IN THE MATTER OF

THE APPLICATION OF THE CITIES OF HAYS, KANSAS AND RUSSELL, KANSAS FOR APPROVAL TO TRANSFER WATER FROM EDWARDS COUNTY, KANSAS PURSUANT TO THE KANSAS WATER TRANSFER ACT.	)))))))	**OAH NO. 23AG0003 AG**

Pursuant to K.S.A. Chapter 77.

EXPERT REPORT OF STEPHEN F. HAMILTON, PH.D.

MAY 24, 2023

EXHIBIT
SFH-01

CONTENTS

I. QUALIFICATIONS

1. I am Professor of Economics at California Polytechnic State University, San Luis Obispo ("Cal Poly"). I received my Ph.D. in Agricultural and Resource Economics from the University of California, Berkeley in 1996 and I have held positions as a Professor at Kansas State University, the University of Arizona, the University of Central Florida, Toulouse School of Economics, and Cal Poly. I was selected as Chair of the Department of Economics at Cal Poly in 2005 and served in that capacity over the period 2005-2017, and I served as Director of Graduate Studies over the period 2016-2019.

2. My research areas focus on the application of statistical methods and economic theories of industrial organization to wholesale and retail market pricing. I have published over 60 articles on a wide range of topics, including the analysis of economic losses from water supply disruptions and the economic benefits of groundwater use. I have won numerous research awards for my academic work, including the *Early Career Award*, the *Atlas Award*, the *Quality of Research Discovery Award*, and the *Distinguished Scholarship Award*.

3. I have published extensively in academic and professional journals on the application of statistical methods, industrial organization, agricultural market pricing, international trade, environmental and resource economics, and public policy. During my academic career, I have served on panels of the U.S. Department of the Interior Science Advisory Board and have been awarded grants for research by the U.S. Department of Agriculture and private foundations. I have secured over $5 million in Federal grants to fund my research. I have provided plenary and keynote addresses at international research conferences, presented scholarly work at over 30 national and international conferences, and delivered invited seminars at over 20 different universities.

4. I have served as an associate editor for the American Journal of Agricultural Economics, the Journal of Industrial Organization Education, and the Journal of Agricultural & Food Industrial Organization. I have served as editor for a special issue on Analytics Insights for the Journal of Public Policy & Marketing and as a member of the editorial council for the Journal of Agricultural and Resources Economics and the Journal of Environmental Economics and Management.

5. In my published academic work on water economics, I have calculated the price elasticity of urban water demand for water utilities in California, analyzed the impact of mandated restrictions in water use by the California State Water Resources Control Board ("SWRCB"), and calculated the economic value of expanded groundwater storage in Los Angeles. I have also calculated the

economic impacts of projected water restrictions from the proposed listing of endangered freshwater mussels in Texas.

6. At Cal Poly, I have taught classes in Microeconomic Theory, Environmental Economics, Natural Resource Economics, and Industrial Organization. In my classes in environmental and resource economics, I lecture on topics that include water valuation, water rationing, the conjunctive use of surface and groundwater sources, discounting, the internal rate of return, and dynamic analysis of non-renewable and renewable resources. I have taught water economics to executives at the Metropolitan Water District of Southern California. In addition to teaching, I have guided and supervised numerous students in their work on company and industry projects dealing with a variety of topics in environmental and resource economics, including energy and natural resource valuation.

7. In addition to my work in academia, I have over twenty years of consulting experience. My consulting engagements have included the measurement of economic damages in complex litigation, the calculation of losses from urban water supply disruptions, the valuation of water for residential, commercial, industrial, and agricultural uses, water recycling, conjunctive use of surface water and groundwater, and the value of expanded groundwater storage capacity. As part of my consulting work, I have employed regression models to measure urban demand for water and the economic cost of water restrictions due to supply shortages. My consulting engagements more broadly have also included market analysis of regulated industries, economic feasibility studies, economic analysis of environmental and land use regulation, economic analysis of groundwater basin management, and portfolio investment modeling.

8. A more detailed list of my qualifications, experience, professional activities, and publications can be found in my curriculum vitae, attached as **Appendix A**: *Curriculum Vitae*. A list of my testimony over the last four years is attached as **Appendix B**: *Testimony in the Past Four Years*.

II. Case Background and Assignment

9. The cities of Hays and Russell, Kansas (each a "City" and, collectively, the "Cities") filed an application (the "First Amended Transfer Application")[1] to transfer up to 6,756.8 acre-feet annually

[1] First Amended Application to Transfer Water from Edwards County, Kansas to the Cities of Hays and Russell, Kansas. *In the matter of the application of the Cities of Hays and Russell, Kansas for approval to transfer water from Edwards County pursuant to the Kansas Water Transfer Act*, Pursuant to K.S.A. 82a-1501, *et seq.* (May 20, 2019) at 1.

from irrigation water rights appurtenant to property owned by the Cities in Edwards County, Kansas (the “R9 Ranch”), located over 70 miles south of the city of Hays, to the Cities for municipal use.

10. The chief engineer of the Division of Water Resources of the Kansas Department of Agriculture contingently approved the Cities’ applications to change water use, the places of use, and the points of diversion under the R9 Ranch water rights in an order (the “Master Order”) on March 27, 2019.[2]

11. The Kansas Water Transfer Act (the “KWTA”) governs transfers of water in a quantity of 2,000 acre-feet per year or more over a distance of 35 or more miles.[3] It provides that: “No water transfer shall be approved […][4] unless: (1) The panel determines that the benefits to the state for approving the transfer outweigh the benefits to the state for not approving the transfer[.]”[5] If balancing the benefits to the State is required, the KWTA requires that “the economic […] impacts of approving or denying the transfer of the water” be considered when determining whether the benefits to the State of approving the transfer outweigh the benefits of not approving it.[6]

12. I have been retained by the city of Hays through its counsel, Foulston Siefkin LLP, to evaluate and offer my professional opinion on the economic impact to the State of Kansas of the proposed water transfer. I understand this report will be considered when the State determines whether the benefits to the State if the transfer is approved outweigh the benefits to the State if the transfer is not approved.

13. I am being compensated at a rate of $500 per hour for my work in these matters. I have been assisted in preparing this report and performing analyses underlying my opinions by the research staff at Vega Economics, who work under my direction. My compensation is independent of the outcome of these matters or of any of the opinions I express in these matters, and the opinions expressed in this report are my own independent conclusions.

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[2] Master Order Contingently Approving Change Applications Regarding R9 Water Rights. *In the matter of the City of Hays’ and the City of Russell’s Applications for Approval to Change the Place of Use, the Point of Diversion, and the Use Made of the Water Under an Existing Water Right* (Mar. 27, 2019).

[3] K.S.A. § 82a-1501-1508 at 1501(a)(1).

[4] Balancing the benefits to the State of approving the transfer with the benefits to the State of denying the transfer is required when the transfer would “reduce the amount of water required to meet the present or any reasonably foreseeable future beneficial use of water by present or future users in the area from which the water is to be taken for transfer.” K.S.A. § 82a-1502. Whether or not the transfer would make reductions that require balancing is beyond the scope of this report.

[5] K.S.A. § 82a-1502(a).

[6] K.S.A. § 82a-1502(c)(3).

14. I hold the opinions stated in this report with a reasonable degree of professional certainty. I reserve the right to amend or supplement my opinions in this report, as appropriate. **Appendix C**: *Materials Relied Upon* lists the documents and data I relied upon in reaching my conclusions.

III. Summary of Opinions

15. Without access to new water sources, firm water yields from existing sources will not be sufficient to meet water demand for the Cities during periods of drought, creating water shortages for municipal water users.[7] Projected climate change for the region has the potential to make water shortages more frequent, longer in duration, and more severe.[8]

16. Approving the water transfer will positively impact the State of Kansas economy both by increasing the economic value of the water through reallocation to urban use and by the associated investments in water infrastructure for conveyance. In terms of the conveyance infrastructure alone, I estimate that these investments would produce a statewide economic impact of $167 million, a statewide employment impact of 752 full-time equivalent jobs, and a statewide tax revenue impact of $4.4 million.

17. Approving the water transfer mitigates the risk of economic losses to the Cities from periodic water shortages, providing a direct benefit to water users as well as indirect and induced benefits to the regional economy through supply chain development to support industrial and commercial uses in Kansas. I calculate these values using a standard economic model of water valuation. My calculation involves calculating the future occurrence of droughts over the period 2023-2072 based on successive 50-year draws of historic water conditions from the official hydrologic readings recorded in Hays over the period 1893-2020. Specifically, I calculate the value of the water in urban use over the period 2023-2072 by matching water conditions with each of 79 successive draws from the historic record (i.e., 1893-1942, 1894-1943, …, 1971-2020).

18. I find the economic benefit of the additional urban water supply provided by the R9 Ranch over the 50-year period 2023-2072 to be $43 million, on average, and up to $117 million if future water conditions match the most adverse historic water draw over the period 1893-1942. The value of the

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[7] I relied on a hydrologic report provided to me for the Cities' firm water yields from existing sources. Memorandum from Paul A. McCormick to David Traster and Daniel Buller. *Wellfield Yield for the City of Hays* (Mar 9, 2023) ("Burns & McDonnell Report").

[8] I relied on a climate report provided to me for projected changes in climate conditions for the Cities. Basara, Jeffrey. "Drought Impacts and Risk to Water Resources in the Smoky Hill Watershed." (May 11, 2023) ("Basara Report").

additional urban water supply provided by the R9 Ranch would be larger still in the event that water conditions over the period 2023-2072 turn out to be drier than the historic record.

19. Combining the statewide economic impact from water infrastructure and the economic benefits of avoiding future water shortages, I find that the water transfer will provide economic benefits to the State of Kansas in excess of $200 million if hydrologic conditions over the period 2023-2072 correspond with average conditions in the hydrologic record, and nearly $300 million if future water conditions correspond to drier periods in the historic water record.

IV. LIMITED WATER ACCESS AND FREQUENT DROUGHTS PUT THE CITIES AT RISK OF WATER SHORTAGES AND THE R9 RANCH IS A VIABLE LONG-TERM SOLUTION.

A. The Cities Are Located in a Region with Limited Water Access.

20. The Cities are located in western Kansas, which has an arid climate in which the evaporation rate exceeds the average annual rainfall.[9] Hays has an average annual precipitation of between 22 and 24 inches per year, and Russell has between 24 and 26 inches per year.[10]

21. Regions with lower annual precipitation tend to rely more on publicly supplied water relative to those regions with greater levels of precipitation. The Kansas Department of Agriculture has divided the State into eight regions, with the lower-numbered regions in the west and the higher-numbered regions in the east.[11] Between 2009 and 2013, the average water use was 273 gallons per capita day (GPCD) for the westmost region 1, compared to just 78 GPCD for the eastmost region 8-S.[12]

22. The unique geographical location of the Cities makes access to water particularly difficult. While urban areas in eastern Kansas have access to relatively abundant surface water,[13] and many communities in western Kansas overlie the Ogallala Aquifer and thus have access to drought-

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[9] Letter from the Cities to David Barfield and Brent Turney, *Re: Hays/Russell Water Transfer – Change applications for water right files numbered: 21,729; 21,730; 21,731; 21,732; 21,733; 21,734; 21,841; 21,842; 22,325; 22,326; 22,327; 22,329; 22,330; 22,331; 22,332; 22,333; 22,334; 22,335; 22,338; 22,339; 22,340; 22,341; 22,342; 22,343; 22,345; 22,346; 27,760; 29,816; 30,083; and 30,084* (June 25, 2015) ("Cover Letter to 2015 Change Applications") at 10.

[10] "Kansas Annual Precipitation." *United States Department of Agriculture, National Resources Conservation Service* (Oct. 18, 2007). <https://www.k-state.edu/ksclimate/images/localimages/ksprecip.png> (accessed Mar. 17, 2023).

[11] Lanning-Rush, Jennifer L. and Patrick J. Eslick. "Public-Supply Water Use in Kansas, 2013." *U.S. Geological Survey* (2015). <https://pubs.usgs.gov/ds/0964/ds964.pdf> (accessed Mar. 20, 2023) at 2.

[12] *Id*.

