of the available water in the ACF Basin, leaving a share for ACF Florida that is greatly out of proportion to the sizes of the respective regions' populations and economies. Specifically, ACF Georgia has 5 times the land area, 56 times the population, 80 times the number of employees, and 129 times the GRP of ACF Florida. Despite these dramatic differences, Georgia consumes only 4 percent of the total waters available in the ACF Basin in an average year, and only 8 percent of the total waters available in the ACF Basin in a dry year, leaving the rest for Florida's use.

- Dr. Sunding suggests there are "numerous" measures that Georgia could "reasonably" undertake to reduce its consumption of water. In aggregate, however, his recommendations would lead to drastic reductions in Georgia's water use. Specifically, under his own assumptions, Dr. Sunding's proposed agricultural water use reductions would eliminate up to 73 percent of *all* irrigation water use; or, using hydrologic assumptions from other Georgia experts, would require the *complete elimination* of agricultural water use. In addition, his proposals would also require reductions of up to 75 percent of all outdoor municipal water use.

- Dr. Sunding severely underestimates the costs of the water conservation measures he proposes, and in many instances, he does not quantify the costs at all. In reality, the total cost of Dr. Sunding's most aggressive restrictions would exceed $2.1 billion for municipal and industrial water users and $335 million for Georgia farmers in the ACF Basin, every single year they are implemented.

- Furthermore, Dr. Sunding severely overestimates the potential increases in streamflows available from the measures he proposes. As a result, his estimates should not be used to set streamflow targets or requirements for Georgia.

- Analyses by Georgia experts demonstrate that ACF Georgia's water consumption has had a negligible impact on the ecosystem in ACF Florida, and analyses by both Georgia and Florida experts indicate that the benefits of Dr. Sunding's conservation measures would be *negligible* in the future. Therefore, I conclude that the benefits of Dr. Sunding's proposed reductions in Georgia's water use would be *de minimis*.

- Consequently, I conclude that the costs of upstream water restrictions proposed by Dr. Sunding would greatly exceed the benefits that would be derived from these restrictions.

5. In light of these and other factors, I find that the analyses from Dr. Sunding and other Florida experts do not support restricting water use in ACF Georgia. In fact, the evidence indicates that restricting water use in ACF Georgia is unwarranted from an economic perspective.

II. BACKGROUND AND PROFESSIONAL QUALIFICATIONS.

6. I am currently the Albert Pratt Professor of Business and Government at Harvard University's John F. Kennedy School of Government. In addition to holding a faculty position, I am also Director of the Harvard Environmental Economics Program, Director of Graduate Studies for the Doctoral Program in Public Policy and the Doctoral Program in Political Economy and Government, and Co-Chair of the Harvard Business School-Harvard Kennedy School Joint Degree Programs. My teaching focus at Harvard is Environmental & Natural Resource Economics and Policy.

7. I formerly served as the Chairman of the U.S. Environmental Protection Agency's ("EPA") Environmental Economics Advisory Committee, which provides expert advice to the EPA Administrator on economic issues related to environmental and natural resource decision making. I was appointed Chairman by Administrator Carol Browner during the Clinton Administration and re-appointed Chairman by Administrator Christie Todd Whitman during the George W. Bush Administration. As Chairman, I directed the review of EPA's *Guidelines for Preparing Economic Analyses*, which is EPA's guidance document for development of Regulatory Impact Analyses of EPA rulemakings. As Chairman of the EPA Environmental Economics Advisory Committee, I also directed reviews of specific EPA economic analyses.

8. My scholarly research, teaching, and public policy engagement with federal, state, and local governments have focused on diverse topics in environmental economics and policy, including the choice of policy instruments to achieve environmental objectives; regulatory impact analysis; factors affecting land-use decisions; innovation and diffusion of pollution-control technologies; environmental benefit valuation; water use and demand; the

competitiveness effects of regulation; and international, national, and sub-national climate change policies.

9. I have examined many specific water policy issues, including water supply, demand, and pricing; recreational fishing; and agricultural land use, in my academic work. For example, I have researched how consumers value water and respond to different pricing structures and the effectiveness of both price and non-price conservation programs. In one paper, my co-authors and I examined how consumers respond to water prices under the types of rate structures predominately used in Georgia and widely regarded as an effective water conservation measure in the municipal and industrial sectors. I have also analyzed the effects of specific government policies on the conversion of forested wetlands in the southern United States to agricultural uses.

10. I have been a consultant to a wide range of organizations, including the National Academy of Sciences; the White House Council of Economic Advisors; the U.S. Departments of Agriculture, Commerce, Energy, Interior, State, and Treasury; the EPA; members of Congress; the Environmental Defense Fund; the Natural Resources Defense Council; the Sierra Club; the Nature Conservancy; and the World Bank. I hold a Ph.D. in Economics from Harvard University, an M.S. in Agricultural Economics from Cornell University, and a B.A. in Philosophy from Northwestern University. GX-1023 is a true and correct copy of my curriculum vitae.

III. ACF GEORGIA USES WATER TO GENERATE SUBSTANTIAL ECONOMIC ACTIVITY.

11. The ACF Basin supports a diverse and robust economy. An overwhelming majority of the land, population, and economic activity in the ACF Basin is located within Georgia. ACF Georgia provides homes for more than 5 million inhabitants and supports an economy annually producing over $280 billion in GRP.[4] Availability of water is vital to the economy in ACF Georgia and to its large and productive agricultural sector in particular.

[4] Gross Regional Product is the regional equivalent of Gross Domestic Product ("GDP"). It includes labor income, certain state and local revenues, and certain business profits. GRP data come from an economic impact model called "IMpact analysis for PLANning," or "IMPLAN" for short. IMPLAN is widely used by federal and state government agencies to assess economic impacts. IMPLAN data are publicly accessible at http://www.implan.com.

A. Municipal and Industrial Water Use in ACF Georgia

12. The M&I sectors in ACF Georgia encompass a diverse set of residential, commercial, and industrial entities that use water to achieve a variety of ends. Residential household water uses in ACF Georgia include basic necessities such as drinking, bathing, cooking, and sanitation/cleaning. Households also use water for landscape irrigation for outdoor plants and lawns, recreational activities, including swimming pools, and other cleaning activities, such as washing cars.

13. Commercial and industrial water use varies by industry, depending on the establishment, but water is often essential to these business operations and provides a fundamental input to the economies of ACF Georgia. In commercial establishments, businesses may use water in ways similar to residential users. For example, in restaurants or other service oriented industries (including private sector and government offices) this can include drinking, cooking, and sanitation services. Industrial users typically have more specific water needs, which vary across sectors. These needs can be categorized into two basic types of uses. One use is as an input to a finished product, such as the inclusion of water in beverages. A second use is as intermediate inputs to production processes, such as the use of water in many manufacturing processes.

14. Within the ACF Basin, there are many industries and businesses for which water is a key input. Stavins Demo. 1 shows total output, water expenditures, and employment in 2013 for some of the most water intensive manufacturing industries within the Upper Chattahoochee, which includes large portions of the Atlanta metropolitan region.[5] As shown in Stavins Demo. 1, water-intensive industries and businesses in the Upper Chattahoochee contribute more than $12.8 billion to GRP and employ more than 35,000 people.

15. Stavins Demo. 1 also includes two "green" industries: landscape and horticultural services; and greenhouse, nursery, and floriculture production. Many businesses in these industries do not purchase water directly from water utilities or other suppliers, but instead rely

---

Experts in my field regularly rely on IMPLAN data, and I reviewed IMPLAN data in preparing my opinions in this case.

[5] Here, I define "water intensive" industries based on total water expenditures.

on their customers' water supply to irrigate lawns and gardens. A reduction in water use by residential customers will tend to reduce consumer spending on water-related services such as landscaping and gardening. These "green" industries alone generated approximately $660 million in GRP and employed more than 14,000 people in the Upper Chattahoochee Region in 2013.

16. Combined, these water-intensive and green industries contribute $13.5 billion to total GRP and employ nearly 50,000 people.

Stavins Demo. 1: Economic Metrics for Water-Intensive Industries in the Upper Chattahoochee (2013)[6]

	Contribution to GRP ($2013 million)	Output ($2013 million)	Total Water Expenditure ($2013 million)	Total Employees
Top 10 Manufacturing Industries				
Flavoring syrup and concentrate manufacturing	$9,159	$16,303	$8.0	4,153
Poultry processing	$393	$2,729	$3.9	11,042
Other basic organic chemical manufacturing	$75	$696	$3.5	349
Pharmaceutical preparation manufacturing	$577	$1,397	$1.7	1,017
Other basic inorganic chemical manufacturing	$234	$634	$1.1	608
Bottled and canned soft drinks & water	$224	$1,191	$1.0	1,492
Plastics material and resin manufacturing	$108	$623	$0.9	416
Aircraft manufacturing	$1,036	$3,805	$0.8	5,299
Printing	$682	$1,432	$0.8	8,393
Paperboard container manufacturing	$352	$1,182	$0.7	2,514
Subtotal	$12,840	$29,991	$22.3	35,283
Green Industries				
Landscape and horticultural services	$621	$910	$0.0	13,810
Greenhouse, nursery, and floriculture production	$37	$54	$0.0	527
Subtotal	$658	$964	$0.0	14,337
Total	**$13,498**	**$30,955**	**$22.4**	**49,620**

[6] Totals include all counties included in the Upper Chattahoochee, deemed to draw on water from the ACF-Georgia. *See* Stavins Demo. 6. Total water expenditure consists of expenditures on water and sewage, based on data from IMPLAN.

B. Agricultural Water Use in ACF Georgia

17. The ACF Basin supports a substantial agricultural sector, with the vast majority of this activity occurring in ACF Georgia, particularly the Lower Flint watershed. Stavins Demo. 2 shows the commercial value of all agriculture products that are produced in ACF Georgia. Total agriculture revenues were $4.7 billion in 2013, with $1.3 billion coming from row and forage crops and another $700 million coming from vegetables, nuts, and fruits.

Stavins Demo. 2: ACF Georgia Agricultural Commercial Value Output in 2013 ($2012 billions)[7]

Crop	Commercial Value in 2013 ($2012 billion)
Row and Forage Crops	
Cotton	$0.6
Peanuts	$0.3
Corn	$0.3
Other row and forage crops	$0.2
Subtotal	$1.3
All Agriculture Commodities	
Row and forage crops	$1.3
Poultry and Eggs	$1.5
Livestock	$0.5
Vegetables	$0.4
Nuts and fruits	$0.3
Other	$0.6
Total	**$4.7**

7 ACF Georgia includes all counties with irrigated acreage drawing from the ACF Basin. Row and Forage crops include Georgia's three largest crops (corn, cotton, and peanuts) as well as barley, hay, oats, rye, silage, sorghum, soybeans, straw, tobacco, wheat, and other. Crop commercial values were sourced from Farm Gate data developed by the University of Georgia ("Farm Gate"), which is publicly available at http://caes2.caes.uga.edu/center/caed/pubs/annual.html. Farm Gate values are compiled from a survey of Georgia Cooperative Extension county agents and commodity specialists for the purpose of providing annual county-level information for the value of all food and fiber commodities grown in the state. Experts in my field regularly rely on values such as these, and I reviewed Farm Gate values in preparing my opinions in this case.

18. Within the ACF Basin, there is also substantial economic activity dependent on output from the agricultural sector. Stavins Demo. 3 shows the economic activities in ACF Georgia that use row crops (corn, cotton, peanuts, and soybeans) and other agricultural commodities as inputs to production. These sectors contributed more than $687 million to GRP and purchased as inputs more than $155 million of raw agricultural commodities from farmers within the region.

Stavins Demo. 3: Select Industries that Rely on Regional Farm Products, Georgia ACF Basin[8]

Description	Contribution to GRP ($2013 million)	Employment	Purchases of Georgia ACF Basin Farm Output ($2013 million)
Fiber, yarn, and thread mills	$127	1,698	$40
All other food manufacturing	$63	909	$10
Breweries	$303	791	$11
Other animal food manufacturing	$69	481	$50
Roasted nuts and peanut butter manufacturing	$68	362	$11
Soybean and other oilseed processing	$54	272	$33
Fats and oils refining and blending	$2	17	$0.3
Total	**$687**	**4,531**	**$155**

19. The agricultural sector is important to the region's economy. For example, within the Lower Flint River Basin (a region of 225,000 people), agricultural activity accounts for 5 percent of total GRP. Including those industries that rely on farm products for their own production, such as nut and bean processing, the total sector accounts for nearly 9 percent of the region's GRP. In the Lower Flint River Basin, the agricultural sector is as large as either the wholesale or retail trade sectors, is comparable in size to the electric and gas sectors, and is nearly twice the size of the construction industry.

20. Georgia's agricultural sector also has national significance. Georgia farmers planted almost 50 percent of all peanut acreage nationwide, with ACF Georgia accounting for

[8] Data sourced from IMPLAN.

more than half of this state total.[9] Georgia is also the nation's second largest producer of cotton, with ACF Georgia contributing nearly half of these sales.[10] Thus, ACF Georgia is responsible for approximately one-quarter of the nation's cotton and peanut production.

21. Dr. Sunding suggests that agriculture in the Georgia ACF is not valuable, based in part on a misleading comparison with Kern County, California, which he says generates $1.8 billion in commercial value from the sale of grapes.[11] He also compares row crop production with the GRP of the entire ACF region.[12] From an economic perspective, an industry does not have to be the most productive or generate the most revenue of all industries in its category to provide important value, nor does it have to be the most productive in the United States before we should consider whether the costs imposed on it are worth it. For example, agriculture and mining together constitute only 2 percent of the California economy, but this does not make the agricultural sector in California unimportant, unproductive, or without value.

C. Water is an essential input to agriculture in ACF Georgia

22. Irrigation is essential to the overall productivity of the agricultural sector in ACF Georgia. Given the natural variability of rainfall, irrigation provides a means of insuring against diminished yields or possibly entire crop losses during periods of limited precipitation. Absent irrigation, yields can drop substantially, potentially leading to a loss of most or all crops. This impact is greatest during dry or drought years.

23. Stavins Demo. 4 shows the differences in yields on irrigated and non-irrigated land during average and dry years based on data collected by the United States Department of Agriculture Agricultural Research Service National Peanut Research Laboratory ("USDA-ARS NPRL").[13] These data illustrate that the differences in yields between irrigated and non-irrigated

---

[9] In 2012, ACF Georgia accounted for 54 percent ($478 million) of statewide peanut sales. National commodity production by state is provided by the United States Department of Agriculture (USDA) National Agriculture Statistics Survey, through its "quick stats" tool, available at http://quickstats.ass.usda.gov. Experts in my field regularly rely on these USDA data, and I reviewed the USDA data in preparing my opinions in this case.

[10] Commercial crop statistics were sourced from Farm Gate data.

[11] Sunding Testimony, at 9.

[12] *Id.*

[13] Specifically, the data were collected from one-acre research plots on the Shellman Farm experiment station located in the Lower Flint Basin, during the time period from 2001 to 2014 (hereafter, "Shellman Farm Data"). A

farms are substantial and particularly significant during dry years. For example, without irrigation, expected yields during dry years would be 51 percent lower for peanuts, 78 percent lower for cotton, and 93 percent lower for corn.

Stavins Demo. 4: Georgia Crop Yields per Acre, 2001-2014[14]

	USDA ARS NPRL	
	Average Year	Dry Year
Cotton (lb)		
Irrigated Yield	1,308	1,518
Non-Irrigated Yield	606	329
Difference	702	1,189
Difference as % of Irrigated Yield	(54%)	(78%)
Peanuts (lb)		
Irrigated Yield	4,675	5,050
Non-Irrigated Yield	3,323	2,471
Difference	1,352	2,579
Difference as % of Irrigated Yield	(29%)	(51%)
Corn (bu)		
Irrigated Yield	191	183
Non-Irrigated Yield	62	13
Difference	129	170
Difference as % of Irrigated Yield	(68%)	(93%)

24. Irrigation is also critical to the profitability of the agricultural sector in ACF Georgia. Without irrigation, many farmers might go out of business. Stavins Demo. 5 provides estimates of the returns per acre for irrigated and non-irrigated farming based on "crop budgets" developed by the University of Georgia College of Agricultural and Environmental Sciences (UGA CAES).[15] As shown in Stavins Demo. 5, the net returns per acre are higher with irrigation

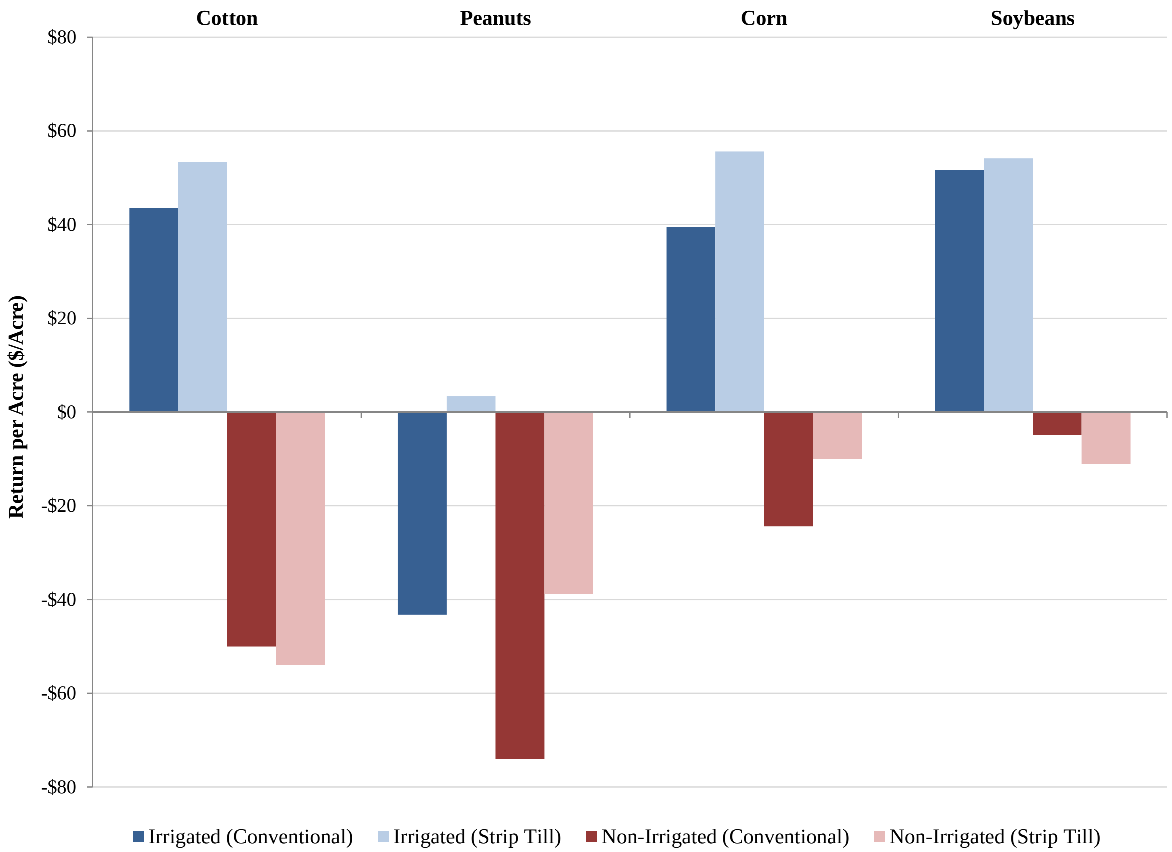
true and correct copy of an Excel spreadsheet containing the Shellman Farm Data is JX-169. Experts in my field regularly rely on data such as the Shellman Farm Data, and I reviewed the Shellman Farm Data in preparing my opinions in this case.

[14] Average Year yields were calculated as the average USDA-ARS NPRL yield over all available data years (2001-2014). Dry Year yields were calculated as the average yields from the USDA-ARS NPRL in 2011 and 2012. *See* JX-169 (Shellman Farm Data).

[15] The UGA CAES crop budgets (the "Crop Budgets") are planning tools designed to assist farmers and provide guidance on cropping decisions. They are developed by an interdisciplinary team of economists, agronomists,

for all crops evaluated (cotton, corn, peanuts, and soybeans). These budgets suggest that net returns could be negative for non-irrigated land, which implies that farmers in Georgia may require irrigation to earn revenues sufficient to cover their costs, even in a year with normal rainfall. These differences in profitability reflect in large part the differences in productivity between irrigated and non-irrigated acreage. They may also be driven in part by other factors not captured in the crop budgets. For example, the financial impacts of certain federal farm programs are not included.

Stavins Demo. 5: Estimated Returns per Acre for Irrigated and Non-Irrigated Farms, Georgia[16]



ecologists, and other agricultural experts, with input from local professionals through extensive outreach. These crop budgets include estimates of the variable and fixed costs faced when producing different crops with and without irrigation. The Crop Budgets data is publicly available at http://agecon.uga.edu/extension/budgets/cct/index.htm. Experts in my field regularly rely on data such as the Crop Budgets, and I reviewed the Crop Budgets in preparing my opinions in his case.

[16] Sourced from Crop Budgets.

25. Dr. Sunding asserts that irrigation use by farms is "clearly discretionary."[17] This terminology is misleading, and focuses on the wrong issue. Nearly all inputs to production processes are, strictly speaking, discretionary. (For example, the use of motors on fishing boats could be said to be "discretionary.") The relevant economic question is how costly it would be to restrict or eliminate the input. This depends on the productivity of irrigated acreage relative to the productivity of non-irrigated acreage, not simply the fraction of farmland that is irrigated. By my estimate, in a typical dry year, irrigated acreage produces 94 percent of corn, 77 percent of cotton, and 63 percent of peanuts grown in the ACF Basin.[18] It follows that eliminating irrigation in ACF Georgia would be costly indeed.

26. Irrigation also plays a key role in the ability of farmers to remain financially viable. Dr. Sunding relies on USDA Agricultural Census data to support his argument that irrigation is "discretionary."[19] These data show that a large fraction of larger farms in Georgia, which tend to be more profitable (relative to smaller farms), rely on irrigation.[20] These data also indicate that many of these larger farms have a mix of both irrigated and non-irrigated acreage, suggesting that having some portion of the farm irrigated is important to financial success through, for example, risk management.[21] Thus, while dryland farming exists within the ACF Basin, it is apparent that irrigation is very important to these larger, more profitable farms, which provide the bulk of the output for the region.[22] In addition, because reductions in irrigation would lead to large reductions in productivity, any reduction would also lead to substantial losses in revenues that could limit farmers' ability to meet debt obligations on irrigation systems (and other loans). Failure to meet debt obligations could lead to farm financial distress.

---

[17] Sunding Testimony at 9.

[18] This estimate reflects total irrigated acreage as reported by Dr. Panday, the proportion of irrigated and non-irrigated acreage in the ACF Basin as identified by the USDA Census (2012) cited by Dr. Sunding, and the USDA NPRL crop yields for irrigated and non-irrigated farms shown in Stavins Demo. 4.

[19] Sunding Testimony at 7-8.

[20] See, for example, USDA 2012 Census of Agriculture – State Data, Table 11. Selected Characteristics of Irrigated and Nonirrigated- Farms: 2012 and 2007, available at https://www.agcensus.usda.gov/Publications/2012.

[21] Moreover, smaller family farms, which seem to have less irrigation, are often unprofitable and often rely on non-farm income to be economically viable.

[22] See, for example, Sunding Depo Tr. 250-253.

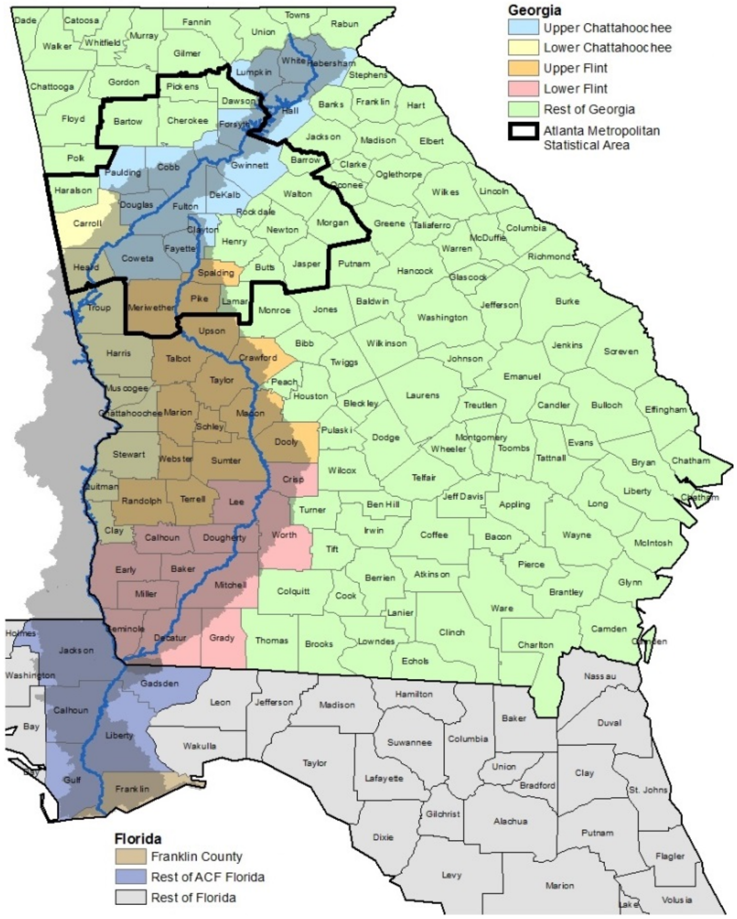
27. Simply put, the loss of irrigation would significantly reduce the productivity and profitability of this important region. I quantify these costs in Section VI.

IV. ACF GEORGIA USES A DISPROPORTIONATELY SMALL SHARE OF THE WATER IN THE ACF BASIN GIVEN THE RELATIVE SIZE OF ITS LAND AREA, POPULATION, AND ECONOMY.

28. ACF Georgia is considerably larger than ACF Florida along many dimensions. Given this relative difference in size (in terms of their respective land areas, populations, and economies), ACF Georgia's consumptive use of water is disproportionately small.

29. The ACF Basin includes the watersheds associated with the Apalachicola, Chattahoochee, and Flint Rivers, which include portions of the states of Alabama, Florida, and Georgia. Stavins Demo. 6 provides a geographic view of these rivers, their watersheds, and the associated counties in each State.

Stavins Demo. 6: The Apalachicola-Chattahoochee-Flint River Basin



30. Stavins Demo. 7 provides summary statistics on the geography, populations, and economies of ACF Florida and ACF Georgia. As shown in Stavins Demo. 7, compared with ACF Florida, ACF Georgia covers five times the land area, supports 56 times the population, has 80 times the employees, supports 148 times the labor income, and generates 129 times the GRP.

Stavins Demo. 7: Overview of Population, Land Mass, and Macro-Economic Indicators, ACF Georgia v. ACF Florida[23]

	ACF Georgia	ACF Florida	Relative Size
Basin land area, sq. miles	14,456	3,066	5x
Population (2015)	5,088,433	90,451	56x
Major metropolitan areas (>50,000 people)	Atlanta, Columbus, Gainesville, Albany, Marietta	None	
Employees (2015)	2,057,639	25,867	80x
Total labor income, ($2013 million)	$176,637	$1,194	148x
Gross Regional Product, ($2013 million)	$282,655	$2,185	129x

31. Differences in economic activity are similarly dramatic for the sectors heavily dependent on water. For example, ACF Georgia has an agricultural production sector with revenues of approximately $4.7 *billion*, while Florida has a fishery sector with revenues of approximately $11.7 *million*.[24]

32. Stavins Demo. 8 compares the net consumption of water in ACF Georgia with the water that remains available to ACF Florida after Georgia's consumption in an average year (defined as the average from 2004 to 2013), and a dry year (2011), based on consumptive use data described in Dr. Bedient's testimony. As shown in Stavins Demo. 8, households, businesses, and farmers in ACF Georgia consumed approximately 4 percent of the total waters available in the ACF Basin in an average year, and approximately 8 percent of the total waters available in the ACF Basin in a dry year. The portion of water not consumed – represented by the blue bars on the left hand side of Stavins Demo. 8 – is available for Florida's use (96 percent

[23] Population, land area, and employees are sourced from a memorandum from Katherine Zitsch to Jud Turner dated December 2, 2015 and titled "Projected Future Water Supply Demands for the Chattahoochee River and Lake Lanier System," a true and correct copy of which is GX-820 (hereafter, "Zitsch (2016)"). Experts in my field regularly rely on memoranda such as Zitsch (2016), and I reviewed Zitsch (2016) in preparing my opinions in this case. Population refers to residents served by waters of the ACF Basin, which is greater than the total population living within the Basin. I include major metropolitan areas that are located wholly or primarily in the basin. Totals for labor income and gross regional product are sourced from IMPLAN, with county totals weighted by percent of population or water in the ACF Basin.