[13] Cover Letter to 2015 Change Applications at 6.

resistant water sources, this is not the case for the Cities. In fact, neither Hays nor Russell is situated close to a major aquifer, and Hays is in the only county in western Kansas with a population over 15,000 that does not have access to a major aquifer.[14]

23. The Cities' regional difficulties in water access are well known. The Kansas Water Office published a 2018 report on the Smoky Hill-Saline regional planning area (in which the Cities are located), which explained that "the region utilizes a mix of surface and groundwater to meet area needs, but often finds supply low in one area or another during periods of drought or low precipitation."[15] The same report concluded:

> The primary concern within the Smoky Hill-Saline Region is future water quality and supply to fully meet the needs of the region. More specifically, it is the ability to maintain present usage while allowing for expanded use to support economic development and growth in the region, even in times of drought.[16]

24. The Cities' difficulties procuring firm water supply places their residents at an economic disadvantage in terms of water use relative to nearby cities and counties, resulting in water use restrictions that curb commercial and industrial development. Indeed, by 1994, Hays had become one of the "stingiest water users in the state, per capita."[17]

25. **Figure 1** shows the remarkable disparity in water usage between Hays and its peers in Water Region 5. Over the displayed 22-year period, residents of Hays used an average of 96 gallons of water per capita per day, compared to an average of 136 gallons of water per capita per day among all users in region 5. Indeed, Hays has never used more than 75 percent of the quantity of water per capita that the average user in Water Region 5 enjoys on a daily basis.

26. Over the same 22-year period, residents of the city of Russell also used less water, on average, than other residents in Water Region 6-ML. Specifically, the average daily water use per capita in Water Region 6-ML is 146.3 gallons, while Russell averaged only 136.7 gallons per capita per day.[18] I understand that Russell's higher water use compared to Hays is driven mostly by two large industrial customers, and that, apart from these two large industrial customers, actual use by residential and

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[14] Cover Letter to 2015 Change Applications at 13.

[15] "State of the Resource & Regional Goal Action Plan Implementation Report: Smoky Hill-Saline Regional Planning Area." *Kansas Water Office* (Aug. 2018). <https://kwo.ks.gov/docs/default-source/State-of-the-Resource/stateoftheresource_shs_final.pdf?sfvrsn=db9c8414_0> (accessed Mar. 20, 2023) at 2.

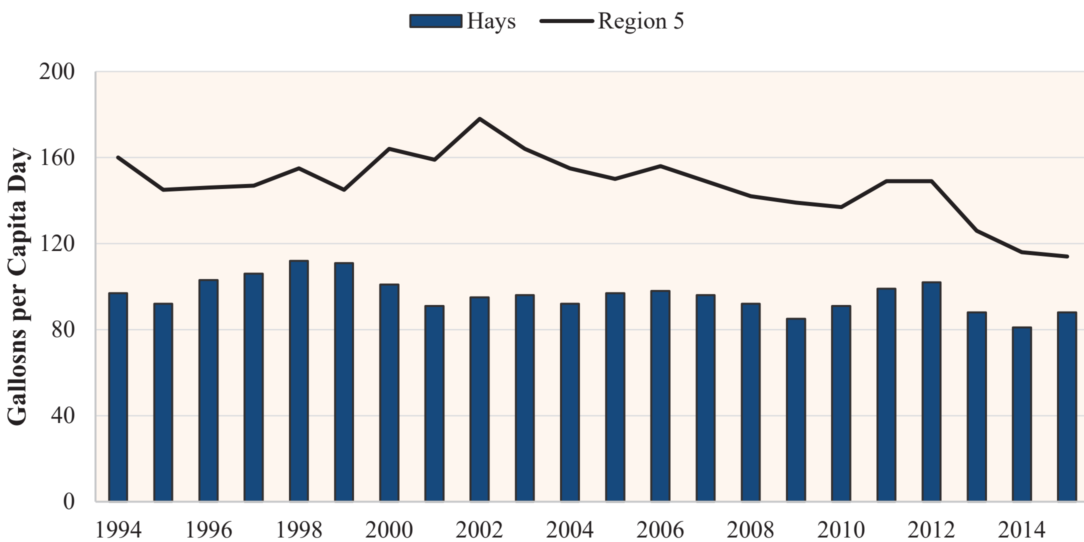
[16] *Id.*

[17] First Amended Transfer Application at Ex. 55 (Berry, Mike. "Hays Covets Supply of Water to the South." *Wichita Eagle* (Sept. 10, 1994)).

[18] *Id.*

commercial customers for Russell is on par with the per capita daily water use in Hays. I corroborated this fact by reviewing Russell's water use records and noted that these two industrial customers accounted for 40 percent of Russell's total water production for the year 2020.[19]

Figure 1: Per Capita Water Use for Hays and Region 5[20]



B. Costly Droughts Frequently Occur in Kansas and the Cities' Existing Water Supplies Are Not Drought Resistant.

27. Drought is a frequent natural hazard in western Kansas that is known to cause great economic losses. Most famously, the area was part of the "Dust Bowl" of the 1930s, and studies have corroborated that Kansas has experienced frequent and often prolonged droughts for at least the past 1,000 years.[21] Indeed, research has concluded that "major multiyear Great Plains drought has occurred naturally

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[19] For the year 2020, Russell's two largest industrial user consumed a combined 100,982,000 gallons of water, while total water production was 252,357,000 gallons. Memorandum from Jon Quinday, City Manager, *Water Usage by Customer Class* (Feb. 10, 2021).

[20] First Amended Transfer Application at Ex. 73 ("1997 Kansas Municipal Water Use." *Kansas Department of Agriculture, Kansas Water Office, and U.S. Geological Survey*), Ex. 78 ("Kansas Municipal Water Use 2002." *Kansas Department of Agriculture, Kansas Water Office, and U.S. Geological Survey*), Ex. 82 ("Kansas Municipal Water Use 2006." *Kansas Department of Agriculture, Kansas Water Office, and U.S. Geological Survey*), Ex 86 ("Kansas Municipal Water Use 2010." *Kansas Department of Agriculture and U.S. Geological Survey*), Ex. 91 (Lanning-Rush, J.L., and D.L. Restrepo-Osorio. "Public-Supply Water Use in Kansas, 2015." *U.S. Geological Survey* (2017)).

[21] Layzell, Anthony L. and Catherine S. Evans. "Kansas Droughts: Climatic Trends Over 1,000 Years." *Kansas Geological Survey Public Information Circular* 35 (Aug. 2013): 1-6; Woodhouse, Connie A. and Jonathan T. Overpeck. "2000 Years of Drought Variability in the Central United States." *Bulletin of the American Meteorological Society* 79.12 (Dec. 1998): 2693-2714.

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once or twice a century over the last 400 years."[22] Because of this, consideration of the economic impacts of the proposed water transfer must account for the anticipated economic loss caused by droughts, and the risk that droughts in the future are more severe than those of the past.

28. Periodic droughts are costly. Researchers have noted that "once largely affecting the agricultural sector, droughts today result in extreme social, economic, and environmental impacts on almost every social and economic sector of a region."[23] Since 1980, there were 26 droughts that cost the United States at least $249 billion, with an average cost of $9.6 billion per drought.[24] In 2012, a drought in the central United States broke records and became the most spatially extensive drought since the 1930s, estimated to have caused an economic loss of more than $35 billion.[25]

29. Existing water supplies for the Cities are not drought resistant. Hays' water supply is derived primarily from two groundwater sources, the Smoky Hill River alluvium and the Big Creek alluvium, with a small quantity of groundwater coming from the Dakota aquifer.[26] **Table 1** compares permitted water rights with sustainable yields from these existing sources under moderate and exceptional droughts from the Burns & McDonnell Report.

Table 1: Hays Permitted Water Rights and Sustainable Yields[27]

Wellfield	Permitted Water Rights	Moderate Drought Sustainable Yield	Exceptional Drought Sustainable Yield
Big Creek	1,429	1,429	1,040
Dakota	882	120	120
Smoky Hill	2,285	1,000	600
Total	3,675	2,549	1,760

Note: Sustainable yield is measured in acre-feet per year.

[22] Woodhouse, Connie A. and Jonathan T. Overpeck. "2000 Years of Drought Variability in the Central United States." *Bulletin of the American Meteorological Society* 79.12 (Dec. 1998): 2693-2714 at 2698.

[23] Fu, Xinyu, Zhenghong Tang, Jianjun Wu, and Kevin McMillan. "Drought Planning Research in the United States: An Overview and Outlook." *International Journal of Disaster Risk Science* 4.2 (June 2013): 51-58 at 53.

[24] "The High Cost of Drought." *National Oceanic and Atmospheric Administration, National Integrated Drought Information System (Drought.gov)* (Jan. 23, 2020). <https://www.drought.gov/news/high-cost-drought> (accessed Apr. 10, 2023).

[25] Fu, Xinyu, Zhenghong Tang, Jianjun Wu, and Kevin McMillan. "Drought Planning Research in the United States: An Overview and Outlook." *International Journal of Disaster Risk Science* 4.2 (June 2013): 51-58 at 51.

[26] Memorandum from Jeff Crispin, Director of Water Resources. *Water Data – City of Hays* (Feb. 11, 2021).

[27] Burns & McDonnell Report at 8. I was further informed that even under normal conditions, Hays is only able to withdraw about 120 acre-feet per year from the Dakota wellfield—even though it is permitted for more than that.

30. A memorandum provided by the city of Russell indicates that, while the city is authorized to use 1,862 acre-feet annually, the maximum withdrawals allowed from existing wellfields is 881 acre-feet and the maximum withdrawals allowed from surface water rights is 767 acre-feet.[28] The Burns & McDonnell Report further notes that "[t]he City of Russell… obtained water from a surface water intake on Big Creek, and from wells located in the Pfeiffer [sic] Wellfield located in the Smoky Hill River alluvial aquifer"[29] and that the "geologic setting of the Pfeifer wellfield is very similar to the SHRWF [Smoky Hill River Wellfield]."[30] During periods of drought, it is "not uncommon for Big Creek flows to be low enough to restrict the use of the surface water intake" and "once flow stops in the Smoky Hill River… Pfeifer Wellfield is pumping from storage and water levels will decline steadily."[31]

31. During a prolonged period of drought, the risk of water shortage increases for Hays and Russell for at least two reasons. First, droughts reduce the Cities' water supply from existing sources. Except for about 120 acre-feet per year from the Dakota wells, the vast majority of Hays' water supply comes from two alluvial well fields that are dependent on surface flow. These aquifers store water that is rapidly depleted when surface flow stops or is substantially reduced. During a period of low precipitation, surface water in rivers can dry up. **Figure 2** shows Big Creek River during the drought in 2012.

32. Nearly half of Russell's water supply comes from surface water, and the rest comes from Russell's alluvial well field that is also dependent on surface flow.[32] Moreover, Russell's entire water supply is downstream from Hays' water supply. Thus, when Hays runs out of water during a period of drought, so too does Russell.

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[28] Memorandum from Jon Quinday, City Manager, *Water Usage by Customer Class* (Feb. 10, 2021).

[29] Burns & McDonnell Report at 8

[30] *Id.* at 9.

[31] *Id.* at 8-9.

[32] Memorandum from Jon Quinday, City Manager, *Water Usage by Customer Class* (Feb. 10, 2021).

Figure 2: U.S. Geological Survey Photo of Big Creek Near Hays, KS in July 2012[33]

33. Second, during periods of drought, water users rely more on publicly supplied water, which further exacerbates the risk of shortage. Rainfall that could substitute for public water supply (e.g., watering lawns) during normal climate conditions becomes unavailable during droughts. Certain conservation practices (e.g., the use of rain barrels) are also not viable options during periods of low precipitation. As an example of the increased use of publicly supplied water during droughts, consider Hays' water use in 2014 compared with its use in 2012. In 2014, a year with slightly above-average precipitation,[34] Hays used 1,954 acre-feet of water, or 81 GPCD,[35] whereas during the 2012 drought in the State of Kansas,[36] Hays used 2,391 acre-feet of water, or 102 GPCD.[37] It is worth noting that

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[33] Clark, Andrew. "0.00 cfs at Big Creek near Hays, KS (06863500) on July 26, 2012." *USGS* (July 26, 2012). <https://www.usgs.gov/media/images/000-cfs-big-creek-near-hays-ks-06863500-july-26-2012> (accessed Mar. 17, 2023).