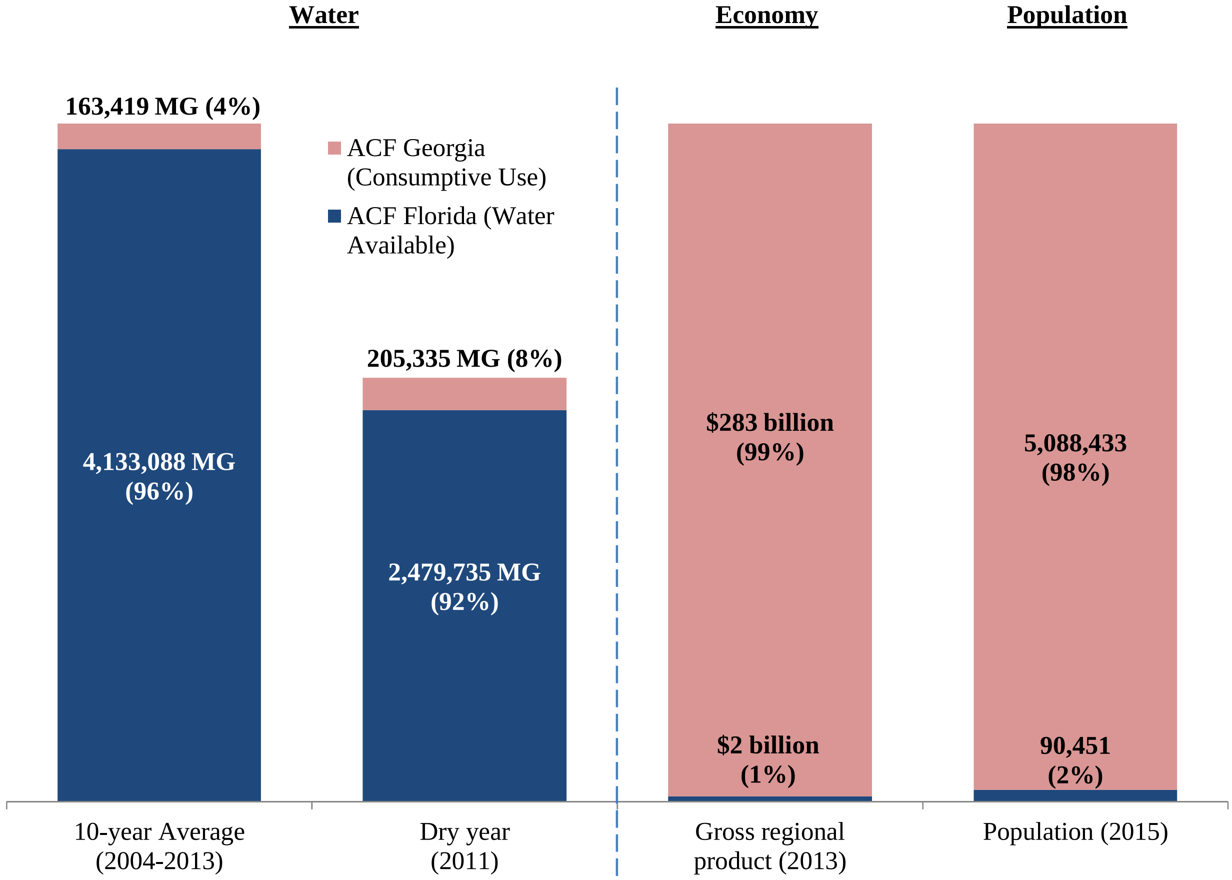
[24] *See* GX-0874 (Stavins Report), at 38.

during an average year, and 92 percent during a dry year). Even during the driest three month period of 2011 (one of the driest years on record), Georgia consumed only approximately 24 percent of the water available to Florida.[25]

33. The difference is even more dramatic in per capita terms. Households and businesses in ACF Georgia use approximately 32,000 gallons per capita each year, while households and businesses in ACF Florida have available, based on flows at the border, nearly 46 *million* gallons per capita per year on average – a difference of a factor of over 1,400. Finally, Stavins Demo. 8 also contrasts the shares of available water with the relative sizes of the populations and economies. Despite using at most 8 percent of the available water on an annual basis (during the dry year of 2011), ACF Georgia accounts for 98 percent of the region's population and 99 percent of total GRP.

[25] I do not display the "dry season of a dry year" in Stavins Demo. 8 because it represents water quantities over a three month period, and is therefore not directly comparable to totals over the full year. These estimates rely on monthly consumption data included with Dr. Bedient's testimony.

Stavins Demo. 8: Comparison of Water Use/Availability and Economic Activity Average and Dry Year Conditions in ACF Georgia and ACF Florida[26]



34. In sum, this analysis demonstrates that although ACF Georgia is larger than ACF Florida by every relevant metric, it uses only a very small fraction of the available water in the ACF Basin, leaving a share for Florida that is out of proportion to the size of each region's population and economy.

V. ANALYSIS OF BENEFITS AND COSTS IS A KEY ECONOMIC TEST FOR ASSESSING DR. SUNDING'S PROPOSED RESTRICTIONS.

35. From an economic perspective, the key approach to evaluating a proposed action or policy is to assess the expected net benefits to society of the action or policy. The *net social benefits* of the action or policy are the difference between the social benefits of the action and its social costs. If the net social benefits of an action or policy are *positive*, that means that society

[26] GX-0939 ("20160203-ACF-summary-GA-water use-1980-2013.xlsx"); Zitsch (2006); and IMPLAN; Direct Testimony of Dr. Philip B. Bedient, Ph.D.

as a whole is made better off as a result of the action or policy. By contrast, if the net social benefits of an action or policy are *negative*, that means that society *as a whole* is made worse off by the action or policy. Therefore, from an economic perspective, the first step in evaluating a proposed action or policy is to separately quantify (a) the *benefits* to society of the action or policy, and (b) the *costs* to society of the action or policy.

36. Critically, both the benefits and costs of an action or policy must be expressed as *changes* measured relative to how well off society would have been without the action or policy. Respected sources in economics and official guidance documents from the U.S. government emphasize the importance of evaluating the *changes* that an action or policy will generate – that is, the benefits and costs of the action or policy. For example, the key guidance document on regulatory analysis from the U.S. Office of Management and Budget ("OMB") states:

> Benefit-cost analysis is a primary tool used for regulatory analysis… Benefits and costs are defined in comparison with a clearly stated alternative. This normally will be a "no action" baseline: what the world will be like if the proposed rule is not adopted.[27]

37. Similarly, the U.S. EPA, in its most recent *Guidelines for Preparing Economic Analyses*, explains:

> An economic analysis of a policy or regulation compares the current state of the world, the *baseline scenario*, to the expected state of the world with the proposed policy or regulation in effect, the *policy scenario*. Economic and other impacts of policies or regulations are measured as the differences between these two scenarios.[28]

---

[27] FX-726 at 2. FX-726 is a true and correct copy of U.S. Office of Management and Budget, Circular No. A-4, Regulatory Impact Analysis: A Primer (hereafter, "OMB (2003)"). OMB (2003) was released by the U.S. Office of Management and Budget in September 2003 to assist agencies in developing required regulatory impact analyses. Experts in my field regularly rely on government publications such as OMB (2003), and I reviewed OMB (2003) in preparing my opinions in this case.

[28] *See* JX-47, U.S. Environmental Protection Agency, "Guidelines for preparing economic analyses" (hereafter, "EPA *Guidelines* (2014)"), p. 5-1.

38. Thus, when evaluating a proposed action or policy, a basic and necessary economic test is to compare the overall benefits of the policy to its overall costs – in other words, to estimate the policy's net social benefits. I address these key issues in the remainder of my testimony. First, I analyze the costs of measures to reduce water use in ACF Georgia. Then I analyze the benefits that such reductions would create. Finally, I assess the relative magnitude of these benefits and costs. If the costs exceed the benefits – which in fact is the case by a wide margin – then these actions are not warranted from an economic perspective.

VI. DR. SUNDING SIGNIFICANTLY UNDERESTIMATES THE COSTS OF HIS PROPOSALS AND OVERESTIMATES THEIR FEASIBILITY AND STREAMFLOW IMPACTS.

39. Dr. Sunding states that Florida seeks a cap on annual average consumption of water and a second more stringent cap to be imposed during drought years. To achieve such a cap, Dr. Sunding claims that Georgia could implement some combination of what he calls "conservation measures."[29] To assess the impacts of such a cap, he analyzes different conservation measures that he characterizes as "reasonable,"[30] "cost-effective,"[31] and "feasible."[32]

40. In his direct testimony, two reports, and additional materials provided, Dr. Sunding analyzes more than 10 different conservation measures reducing water in the agricultural sector, and the municipal and industrial sectors.[33] Dr. Sunding suggests that any "reasonable" combination of these conservation measures could be used to increase peak season streamflow during drought years[34] by 1,000 cfs to 2,000 cfs, but he analyzes eight specific

[29] *See* Sunding Testimony at 19-41.

[30] *See* Sunding Testimony at 58.

[31] *See* Sunding February Report at 1 and Testimony at 41.

[32] *See* Sunding Testimony at 3.

[33] "Conservation measures" affecting agricultural sector water use include what Dr. Sunding characterizes as: deficit irrigation, center pivot efficiency improvements, use of deeper aquifers for high-value crops, reduced early season pecan irrigation, elimination of excessive irrigation, elimination of irrigation on unpermitted acreage, irrigation buyback, and reduced evaporation from farm ponds. Conservation measures affecting municipal and industrial use include: reduction in outdoor water use, municipal leak abatement, and elimination of net basin exports.

[34] In his testimony, Dr. Sunding indicates that Florida's proposed remedy would impose a more stringent cap in "dry" or "drought" years, indicating that such years would occur once every three years. (e.g., at 43). His analysis of impacts in these dry years appears to be based on irrigation application rates in 2011 (e.g., at 43 and 58).

combinations ("scenarios") in his various reports and testimony. In his direct testimony, for the first time, he considers reductions in streamflow during non-drought years, as well as the "dry" or "drought"-year measures considered in his prior reports.

41. This portion of my testimony assesses Dr. Sunding's conservation measures, individually. In doing so, I rely on results I provided in my expert report,[35] which focused on analyses performed by Dr. Sunding in his February Report, and an analysis of a combination proposed by Dr. Sunding in his May Report. I am continuing to review the new proposals and analysis presented by Dr. Sunding in his direct testimony (having received them on October 14, 2016) and backup materials (which were received as recently as October 24, 2016). I reserve the right to supplement or modify my testimony once I have had more time to review.

A. Dr. Sunding Fails to Consider Significant Policy Issues with his Proposals.

42. Before evaluating each of Dr. Sunding's measures, individually, I first discuss a number of important policy issues that Dr. Sunding fails to address which affect both the reliability of his estimated costs and the real-world feasibility of the measures he evaluates.

1. Dr. Sunding Fails to Account for Uncertainties in Determining in Advance When a "Dry" Year Will Occur

43. Dr. Sunding proposes that several of his conservation measures be implemented only in "dry" years, which he assumes would occur once every three years. However, Dr. Sunding does not consider the practical issues of how and when to declare "dry" year restrictions in advance of the agricultural season, given meteorological and hydrological uncertainties. The costs to farmers will be very sensitive to the timing of when restrictions are imposed. Because farmers who irrigate make cropping and investment decisions based on water availability, a restriction on irrigation instituted during the middle of the growing season could result in larger than expected costs (because, for example, a farmer could not switch to an alternative crop)

However, 2011 was one of the driest years on record, and based on climate data was the 93rd percentile for precipitation during the growing season, which would occur only once every 14 years. Thus, Dr. Sunding overestimates the potential increases in streamflow that could be achieved if such measure were to be implemented once every three years.

[35] GX-0874 (Stavins Report).

and/or achieve less reduction in water use (due to irrigation applied before restrictions are imposed).

44. Dr. Sunding also does not address the implications of the inherent uncertainty facing any policy that imposes "dry" year requirements before information about natural precipitation levels are known. Given such uncertainty, there is both the risk of "false positives" (that is, imposing restrictions when rainfall turns out to be at normal levels) and "false negatives" (that is, allowing irrigation during drought conditions). Because of this uncertainty, policies that impose restrictions in "dry" years will necessarily incur additional costs and provide diminished benefits compared with an analysis that assumes perfect foresight.

2. Dr. Sunding Fails to Account for Administrative and Policy Costs

45. The development and implementation of policies to achieve water conservation entail a number of policy costs that Dr. Sunding fails to consider. As described in JX-47, the EPA *Guidelines*, the policy costs Sunding fails to account for include "wages paid to employees for developing a regulation and then for administration, monitoring, and enforcement" of the policy.[36] Given the potential complexity of the policies under consideration, developing an effective plan for water reductions and then, as described above, monitoring, verifying, and enforcing those water reductions could be very costly. Dr. Sunding does not consider such additional costs, and therefore underestimates the costs of his proposals.

3. Dr. Sunding Fails to Consider the Policy Feasibility of His Conservation Measures

46. The agricultural conservation measures analyzed by Dr. Sunding reflect specific conservation *actions* that farmers could *in theory* undertake. But Dr. Sunding fails to identify *how* farmers would be induced to undertake those actions – that is, he does not adequately consider whether there are *policies* or other *initiatives* that can achieve the assumed reductions. In fact, for some of the measures he considers there are no apparent policies or initiatives that could achieve the reductions assumed in his analysis.

[36] JX-47 (EPA *Guidelines* (2014)), at 8-7.

47. One example is Dr. Sunding's deficit irrigation measure. Dr. Sunding does not clearly describe the mechanics of his deficit irrigation measure in his direct testimony. His February Report makes clear, however, that this measure assumes that Georgia farmers reduce water use in 10 percent increments, and that water reductions are allocated across individual farms and parcels in the most cost-effective manner, given variations across farms in crop choice, soil type, water application intensity (and lost crop yields), and groundwater connectivity. In total, Dr. Sunding evaluates more than 2,000 unique combinations of these farm characteristics in achieving reductions at the "least cost." His analysis assumes perfect information about all of these many factors affecting the cost of streamflow reductions. Dr. Sunding provides no examples of such deficit irrigation policies in practice. In his direct testimony, however, Dr. Sunding hypothesizes a number of policy mechanisms he believes could achieve his proposed restrictions. I address each in turn below.