[34] In 2014, Hays' cumulative precipitation was 25.30 inches, as compared to a normal precipitation amount of 22.78 inches. By way of comparison, Hays' cumulative precipitation was only 14.39 inches in 2012. "Weather – Hays, KS." *Kansas State University Agricultural Research Center – Hays.* <https://www.hays.k-state.edu/weather/index.html> (accessed Mar. 21, 2023).

[35] Memorandum from Jeff Crispin, Director of Water Resources, *Water Data – City of Hays* (Feb. 11, 2021).

[36] Anandhi, Aavudai and Mary Knapp. "How Does the Drought of 2012 Compare to Earlier Droughts in Kansas, USA?" *Journal of Service Climatology* 9.1 (2016): 1-19 at 2.

[37] Memorandum from Jeff Crispin, Director of Water Resources, *Water Data – City of Hays* (Feb. 11, 2021).

during the 2012 drought, Hays' water use nevertheless remained far below the regional average of 149 GPCD.[38]

34. Droughts are projected to be more frequent and more severe in the decades to come. According to an expert report by climatologist Dr. Jeffery Basara, the climate in the Smoky Hills Watershed region is "becoming increasingly arid"[39] and "[d]rought occurrence at multiple temporal scales will continue within the hydroclimate of the SHW [Smoky Hill Watershed] region including megadrought, decadal, annual, S2S [subseasonal to seasonal], and flash drought."[40] Moreover, there is "[a] significant increase in decadal and multi-decadal drought risk of 35-60% and 60-85% respectively" and a decadal drought in the future would "lead to water loss from the SHW of approximately 2 trillion gallons."[41]

35. The history of droughts, the Cities' existing drought-vulnerable water supplies, and the anticipated increase in duration, frequency, and intensity of future droughts all suggest that, absent additional water sources, the Cities will likely be forced to divert water from existing sources in an unsustainable way or ration water consumption further below a level that is already deeply beneath the regional average. Neither outcome is economically desirable.

C. The R9 Ranch Is a Viable Long-Term Solution to the Cities' Water Supply Problem.

36. Both Hays and Russell have attempted to overcome their water supply limitations with aggressive conservation efforts. Hays' water conservation efforts stretch back to at least March 1991, when the Ellis County Coalition for Economic Development published the "Hays Water Survey."[42] This survey was a study of different conservation measures that could be used to address Hays' long-term "problem of an adequate supply of potable water."[43] The city began implementing these conservation recommendations shortly thereafter.

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[38] First Amended Transfer Application at Ex. 91 (Lanning-Rush, J.L., and D.L. Restrepo-Osorio. "Public-Supply Water Use in Kansas, 2015." *U.S. Geological Survey* (2017)).

[39] Basara Report at 4.

[40] *Id*. at 19.

[41] *Id.*

[42] First Amended Transfer Application at Ex. 56 ("Hays Water Survey." *Ellis County Coalition for Economic Development* (Mar. 1991) at 3).

[43] *Id.*

37. Hays currently uses a variety of methods to encourage and mandate conservation. For example, the city has installed high efficiency fixtures in all city-owned properties.[44] It uses treated effluent from its municipal sewage treatment plant for irrigation purposes, allocating approximately 25 percent of the treated water to irrigate local outdoor recreation facilities.[45] To discourage excessive water use, the city has adopted increasing block water rates that penalize excessive water uses.[46] Hays also offers various incentives to its residents to promote water conservation, including free low-flow shower heads and faucet aerators, rebates for high efficiency appliances,[47] and rebates for converting irrigated turfgrass to water-efficient, drought tolerant landscaping.[48] In addition, Hays has the only cash-for-grass program east of the Rocky Mountains and north of Texas.[49]

38. Hays also uses compulsory measures to ensure conservation. During summer months, the city prohibits outdoor water use from noon to 7:00 p.m., and it has year-round water restrictions including forbidding washing down hard surfaces like driveways or windows.[50] Today, Hays is currently the only city in Kansas that has adopted the green plumbing code, which requires reduced-flow appliances and fixtures to encourage water conservation."[51]

39. In 1985, Hays requested and DWR issued an order establishing the Hays Intensive Groundwater Use Control Area.[52] The order requires all domestic wells within the City to be registered with the DWR. While the use of registered wells is not subject to the Hays water conservation plan, the Chief Engineer may ban, or allow the City to ban, the use of private wells to water lawns, gardens, trees,

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[44] "Our Conservation Efforts." *City of Hays.* <https://ks-hays.civicplus.com/203/Our-Conservation-Efforts> (accessed Mar. 17, 2023).

[45] "Water Reclamation & Reuse." *City of Hays.* <https://ks-hays.civicplus.com/362/Water-Reclamation-Reuse> (accessed Mar. 17, 2023).

[46] "Municipal Water Conservation Plan for the City of Hays." *City of Hays* (Mar. 27, 2014). <https://ks-hays.civicplus.com/DocumentCenter/View/160/Water-Convservation-Plan-and-Drought-Response-Plan-03-27-2014-PDF?bidId=> (accessed Mar. 17, 2023).

[47] "Rebates & Programs." *City of Hays.* <https://www.haysusa.com/161/Rebates-Programs> (accessed Mar. 17, 2023).

[48] "Turf Conversion Rebate." *City of Hays.* <https://www.haysusa.com/575/Turf-Conversion-Rebate> (accessed Mar. 17, 2023).

[49] First Amended Transfer Application at 37.

[50] "Water Rules/Restrictions." *City of Hays.* <https://ks-hays.civicplus.com/565/Water-RulesRestrictions> (accessed Mar. 17, 2023).

[51] First Amended Transfer Application at 35.

[52] "Hays IGUCA." *Kansas Department of Agriculture*. <https://agriculture.ks.gov/divisions-programs/dwr/managing-kansas-water-resources/intensive-groundwater-use-control-areas/hays-iguca.> (accessed Mar. 20, 2023).

shrubs, and similar outdoor vegetation from noon through 7:00 p.m. daily from June 1 through September 30.[53]

40. The city of Russell has used many of the same tools to promote water conservation. Like Hays, Russell has a water-rate ordinance with an increasing block structure.[54] The city of Russell uses wastewater to irrigate its golf course,[55] and more than a third of its residents use rain barrels.[56] The city also started a program in 2013 that offers free low-flow showerheads and rebates for installation of high efficiency toilets.[57]

41. While conservation efforts by the Cities are commendable, nevertheless there are limits to water conservation. Because water use for the Cities is already below the regional average the risk of economic losses from water shortage is exacerbated when water supplies are susceptible to droughts. During periods of exceptional drought, Hays' firm water yield is not sufficient to support even its current water use, and demand for water is hardened by existing conservation efforts, making further conservation costly. The same is true for Russell.[58] Absent the water transfer, when the Cities are forced to deal with insufficient water supply by restricting water use beyond what they have already accomplished, achieving further reductions in water use per capita is more costly because the most economical methods of conservation have already been exhausted.

42. Before filing the First Amended Transfer Application, the Cities embarked upon a decades-long search for alternative water sources to meet present and future needs.[59] They evaluated over 25 possible water sources in Kansas, considering the acquisition and infrastructure costs, amounts of water available, and the quality of the water.[60] The First Amended Transfer Application states that

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[53] *Id.*

[54] "Ordinance 1956 - Amending Water Rates for Water Sold and Furnished by the Municipal System." *Governing Body of the City of Russell, Kansas.* <https://www.russellcity.org/DocumentCenter/View/909/Ordinance-1956---Amending-Water-Rates-for-Water-Sold-and-Furnished-by-the-Municipal-System> (accessed Apr. 10, 2023).

[55] "Waste Water." *City of Russell.* <https://www.russellcity.org/200/Waste-Water> (accessed Mar. 17, 2023).

[56] First Amended Transfer Application at Ex. 53 (*In re the Designation of an Intensive Groundwater Use Control Area in Hays, Kansas, and the Immediate Area* (July 25, 1985)).

[57] "Water Conservation Program." *City of Russell.* <https://www.russellcity.org/149/Water-Conservation-Program> (accessed Mar. 17, 2023).

[58] Hays used 1,792 acre-feet of water in 2020 but has firm water yield of only 1,760 acre-feet during an exceptional drought. Russel used 974 acre-feet of water in 2020 but has firm water yield of only 789 acre-feet during an exceptional drought.

[59] First Amended Transfer Application at 11.

[60] First Amended Transfer Application at Appendix B.

the R9 Ranch was selected because "[t]here are no other sustainable, environmentally, economically, or technologically feasible water-supply alternatives available."[61]

43. In 1995, the Cities purchased the R9 Ranch intending to develop an alternative, drought-resistant raw water source.[62] The R9 Ranch and the associated water rights were historically used for irrigated agriculture such as corn, alfalfa, and soybeans.[63] The irrigation wells on the R9 Ranch were decommissioned between 2007 and 2017.[64] The land on the Ranch is currently in the process of being converted to native grassland.

44. The Cities intend to sustainably develop a municipal wellfield at the R9 Ranch, accounting for the effects of the pumping on the local aquifer and surrounding users.[65] The project will eventually involve the installation of 14 public water supply wells on the Ranch as well as all of the necessary accompanying infrastructure, including well houses, a water storage tank, and a high service pump station.[66]

45. In addition to infrastructure on the Ranch, the project will require the construction of pipelines to transport the water to the Cities. Phase I of the project will install an approximately 65-mile-long pipeline that connects the Ranch to Hays' current water infrastructure in Schoenchen, Kansas.[67] Phase II of the project will install a separate pipeline from Schoenchen to Russell's raw water collection system, which will start when Russell begins using water from the Ranch.[68]

46. Once the transfer is approved, the Cities estimate that it will take between 37 and 63 months to complete the initial phase of the project.[69] This timeframe accounts for the design of infrastructure, including the wells, pump station, and pipeline, as well as for permits, funding, and approval. It also

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[61] First Amended Transfer Application at 11.

[62] McCormick, Paul. "R9 Ranch Modeling Results – Revision 2." *Burns & McDonnell* (Sept. 24, 2018) at 1, attached to Letter from Paul McCormick (Burns & McDonnell) to Toby Dougherty (City of Hays), *Re: R9 Ranch Modeling Results – Revision 2* (Sept. 24, 2018).

[63] *Id.*

[64] First Amended Transfer Application at 33.

[65] McCormick, Paul. "R9 Ranch Modeling Results – Revision 2." *Burns & McDonnell* (Sept. 24, 2018) at 1, attached to Letter from Paul McCormick (Burns & McDonnell) to Toby Dougherty (City of Hays), *Re: R9 Ranch Modeling Results – Revision 2* (Sept. 24, 2018).

[66] First Amended Transfer Application at 12.

[67] First Amended Transfer Application at 12.

[68] First Amended Transfer Application at 13.

[69] First Amended Transfer Application at 14.

accounts for a period of 24 to 36 months for bidding and construction of the project.[70] The total construction cost for Phase I of the project is currently estimated to be $106.6 million.[71] Phase II of the project was estimated in 2021 to cost $7.7 million.[72]

47. According to the Master Order, the Cities are limited to pumping a maximum of 6,756.8 acre-feet per year from the R9 Ranch. The Master Order also imposes a 10-year rolling aggregate limit of 48,000 acre-feet (that is, 4,800 acre-feet per year on average).[73] Given these limitations, the total water transferred will represent only three percent of the total water use in Edwards County.[74] Thus, approving the water transfer is not expected to adversely impact the existing water users in Edwards County.

48. The R9 Ranch provides a viable long-term solution to the Cities' water supply problem, by transforming the Cities' water supply from one that is drought-vulnerable to one that is drought-resistant. Under the ten-year limit imposed in the Master Order, the Ranch provides a supplemental groundwater source of up to 4,800 acre-feet per year, which, unlike the Cities' existing sources, is less dependent on surface water flow and more drought resistant. During periods of exceptional drought, when firm water yields from existing sources are not sufficient to meet the Cities' current and projected future water needs, the shortage can be mitigated by sustainably diverting groundwater from the Ranch without materially impacting the total water supply in Edwards County.

V. APPROVING THE WATER TRANSFER PROVIDES SUBSTANTIAL BENEFITS TO THE STATE OF KANSAS.

49. To evaluate the economic impact of approving the water transfer, I compare a hypothetical but-for world in which the water transfer is approved to the case in which it is denied. The difference in value between these scenarios provides a measure of the economic impact to the State of Kansas of approving the water transfer.