48. ***"Cap-and-Trade."*** In his direct testimony, Dr. Sunding suggests that his "deficit irrigation" approach could be implemented using a cap-and-trade system, whereby the State would impose a numerical limit on overall agricultural water use, somehow assign rights to individual farmers, and then allow farmers to trade water rights.[37] As an initial matter, I understand that Georgia is a "riparian rights" state, meaning that land owners – including those with agricultural land – whose properties adjoin a body of water are entitled to "reasonable" use of that water but do not have a transferable right to water use. That is, they do not have a right to water that they can trade. I am not aware of a "riparian rights" state such as Georgia implementing the cap-and-trade approach described by Dr. Sunding, and Dr. Sunding has not provided any examples.[38]

49. More fundamentally, a cap-and-trade system is simply not a feasible policy mechanism for achieving stream flow increases in Georgia, as envisioned by Dr. Sunding. This is abundantly clear based upon the extensive research and writing I have carried out on cap-and-trade systems around the world, including in the United States, over the past three decades.[39]

---

[37] See Sunding Testimony at 40-41.

[38] See Sunding Dep. Tr. at 398-403.

[39] See, for example: Stavins, Robert N. "Harnessing Market Forces to Protect the Environment." *Environment: Science and Policy for Sustainable Development* 31 (1989): 5–35; Stavins, Robert N. "Transaction Costs and Tradeable Permits." *Journal of Environmental Economics and Management* 29 (1995): 133–148; Stavins, Robert N.

Cap-and-trade systems can lead to a cost-effective outcome only when the individual entities to be engaged in trade can be assigned full and complete property rights, and experience the benefits and costs of their actions.

50. Significant differences in the groundwater connectivity associated with different locations means that simple water trading would surely *not* lead to the cost-effective allocation of water-use reductions contemplated by Dr. Sunding. To denominate rights in terms of streamflow impacts, rather than water quantity, the regulator would need to develop a matrix of transfer coefficients that accounts for different connectivity values to enable a non-uniform trading regime. That is, the regulator would need to know the potential change in streamflow that could result from trades between any two connectivity zones. The more connectivity zones included (such as the twelve included in Dr. Sunding's analysis), then the larger the matrix or set of possible trade combinations. Such a matrix would add massive complexities to the market, which would raise transaction costs and reduce the likelihood that farmers would find it profitable to trade. Furthermore, such a non-uniform trading system has not been successfully implemented, even in the case of air pollution, where the most sophisticated policies have been developed.

51. ***Irrigation Auctions***. Dr. Sunding has also suggested that auctions may be a cost-effective means of achieving his conservation goals.[40] Georgia's experience with auctions, however, illustrates the challenges of implementing such a policy in the real world. Georgia held auctions during the droughts of 2001 and 2002 to remove irrigated acreage from production. Those auctions are reported to have removed more than 33,000 and 41,000 acres from production, respectively. The State discovered, however, that some of these retired acres included land from farmers who nominally qualified for the program but were paid to take marginal or long-fallowed land out of production. The State also discovered that it had paid for

---

"Experience with Market-Based Environmental Policy Instruments." In *Handbook of Environmental Economics*, edited by Karl-Göran Mäler and Jeffrey Vincent, I: 355–435. Amsterdam, Netherlands: Elsevier Science, 2003; Schmalensee, Richard, and Robert N Stavins, "The SO_2 Allowance Trading System: The Ironic History of a Grand Policy Experiment." *Journal of Economic Perspectives* 27 (2013): 103–122; Schmalensee, Richard, and Robert N Stavins, "Lessons Learned from Three Decades of Experience with Cap-and-Trade." RFF DP 15-51, November 2015.

[40] *See*, for example, Sunding February Report, at 94 and Testimony at 29-30.

land that was not typically irrigated, such as pasture or trees.[41] Georgia subsequently made changes and modifications to its auction process to address these concerns, but challenges are likely to remain. In particular, the need to define a "baseline" level of water use against which to measure reductions (and to ensure that potential program participants are, in fact, irrigators) creates challenges for reliably measuring reductions and may result in incentives to increase water use. For example, given the potential to receive revenue for eliminating irrigation use, this may create the incentive for farmers to increase irrigation pumping during other periods to increase their "baseline" level of irrigation. In addition, because of the voluntary nature of auction programs, it is difficult for the state to target particular users whose water use has the greatest impact on streamflow. These types of policy challenges raise program costs and decrease potential reductions in water use.

52. ***Nebraska and Florida***. Lastly, Dr. Sunding has pointed to policies in place in Nebraska and Florida as examples that Georgia should follow for its agricultural sector.[42] These examples are distinguishable from Dr. Sunding's proposed deficit irrigation measure in ways that further illustrate the infeasibility of his proposal.

53. For example, Dr. Sunding refers to agricultural water permitting in Florida, focusing particular attention on the Northwest Florida Water Management District ("NWFWMD"), which regulates water use in ACF Florida.[43] I understand that agricultural permits in the NWFWMD do not provide landowners with the option to trade water rights.[44] Thus, this district's water permitting system would not lead to the cost-effective reduction of agricultural water use that Dr. Sunding assumes in his deficit irrigation measure.

54. I understand that Florida permits include a numerical limit on water use over the year, based on calculations of an agronomy software model.[45] Dr. Sunding claims that these

---

[41] *See* JX-21 (Flint River Plan) at 45-47.

[42] Sunding Testimony at 33 (Nebraska), 40 (Florida).

[43] Sunding Testimony at 40.

[44] Based on the information I have reviewed, I have not identified any formal trading mechanism for water rights within the NWFWMD.

[45] NWFWMD, Water Use Permit, Applicant's Handbook, Incorporated by Reference in Section 40A-2.061, Florida Administrative Code, effective April 2015, p. 32-33.

limits would provide farmers with insufficient water to maximize yields during drought years,[46] but the NWFWMD Executive Director testified that the limit is designed to provide "more than you conceivably … could need" during a drought.[47] Thus, it is unclear whether the numerical permit limits impose a real constraint on farmers' use of water.

55. When district officials do find that farmers exceed the numerical permit limit, it is unclear whether there are any meaningful adverse consequences for the farmer. During deposition, the assistant director of the NWFWMD could not recall an instance in which a permit was revoked.[48] Permits also include provisions that limit irrigation flexibility during shortage conditions declared by District officials. However, these limits generally only restrict irrigation timing (such as limits on mid-day irrigation) and impose no restrictions on "low volume" irrigation.[49] Moreover, in the NWFWMD, it appears that mandatory limitations have never been imposed in the ACF Basin.[50]

56. In his direct testimony, Dr. Sunding suggests that an irrigation program in operation in Nebraska for the Republican River provides an example of a cap-and-trade program Georgia could adopt that would achieve his cost-effective deficit irrigation water reductions.[51] Dr. Sunding suggests that this program may be relevant to Georgia because it considers connectivity of aquifers for particular geographic areas when evaluating trading of water rights between landowners. However, far from demonstrating the feasibility of a cap-and-trade program, experience with this program illustrates the limitations of using a cap-and-trade type of approach to reducing agricultural water use.

57. In contrast to the complex system assumed in Dr. Sunding's analysis, with twelve different connectivity levels, the Nebraska program has two levels – a "Rapid Response" area,

---

[46] Sunding May Report, at 20.

[47] Brett Cyphers Deposition, at 258-259.

[48] Wallace Gowens Deposition, at 158. I have also seen evidence of permits that received revised or new quantities of water, even after violations of existing permit terms. *See* GX-0219 (NWFWMD Staff Report).

[49] Florida Administrative Code 40A-21.641.

[50] Wallace Gowens, NWFWMD, states that a Water Shortage has only been declared once in the District, for a brief period of time *outside* the ACF Basin. Wallace Gowens Deposition, at 253.

[51] Sunding Testimony at 33.

and areas outside the "Rapid Response" area.[52] As of 2012, the District appears to evaluate and approve each trade individually and it is not clear whether the District was even required to account for streamflow impacts when approving trades (let alone providing connectivity transfer coefficients in advance). Such trade-specific approvals increase transactions costs and uncertainty about trade success, which in turn reduces incentives to trade. Second, I understand that the legal context for this program differs substantially from that in Georgia. For example, I understand that Nebraska is a "prior appropriation" state, and the issue of allocating water rights among landowners has already been addressed, through historical uses and priority rights. Moreover, I understand that Nebraska operates under an inter-state water compact for the Republican River ("Republican River Compact) that dates back to 1943, and was negotiated as a prerequisite to the establishment of Bureau of Land Management projects, designed to provide flood control and irrigation.[53]

B. Dr. Sunding Underestimates the Costs and Overestimates the Streamflow Impacts of his Proposals.

58. Even setting aside the policy issues with his analysis, Dr. Sunding dramatically underestimates the costs and overestimates the streamflow impacts of his proposed conservation measures. I describe and document Dr. Sunding's errors for each of his specific measures below.

1. Deficit Irrigation

59. In his February report, Dr. Sunding proposed a range of reductions in the use of row crop irrigation by way of "deficit irrigation," ranging from 404 cfs to 1000 cfs (as measured by Dr. Sunding). Subsequent reports and testimony have included other measures subsumed by his original deficit irrigation measure, such as elimination of "excessive irrigation." In this section, I analyze the costs associated with Dr. Sunding's proposed reductions from deficit irrigation. My analysis builds off of Dr. Sunding's deficit irrigation analysis presented in his February Report, but differs in three important respects.[54]

---

[52] Sunding Dep. Tr. 155:15 – 156:8.

[53] See, for example, No. 126 Original, 574 U.S. (2015).

[54] Consistent with his February Report and my own Expert Report, I estimate losses assuming "dry" year conditions which reflect average 2011 and 2012 conditions. In contrast, Dr. Sunding's direct testimony appears to focus only

60. First, my analysis considers policy feasibility. Given the policy feasibility problems that I identified above with Dr. Sunding's deficit irrigation analysis, I consider a policy that either fully eliminates irrigation for a given parcel of land or makes no change in irrigation (rather than assume economically optimal reductions in 10 percent increments, as Dr. Sunding does). I refer to this approach as "irrigation reduction," rather than "deficit irrigation." Second, my analysis assumes irrigated acreage and a seasonal adjustment factor consistent with the expert opinion of Dr. Panday.[55]

61. Third, my analysis reflects alternative estimates of the reduction in crop yield from the elimination of irrigation. These alternative estimates differ along two important dimensions: the data source for crop yields and crop yield improvements from irrigation. With respect to crop yield data, Dr. Sunding uses estimates generated by a crop simulation model called "DSSAT" to determine the relationship between irrigation and crop yields, instead of using yield data from actual production in the region of interest.[56] In my analysis, I consider yield impacts based on actual field measurements performed in the Lower Flint Basin from 2001 to 2014.[57] I note that Dr. Irmak indicates that yield data from actual production in the region would be preferred to estimates from engineering models, such as DSSAT. Stavins Demo. 9 compares dry year irrigation yield impacts that I use in my analysis to those used by Dr. Sunding.

---

on 2011 "drought" year results. My use of average 2011 and 2012 conditions is conservative and will tend to underestimate the total costs that would be expected during a 2011-type drought.

[55] Consistent with Dr. Panday's analysis, I excluded the acreage connected to the Clayton, Claiborne, and Cretaceous aquifers based on NESPAL data that identifies the water source for each irrigated parcel included in its database. I also understand that additional analysis performed by Dr. Panday on the impact of irrigation drawn from the Clayton, Claiborne, and Cretaceous aquifers on streamflow demonstrates that these impacts are minimal. Consequently, this analysis confirms that the exclusion of these withdrawals from my analysis is appropriate. In his direct testimony, Dr. Sunding claims that this was implemented incorrectly. (Sunding Testimony at 47.) He appears to have misunderstood the method I used to exclude acreage connected to non-Floridan aquifers (as indicated above, I did not "simply remove the total amount of Claiborne acreage in the ACF proportionally across the Basin").

[56] DSSAT is the "Decision Support System for Agrotechnology Transfer."

[57] *See* JX-160 (Shellman Farm Data).

Stavins Demo. 9: Georgia Crop Yields per Acre, 2001-2014[58]

	USDA ARS NPRL		Sunding Analysis
	Average Year	Dry Year	Dry Year
Cotton (lb)			
Irrigated Yield	1,308	1,518	1,389
Non-Irrigated Yield	606	329	539
Difference	702	1,189	850
Difference as % of Irrigated Yield	(54%)	(78%)	(61%)
Peanuts (lb)			
Irrigated Yield	4,675	5,050	5,321
Non-Irrigated Yield	3,323	2,471	865
Difference	1,352	2,579	4,456
Difference as % of Irrigated Yield	(29%)	(51%)	(84%)
Corn (bu)			
Irrigated Yield	191	183	134
Non-Irrigated Yield	62	13	44
Difference	129	170	90
Difference as % of Irrigated Yield	(68%)	(93%)	(67%)
Soybeans (bu)			
Irrigated Yield	-	-	63
Non-Irrigated Yield	-	-	10
Difference	-	-	53
Difference as % of Irrigated Yield	-	-	(84%)

62. My analysis also makes different assumptions about the crop yield improvements resulting from irrigation. Dr. Sunding's analysis compares estimated application rates to simulated yield curves to arrive at yield impacts, which appears to result in a number of empirical and computational errors.[59] Instead, my analysis makes simplifying, but reasonable, assumptions to avoid these errors.