50. If the water transfer is approved, the economic impact to the State of Kansas derives from two sources: (i) the economic benefit derived from new water infrastructure investments to connect water from the R9 Ranch to the Cities' distribution system; and (ii) after the project is completed, the value

[70] First Amended Transfer Application at 14.

[71] Declaration of Kevin D. Waddell relating to probable construction costs (March 9, 2023) at 1.

[72] McCormick, Paul. "R9 Water Delivery Project – Russell Pipeline." *2021-07-16 Russell Pipeline Cost Est*.

[73] Master Order ¶¶ 87-89, 95-96.

[74] "The Journey: Securing a Long-Term Water Supply for Hays and Russell." *Hays Daily News* (Dec. 10, 2017) at 5.

of avoided water shortages by having access to water from the R9 Ranch during periods of drought. In terms of the infrastructure spending, I estimate that these investments would have a statewide output impact of $167 million and a statewide employment impact of 752 full-time equivalent jobs. In addition, these investments would contribute $4.3 million in tax revenue to the State.

51. Approving the water transfer also mitigates economic losses incurred by the Cities during periods of drought. Specifically, the economic impact to the State of Kansas arises from lessening or avoiding economic losses caused by periodic water shortages, as the Cities' existing water supplies absent the transfer are not sufficient to meet future water needs during periods of drought, resulting in periodic water shortages that will disrupt economic activities. Water shortages create economic losses not only directly for water users due to reduced consumption and production values, but also indirectly for the regional economy via supply chain and employment effects.

52. I use a standard economic model of the value of water to calculate the economic loss arising from water shortages. My calculation involves simulating future occurrence of droughts over the 2023-2072 period based on actual, official hydrologic readings recorded in Hays from 1893-2020. My analysis yields a distribution of economic losses based on the 79 different, 50-year draws from the historic hydrologic record (i.e., 1893-1942, 1894-1943, …, 1971-2020). I calculate economic losses for each of these draws and find that, on average the economic loss over the period 2023-2072 is $43 million, with an associated loss of $2.6 million in tax revenue.

53. The average economic loss from water shortages understates the economic damages brought by future water shortages to the Cities and the regional economy, because it does not account for the risk that water conditions for the Cities are drier in the future than the average hydrologic conditions observed over the period 1893-2020. My analysis below shows that the odds are 1 in 7 that the Cities and the regional economy would incur economic losses of $84 million or more during the 2023-2072 period if the water transfer is denied, and that the economic loss would approach $117 million, with an associated loss of tax revenue of $6.7 million, under the most adverse water draw (i.e., if water conditions matched that which occurred over the period 1893-1942).

54. I have been informed that the Cities do not intend to convert the Ranch back to irrigated farmland if the water transfer is denied. I corroborated this information by examining the recent pattern of water use on the Ranch under its current designation for irrigation use, and noted that the wells have been decommissioned since 2017.[75] Taking into account the intention of the Cities and the reality of the infrastructure on the Ranch, I do not consider offsetting economic activities on the Ranch if the water

[75] First Amended Transfer Application at 33.

transfer is denied. In the event the water transfer is denied, economic activity is likely insignificant on the R9 Ranch during the time period relevant to my analysis.

55. Based on my analysis of economic impact, I conclude that the benefits to the State of Kansas if the water transfer is approved are substantial, resulting in a statewide economic impact from infrastructure spending of $167 million, and up to an additional $117 million in economic benefits over the next 50 years from avoiding economic losses resulting from water shortages during periods of drought. In the sections below, I describe in detail the methodology used for my economic impact analysis.

A. Economic Impact of Infrastructure Investment

56. If the water transfer is approved, transferring water from the R9 Ranch to the Cities requires substantial investments in infrastructure to develop a water conveyance system that is currently not in place. Conditional on approval, the Cities plan to conduct this investment in two initial phases. Phase I consists of installing public water-supply wells, a gathering system, and a pump station on the R9 Ranch and a pipeline connecting the Ranch to Hays' existing water facility near Schoenchen, Kansas. These pipelines will start in Edwards County and cross Pawnee County and Rush County before terminating at Schoenchen in Ellis County. In Phase II, additional pipelines will be installed to deliver water from the Schoenchen facility to Russell and Hays.[76] The remaining municipal wells will be installed during a third phase; however, the projected costs for Phase III are not included in my analysis.

57. Investment in water infrastructure creates economic opportunities for businesses directly involved in the design, engineering, and construction of water supply infrastructure. Importantly, these opportunities are not confined by the boundaries of the Cities but, instead, are shared by individuals and businesses specializing in water projects across the State of Kansas. Infrastructure investment also creates stable, well-paying employment opportunities and full-time head-of-household jobs that are accessible to a broad segment of the labor force in the State of Kansas.

58. Investment in water infrastructure generates additional economic impact through spending by directly impacted firms and their employees. These "ripple effects" through the regional supply chain further amplify the economic impact of the initial investment in infrastructure. And the economic impact does not stop here; increased economic activities and employment generated by the

[76] First Amended Transfer Application at 12.

project, in turn, contributes to fiscal capacity by generating tax revenue at different levels of government.

59. To quantify the statewide economic impact of infrastructure investment, I use IMPLAN (Impact Analysis for Planning), an input-output model developed and maintained by the Minnesota IMPLAN Group ("MIG"). IMPLAN is used for economic impact analysis by many public and private institutions, including the Kansas Department of Agriculture and the Kansas Department of Transportation.[77, 78] The analysis draws on data collected from numerous state and federal sources, including the Bureau of Economic Analysis, Bureau of Labor Statistics ("BLS"), and the U.S. Census Bureau.

60. The IMPLAN modeling system relies on a matrix representation of the economy that describes the relationships among industries, consumers, government, and foreign suppliers in order to derive the economy-wide impacts of changes in a specific industry. This matrix representation is the so-called Leontief matrix, which contains average input (purchase) coefficients that describe the mix of goods, services, and labor that are required to produce a unit of output; that is, how the output of one industry is used as an input in other related industries. The resulting input-output coefficients represent what economists refer to as production functions. The basic input-output model can be expressed in the equation: $X = (I - A)^{-1} \times dY$, where $(I - A)^{-1}$ is the inverse of the Leontief matrix, dY is a change in final demand, and X is output.

61. The IMPLAN model aggregates the US economy into 546 unique sectors and allows for regional disaggregation down to the county level. The model can be used to estimate the direct, indirect, and induced impacts on employment, earnings, and output as a result of final demand changes initiated by a new investment in a particular industry or compilation of industries. The *direct effect* captures the initial change in economic activity resulting from the new investment. The *indirect effect* reflects new economic activity that is stimulated by the direct investment in industries that supply inputs to the sector of initial change. The *induced effect* captures the economic activity that results when the increased earnings generated by the direct and indirect economic activity is spent on goods and services.

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[77] *See, e.g.*, "Kansas Agriculture and Agriculture Related Industries Economic Contribution Report." *Kansas Department of Agriculture* (Aug. 15, 2022). <https://www.agriculture.ks.gov/docs/default-source/ag-marketing/county-ag-stats/2022-county-ag-stats/state-of-kansas-reports-8-12-2022.pdf?sfvrsn=553e9bc1_4> (accessed Mar. 17, 2023).

[78] *See, e.g.*, "Kansas Aviation Economic Impact Study." *Kansas Department of Transportation* (2017). <https://www.ksdot.org/Assets/wwwksdotorg/bureaus/divAviation/pdf/2016EISFinalReport.pdf> (accessed Mar. 17, 2023).

62. An example may help illustrate the economics behind IMPLAN. Consider a hypothetical project in which Hays spends $100,000 to install a pipeline to transfer water to the city. Suppose that $60,000 is spent on materials, including fabricated pipelines and other materials. The remaining $40,000 is spent on labor, which involves workers digging trenches, laying pipelines, and restoring the construction site after completion.

63. There are several ways Hays' water project generates economic impact in other parts of Kansas. The first one is the direct effect of the spending. Fabricated pipelines are highly specialized goods that may not be produced or sold in Hays. If they are instead purchased from elsewhere in Kansas, for instance from an urban center such as Wichita, then Hays' water project will directly generate sales of $60,000 elsewhere in Kansas. In IMPLAN, this channel of economic impact is termed the *direct effect*.

64. The initial spending on these materials creates additional economic ripple effects in other regions in Kansas via the regional supply chain. Production of final goods requires intermediate inputs, sometimes numbering in thousands. When more of a final good is produced and consumed, it creates additional demand for downstream intermediate inputs as well. In this example, the production of pipelines might source intermediate inputs from many places in Kansas. For example, an additional sale of $60,000 in fabricated pipelines may generate $30,000 of additional sales of resin plastics fabricated in Topeka, $20,000 additional sales of piping materials from Lawrence, and $10,000 additional sales of concrete from Manhattan. This channel of economic impact via inter-industry supply chain linkage is termed the *indirect effect*.

65. Economic activity in different parts of Kansas may also be connected through the mobility of workers and the geographical distribution of their consumption activities. To see this, consider the Hays example again and, for simplicity, suppose that the project hires exactly one worker. In this case, the project may generate an annual income of $40,000 for the worker. The worker can take his income—and consequently, his spending—anywhere in Kansas; for example, going to a Jayhawks game, visiting the Sedgwick County Zoo, or paying for a son or daughter's tuition at Kansas State University. Therefore, the additional income generated from a water project in Hays ends up creating additional spending and demand in other parts of Kansas. This channel of economic impact is termed the *induced effect*.

66. IMPLAN uses regional economic data to estimate the direct, indirect, and induced effects of a given economic event, including output, value added, wage income, proprietary income, and employment. IMPLAN also estimates changes to tax revenues at different levels of government, including sales tax, federal and state personal income tax, and payroll taxes. As such, IMPLAN provides a

quantitative assessment of how an economic event, such as investing in water transfer infrastructure, benefits a region via increased economic output, increased employment, and increased fiscal capacity.

67. I developed a Multi-Region Input-Output (MRIO) analysis in IMPLAN to estimate the statewide economic impact of the water transfer infrastructure investment in the event the water transfer is approved. My analysis consists of three regions: (i) the Phase I Region, comprised of Edwards County, Pawnee County, Rush County, and Ellis County; (ii) the Phase II Region, which consists of solely of Russell County; and (iii) all other counties of Kansas (the "Rest of Kansas"). According to the Master Order, Phase I is expected to commence in 2023 and be completed in five years, and Phase II is expected to take place after the conclusion of Phase I in 2028.

68. I have been provided cost proposals describing the itemized expenditures, estimated in 2015, for both Phase I and Phase II of the proposed infrastructure investment.[79, 80] I also have been informed that, due to inflation, the current costs would be 46.29 percent higher than the 2015 estimates.[81] Correspondingly, I revised upward the expenditures in the 2015 budget by the same percentage to estimate current costs. These economic impact of these spendings are analyzed in IMPLAN by creating appropriate economic events in the corresponding regions.[82]

69. Once economic events are created, IMPLAN uses its proprietary data and algorithms to calculate how output for different industries would adjust in response to increased demand induced by the spendings. Producing more output requires more input. Correspondingly, IMPLAN also estimates changes to factors of production, such as labor, and the associated changes to factor payments, such as labor income. Finally, changes to output and factor payments affect tax revenues, such as sales tax and income tax. IMPLAN estimates these tax effects at various levels of the government, including state, county, and city.

70. I further note that in IMPLAN analyses, the estimated economic impact could be affected by not only the total dollar amount of spending, but also the origins of supply. Because the cost proposal provided to me does not specify where different goods and services would be sourced from, there is

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[79] Letter from Paul McCormick (Burns & McDonnell) to Toby Dougherty (City of Hays), *Re: R9 Ranch Conceptual Development Summary* (May 7, 2015) at 13.

[80] McCormick, Paul. "R9 Water Delivery Project – Russell Pipeline." *Burns & McDonnell* (July 16, 2021).

[81] Declaration of Kevin D. Waddell relating to probable construction costs (March 9, 2023) at 1.

[82] There are two types of economic events in my IMPLAN analysis. Spendings on specific goods and materials such as transmission pipes and pump stations are modeled as "Commodity Output Event." Other spendings are modeled as "Industry Output Events."

insufficient information to specify the geographic distribution of spending. In cases where the geographic location of spending is unspecified, the default value in IMPLAN is used.[83]

71. **Table 2** summarizes the statewide direct, indirect, and induced impact in terms of output and employment. In IMPLAN, the employment figures are expressed in full-time equivalent ("FTE") jobs to facilitate the comparison of employment effects across sectors with different compositions of part-time and full-time employees. My analysis shows that, if the water transfer is approved, the statewide output impact would be $167 million, which is comprised of a direct impact of $112.4 million, an indirect impact of $32.2 million, and an induced impact of $22.5 million. In total, the level of economic activity in the State would be $167 million higher as a result of the infrastructure investment if the water transfer is approved.