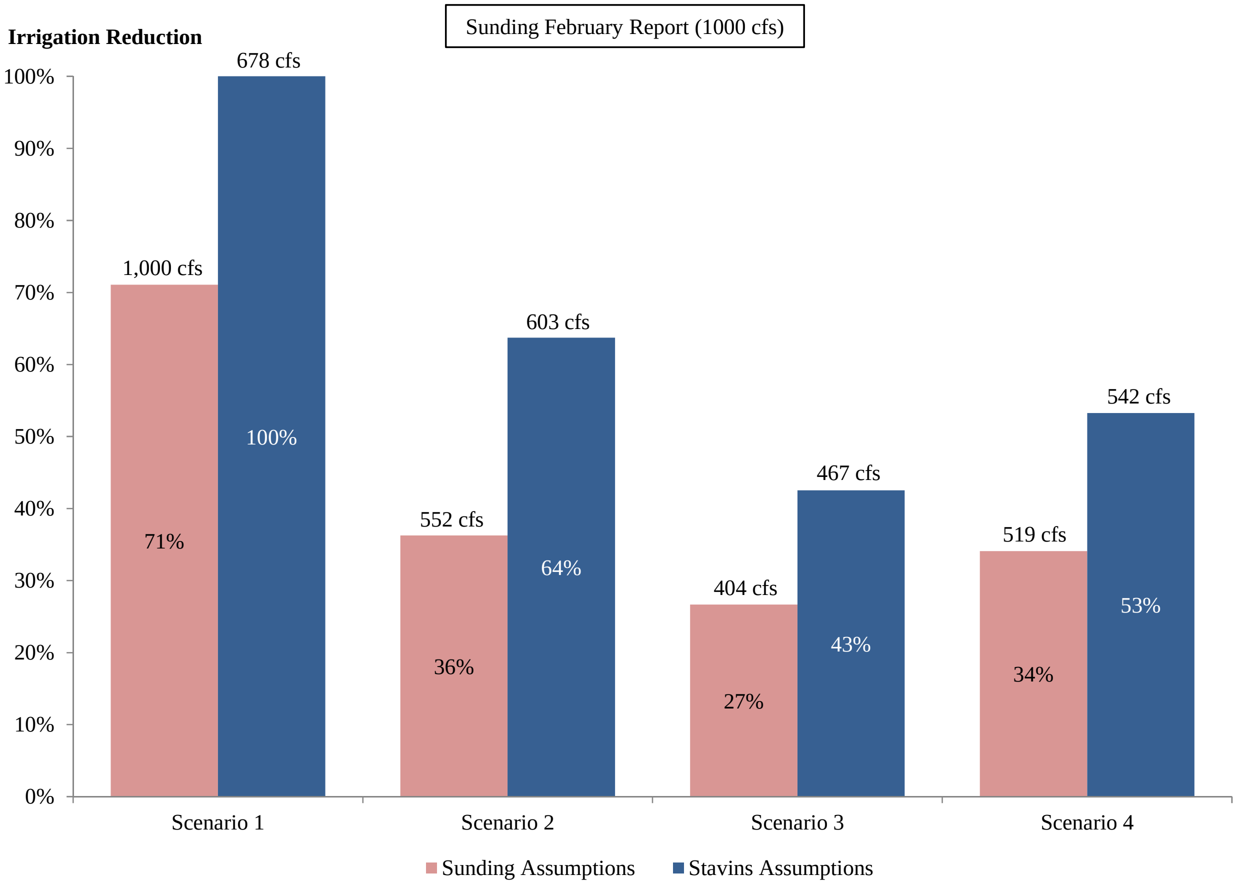
58 USDA-ARS-NPRL Dry Year yields were calculated as the average yields from the Shellman Farm Data for the years 2011 and 2012.

59 GX-0874 (Stavins Report) at 74-77.

63. Specifically, I assume that the reduction in crop yield from eliminating irrigation on a parcel is equal to 90 percent of the difference in irrigated and non-irrigated yields reported in Stavins Demo. 9. My estimates are conservative, because I assume that farmers do not achieve the maximum potential yield available through irrigation. Generally speaking, farmers are rational economic actors and have incentives to maximize their profits. As such, they have strong economic incentives to irrigate with a quantity of water that leads to the maximization of profitability, taking account of both the revenues from the sale of crops and their costs of production, including costs of pumping and irrigation equipment.

64. Stavins Demo. 10 shows the percentage of total row crop irrigation that would be eliminated under four of Dr. Sunding's scenarios from his February Report (and the resulting streamflow increase, in cfs), using both Dr. Sunding's assumptions and the assumptions used in my analysis. While Dr. Sunding's analysis concludes that his Scenario 1 (from the Sunding February Report) would require the elimination of 71 percent of total row crop irrigation, I find that there is insufficient water from row-crop irrigation to achieve the targeted 1,000 cfs streamflow increase. Instead, I find that *the complete elimination of all row crop irrigation* in dry years would only generate 678 cfs, an amount far below the 1,000 cfs stream flow increase targeted by Dr. Sunding.

Stavins Demo. 10: Reductions in Row Crop Irrigation Applications, by Scenario[60]



65. Stavins Demo. 11 shows the results of my analysis of the costs of irrigation reduction, compared to Dr. Sunding's cost estimates. In his February Report, Dr. Sunding claimed that an increase in summer peak stream flow of 1,000 cfs could be achieved at a cost of $191 million in the year in which the restrictions are implemented. This would require a 71 percent reduction in total row crop irrigation. By contrast, I find that elimination of all row crop irrigation would achieve only 678 cfs of summer peak streamflow increases, and result in costs of $335 million in each dry year.

---

[60] Percent reductions in irrigation applications are quantified using Dr. Sunding's deficit irrigation model provided with his February Report. My scenarios reflect my adjustments to Dr. Sunding's deficit irrigation estimates. However, results are not adjusted for Dr. Sunding's modifications presented in his direct testimony. These modifications appear to include the use of different average connectivity values; 2011 application rates; and adjusted application rates for throw acreage.

Stavins Demo. 11: Summary of Economic Costs of Deficit Irrigation Reduction[61]

	Total Cost ($ million)	Application Reduction		Streamflow Returns
		AFY	Percent	CFS
Sunding Analysis	$191	447,603	71%	1,000
Stavins Analysis	$335	495,064	100%	678

66. Stavins Demo. 12 shows the deficit irrigation costs and streamflow increases at less stringent levels. Even at a reduction of 20 percent, I find costs to be $69 million in each dry year.

Stavins Demo. 12: Economic Costs of Deficit Irrigation Reduction for Alternative Scenarios

	Irrigation Reduction			
	20%	50%	75%	100%
Sunding Analysis				
Total Cost ($2012 million)	$15	$106	$208	$302
Peak Streamflow (cfs)	293	762	1,027	1,068
Stavins Analysis				
Total Cost ($2012 million)	$69	$161	$240	$335
Peak Streamflow (cfs)	246	515	650	678

67. My analysis considers costs from the implementation of deficit irrigation during dry years only. However, in his testimony, Dr. Sunding also evaluates (for the first time) impacts during non-dry years.[62]

2. Center Pivot Efficiency

68. Another measure Dr. Sunding proposes is the adoption of more water-efficient center-pivot irrigation systems. While not clearly specified, Dr. Sunding appears to assume a widespread switch from (lower-efficiency) high-pressure systems to (higher-efficiency) low-pressure systems. In his February Report, Dr. Sunding estimates that Georgia can achieve peak summer streamflow increases of 111 cfs at a cost of $3 million per year by upgrading center

[61] For Sunding analysis, see Sunding February Report at 79-82. For Stavins Analysis, see GX-0874 (Stavins Report) at 69-79.

[62] I reserve the right to supplement my testimony once I receive the necessary materials from Florida and have adequate time to review those materials and Dr. Sunding's new analyses.

pivots to more efficient systems.[63] In his direct testimony, Dr. Sunding estimates that Georgia could increase peak summer streamflows by 107 to 127 cfs at "less than $4 million". In both instances, Dr. Sunding overestimates the streamflow impacts of his center pivot efficiency measure for two principal reasons.[64]

69. *First*, Dr. Sunding significantly underestimates the current market penetration in Georgia of more efficient center pivot systems, and therefore significantly overestimates the streamflow impacts that are available from efficiency upgrades. Based on one email message, Dr. Sunding assumes that 50 percent of acreage irrigated with center pivot systems have an efficiency of 70 percent (presumably, high pressure systems). In contrast, based on data from Mark Masters, I understand that in the Lower Flint River Basin only about 7 percent of acreage is being irrigated by high-pressure, lower efficiency irrigation systems. Similarly, while Dr. Sunding assumes that systems on 50 percent of acreage have a higher efficiency of 80 percent (presumably, low pressure systems), in fact, 93 percent of acreage in the Lower Flint River Basin is being irrigated by low-pressure sprinkler systems, with 65 percent using low-pressure drop nozzle systems that have even higher than 80 percent efficiency.[65] Georgia has also imposed irrigation efficiency requirements for all irrigation systems in the Flint River Basin. The timing of these requirements varies with the age of the system's operating permit, but all systems must meet an 80 percent efficiency standard by 2020.[66]

70. In light of these factors, in my analysis of center pivot irrigation, I only consider reductions that are incremental to this 80 percent standard. After accounting for these existing requirements (and the same acreage and seasonal factor adjustments assumed for irrigation reduction), I find that potential summer peak streamflow would increase by 35 cfs, rather than the 111 cfs originally estimated by Dr. Sunding.

---

63 Sunding Testimony at 28.

64 My analysis in this section is based on the production materials provided with Dr. Sunding's February Report. Because the values in his direct testimony are similar to the estimates in his February report, I expect my critiques to apply to his updated estimates. I reserve the right to supplement or modify my testimony, however, once I receive and have adequate time to review a full set of backup materials from Florida.

65 See Direct Testimony of Mark Masters.

66 *See* GX-932, which is a true and accurate copy of the 2014 amendments to the Flint River Drought Protection Act. Experts in my field regularly rely on state statutes and statutory amendments, and I reviewed these amendments in forming my expert opinions.

71. *Second*, Dr. Sunding fails to consider overlaps among his conservation measures, and thus double counts water use reductions. In particular, deficit irrigation and center pivot irrigation efficiencies target the same water use. For example, if a farmer eliminates all of the irrigation on his farm through deficit irrigation, then a more efficient center pivot system will not result in any additional water savings. Dr. Sunding's analysis assumes that the same water is reduced twice – once when irrigation is eliminated, and a second time with the more efficient technology. After accounting for this overlap, increased center pivot efficiencies would only yield 13 to 16 cfs in peak summer streamflow benefits during a dry year.

3. Increased Reliance on Deeper Aquifers

72. Dr. Sunding proposes that Georgia shift 75 percent of all high-value crop irrigated acreage in the ACF, such as produce, sod, peach, and nursery acreage, to deeper aquifers, including the Claiborne, Clayton, and Cretaceous aquifers. Dr. Sunding estimates that these crops cover 83,392 acres of irrigated agricultural land. In his February Report, Dr. Sunding estimates that Georgia can achieve peak summer streamflow increases of up to 337 cfs at a cost of $14 million per year by switching high value crops to deeper aquifers. In his direct testimony, he claims streamflow increases of 198 and 232 cfs at a cost of only $7.6 million per year.

73. I understand that Georgia has yet to reach conclusions about the suitability of water supplies from deeper aquifers, the sustainability of this source of supply (given limited recharging of these aquifers), or the costs of developing and operating such wells. Moreover, I understand that Dr. Sunding relies upon cost estimates from a different Florida expert, Dr. Bottcher, even though Dr. Bottcher's cost estimates for drilling new deep water wells are based on input from a single unnamed contractor, and Dr. Bottcher himself did not independently verify the accuracy of these numbers.[67] As such, it is excessively speculative for Dr. Sunding to conclude that increased reliance on deeper Non-Floridan Aquifers in ACF Georgia would provide meaningful peak summer streamflow benefits.

[67] Bottcher deposition, 157:18-24, 159:1-14, 162:2-24.

4. Early Season Pecan Irrigation

74. Dr. Sunding proposes reducing irrigation of pecan trees.[68] Citing the results of a single study (Wells 2015) about the effects of irrigation on pecan yields, Dr. Sunding concludes that 102 to 119 cfs of additional peak summer streamflow would be available through reduced early-season irrigation at no cost to pecan yields or profits.

75. As a threshold matter, I note that the Wells (2015) study is just one analysis conducted at a single orchard in Berrien County in south central Georgia, which is not even part of the ACF Basin. In my opinion, the results of a single study conducted outside the ACF Basin are not an appropriate basis to justify potentially costly requirements for the entire ACF Basin, particularly given the high value of the pecan industry in Georgia.

76. Moreover, the Wells (2015) study actually estimates a decline of 22 percent in pecan yields under the reduced irrigation scenario in 2012, which Dr. Sunding considers a "dry" year. While the confidence interval for this estimated decline in yield in 2012 includes zero, which means that the result is not "statistically significant," the size of the estimated effect is substantial. Assuming a decline of 22 percent in yield, and employing other reasonable assumptions, the cost of Dr. Sunding's proposed measure would be $39 million per dry year, not $0 as he reports.

5. Leak Abatement

77. With regard to municipal and industrial water use, Dr. Sunding proposes that Georgia, and the Metropolitan North Georgia Water Planning District ("Metro North") in particular, achieve additional water conservation through increased leak detection and mitigation. In his direct testimony, Dr. Sunding estimates that these measures would achieve peak summer streamflow increases of 42 cfs, though he does not present the costs. Based on the methodology presented in his February Report, Dr. Sunding's estimate of the cost of leak abatement measures necessary to achieve comparable water savings appears to be approximately $7 million year.[69]

---

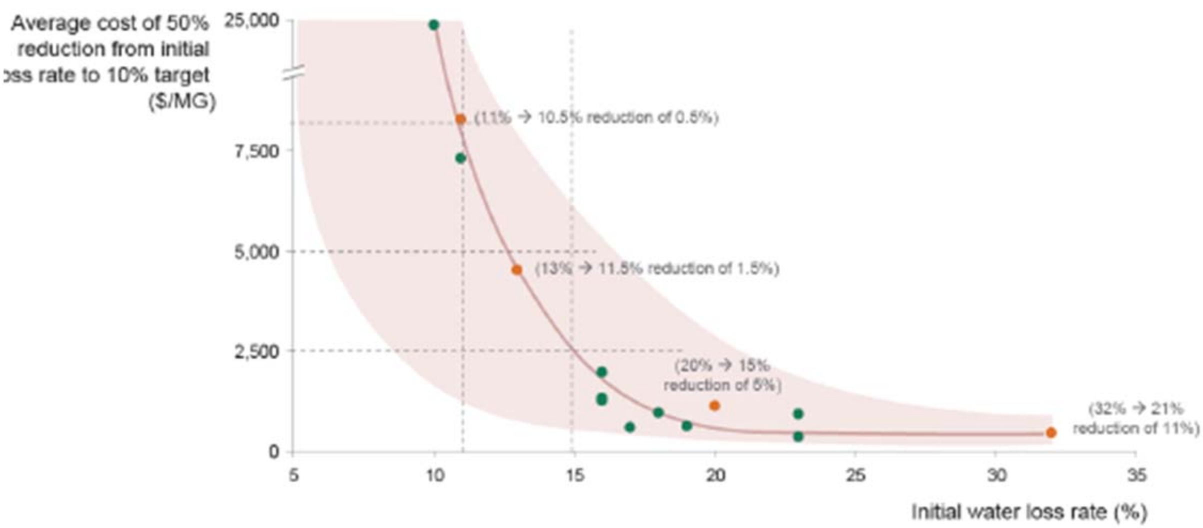
[68] Sunding Testimony at 26-27.

[69] In his February Report, Dr. Sunding estimated that implementing "full" leak abatement would achieve 95 cfs peak summer streamflow at a cost of $21 million per dry year. These results were developed, in part, through his application of an agricultural seasonal factor to annual M&I conservation measures. In his testimony, Dr. Sunding

78. Dr. Sunding's analysis relies entirely on the findings of the Water Contingency Planning Task Force, which was formed to develop a set of contingency plans in response to a federal court decision (later overturned) that sharply limited the Army Corps' ability to provide the City of Atlanta with water supply from Lake Lanier. [70]

79. To develop his analysis, Dr. Sunding used the Task Force's initial cost estimate of $1,200 per million gallons ("MG"), consistent with a real water loss rate greater than 20 percent, as shown in Stavins Demo. 13. However, the Task Force provided additional cost estimates that recognized the increasing (marginal) cost of additional reductions.

Stavins Demo. 13: Cost of Water Loss Reduction[71]



80. Using the correct loss rate of 14.1 percent estimated by Mr. Mayer, rather than the 20 percent or greater loss rate implied by Dr. Sunding's cost estimates, I find that the cost of additional leak abatement is at least $2,500/MG, more than double Dr. Sunding's estimate. Moreover, because (marginal) costs will continue to increase as the loss rate is reduced, further reductions would come at an increasingly higher cost than the $2,500/MG value used in my analysis.

---

assumes that leaks would occur equally throughout the year. Thus, he appears to have reduced his peak summer streamflow benefit from 95 cfs to 42 cfs by abandoning the use of a seasonal factor, previously assumed to be 2.28 (i.e., 42 = 95 / 2.28). See Sunding Testimony, at 21.

[70] *See* JX-41 (Task Force Report).

[71] JX-40 (Appendix III to Task Force Report), at 64.

81. In addition, Dr. Sunding ignores the fact that the Contingency Task Force assumes that leak abatement activities will be implemented every year to achieve potential water savings. Instead Dr. Sunding incorrectly assumes that only one third of all annual variable costs are necessary, implying the Task Force's estimated water savings could be saved by implementing leak abatement every third year instead of every year.

82. I find that after accounting for increased marginal costs, and correcting for Dr. Sunding's flawed assumption that leak abatement activities only occur every third year, the lower bound for the true cost of Dr. Sunding's leak abatement conservation scenario on an annual basis would be $34.5 million per year, nearly 500 percent greater than his estimate of $7.0 million per year.

6. Outdoor Water Use Reduction

83. Dr. Sunding also evaluates reductions in municipal outdoor water use and considers reductions in outdoor water use ranging from 20 percent (in one of the 1,000 cfs scenarios in his February Report) to 75 percent (in the 2,000 cfs scenario in his May Report). Lacking data on outdoor water use, Dr. Sunding performs an approximation that he acknowledges was performed incorrectly, resulting in an overestimate of outdoor water use.[72] To date, Dr. Sunding has provided three separate estimates of total outdoor water demand during the 2011 drought, all purportedly developed using the same data. These include 114,550 AFY, approximately 130,000 AFY, and 162,796 AFY.[73] As a conservative measure, I estimate costs using Dr. Sunding's lowest total outdoor water demand (the 114,550 AFY estimate).

84. To estimate the cost of an outdoor watering ban, Dr. Sunding relies on the implied demand curve for municipal water use.[74] I perform an analysis of reductions in outdoor water use which reflects several corrections to and modifications of Dr. Sunding's analysis. *First*, Dr.

---

[72] Sunding Dep. Tr. at 368-394; and Sunding Testimony at 48.

[73] February Report, Table 11; May Report, Table 2; and Sunding Testimony, at 36. In his February Report, Dr. Sunding quantified the economic costs and potential streamflow benefits using the 162,792 AFY measure. See Sunding Report, Table 13. Given the nature of these multiple estimates, I understand that other experts are reviewing Dr. Sunding's outdoor water use calculations and may independently provide alternative values. I reserve the right to supplement my opinions.

[74] This model estimates costs as a function of the current price of water and a consumer price elasticity, which is a measure of how much consumers are willing to reduce consumption for a given price increase.

Sunding improperly relies on the same seasonal scaling factor that was developed based on agricultural pumping. Dr. Sunding provides no explanation for why this scaling factor, which he used to relate annual *agricultural* pumping to peak summer streamflows, is appropriate when considering reductions in *municipal and industrial* outdoor water use. I understand that the proper scaling factor depends on many factors, such as storage in Lake Lanier and the Army Corps of Engineers' policies regarding maintenance of flow on the Chattahoochee River.[75] *Second*, Dr. Sunding estimates total welfare using a "linear approximation" of the demand curve. In my analysis, I utilize a "constant elasticity" demand curve, which is commonly used in the economics literature, is an implicit assumption used by Dr. Sunding to estimate a key parameter in his analysis, and is consistent with the models used by Dr. Sunding in his previous work.[76] *Third*, Dr. Sunding uses assumptions that *overstate* the costs that would be *avoided* from reductions in outdoor water use. By overestimating these avoided costs, he underestimates the total costs of reductions. Specifically, Dr. Sunding assumes that a reduction in outdoor water use will avoid *all* wastewater treatment costs despite the fact that water used in outdoor watering is typically not returned to a wastewater treatment plant.

85. Stavins Demo. 14 illustrates the impact of these adjustments. The cost of outdoor water use reductions would be $156 million for a 30 percent reduction, $445.3 million for a 50 percent reduction, and $2.1 billion for a 75 percent reduction.

Stavins Demo. 14: Corrected Assessment of Cost of M&I Outdoor Water Use Restrictions

	Increase in Peak Summer Stream Flow (cfs)	Cost in a Dry Year ($ million)
Outdoor Water Restriction		
30% Reduction	52	$156
50% Reduction	86	$445
75% Reduction	129	$2,098

[75] For example, *see* GX-0874 (Stavins Report), at 87. See also Direct Testimony of Dr. Philip B. Bedient, Ph.D.

[76] Brozovic, N., Sunding, D.L., and D. Zilberman (2007); and Buck, S., Auffhammer, M., Hamilton, S., and D. Sunding, (2016), which was released in the past year.

86. When assessing "combinations" of conservation measures in his direct testimony, Dr. Sunding excludes the costs of outdoor water use restrictions, theorizing that the value Georgia households place on their knowledge of downstream benefits from reductions in outdoor water use outweigh the "welfare" losses they face from these restrictions.[77] He justifies this conclusion with the results of a survey he performed of Georgia households. As I understand Dr. Robin Cantor addresses in her testimony, however, Dr. Sunding's survey is flawed and insufficiently reliable as a basis for ignoring the substantial welfare losses shown, for example, in Stavins Demo. 14. For example, as Dr. Cantor describes in her testimony, the sample size he relies upon is small (73 respondents), and Dr. Sunding omits other results from his survey showing that very few Georgia respondents affirmatively expressed a willingness to pay to preserve resources in the Apalachicola River region.

87. Dr. Sunding also errs by assuming that a reduction in outdoor water use will have no impact on the landscaping sector (and by extension, broader economic activity) in the ACF Basin.[78] There is substantial economic activity in the ACF Georgia green industries; as discussed earlier, the GRP of the Upper Chattahoochee Region green industries was approximately $658 million in 2013. Thus, even a small (in percentage terms) reduction in output from these industries would be expected to impose millions of dollars in losses to the Georgia economy.

88. The potential for reductions in economic activity in these green sectors is a logical consequence of the reduction in outdoor water use, which would reduce the need to maintain existing landscaping. As a result, it is sensible to expect output and employment in the landscaping and horticultural services sector (and other related sectors) to decline in the event of outdoor water restrictions. Indeed, using data from the Bureau of Labor Statistics (BLS), Dr. Sunding demonstrates that within the landscaping services sector, total employment in the Atlanta metro area fell by 9 percent from 2006 and 2008. However, he then comments that "landscaping jobs fell by a larger percent in 2009 and 2010, when no outdoor water restrictions were in place," without any recognition that the "Great Recession" severely depressed employment over this time, while the job declines from 2006 to 2008 happened during a period

[77] Sunding Testimony at 37-38.

[78] Sunding Testimony at 37-38.

of economic growth. Thus, during the drought period, landscaping employment fell despite economy-wide economic growth, suggesting real economic losses to this sector.

C. Dr. Sunding's Proposed Restrictions on Georgia's Consumptive Water Use Would Have Severe Distributional Impacts.

89. Dr. Sunding's proposed measures would have economic impacts that extend beyond the immediately affected industries and would be concentrated in certain regions. In particular, much of the impact of Dr. Sunding's scenarios would be concentrated in certain communities within Georgia, particularly the Flint River region and the agricultural sector in particular. As indicated in Stavins Demo. 11, the complete elimination of row crop irrigation in ACF Georgia would result in a direct cost of $335 million in a dry year. Using two economic impact models – IMPLAN and REMI – I evaluate the broader economic impacts of such a reduction (1) on a state-wide basis and (2) in the Flint River region specifically.[79]

90. As shown in Stavins Demo. 15, using IMPLAN, state-wide GRP would decline by $322 million annually, employment would decline by 4,173 annually, and taxes would decline by $15.4 million annually. In present value terms, reflecting impacts over the indefinite future, reduction in GRP would be $3.6 billion, and lost taxes would be $171 million.[80]

91. Using the REMI model, I find that state-wide GRP would decline by $341 million in total over a dry year cycle,[81] employment would decline by 5,298 in total over a dry year cycle, and taxes would decline by $21 million in total over a dry year cycle. In present value terms, reflecting impacts over the indefinite future, reduction in GRP would be $4.2 billion, and lost taxes would be $276 million. These values are higher than the corresponding IMPLAN values, reflecting in part the potential for long-term, structural changes to the economy in the Georgia ACF Basin region and in part the intertemporal economic impacts following a dry year.

---

[79] REMI stands for Regional Economic Models, Inc. REMI, like IMPLAN, is a model widely used by federal and state government agencies to assess the economic impacts; information on the methodology and data contained in REMI is publicly accessible at http://www.remi.com/. Experts in my field regularly rely on REMI data, and I reviewed REMI data in preparing my opinions in this case.

[80] I present my results assuming a real discount rate of 3 percent, consistent with OMB (2003).

[81] In my analysis, a "dry year cycle" is a three-year period consisting of a dry year followed by two non-dry years.

92. Because Dr. Sunding's measures focus on the agricultural sector, these economic impacts are largely concentrated in the Flint River agricultural production region. Across the economic metrics evaluated, impacts within the Lower Flint account for 62 to 68 percent of the state-wide impacts shown in Stavins Demo. 15. However, these impacts are spread over a much smaller existing economy, accounting for less than 3 percent of the total ACF Basin economy.

Stavins Demo. 15: Summary of Economic Impacts of Irrigation Reduction[82]

	Gross Regional Product	Output	State & Local Tax	Employment	Gross Regional Product	State & Local Tax
	($2012 million)			(Annual FTE)	($2012 million)	
Georgia						
IMPLAN	$322	$629	$15	4,173	$3,573	$171
REMI	$341	$663	$21	5,298	$4,169	$276
Lower Flint						
IMPLAN	$213	$416	$10	2,658	$2,363	$106
REMI	$197	$400	$12	2,985	$2,355	$157

93. Impacts estimated by IMPLAN and REMI do not reflect any potential impacts to sectors that use the outputs from the agricultural sector as inputs to their own production processes. However, as described in Section III, *supra*, ACF Georgia has processing industries that use commodities produced locally as key inputs to production. For example, in 2013, these industries in ACF Georgia accounted for $687 million in gross regional product, purchased more than $155 million in regional farm products to serve their businesses, and employed more than 4,500 individuals. Inputs may be sourced locally or from producers at greater distances. To the extent that these industries would reduce activity due to the reduction in agricultural output in ACF Georgia, impacts would be larger than those reflected in Stavins Demo. 15.

94. Irrigation restrictions could also have implications for the ability of farmers in the ACF Basin to secure loans on favorable terms (if at all). Farmers typically seek loans both for long-term investments (for example, to purchase land or equipment, including irrigation systems)

[82] GX-0874 (Stavins Report), at 57-58.

and short-term operating needs (for example, to purchase seed). From the lender's perspective, the farmer's ability to repay loans in a timely manner depends on successful harvests. In the event that a borrower is unable to repay, the lender may seize the collateral, which is often the farmland itself.

95. Under Dr. Sunding's scenarios, many – *if not all* – irrigated row crop farms in ACF Georgia would essentially become dryland farms during the years his proposed measures are implemented. In these years, deprived of the insurance provided by irrigation, these farms will be at increased risk of poor yields. Knowing this ahead of time, potential lenders would likely consider these farms at increased risk of default. Moreover, the same lenders would likely revise their estimates of the value of the farm land as collateral. Both of these developments would make it more difficult for farmers to obtain short- and long-term loans on the same terms as before, or to obtain financing at all.

96. Evidence I have reviewed suggests that these are not merely theoretical concerns. For example, in a letter dated April 7, 2016, Richard S. Monson, the CEO of the largest agricultural lender in the region, Southwest Georgia Farm Credit, stated: "Loss of a readily available and consistent source of water would likewise have the compounding effect of not only decreasing loan repayment capacity; it would also translate into deteriorating farm real estate values.… From a financing proposition this becomes somewhat of an untenable situation. Aside from problematic cash flows, row crop farmers would have weakening collateral and equity positions, making it all the more difficult to obtain constructive financing."[83]

97. In his February Report, Dr. Sunding estimates regional economic impacts using the same IMPLAN model that I use, as reported in Stavins Demo. 15.[84] However, in his direct testimony, he claims that these employment and regional impacts would not be large.[85] His arguments largely amount to the claim that reducing irrigation in the agricultural sector would not be costly, and, as a result, would not have broader economy-wide consequences. As

---

[83] GX-0862 is a true and correct copy of a letter from Richard S. Monson to Mark Masters, dated April 7, 2016. Experts in my field regularly rely on supporting documents such as this letter, and I reviewed this letter in preparing my expert opinions.

[84] Sunding February Report, at 54-55 and Table 9.

[85] Sunding February Report, at 54.

illustrated above, reductions in water use – regardless of the measures used to achieve them – would impose substantial costs, which would, in turn, flow through the regional and state economy. He also suggests that these costs – and the associated regional impacts – could be mitigated by compensating farmers for their water conservation efforts.[86] However, such compensation simply shifts the incidence of the costs of reducing water use, and the corresponding economic impacts, rather than actually eliminating those impacts.

D. A Cap on Municipal and Industrial Usage Would Impose Significant Costs on Georgia.

98. Dr. Sunding's testimony notes that Florida seeks a cap on Georgia's annual average consumption, although he does not provide details on what level or what sectors. Accordingly, I also analyzed the cost of caps on future M&I water use within the Metro North Water District. Specifically, I have analyzed the potential impact from a mandatory cap on consumptive water use by M&I users in the Metro Water District under three cases: (1) a cap on future use at currently projected 2016 withdrawals; (2) a cap on future use at 2011 levels of use (a recent dry year, used by Dr. Sunding in his outdoor watering demand analysis); and (3) a cap on future use at 1992 levels of use.