72. These infrastructure investments have an estimated statewide employment impact of 752 full-time equivalent jobs. While most of the direct impact is expected to occur in the pipeline manufacturing and construction industries, jobs created via the indirect and induced channels would spread over many sectors. Industries receiving the most employment impact via the indirect effect include durable goods wholesale, real estate, and truck transportation. Industries receiving the most employment impact via the induced effect include restaurants, retail, and hospitals. According to IMPLAN, these jobs would generate average earnings of $53,880.79 per year per full-time equivalent job, which is higher than the average salary the Bureau of Labor Statistics estimated for Kansas.[84]

Table 2: Statewide Economic Impact of Infrastructure Investment

Impact	**Job Years (FTEs)**[1]	**Employee Compensation**[2]	**Economic Output**
Direct	448	$23,959,569	$112,425,036
Indirect	166	$9,719,355	$32,202,857
Induced	138	$6,839,432	$22,514,971
Total	**752**	**$40,518,356**	**$167,142,864**

1. Job estimates include part-time and full-time employment.
2. Employee compensation includes wages and fringe benefits paid for by employers.
Source: IMPLAN® model, 2019 Data.

[83] For "Commodity Output Events," IMPLAN by default sets the "Local Purchase Percentage" parameter to 100 percent. "Local Purchase Percentage (LPP) & Regional Purchase Coefficients (RPC)." *IMPLAN*. <https://support.implan.com/hc/en-us/articles/360035289433-Local-Purchase-Percentage-LPP-Regional-Purchase-Coefficients-RPC-> (accessed May 18, 2023).

[84] "Annual mean wage" for occupation title that is equal to "All Occupations" is $49,680. "May 2021 State Occupational Employment and Wage Estimates – Kansas." *Bureau of Labor Statistics*. <https://www.bls.gov/oes/current/oes_ks.htm> (accessed Mar. 21, 2023).

73. **Table 3** summarizes the impact of the infrastructure investment on tax revenues at the state level and at the county level. At the state level, approving the water transfer is estimated to increase tax revenue by approximately $2.7 million, including $1.3 million in sales tax and roughly $1 million in income tax and property tax combined. At the county tax level (i.e., county taxes collected for all counties in the State including Ellis County and Russell County), approving the water transfer is estimated to generate additional tax revenue of $1.7 million, the majority of which comes from property tax.

Table 3: State and County Tax Impact of Infrastructure Investment

	State	County[85]
Sales Tax	$1,356,332	$403,569
Income Tax	$800,267	$333
Property Tax	$237,865	$1,212,535
Other Taxes	$302,103	$87,096
Total	**$2,696,567**	**$1,703,533**

B. Economic Benefit of Avoiding Water Shortages

74. To evaluate the economic impact to the State of the water transfer in avoiding or mitigating economic losses during periods of water shortages, I analyze the economic losses to the Cities and the regional economy resulting from water shortages in the but-for transfer scenario in which the water transfer is denied. My analysis recognizes both the commendable conservation efforts by the Cities' citizens and their vision for economic growth, and the harsh reality that, without water from the Ranch, the Cities face significant risks of water shortages resulting in economic losses.

75. I apply a standard economic model of the value of water to calculate economic loss resulting from water shortages using data provided to me by the Cities. Under the baseline climate conditions characterized by actual past hydrologic records for Hays from 1893-2020, my analysis shows that if the water transfer is approved and after the water infrastructure is completed, the Cities would avoid economic losses over the 2023-2072 period that amount to $43 million, on average, and as high as $117 million under the most adverse draw from the hydrologic record (the period 1893-1942). These

[85] IMPLAN estimates separately three types of tax impacts that align with how taxes are levied at the local government level: County, Sub County (General), and Sub County (Special District). Throughout this report, these three different tax impacts are aggregated to one number that represents the total tax impact at the county level.

figures do not account for the losses resulting from a potential decadal or multidecadal drought, which I discuss below.

76. My calculation of the economic benefit of the water transfer in mitigating future economic losses during periods of drought is conservative because it relies on the historical drought record over the period 1893-2020, and therefore does not incorporate the potential impact of climate change or account for the extended historical droughts evidenced in the tree-ring fossil record referenced above, which indicate "numerous years in the past where drought conditions exceeded the severity of the 1930s and 1950s droughts[.]"[86] I show that the economic benefits of the water transfer are much larger when extreme droughts such as decadal and multidecadal droughts are considered.

77. Unlike the economic impact of infrastructure investment, the economic loss of water shortages is largely local to the Cities and the regional economy. This is because the economic value of water consumption in residential, commercial, and industrial uses is highly localized. During periods of drought, residents and businesses in the Cities bear most of the economic losses due to water shortages, only a portion of which spill over to reduce economic activity more broadly in the State of Kansas. Nonetheless, these economic losses are a relevant component of the Statewide economic impact.

78. The regional economy of Ellis and Russell Counties is an important part of the fabric of the Kansas economy. According to a report published by the Docking Institute at Fort Hays State University, Hays is "the economic center of a regional economy in northwestern Kansas that is important to the State of Kansas." Indeed, Ellis and Russell counties contributed $1.8 billion in gross output to the Kansas economy.[87] Approving the water transfer further deepens this economic contribution by providing a more resilient water supply for the Cities that can expand the reach of this economic center in northwestern Kansas.

79. In sections below, I describe steps in my economic loss calculation. Because residential users and commercial and industrial (C&I) users have markedly different economic characteristics, a separate description is warranted for each user type.

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[86] Layzell, Anthony L. and Catherine S. Evans. "Kansas Droughts: Climatic Trends Over 1,000 Years." *Kansas Geological Survey Public Information Circular* 35 (Aug. 2013) at 4.

[87] "Economic Impact of the Hays and Russell Region on the Kansas Economy." *Docking Institute of Public Affairs, Fort Hays State University* (Nov. 2022) at 12.

1. *Residential Losses*

80. Residential losses are measured by computing consumer willingness to pay to avoid water shortages.[88] Willingness to pay is a term in economics that describes the maximum dollar amount a consumer is willing to spend on a good or a service. For a typical consumer, willingness to pay reflects the intrinsic benefits the individual expects to derive from the good or service if purchased. For example, if a consumer is willing to pay $5 for an apple, and the apple costs $1, then economists can infer that the consumer expects to benefit at least $4 (= $5 - $1) when purchasing the apple for $1. Similarly, if a community is willing to pay $5,000 to avoid a water shortage of 1 acre-foot, economists deduce that the benefits of consuming the extra acre-foot of water are worth at least $5,000 to the community net of the cost of supplying it.

81. Within the residential sector, water use can be classified into several broad categories, where consumers prioritize some categories of water use over others. Thus, the willingness to pay for water by residential customers depends on the intended use of each unit of water. For example, households' willingness to pay for water used for drinking and basic sanitation is greater than their willingness to pay for water used for bathing and laundry which, in turn, is greater than their willingness to pay for water used for outdoor irrigation. When faced with a water shortage of a given magnitude, residential consumers have the choice over which types of water uses to curtail. The framework for measuring residential losses incorporates the idea that residents respond to a water shortage by eliminating less valuable water units before eliminating more valuable water units.

82. Economic losses for residential users depend on the price of water in a region prior to a water shortage. For example, when water is less expensive, consumers might make landscaping choices that devote a greater quantity of water to outdoor irrigation uses than they would when facing higher water rates. If a water shortage occurs, there are low-cost opportunities for water conservation because consumers can cut back on outdoor irrigation—a low value use of water. Therefore, the economic loss is relatively small. If water was expensive even prior to the water shortage, the same "low hanging fruit" would not exist, as consumers would have already restricted water usage in low value areas to prioritize water for high value uses such as drinking and sanitation. Because of the conservation measures imposed on water users in Hays and Russell, much of the low value uses of

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[88] This approach follows Jenkins, M.W., J.R. Lund, and R.E. Howitt. "Using Economic Loss Functions to Value Urban Water Scarcity in California." *Journal of the American Water Works Association* 95 (2003): 58-70; Brozovic, N., D. Sunding, and D. Zilberman, "Estimating Business and Residential Water Supply Interruption Losses from Catastrophic Events." *Water Resources Research* (2007); and Buck, S., M. Auffhammer, S. Hamilton, and D. Sunding. "Measuring the Welfare Losses from Urban Water Supply Disruptions." *Journal of the Association of Environmental and Resource Economists* 3 (2016) 743-778.

water have already been exhausted. Thus, during droughts, the economic impact in Hays and Russell is higher than in other communities that have not actively engaged in conservation measures.

83. During a water shortage, residential consumers make a sequence of adjustments to their water use, for example, first by cutting back on irrigation uses before reducing indoor water uses such as sanitation and drinking water uses when all other water conservation measures have been exhausted. The calculation of economic loss requires measuring the consumers' willingness to pay for each such *incremental* adjustment. In economic jargon, such adjustments represent movements along the demand curve, and the willingness to pay for the water (or the intrinsic value of water) is derived by integrating the area under the demand curve. Therefore, it is necessary to characterize the demand curve at levels below the observed consumption level to calculate the economic loss of a water shortage.

84. A water demand curve is a mathematical function that characterizes a consumer's willingness to pay for each incremental unit of water. My calculation assumes an isoelastic demand curve with a price elasticity of water demand of e_r = -0.19. This specification is consistent with numerous studies in the academic literature.[89] I further note that using this value in my analysis is conservative, because the potential for outdoor water conservation in the Cities is more limited than in other communities due to past conservation mandates. It is well recognized in the literature that indoor water uses are less price elastic than outdoor water uses.[90]

85. A price elasticity of -0.19 implies that, when the price of water increases by one percent, all else the same, water use by residential consumers decreases by 0.19 percent. In other words, consumers are

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[89] The demand elasticity of -0.19 is consistent with econometric results from multiple studies, including a comprehensive study of residential water demand in California ("Measures to Reduce the Economic Impacts of a Drought-Induced Water Shortage in the SF Bay Area." San Francisco Public Utilities Commission (SFPUC) (May 3, 2007): 19-21), a study of 221 Texas communities (Gaudin, Sylvestre, Ronald C. Griffin, and Robin C. Sickles. "Demand Specification for Municipal Water Management: Evaluation of the Stone-Geary Form." *Land Economics* 77.3 (2001): 399-422), and a study of the Chicago metropolitan area (Mieno, Taro and John B. Braden. "Residential Demand for Water in the Chicago Metropolitan Area." *Journal of the American Water Resources Association* 47.4 (2011): 713-723). *See also* Renwick, Mary E. and Richard D. Green. "Do Residential Water Demand Side Management Policies Measure Up? An Analysis of Eight California Water Agencies." *Journal of Environmental Economics and Management* 40.1 (2000): 37-55; Arbués, Fernando, Marıa Ángeles Garcıa-Valiñas, and Roberto Martínez-Espiñeira. "Estimation of Residential Water Demand: A State-of-the-Art Review." *The Journal of Socio-Economics* 32.1 (2003): 81-102; Buck, S., M. Auffhammer, S. Hamilton, and D. Sunding. "Measuring Welfare Losses from Urban Water Supply Disruptions." *Journal of the Association of Environmental and Resource Economists* 3 (2016): 743-778.

[90] Arbués, Fernando, Marıa Ángeles Garcıa-Valiñas, and Roberto Martínez-Espiñeira. "Estimation of Residential Water Demand: A State-of-the-Art Review." *The Journal of Socio-Economics* 32.1 (2003): 81-102 at 88. *See also* Sebri, Maamar. "A Meta-Analysis of Residential Water Demand Studies." *Environment, Development and Sustainability* 16 (2014): 499-520 at 518-519.

not very sensitive to water price changes, as a price change of a given magnitude elicits a much smaller change in usage, proportionally.