99. In each case, I assume that the cap will go into effect starting in 2017 and will remain in effect from that point forward. The analysis assumes future year demand based on forecasts developed by the Metro Water District for water from Lake Lanier and the Chattahoochee River.[87] To estimate the cost of restrictions in each year, I estimate the value of reduced water use net of any cost savings from reduced water use. Lost value is calculated using an elasticity-based approach, which is standard in the economics literature and similar to that used by Dr. Sunding to analyze the costs of outdoor water restrictions. Costs savings reflect the economic costs avoided through the reduction in water supply.

100. Stavins Demo. 16 shows my estimates of the costs of alternative caps on M&I water use in the Metro Water District. I find that the annualized cost of capping use at 2016 levels would be $350 million per year with a present value of $11.7 billion. The annualized

[86] Sunding Testimony, at 46.

[87] *See* JX-126 (December 2015 Water Supply Request).

costs of capping use at 2011 use levels would be $462 million per year, 32 percent higher than with the 2016 cap. In present value terms, the 2011 cap would result in costs of $15.4 billion. A cap at 1992 levels would impose the highest cost: $917 million annualized, and $30.6 billion in net present value.

Stavins Demo. 16: Economic Costs of Alternative M&I Restrictions in Future Water Use ($millions)[88]

	Cost	
	Annual ($ millions)	Net Present Value ($ millions)
Cap on Future Metro Water District M&I Withdrawals		
Cap at 2016 levels	$350	$11,668
Cap at 2011 levels	$462	$15,393
Cap at 1992 levels	$917	$30,579

101. Notably, these estimates do not consider any broader economic effects that could occur from restrictions on M&I water use. For example, industries may relocate for cheaper or more plentiful water supplies, or otherwise fail to attract the necessary workers required to operate their businesses. These scenarios would depend, in part, on the final manner used to achieve reductions in water use, the costs of water in alternative and competing locations, and the exact nature of future business demand. To the extent such effects were to occur, my estimates could underestimate true costs, since they do not account for any such effects.

E. Dr. Sunding's Estimates of the Costs of Buying Irrigation Permits is Unreliable.

102. In an appendix to his February Report, Dr. Sunding included a hedonic analysis (the "Hedonic Analysis") which purports to calculate the implied premium for access to irrigation water at $864 per acre. In his direct testimony, for the first time, Dr. Sunding uses this value to estimate the cost of a permanent buyback of irrigation permits. In my opinion, Dr. Sunding's Hedonic Analysis is unreliable for the following reasons.

88 JX-126 (December 2015 Water Supply Request).

103. *First*, as Dr. Sunding states, his model is designed to measure the "value of the option to irrigate." However, policies that eliminate irrigation from farms that are already irrigating do not eliminate "the option to irrigate," they eliminate irrigation itself. Dr. Sunding does not explain why the option to irrigate is a good measure of the value of irrigation. One would expect that the option to irrigate would typically be worth far less than the value of irrigation, particularly given the investments in irrigation equipment and groundwater wells that have been made by farms that already have irrigation systems in place.

104. *Second*, the data used in Dr. Sunding's analyses suffer from some basic flaws. One particularly serious flaw is his estimate of the number of permitted acres, which is the key variable used to measure the option value of irrigation. For a large fraction of the transactions in Dr. Sunding's data, the total number of permitted acres is actually *greater than* the total size of the parcel. Because the permitted acreage and the parcel size come from two different data sources, this potential mismatch in the measurement of the key variable of interest suggests that the model data – and as a result the analysis – are unreliable. In addition, his sample only includes 27 transactions of land with a permit in the moratorium during the period of interest. Dr. Sunding would extrapolate from these 27 sales to the *entire basin.*

105. *Third*, Dr. Sunding's analysis is designed to measure the difference in the value of an irrigation permit before and after the moratorium on issuing additional permits. However, Dr. Sunding's analysis includes very few variables that control for the quality of the agricultural land, nor does it consider the interaction between them.[89] Lacking sufficient control variables, the analysis fails to capture potentially relevant information, thus potentially rendering the analysis unreliable. It also differs from the prior research he cites as the basis for his approach.[90]

106. Given these issues, I revised Dr. Sunding's model. Specifically, I used a more precise specification that distinguishes the value of permits for agricultural land and forested land. After making this change, I find that the value of a permit is $1,406 per acre, 63 percent

[89] For example, consider a simple residential house. The value of the house will be a function of the number of rooms, bedrooms, and bathrooms.

[90] Petrie, Ragan A. and Laura O. Taylor, "Estimating the Value of Water Use Permits: A Hedonic Approach Applied to Farmland in the Southeastern United States," *Land Economics*, 83(3), (2007): 302-318.

greater than Dr. Sunding's result.[91] Moreover, I find that neither his estimate nor mine are statistically significant. This indicates that the model does not provide a reliable basis for estimating the (option) value of irrigation permits (let alone the value of irrigation).

107. Having estimated the value of the option to irrigate, Dr. Sunding then uses this measure to estimate that costs of a permanent buyback of irrigation rights measure that he proposes. Stavins Demo. 17 compares estimates of the cost of such a measure using two approaches.

108. The first approach ("Hedonic Model") relies on Dr. Sunding's Hedonic Model to estimate the per acre cost of this measure, but uses Dr. Panday's estimate of irrigated row-crop acres rather than Dr. Sunding's to derive the total cost. Using this method, costs range from $90 million (20 percent) to $452 million (100 percent). For the reasons described above, these values should not be relied on for the costs of a permanent irrigation buyback.

109. The second approach ("Loss of Agricultural Productivity") uses the irrigation reduction analysis I described in Section VI.B.1, which evaluated the costs from the elimination of irrigation for a *single year*. In this case, I analyze the cost associated with the *permanent* elimination of irrigation rights, which would impose these same *annual* costs in *all* future years. However, my analysis conservatively accounts for certain cost savings that could occur when irrigation rights are permanently eliminated (avoided irrigation equipment costs) and yield impacts reflecting average precipitation years (rather than dry years, as was assumed with irrigation reduction previously).

110. Using Dr. Sunding's assumptions regarding the loss of yield from elimination of irrigation ("Based on Sunding Deficit Irrigation"), I find that costs range from $809 million for a 20 percent reduction to $4.0 billion for a 100 percent reduction. Using the same USDA yields impacts that I used in my irrigation reduction analysis ("Based on Stavins Irrigation Reduction"), costs are higher: $903 million for a 20 percent reduction and $4.5 billion for a 100 percent reduction.

[91] My results are robust to other modeling decisions. For example, I restricted the analysis to transactions for parcels within the area subject to the moratorium and found similar results.

Stavins Demo. 17: One-Time Costs of a Permanent Irrigation Buyback ($2012 million)[92]

	Reduction in Irrigated Acreage			
	20%	50%	75%	100%
Total Acreage:	104,539	261,348	392,021	522,695
Hedonic Model				
Sunding Analysis	$90	$226	$339	$452
Loss of Agricultural Productivity				
Based on Sunding Deficit Irrigation	$809	$2,023	$3,034	$4,045
Based on Stavins Irrigation Reduction	$903	$2,258	$3,388	$4,517

VII. FLORIDA'S PROPOSED CONSERVATION MEASURES AND REMEDIES WOULD PROVIDE NEGLIGIBLE, IF ANY, ECONOMIC BENEFITS.

111. I have discussed the costs of Dr. Sunding's proposed measures in Section VI. In this section, I discuss the benefits. I find that analyses by Georgia experts indicate that Georgia's consumption of water in the past has had a negligible impact on Florida's ecosystem; and analyses by Georgia and Florida experts indicate negligible economic benefits to Florida from restrictions on water use in Georgia in the future.

A. It is Important – and Possible – to Estimate the Benefits of Florida's Proposed Conservation Measures and Remedies.

112. As noted above, when evaluating a proposed action or policy, a basic and necessary economic test is to compare the overall benefits of the policy to its overall costs – in other words, to estimate the policy's net social benefits. To do so, one must estimate the benefits of the proposed action or policy. The benefits are the *change in value* that the proposed action or policy is expected to create. In this matter, the potential benefits are the changes in the values of Florida's natural resources and ecosystems. In order to compare directly the benefits with the costs of the proposed remedies and determine whether the benefits of the proposed action or remedy exceed the costs, it is necessary to estimate benefits and costs in the same units, typically in monetary terms.[93]

---

92 Deficit irrigation cost estimates are based on average annual losses, discounted into perpetuity with a 3 percent discount rate.

93 Dr. Sunding introduces the term "externality" into the discussion. The mere presence of an externality does not justify government intervention to mitigate the externality. Thus, Dr. Sunding is incorrect in assuming that the

113. In his direct testimony, Dr. Sunding claims that it is "not appropriate or possible" to value the potential benefits to Florida in economic terms, and that the effects are "not amenable" to quantification.[94] Dr. Sunding claims that "[m]ost economists" agree with him, but does not provide any support for his assertion.[95]

114. I strongly disagree with Dr. Sunding's assertion. There are well-developed methods in mainstream economics to value the potential benefits that Florida's experts have claimed. These methods are well accepted; taught at universities from Maine to California and around the world; regularly utilized in scholarly research in published refereed journals, policy papers, and government reports; and used frequently in litigation. These methods include, but are not limited to, recreational demand models (for recreational benefits) and stated preference methods (for a broad set of use and non-use values). In instances in which it is not feasible to conduct original research, economists have frequently relied upon estimates of values of similar resources from existing studies, properly adjusted for the resource at issue (a technique called "benefit transfer"). U.S. EPA, among others, has provided guidelines regarding the appropriate use of these methods.[96]

115. Indeed, Florida's own expert witness, Dr. Daniel Phaneuf, submitted a report in this matter in which he attempted to value Florida's ecosystem and natural resources using methods such as benefit transfer. (I understand that Florida will not be calling Dr. Phaneuf to testify at trial.) As I described in my Expert Report, I have severe misgivings about the ways in which Dr. Phaneuf implemented his valuation exercise, including that he failed to look at the *changes* in natural resource values, instead deciding only to evaluate the *gross* resource values. But the fact remains that Dr. Phaneuf utilized some of the available methods for valuing natural

---

claimed "externality" that use of water in Georgia has on downstream users implies that restrictions on water use in Georgia are economically justified. New regulations or actions enhance social well-being only when the benefits outweigh the costs, which include the costs of implementing and complying within the new requirements, and given the limits of regulatory mechanisms to achieve desired responses.

[94] Sunding Testimony at 53-54. While claiming that it is "not appropriate or possible" to value the potential benefits, I note that Dr. Sunding relies on a survey that he designed in an attempt to estimate a value of downstream improvements.

[95] Sunding Testimony at 53.

[96] *See* JX-47 (EPA *Guidelines* (2014)).

resources in economic (monetary) terms, and thereby demonstrated that the resources in the Apalachicola Basin are amenable to valuation through these methods.

116. Dr. Sunding cites a report to make the case that the U.S. Fish and Wildlife Service does not value benefits in a specific analysis for a particular critical habitat designation. However, in that report, the Service explained that it did not do so in that case because, in part, the potential benefits were so small.[97] Notably, the Service did not say that it was *impossible* to value such benefits.

117. Finally, I note that Dr. Sunding cites a 1993 article by several co-authors and me (and a related post from my blog) about the role of benefit-cost analysis in justifying regulations. Dr. Sunding claims that the article provides support for the notions that the incremental benefits of actions need not be expressed in monetary terms, and (quoting us) that "quantitative factors" should not "dominate qualitative factors in decision making." However, my co-authors and I also state – in a passage that Dr. Sunding quotes – that "benefits and costs of proposed policies should be *quantified wherever possible*" (emphasis added). Dr. Sunding apparently believes that to quantify (i.e., monetize) benefits in this case is beyond "mainstream economic science." As described above, I strongly disagree. There are well-developed methods in mainstream economics to value the potential benefits that Florida's experts have claimed. Moreover, Dr. Sunding does not point out that the overall thrust and a vast majority of the 1993 article emphasizes the importance of conducting rigorous, *quantitative*, monetized benefit-cost analyses.

118. Given all this, the relevant question to ask is not *whether* the benefits to Florida can be valued or quantified in economic terms. They could have been valued, but Florida's experts apparently choose not to do so. The question is *how large* those benefits are. I turn now to this question.

---

[97] Industrial Economics, Draft Economic Analysis for Texas Golden Gladecress and Neches River Rose-Mallow, 2013, at 5-2.

B. Georgia Expert Analyses Indicate that Georgia's Consumptive Use Has Had a Negligible Impact on Florida's Ecosystem.

119. Analyses by Georgia's experts, Dr. Menzie and Dr. Lipcius, demonstrate that ACF Georgia's water consumption has had a negligible impact on the ecosystem in ACF Florida.

120. *First*, Georgia's expert Dr. Menzie has examined the impact of water consumption by ACF Georgia since 1992 on a variety of potential ecological dimensions. I understand from the direct testimony of Dr. Menzie that Georgia's consumption of water has had a minor incremental influence on the flows of fresh water entering Apalachicola Bay; a negligible influence on salinity in the Bay; a negligible effect on the populations of fish, crabs, and shrimp in the Bay; and a minor influence on inundation patterns and floodplain habitat along the Apalachicola River.[98]

121. *Second*, Georgia's expert Dr. Lipcius has examined the causes of the decline in the Eastern oyster fishery in Apalachicola Bay. Dr. Lipcius concludes that low flows in the Apalachicola River due to Georgia water consumption did not cause the collapse of the Apalachicola Bay oyster fishery.[99]

122. Because, according to Dr. Menzie and Dr. Lipcius, ACF Georgia's consumption of water has had at most a trivial impact on various ecological measures of the health and status of the ecosystem in ACF Florida, it is reasonable to conclude that the harm in *economic terms* to the Apalachicola River and Bay ecosystem as a result of ACF Georgia's consumption of water is similarly insignificant. Moreover, it suggests that the benefits to Florida of Dr. Sunding's proposed conservation measures and Florida's remedy may be insignificant as well.

C. Georgia and Florida Expert Analyses Indicate Negligible Economic Benefits to Florida from Restrictions on Water Use in Georgia in the Future.

123. Georgia's and Florida's experts indicate that reducing ACF Georgia's future water consumption will have a negligible impact on the ecosystem in ACF Florida in the future.

---

[98] Direct Testimony of Charles Menzie, Ph.D, October 26, 2016 ("Menzie Testimony").

[99] Direct Testimony of Romuald N. Lipcius, Ph.D, October 26, 2016 ("Lipcius Testimony").

124. For example, I understand that Dr. Menzie has evaluated the impact of Dr. Sunding's 1,000 cfs proposal on various ecological characteristics of the Apalachicola River and floodplain. Based on his analyses, Dr. Menzie concludes that any contemplated protective measures that require incremental increases in flow would have negligible effects on the ecology of the Bay, and similarly negligible effects on the ecology of the Floodplain.[100] In other words, based on my understanding of Dr. Menzie's testimony, the benefits of Dr. Sunding's original 1,000 cfs proposal would be *de minimis*.

125. Analyses by Florida's own ecological experts suggest that the economic impacts of streamflow increases would be very small compared with the costs of water use reductions. For example, in his report, Florida's expert Dr. Jenkins estimates the supposed changes in biomass (tons) of oysters and blue crabs in the Apalachicola Bay in an "unimpacted" scenario. (I understand that Florida will not be calling Dr. Jenkins to testify at trial.) Here, for illustrative purposes, I take his results as given, and show that the economic value of the benefits he estimates, even when making assumptions generous to his results, are exceptionally small compared with the costs Dr. Sunding estimates.

126. Dr. Jenkins estimates that, absent any Georgia water withdrawals (an extreme assumption), the Apalachicola Bay would have produced an additional 3,225 metric tons of oyster biomass and an additional 173 metric tons of crab biomass over the 22-year period between 1992 and 2013, which results in an average of 147 metric tons of oysters and 8 metric tons of crabs per year. Making a number of reasonable assumptions, I estimate that the additional fishing revenues from these increases in harvest would be approximately $760,000 per year ($740,000 for oysters and $20,000 for crabs).[101]

127. This increase in revenues, however, does not represent net economic benefits, because it does not account for the incremental costs of additional fishing activity. Assuming that those costs represent at least 75 percent of revenues – or, equivalently, that profit margins

[100] Menzie Testimony.

[101] These assumptions include: future elimination of Georgia's water withdrawals will have the same effect as Dr. Jenkins' estimated impact of Georgia's past consumptive use; "biomass" means meat, not shells; all additional oysters and crabs biomass will be harvested; and fishermen in the Bay could sell the additional oysters and crabs at prices equal to the respective average prices over the period from 1992 to 2013. Values in 2015 dollars.

for oyster and crab fishing are no more than 25 percent – then the economic benefits of the complete elimination of Georgia water use to the oyster and blue crab fisheries would be approximately $190,000 per year. Further accounting for the increases in streamflows (compared to elimination of all consumptive use) implied by Dr. Sunding's proposals, I find that the benefits to the oyster and blue crab fisheries under Dr. Sunding's proposal would be approximately $40,000 per year. A hypothetical benefit of $40,000 per year to Florida is several orders of magnitude smaller than the annual costs of the actions required to reduce water use in Georgia, even based on Dr. Sunding's estimates, which, as I have shown, significantly underestimate true costs.

128. Several of Florida's other ecological experts estimate the biophysical impacts in Florida of certain reductions in water use in Georgia. Stavins Demo. 18 summarizes the scenarios evaluated by four Florida experts and the metrics they use to quantify the *changes* in biophysical conditions for each reduction scenario.

Stavins Demo. 18: Summary of Scenarios Analyzed By Selected Florida Experts[102]

Florida Expert	Water Reductions Analyzed	Metric
Dr. J. David Allan	• "Remedy" Scenario • "Unimpacted Flow" Scenario • "Future" Scenario	"Harm" in the Apalachicola River and floodplain to: • Mussels • Fish • Sturgeon • Floodplain trees (e.g., Tupelo forests)
Dr. Patricia M. Glibert	• "Remedy" Scenario • "Unimpacted Flow" Scenario • "Future" Scenario	Various water quality indicators in the Apalachicola Bay, such as: • Nitrate plus nitrite concentrations • Percent of time anoxic • Temperature • Concentration in chlorophyll • Concentration of cyanobacteria
Dr. David L. Kimbro	• "Unimpacted Flow" Scenario	Apalachicola Bay oyster population health: • Oyster mortality/survival • Strength of oyster predation
Dr. J. Wilson White	• "Remedy" Scenario • "Unimpacted Flow" Scenario	Oyster density in the Apalachicola Bay

129. The analyses performed by these Florida experts fail to fill the gap in Dr. Sunding's economic assessments for two key reasons. *First*, none of Florida's scientific experts evaluate the precise reductions in water use proposed by Dr. Sunding. Consequently, none of the biophysical changes evaluated by Florida's experts directly translate to benefits that might be anticipated from Dr. Sunding's scenarios. *Second*, the metrics employed by Florida's experts to estimate benefits have not been valued in economic terms, and Dr. Sunding makes no attempt to translate these biophysical changes developed by Florida's scientific experts into economic values.

[102] Pre-Filed Direct Testimony of Florida Witness J. David Allan, Ph.D, October 14, 2016 ("Allan Testimony"), at 57-58; Pre-Filed Direct Testimony of Florida Witness Patricia Glibert, Ph.D, October 14, 2016 ("Glibert Testimony"), at 20-28; Pre-Filed Direct Testimony of Florida Witness David Kimbro, Ph.D., October 14, 2016 ("Kimbro Testimony"), at 40-42; Pre-Filed Direct Testimony of Florida Witness J. Wilson White, Ph.D, October 14, 2016 ("White Testimony"), at 46-49.

130. In sum, while there are ways in which biophysical or ecological metrics can be valued in economic terms, the metrics used by Florida's experts are disconnected from Dr. Sunding's proposed scenarios, and Florida's experts do not attempt to value them economically. Florida's experts' analyses therefore offer no evidence that their proposed restrictions on water use in Georgia would provide positive net benefits from society's standpoint.

VIII. DR. SUNDING'S PROPOSALS TO RESTRICT WATER USE IN ACF GEORGIA WOULD IMPOSE COSTS FAR IN EXCESS OF BENEFITS.

131. My economic analysis considers the costs and benefits of reductions in water use by Georgia, and finds that the restrictions on Georgia's consumptive water use proposed by Dr. Sunding would impose substantial costs on Georgia which greatly exceed any *de minimis* benefits to Florida. As a result Dr. Sunding's proposals would – on net – make society worse off. In other words, they would provide *negative* net benefits.

A. Dr. Sunding Improperly Evaluates His Proposed Conservation Measures

132. In his direct testimony, Dr. Sunding significantly modifies, and in some cases completely eliminates, the estimated costs of his measures which he previously included in his February Report. By way of example, Dr. Sunding's February Report estimates that the cost to achieve streamflow increases of 1,000 cfs would range from $100 million to $191 million *per dry year*, whereas his direct testimony finds that the same streamflow increase could result in costs of just $8.9 million *per year*.[103] Florida recently provided backup materials for Dr. Sunding's new analyses; to date, I have not had sufficient time to assess all sources of the discrepancies in costs between Dr. Sunding's February Report and his direct testimony.

133. However, one obvious source of discrepancy is that Dr. Sunding's testimony, without explanation, now *assumes* that many of these measures can be implemented at *no incremental cost*, despite accounting for their *incremental streamflow increases*.[104] This approach is inappropriate. When performing such a policy analysis, the *only* correct way to evaluate alternatives is to consider both the incremental costs and benefits. Any analysis that

[103] In his testimony, Dr. Sunding does not provide sufficient detail to estimate costs during dry years only. See Sunding Testimony, Table 6. Consistent with his February Report, I assume that dry year costs occur once every three years and present dry year costs as 3 times annual costs.

[104] *See* Sunding Testimony at 19 and 43-45.

considers only benefits, but without considering costs, will misrepresent the policy's true impacts. Thus, the results in Tables 4 to 6 of Dr. Sunding's direct testimony are unreliable because they provide an apples-to-oranges comparison of costs and streamflow changes.[105] Moreover, Dr. Sunding notes that his analysis only considers the "fiscal" costs of his measures. However, it is important to note that fiscal costs are no more real and important from an economic perspective than the welfare costs that are not reflected in his final cost estimates.

134. Dr. Sunding's combinations (scenarios) disproportionately target the agricultural sector. As I showed earlier, the 1,000 cfs scenarios from his February Report would lead to reductions ranging from 43 percent to 100 percent, based on my analysis.[106] Similarly, in his direct testimony, Dr. Sunding's combinations would require that agriculture conservation measures provide 74 to 85 percent of the total 2,000 cfs streamflow benchmark.[107] The quantity of these reductions would lead to massive changes in the agricultural sector. Dr. Sunding's proposed agricultural water use reductions – under his own analysis – would eliminate up to 73 percent of *all* irrigation water use during drought years. Using hydrologic conditions from other Georgia experts, his proposals would require the *complete elimination* of agricultural water use.

B. Analysis of Dr. Sunding's Proposed Combinations of Conservation Measures

135. In his testimony, Dr. Sunding presented several combinations of conservation measures in both the municipal and industrial sectors, and the agricultural sector that could be used to achieve streamflow increases of 1,000 cfs, 1,500 cfs, and 2,000 cfs. As shown in Stavins Demo. 19, in his direct testimony, Dr. Sunding counted "fiscal" costs that ranged from $27 million to $106 million per dry year, respectively, for these scenarios.[108] Note that Stavins

[105] Moreover, Dr. Sunding's analysis is also deficient because the streamflow increases he measures are *not* an estimate of economic benefits.

[106] Scenarios 1 and 2 anticipated 100 percent of available reductions from the agricultural sector. Scenario 4 anticipated 755 cfs coming from center pivot efficiency improvements (111 cfs), deficit irrigation of rotation crops (519 cfs), and reduced early season pecan irrigation (125 cfs).

[107] These include measures to "eliminate unpermitted acreage" (125 to 151 cfs), "eliminate excessive irrigation of row crops" (150 to178 cfs), "irrigation permit buyback" (306 to 375 cfs), "deficit irrigation" (430 to 480 cfs), "reduced evaporation from farm ponds" (271 to 279 cfs), and "switch high value crops to deeper aquifers" (198 to 232 cfs).

[108] These values are based on Sunding Testimony, Tables 4 to 6. Dr. Sunding notes that he annualizes all measures assuming a dry year occurs once every three years. Therefore, I report dry year costs as 3 times his annual costs.

Demo. 19 does not include estimates from the Sunding February Report. In that report, Dr. Sunding evaluated scenarios that achieved 1,000 cfs steamflow increases, finding costs higher than the $27 million estimate shown in Stavins Demo. 19 (between $105 million and $201 million per dry year).

Stavins Demo. 19: Comparison of Conservation Scenarios, Costs and Streamflow

	Increase in Peak Summer Stream Flow (cfs)	Costs in a Dry Year ($ million)
Sunding Testimony		
M&I and Agriculture (least stringent)	1,000	$27
M&I and Agriculture	1,500	$58
M&I and Agriculture (most stringent)	2,000	$106
Stavins Analysis		
Agriculture Only (including partial deficit irrigation)	616	$205
Full Deficit Irrigation (row crops only)	678	$335
M&I and Agriculture (including partial deficit irrigation)	682	$433
M&I and Full Deficit Irrigation (row crops only)	855	$2,467

Stavins Demo. 20: Stavins Analysis, Costs and Streamflow: M&I and Full Deficit Irrigation [109]

	Increase in Peak Summer Stream Flow (cfs)	Costs in a Dry Year ($ million)
Stavins Analysis		
Agriculture		
Full Deficit Irrigation (row crops only)	678	$335
Municipal and Industrial		
Full Leak Abatement	48	$34
Outdoor Watering Restriction (75%)	129	$2,098
M&I sub-total	*177*	*$2,132*
Total	**855**	**$2,467**

[109] In both Stavins Demo. 19 and 20, I include the annual costs for the implementation of leak abatement programs as the cost that would be incurred in a dry year. See Section VI.B.5.

136. By contrast, in my Expert Report and in the analyses presented above, I demonstrate that the cost of the combinations of conservation measures I evaluate (based on scenarios evaluated in Dr. Sunding's Reports) range from $205 million (for a 616 cfs increase) to a cost of $2.5 billion for an increase of 855 cfs. As shown in Stavins Demo. 20, the cost of the "M&I and Full Deficit Irrigation" combination reflects the *complete* elimination of row crop irrigation on more than 520,000 acres plus the costs for additional leak abatement activities and a *75 percent reduction* in outdoor water use during drought years.

137. My analysis likely substantially underestimates the costs contemplated in Dr. Sunding's 2,000 cfs scenario, for several reasons. First, my agricultural loss estimates are based on an "average" dry year as in Dr. Sunding's February Report, and not on the more extreme drought year contemplated in his Testimony. Second, I do not quantify the costs of several of Dr. Sunding's more speculative measures, such as switching high value crops to deeper aquifers and eliminating net basin exports. These measures may be extremely costly, and given their speculative nature, uncertain to achieve the stream flow targets assumed by Dr. Sunding. For example, I understand from Mr. Mayer's direct testimony that eliminating interbasin transfers could potentially require development of substantial new wastewater infrastructure at a cost of hundreds of millions or billions of dollars.[110]

138. The increases in peak summer streamflow achieved in these scenarios are less than the stream flow increases targeted by Dr. Sunding in his corresponding scenarios, reflecting a combination of factors described earlier in my testimony, including corrections to the quantity of available water assumed by Dr. Sunding, elimination of double-counting, and my inability to develop reliable quantitative estimates of certain conservation measures because available information about costs or reduction potential is not sufficiently reliable.

139. While imposing substantial costs, the streamflow increases in these various hypothetical conservation measures would result in no meaningful benefits in the Florida portion of the ACF Basin. Therefore, I conclude that the net benefits of the proposed restrictions on water use in ACF Georgia would be negative by $205 million to $2.5 billion in each year they

[110] Direct Testimony of Peter Mayer.

are implemented, indicating that the proposed reductions in water use in Georgia would make society significantly worse off.

IX. CONCLUSION.

140. Based on my review of the evidence available to me to date, I conclude that:

- Neither Dr. Sunding nor other Florida experts in this matter (of whom I am aware) have provided a suitable analysis that assesses the anticipated net benefits of Florida's proposed restrictions on Georgia water use and that could be used to attempt to justify the proposed restrictions;
- Although ACF Georgia is larger than ACF Florida across multiple dimensions, it uses only a small fraction of the available water in the ACF Basin, leaving a share for Florida that is greatly out of proportion to the size of the respective regions' populations and economies;
- Dr. Sunding's estimates of the costs of water conservation measures are understated, and the potential increases in streamflows available from the measures he considers are overstated;
- Based on the testimony of other experts, Florida has not incurred any apparent meaningful injury from Georgia's water use; and
- The costs of upstream water restrictions estimated by Dr. Sunding greatly exceed the benefits that would be derived from these restrictions, which are *de minimis*.

141. In light of these and other factors, I conclude that restricting water use in ACF Georgia is not warranted from an economic perspective.