86. Economic losses in the residential segment of the market are determined by two components. The first component is consumer willingness to pay to avoid a water shortage of a given magnitude. This is calculated by aggregating consumer willingness to pay for each successive unit of reduction in water use by integrating the area under the demand curve, until total water reduction is equal to the amount of shortage.[91]

87. For illustration, consider a simplified example where a residential consumer who wishes to use 100 gallons of water but, because of drought, is supplied with only 80 gallons (i.e., there exists a water shortage of 20 gallons). The consumer is willing to pay $10 to increase her water consumption from 80 gallons to 90 gallons but, afterwards, only $5 more to increase consumption from 90 gallons to 100 gallons. This decline in willingness to pay for the same incremental quantity reflects the law of diminishing marginal returns in economics. It follows that, in my approach, the economic loss due to the first 10 gallons of water shortage (i.e., from 100 to 90 gallons) is $5 and the economic loss due to the next 10 gallons of water shortage is higher at $10. Again, the increase in economic loss of the same quantity of water shortage reflects the fact that consumers are forced to cut water use of increasingly higher value as shortage deepens. The total economic loss due to 20 gallons of water shortage in this example is thus $10 + $5, or $15.

88. The second component of the economic loss is the avoided cost of water delivery. Following a water shortage, water purveyors deliver a smaller quantity of water to residential customers, and this reduces the total cost of water distribution in the network. Generally, the overall cost of water service includes substantial fixed costs that do not vary with the amount of water delivered through the system (infrastructure costs, repair and maintenance, administrative expenses, etc.). Thus, the avoided cost that results from a water shortage is relatively small in relation to total cost. The reduction in the cost of water service that occurs in response to a one-unit reduction in water deliveries is referred to as the avoided *marginal* cost of service, for instance the avoided energy cost of conveying and treating water units that are no longer delivered.

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[91] Specifically, this is done by integrating the area under the demand curve between the initial consumption level Q^* and the rationed consumption quantity Q^R using the approach of Brozovic, Sunding and Zilberman (2007). *See* Brozović, Nicholas, David L. Sunding, and David Zilberman. "Estimating Business and Residential Water Supply Interruption Losses from Catastrophic Events." *Water Resources Research* 43.8 (2007).

89. The economic loss following a water shortage in the residential segment of the market is the difference between consumer willingness to pay to avoid the shortage and the avoided cost of water delivery to residential households.

2. Commercial and Industrial (C&I) Losses

90. Economic losses for the commercial and industrial (C&I) segment are calculated as the sum of (i) the willingness to pay of commercial and industrial users to avoid a water shortage, (ii) the avoided cost of water delivery, and (iii) the indirect and induced impact on the regional economy. The last component is specific to the C&I segment. During a water shortage, reduced water consumption for commercial and industrial users generates not only a direct reduction in economic output, because water is an essential input, but also indirect and induced impacts via local supply chain and employment effects. For example, when a gluten plant is forced to reduce production because of a water shortage, some local workers lose their paychecks, and some suppliers lose their contracts. Thus, the overall economic loss needs to account for not only the direct production loss at the gluten plant, but also subsequent losses created through the regional supply chain. These indirect and induced impacts for the C&I sector are estimated using IMPLAN.

91. The willingness to pay of commercial and industrial users is calculated using an identical method as the one described above for residential users. C&I water demand is characterized by an isoelastic demand curve with a price elasticity of demand $e_c = -0.12$,[92] meaning that a one percent increase in the price of water will cause a 0.12 percent decrease in water usage by commercial and industrial users, all else the same. Compared to the residential sector, the C&I sector is less sensitive to water price changes when determining water uses.

92. The economic loss following a water shortage in the C&I segment is taken to be the sum of direct impacts (the willingness to pay of urban commercial and industrial water users) and indirect and induced impacts that arise through local employment effects, net of the avoided cost of water delivery.

3. Reductions in End-Use During Water Shortages

93. As discussed above, the economic loss following a water shortage in each segment of the market is calculated as the willingness to pay to avoid the shortage net of the avoided cost of water delivery to

[92] The demand elasticity of -0.12 for the aggregated commercial and industrial segment is consistent with the values reported by McLeod, Philip. "The Economic Impact of Water Delivery Reductions on the San Francisco Water Department Service Area's Commercial and Manufacturing Customers." *San Francisco Public Utilities Commission* (June 29, 1994) and Arbués, Fernando, Marıa Ángeles Garcıa-Valiñas, and Roberto Martínez-Espiñeira. "Estimation of Residential Water Demand: A State-of-the-Art Review." *The Journal of Socio-Economics* 32.1 (2003): 81-102.

users in the market segment. In the C&I segment, the loss further includes indirect and induced impacts to the local economy via supply chain and employment effects. The remaining data required for performing the economic loss calculation are: (i) the price of water; (ii) the marginal cost of water service; and (iii) the magnitude of the water shortage.

94. The relevant water rate for calculating economic losses in each market segment is the rate paid on the highest pricing tier by buyers in each segment during periods of water emergency. Hays has increasing block rates for municipal water that start at $2.71 per 100 cubic feet (748.052 gallons) for the Base Tier and increases to $15.01 per 100 cubic feet for Conservation Tier 2-water warning or water emergency.[93] These rates are effective January 2021.[94] To be conservative, I used rates of $7.86 per 100 cubic feet ($3,423 per acre-foot) for the C&I segments and $10.82 per 100 cubic feet ($4,713 per acre-foot) for the residential segment in my analysis. These rates correspond to Conservation Tier 2 prices for "Residential Only" and "Business Mixed Use and Multi-Family," respectively. The conservation rates charged by the Cities are relevant for my analysis, because during periods of drought conservation mandates are likely to be in effect.

95. Russell's published rates are effective March 2, 2021.[95] For residential users, I used the marginal rate of $1.008 per hundred gallons ($3,285 per acre-foot). Industrial users pay a uniform price of $0.841 per hundred gallons ($2,740 per acre-foot).

96. I calculated the marginal cost of water production using data provided by Hays' Water Resources Department.[96] For each year between 2006 and 2020, the data contains information on the gallons of water produced as well as detailed production costs, including chemicals, energy, labor, and other costs. The marginal cost of water is derived by first differencing total operating costs (adjusted for inflation) and total production levels between two consecutive years over the period 2006-2020, and then taking the ratio of the difference in total operating cost to the difference in production levels. The estimated marginal cost of municipal treated water for Hays is $307 per acre-foot. Because data specific to Russell was not provided to me, I applied Hays' marginal cost to Russell in my analysis.

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[93] "Water Rates." *City of Hays.* <https://www.haysusa.com/210/Water-Rates> (accessed Mar 21, 2023).

[94] *Id.*

[95] "Ordinance 1956 - Amending Water Rates for Water Sold and Furnished by the Municipal System." *Governing Body of the City of Russell, Kansas.* <https://www.russellcity.org/DocumentCenter/View/909/Ordinance-1956---Amending-Water-Rates-for-Water-Sold-and-Furnished-by-the-Municipal-System> (accessed Apr. 10, 2023).

[96] Memorandum from Jeff Crispin, Director of Water Resources, *Water Production Cost Per Year – City of Hays* (Apr. 6, 2021).

97. The magnitude of water shortage at any given point in time depends on water demand and firm water supply. First, I set initial water demand for each market segment to be equal to historical usage in that segment using the Cities' water use records by class from 2018-2020.[97, 98] Initial demand is then modeled to grow at the same rate as population growth projected in the Cities' comprehensive plans.[99, 100]

98. Once firm water yield is known, calculating aggregate water shortage is a matter of simple algebra. Allocating shortage across market segments, on the other hand, is more complex. In general, the economic loss that results from a water shortage is smaller when the shortage is allocated to market segments with relatively elastic demand (i.e., where the valuation of successive water units does not rise rapidly during periods of water rationing). Residential demand is relatively more elastic than C&I demand, and the implication is that it is socially desirable for residential users to bear the largest share of a water shortage in meeting the goal of minimizing economic losses.

99. Because a market does not exist to reallocate water from users with lower willingness to pay to users with higher willingness to pay, the prevailing end uses of water may not be rationed during water shortages in the most economically efficient manner. Absent a market for water trading between residential and commercial segments, droughts can create shortages for some user groups that are more severe than for other user groups. The resulting economic loss in this case would be higher than the values I calculate due to inefficiency arising from the lack of a water market between these different end-users.

100. My calculation of economic losses is conservative by assuming efficient water transfers occur between residential and C&I market segments in the Cities' response to droughts. Economic losses from water shortages in the C&I segment tend to be greater than losses in the residential segment both because users in the residential segment are better able to adjust to water shortages (i.e.,

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[97] Memorandum from Jeff Crispin, Director of Water Resources, *Water Usage by Customer Class* (Feb. 5, 2021). The residential segment includes "residential" and "city property" user classes and the C&I segment includes the "commercial" and "industrial" user classes.

[98] Memorandum from Jon Quinday, City Manager, *Water Usage by Customer Class* (Feb. 4, 2021). The residential segment includes "residential" and "city property" user classes and the C&I segment includes the "commercial" and "industrial" user classes.

[99] Hays projected an annual growth rate of one percent through to 2030. "Hays Kansas Comprehensive Plan." *City of Hays*. <https://www.haysusa.com/315/Comprehensive-Planning> (accessed Mar. 21, 2023) at 12.

[100] Russell projected an annual growth rate of 0.25 percent through to 2036. "Comprehensive Development Plan for the Russell Area, Kansas 2016 – 2036." *City of Russell*. <https://www.russellcity.org/DocumentCenter/View/303/City-of-Russell-Comprehensive-Plan-PDF?bidId=> (accessed Mar. 21, 2023) at 11-1.

residential demand is more elastic) and because water shortages in the C&I segment also create additional losses to the local economy through supply chain and employment effects. For this reason, most water agencies respond to water shortages with programs that specifically target the residential segment such as limits on car washing and outdoor irrigation, rather than targeting water restrictions in the C&I segment.

101. Similar institutional responses are also at the Cities' disposal. Water ordinances in Russell permit "[r]estrictions on the use of water in one or more classes of use, in whole or in part" upon the declaration of a Water Warning – Stage II or Water Emergency.[101] Similarly, the city of Hays permits "[r]estrictions on the time of day or time of week of water uses in one or more classes of water use as described in subsection (b)(4), wholly or in part" upon the declaration of water warning or emergency.[102]

102. To account for this institutional response to a water shortage, my analysis imposes the constraint that all water supply shortages of less than 20 percent of residential demand are mediated entirely through the residential segment of the market. The water shortage then cascades into the C&I segment only for levels of shortage in excess of 20 percent of residential demand. This assumption is conservative in measuring economic losses of water shortages because it limits the role of "multipliers" in the economic loss calculation that result from indirect and induced effects of water shortages in the C&I segment.

103. To summarize, shortages are allocated in my model as follows. When a water shortage exists in the combined residential and C&I segments, mandatory conservation measures occur in the residential segment to reconcile shortages of up to 20 percent of residential demand. If a shortage still remains after the conservation response in the residential segment, the residential and C&I segments are jointly rationed in a manner that allocates water to each segment until the willingness to pay for the last unit of water is equal across the residential and C&I segments. This last joint-rationing measure, which occurs infrequently and under only more severe droughts, mimics the outcome that would arise if a market existed for residential and C&I users to efficiently trade water to its highest and most valuable end use. In the likely event that water shortages are not able to be rationed efficiently

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[101] "Code of the City of Russell, Kansas." *City of Russell* (Mar. 29, 2018). <http://russellcity.citycode.net/index.html#!codeOfTheCityOfRussellKansas> (accessed Mar. 16, 2023) at Chapter 15, Article 5.

[102] "Code of Ordinance – Supplement 41." *City of Hays* (Mar. 1, 2023). <https://library.municode.com/ks/hays/codes/code_of_ordinances?nodeId=PTIICOOR_CH65UT_ARTIIIWASESY_DIV1GE_S65-73WASUCOPR> (accessed Mar. 16, 2023) at Section 65-73(e).

by the Cities, the economic value of approving the water transfer would be greater than the value I calculate below.

4. Economic Loss Calculation

104. As explained above, economic loss calculation requires data on firm water yields. The Burns & McDonnell Report provides estimates of firm water yields under three drought conditions: no drought, moderate drought, and exceptional drought.[103] With this data, firm water yield in any given year can be estimated once the drought condition for that year is known.

105. Future drought conditions are simulated over a 50-year period starting in 2023 (the "Model Period"), by taking sequential, 50-year draws from the historic hydrologic record and applying them to the Model Period. Each draw represents a different, continuous 50-year segment of historical annual drought data recorded at the official weather station in Hays over the period 1893-2020.[104] The first such draw corresponds to the hydrologic record for the period 1893-1942, the second one for the period 1894-1943, and so on, where the last draw corresponds to the hydrologic record for the period 1971-2020. In total, there are 79 such draws from the historical record.

106. For a given draw, drought conditions are identified based on the recorded Palmer Hydrological Drought Index ("PHDI"). A value below -3 indicates an exceptional drought. A value between -3 and -1 indicates a moderate drought. A value above -1 indicates a normal climate condition. Once the drought condition is identified, I use the drought-specific firm yield data from the Burns & McDonnell Report to generate a simulated record of firm water yields for the Model Period.

107. For each hydrologic draw, I calculate the economic loss caused by water shortages for the Cities under the approach described above for allocating water shortages between residential and C&I segments. I restrict the calculation of economic loss to the year 2028 and beyond in the Model Period because the water infrastructure is not scheduled for completion until that date.[105] Prior to that, water shortages cannot be avoided or mitigated using additional water supply from the Ranch. This way, my calculation captures only economic loss that could be avoided or mitigated if the water transfer is approved.

[103] For Russell, I reduced its sustainable yield from Smoky Hills Wellfield and Big Creek by the same proportions as Hays' sustainable yields were reduced during droughts, as shown in Table 1 in this report.

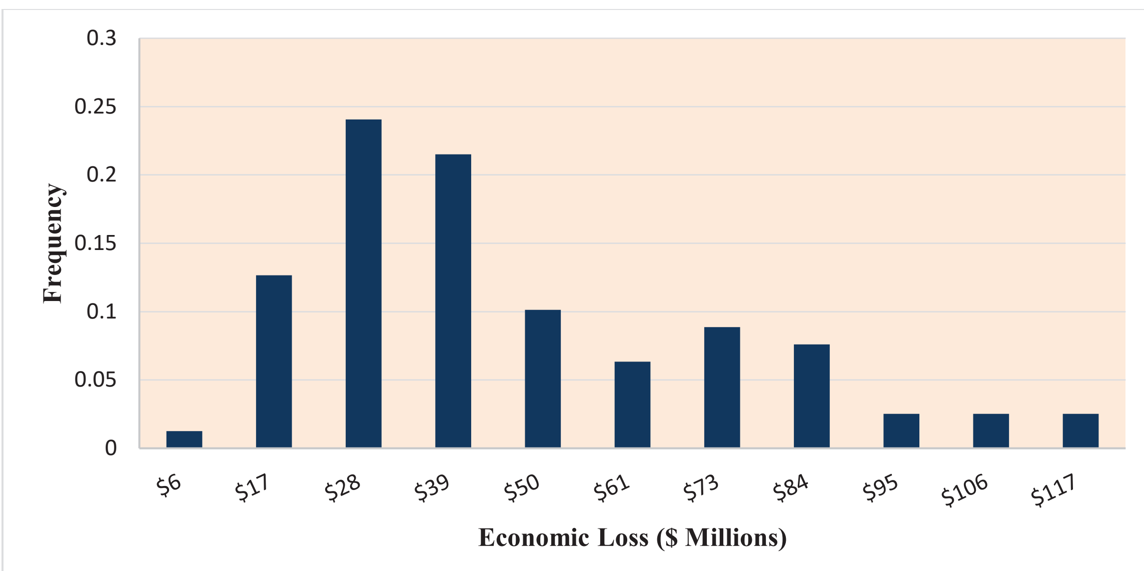
[104] "Drought Indices and Data – Palmer Drought Index." *National Centers for Environmental Information, National Oceanic and Atmospheric Administration*. <https://www.ncei.noaa.gov/access/monitoring/nadm/indices/palmer/div> (accessed Mar.17, 2023).

[105] First Amended Transfer Application at 14.

108. Since the Model Period extends fifty years into the future, it is important to discount future losses to provide a fair comparison between loss in the present versus loss in the distant future. To do so, I use an annual discount rate of 2 percent. Because the discount rate used in my analysis is broadly in line with the inflation-adjusted yield on 30-year treasury bonds, which remains below 1.5 percent, relying on a discount rate of 2 percent reduces future economic benefits in present value terms relative to use of the 30-year treasury rate.[106]

109. **Figure 3** shows the distribution of economic losses from water shortages across the 79 hydrologic draws over the period 2023-2072. The distribution has a statistical mean of $43 million. Thus, if the water transfer is denied, the economic loss to the Cities and the regional economy, on average, is $43 million over the next fifty years. This average loss closely approximates the economic loss that would have occurred if the Cities were to repeat water supply conditions that occurred over the period 1920-1969 (the "Average Drought Record"). The economic loss of $43 million is economically significant—it is roughly equivalent to six years of general fund sales tax receipts for the city of Hays from 2016 to 2021.[107]

Figure 3: Economic Loss of Water Shortages, 2023-2072



110. Figure 3 also reveals significant "tail risk" from water shortage events, i.e., the possibility that economic loss significantly exceeds its statistical average. For example, the cumulative probability

[106] "Selected Interest Rates (Daily) - H.15." *Board of Governors of the Federal Reserve System*. <https://www.federalreserve.gov/releases/h15> (accessed Mar. 20, 2023).

[107] "Sales Tax Receipts, City of Hays, General Fund 1.25%." *City of Hays* (2014-2018); "Sales Tax Receipts, City of Hays, General Fund 1.25%." *City of Hays* (2018-2022).

that the economic loss would exceed $84 million—roughly twice the predicted average loss—is 15 percent. That is, although the expected economic loss from water shortages but-for the transfer is $43 million, the odds are roughly 1 in 7 that the Cities would incur economic losses of $84 million or more over the next 50 years absent the water transfer.

111. In the most adverse draw, which corresponds to the historical drought record that occurred over the period 1893-1942, the economic loss to the Cities is roughly $117 million. This loss amounts to 6.5 percent of the combined gross domestic output for Ellis and Russell Counties estimated by the Docking Institute at Fort Hays State University.[108] This economic loss is roughly equivalent to erasing 13 years of cumulative economic growth for the region.[109]

112. **Table 4** provides a breakdown of the calculated economic loss into its constituent components: (i) the direct loss due to water shortages caused by droughts, (ii) the avoided cost of water delivery, and (iii) the economic loss to the regional economy via indirect and induced effects. It also presents the estimated impact on tax revenue at the State and County levels.

Table 4: Components of Economic Loss

	Average Loss Scenario	**Adverse Scenario**
Direct Loss Due to Water Shortage	$38,525,910	$103,391,199
Avoided Cost of Water Delivery	($827,990)	($1,361,202)
Indirect Effect	$3,289,495	$9,234,521
Induced Effect	$1,910,362	$6,180,589
Total Economic Loss	**$42,897,777**	**$117,445,107**
State Tax Loss	$1,185,655	$3,863,065
County Tax Loss	$881,244	$2,851,431
Total Tax Loss	**$2,066,899**	**$6,714,496**

113. The majority of the economic loss comes from direct loss to consumers in the residential and C&I segments. By comparison, the avoided loss of water delivery is negligible, which reiterates the fact that water delivery has a large fixed-cost component. Absent the water transfer, the economic loss from water shortages also translates to substantial losses in State and County tax revenue. The

[108] "Economic Impact of the Hays and Russell Region on the Kansas Economy." *Docking Institute of Public Affairs, Fort Hays State University* (Nov. 2022) at 12.

[109] Between 2011 and 2021, combined real GDP for Ellis and Russell Counties grew at an average annual rate of 0.5 percent. "Real Gross Domestic Product: All Industries in Russell County, KS [REALGDPALL20167]." *FRED, Federal Reserve Bank of St. Louis*. <https://fred.stlouisfed.org/series/REALGDPALL20167> (accessed Apr. 10, 2023); "Real Gross Domestic Product: All Industries in Ellis County, KS [REALGDPALL20051]." *FRED, Federal Reserve Bank of St. Louis*. <https://fred.stlouisfed.org/series/REALGDPALL20051> (accessed Apr. 10, 2023).

"Average Loss Scenario" corresponds to the draw in which the Cities repeat the Average Drought Record in the next fifty years. In this case, the combined tax revenue loss would be over $2 million. The "Adverse Scenario" corresponds to the draw in which the Cities repeat the 1893-1942 drought record. In this case, the combined tax loss would more than triple to $6.7 million.

5. Impact on Economic Loss of Decadal and Multidecadal Droughts

114. My analysis indicates that but for the water transfer, periodic water shortages would cause economic losses that approach $117 million under adverse water conditions. This calculation is conservative because the baseline climate condition merely repeats the historic hydrologic record and does not consider the effect of a potentially drier water future due to climate change. The avoided economic loss from approving the water transfer would be larger if droughts turn out to be more frequent, more severe, or longer in duration in the future, compared to those in the relatively recent past.[110] Correspondingly, the economic benefits of approving the water transfer would be larger.

115. The Basara Report has estimated that for the Smoky Hill Watershed region, the risk of a decadal drought during the 2055-2099 period exceeds 80%, and could occur at any time.[111] During a prolonged drought, the City's existing sources from the Smoky Hill River and Big Creek, which are highly dependent on surface water, will continue to decline along with the Cities' ability to produce water from existing sources. During a decadal drought, for example, Hays' firm water yield will decline to 840 acre-feet per year, resulting in devasting losses to the Cities.[112]

116. During a decadal drought, the Cities not only suffer further reduction in firm water yield from existing sources, but also a prolonged period of insufficient water supply. Water shortages would deepen drastically, and the resulting economic loss could increase exponentially. On the one hand, consumers may be forced to give up high-value water uses such as drinking or sanitation. Shortages could also cascade into the C&I sector where economic loss is magnified via the multiplier effect. On the other hand, sustained water shortages could lead to permanent losses in population and business, rather than temporary disruption to residential and business activities.

[110] As concluded by Layzell, in geologic history, there were "numerous years in the past where drought conditions exceeded the severity of the 1930s and 1950s droughts[.]" Layzell, Anthony L. and Catherine S. Evans. "Kansas Droughts: Climatic Trends Over 1,000 Years." *Kansas Geological Survey Public Information Circular* 35 (Aug. 2013) at 4.

[111] Basara Report at 18.

[112] Burns & McDonnell Report at 8.

117. To illustrate the potential impact of extreme droughts, I calculate the economic loss for a single year during a decadal drought. Specifically, **Table 5** shows the economic loss I calculate in the event that Hays is hit by a decadal drought in 2028 that reduces its firm water yield to 840 acre-feet per year.

Table 5: Economic Loss for the Year 2028 During Decadal Drought

	Economic Loss
Direct Loss Due to Water Shortage	$214,736,983
Avoided Cost of Water Delivery	-$290,130
Indirect Effect	$20,475,697
Induced Effect	$16,198,862
Total Economic Loss	**$251,121,412**
State Tax Loss	$10,196,597
County Tax Loss	$7,474,305
Total Tax Loss	**$17,670,902**

118. **Table 5** shows that for a single year of a decadal drought event, the economic loss is $251 million, and the associated tax revenue loss is $17 million.[113] These losses are many times larger than the losses under the baseline climate conditions derived from the historical record (as shown by the range of losses in Table 4). This analysis demonstrates that economic loss does not increase linearly with the severity of droughts. Instead, economic loss during extreme droughts would likely be disproportionately larger.

119. It is possible that droughts even more extreme than a decadal drought may occur in the future for the Cities. The Basara Report has estimated that the risk of a multidecadal drought is projected to increase by 60 to 85 percent during the 2055-2099 period, compared to the reference period (1950-2000).[114] During a 20-year multidecadal drought, Hays can only withdraw 480 acre-feet of water each year from its existing sources,[115] which is sufficient to support water use of at most 20 gallons per capita per day for its residents.[116] This is an extraordinarily low level of water use that would not suffice to even support basic needs. According to the World Health Organization (WHO), "between

[113] I do not perform a calculation of economic loss for each year over the Model Period under a decadal drought using the historical record, because unlike the case of moderate and exception droughts, a decadal drought cannot be identified in the historical hydrologic record based on information from the Burns & McDonnell Report.

[114] Basara Report at 18.

[115] Burns & McDonnell Report at 8.

[116] This is calculated based on a population of 20,795 for Hays and 365 days per year. "Quick Facts – Hays City, Kansas." *United States Census Bureau*. <https://www.census.gov/quickfacts/fact/table/hayscitykansas/PST045221> (accessed Jan. 31, 2023).

50 and 100 litres [13 to 26 gallons] of water per person per day are needed to ensure that most basic needs are met and few health concerns arise."[117]

120. My analysis of decadal and multidecadal droughts further highlights an important aspect of the benefits of approving the water transfer. Approving the water transfer from the R9 Ranch provides insurance against the risk of catastrophic natural disasters. Natural catastrophes such as decadal and multidecadal droughts, while relatively unlikely in a single year, are likely to occur eventually in the region, and could impose extreme economic damages on the Cities. Hedging against the risk of extreme drought is therefore important. To citizens of the Cities, approving the water transfer provides a viable insurance mechanism against extreme droughts, which the evidence suggests are increasingly likely in the future.

121. My analysis shows that if the water transfer is approved, the Cities would avoid economic losses of $43 million over the next 50 years under average hydrologic conditions that occurred over the period 1893-2020. The economic loss of water shortages rises to $117 million under hydrologic conditions that mirror the 1893-1942 drought record. I also show that the benefits of the water transfer could be much larger when increased risks of extreme drought events are factored into the analysis. Approving the R9 Ranch water transfer hedges the Cities against this risk.

122. The potential economic benefit of the water transfer includes qualitative factors that are not monetized in this report. First, a reliable municipal water supply provides numerous non-use benefits. For example, years of conservation efforts by the Cities have "created a widely held perception that the Cities lack water,"[118] hampering the ability of the Cities to attract commerce. A reliable water supply can help the Cities rebrand their water circumstances in a way that attracts new residents, stimulates commercial investment, and provides additional fiscal benefits that support the Kansas economy. Second, my analysis does not include positive social benefits. For example, increased outdoor irrigation produces more aesthetic landscapes, which benefits not only the water users, but also visitors and other community members. A more secure water environment can also contribute to improved physical and mental health and increased productivity.

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[117] Ki-moon, Ban and UN Secretary General. "The Human Right to Water and Sanitation." *Media Brief at the United Nations General Assembly* (July 28, 2010). <https://www.un.org/waterforlifedecade/pdf/human_right_to_water_and_sanitation_media_brief.pdf > (accessed Jan. 31, 2023).

[118] First Amended Transfer Application at 37.

C. Approving the Water Transfer Provides Substantial Economic Benefits to the State of Kansas.

123. My analysis shows that approving the water transfer would create positive economic impact on the State, including a statewide output impact of $167 million, a statewide employment impact of 752 full-time equivalent jobs, and a statewide tax revenue impact of $4.4 million.

124. My analysis also shows that approving the water transfer would generate a positive economic impact on the Cities and the regional economy by avoiding and mitigating the economic loss of water shortages during periodic droughts. Under baseline climate conditions characterized by the Cities' historic drought records, the avoided economic losses are on average $43 million and would approach $117 million under water conditions corresponding to adverse periods in the historic drought record. Losses would be greater still if future hydrologic conditions are drier than those of the recent past and include decadal or multidecadal droughts, which would result in economic losses of approximately $251 million, and tax revenue losses of $17 million. Approving the water transfer from the R9 Ranch hedges the Cities against this risk.

125. Combining the statewide economic impact from water infrastructure and the economic benefits of avoiding future water shortages, I find that the water transfer will provide economic benefits to the State of Kansas in excess of $200 million if hydrologic conditions over the period 2023-2072 correspond with average conditions in the historic water record ("Average Loss Scenario"), and nearly $300 million if future water conditions correspond to drier periods in the historic water record ("Adverse Scenario"). In addition, the water transfer will positively impact statewide tax revenue by $6.4 million and $11.1 million, respectively. **Table 6** summarizes the statewide economic benefits of approving the water transfer.

Table 6: Economic Benefits to the State of Approving the Water Transfer

	Average Loss Scenario	**Adverse Scenario**
Statewide Output Impact		
Due to Infrastructure Investment	$167,142,864	$167,142,864
Due to Avoided Water Shortages	$42,897,777	$117,445,107
Total	**$210,040,641**	**$284,587,971**
Statewide Tax Revenue Impact		
Due to Infrastructure Investment	$4,400,100	$4,400,100
Due to Avoided Water Shortages	$2,066,899	$6,714,496
Total	**$6,466,999**	**$11,114,596**

126. Based on my economic analyses in this report, I conclude that approving the water transfer will generate substantial economic benefits to the State of Kansas.

Executed on May 24, 2023, at San Luis Obispo, California.

Stephen F. Hamilton, Ph.D.

Appendix A

Curriculum Vitae

CURRICULUM VITAE

STEPHEN F. HAMILTON

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EDUCATION

Ph.D., Agricultural and Resource Economics, University of California at Berkeley, 1996.
M.S., Agricultural and Resource Economics, University of California at Berkeley, 1994.
B.A., Environmental Studies (with distinction) and Economics, *magna cum laude*, University of California, Santa Barbara, 1991.

PROFESSIONAL EXPERIENCE

2019 to date	Professor of Economics, Cal Poly San Luis Obispo
2016 to 2019	Professor and Director of Graduate Studies, Department of Economics, Cal Poly San Luis Obispo
2005 to 2017	Professor and Chair of Economics, Cal Poly San Luis Obispo
2011	Visiting Researcher, Institut National de la Recherche Agronomique (INRA) and Toulouse School of Economics (TSE)
2004 to 2005	Associate Professor, Cal Poly San Luis Obispo
2001 to 2004	Director of Graduate Studies, University of Central Florida Associate Professor, University of Central Florida
1999 to 2001	Associate Professor, University of Arizona
1996 to 1999	Assistant Professor, Kansas State University

HONORS AND AWARDS

Distinguished Scholarship Award, California Polytechnic, 2021.
Quality of Research Discovery Award, European Association of Agricultural Economists, 2020.
Keynote Address, TRANSFORuM: Industry Pioneers & Visionaries, Waste Expo, 2019.
Scientific Committee, Industrial Organization in the Food Industry workshop, TSE, 2018-19.
Atlas Award, Research with Social Impact, Elsevier-Science Direct, 2018.
Keynote Address, 3rd GAEL Conference, Product Differentiation and Innovation, Grenoble France, June 2013.
Outstanding Doctoral Dissertation Award, (Advisee: William Allender), American Agricultural and Applied Economics Association, 2014.
Invited Participant, NBER Summer Workshops on Environmental Economics, 2004-present.
Fellow, Rural Development Research Consortium.
Early Career Award for Outstanding Research, Gamma Sigma Delta, 1999.
Faculty of the Semester Award for Instruction, Kansas State University, 1998.

Outstanding Graduate Student Instructor Award, University of California at Berkeley, 1994.

EDITORIAL BOARDS

Editor, *Journal of Public Policy & Marketing*, special issue on Analytics Insights, 2019-2021.
Editorial Board, *Journal of Environmental Economics and Management*, 2008-2015.
Editorial Council, *Journal of Agricultural and Resource Economics*, 2009-2012.
Associate Editor, *Journal of Industrial Organization Education*, 2005-2009.
Associate Editor, *Journal of Agricultural & Food Industrial Organization*, 2003-2007.
Associate Editor, *American Journal of Agricultural Economics*, 2001-2005.

FIELDS OF INTEREST

Agricultural Economics
Industrial Organization and Antitrust Analysis
Law and Economics
Policy and Regulation
Natural Resource Economics
Environmental Economics
Public Economics
International Trade

MEMBERSHIP IN PROFESSIONAL SOCIETIES

American Agricultural Economics Association
American Economic Association
Association of Environmental and Resource Economics
European Association of Agricultural Economics

PUBLICATIONS

Articles in Refereed Journals

"Food Banks and Food Retailing," (with John Lowrey and Timothy Richards), *Manufacturing and Service Operations Management*, in Press: https://doi.org/10.1287/msom.2022.1185.

"Food Banks and Retail Markups," (with John Lowrey and Timothy Richards), *European Review of Agricultural Economics*, 49 (5), December 2022, pp. 1027-1055.

"Inventory Management and Loss in Beer Retailing," (with Timothy Richards), *Agribusiness: An International Journal*, 38(3), Summer 2022, pp. 461-485 (***lead article***).

"Farm Labor Productivity and the Impact of Mechanization," (with Aric Shafran, Katya Vasilaky, and Timothy Richards), *American Journal of Agricultural Economics,* 104(4), August 2022, pp. 1435-1459.

"The Future of Marketing Analytics and Public Policy," (with Brennan Davis and Dhruv Grewal), *Journal of Public Policy and Marketing*, 40(4), October 2021, pp. 447–452.

"Differentiation by Certification: Quantity Effects on Tropical Timber Production," (with Jackie Doremus and Matt Cole), *Journal of Environmental Economics and Management*, 107, May 2021, Article 102423.

"Joint Oligopsony-Oligopoly Power in Food Processing Industries: Application to the US Broiler Industry." (with David Sunding), *American Journal of Agricultural Economics*, 103(4), August 2021, pp. 1398-1413.

"Retail Price Discrimination and Food Waste," (with Timothy Richards), *European Review of Agricultural Economics*, 47(5), December 2020, pp. 1861–1896.

"Pricing Strategies of Food Retailers," (with Jura Liaukonyte and Timothy Richards), *Annual Review of Resource Economics*, 12 (2020), pp. 87-110.

"Spatial and Temporal Variation of Offshore Wind Power and its Value along the Central California Coast," (with Yi-Hui Wang, Ryan Walter, Crow White, Matt Kehrli, Patrick Soper, and Ben Ruttenberg), *Environmental Research Communications*, 1(12), October 2019.

"Agricultural Policy and Household Food Waste," (with Timothy Richards), *American Journal of Agricultural Economics*, 101(2), March 2019, pp. 600-614.

"Coordination for Collective Rents: An Experimental Analysis," (with Olivier Bonroy, Alexis Garapin and Diogo M. Souza Monteiro), *American Journal of Agricultural Economics*, 101(1), January 2019, pp. 89-108. (***Recipient of EAAE's Quality of Research Discovery Award***.)

"Retail Market Power in a Shopping Basket Model of Supermarket Competition," (with Timothy Richards and Koichi Yonezawa), *Journal of Retailing* 94(3), September 2018, pp. 328-342.

"Food Waste and the Sharing Economy," (with Timothy Richards), *Food Policy* 75, February 2018, pp. 109-123. (***Recipient of Elsevier's Atlas Award***.)

"Market Competition and the Health Composition of Manufactured Food," (with Vincent Réquillart), *Health Economics*, 26(12), December 2017, pp. 1637-1643.

"Slotting Allowances and Product Variety in Oligopoly Retail Markets," (with Robert Innes). *Economics Letters*, 158, September 2017, pp. 34-36.

"Retail Intermediation and Local Foods," (with Timothy J. Richards, Elliot Rabinovich, and Miguel Gomez), *American Journal of Agricultural Economics*, 99(3), April 2017, pp. 637-659.

"Variety and the Cost of Search in Supermarket Retailing," (with Timothy J. Richards and Koichi Yonezawa), *Review of Industrial Organization*, 50(3), May 2017, pp. 263-285 (***lead article***).

"Attribute Search in Online Retailing," (with Timothy J. Richards and Janine Empen), *American Journal of Agricultural Economics* 99(1), January 2017, pp. 225-242.

"Measuring the Welfare Losses from Urban Water Supply Disruptions," (with Steven Buck, Max Auffhammer and David Sunding), *Journal of the Association of Environmental and Resource Economists* 3(3), September 2016, pp. 743-778.

"Search and Price Dispersion in Online Grocery Markets." (with Timothy J. Richards and William Allender), *International Journal of Industrial Organization* 47, July 2016, pp. 255-281.

"Optimal Recycling Policy for Used Lubricating Oil: The Case of California's Used Oil Management Policy," (with David Sunding), *Environmental and Resource Economics* 62(1), September 2015, pp. 3-17 (***lead article***).

"Oligopoly Intermediation, Relative Rivalry, and Market Conduct," (with Philippe Bontems and Jason Lepore), *International Journal of Industrial Organization* 40, May 2015, pp. 49-59.

"Variety Pass-Through: An Examination of the Ready-to-eat Breakfast Cereal Market," (with Timothy J. Richards), *Review of Economics and Statistics* 97(1), March 2015, pp. 166-180.

"How Do Supermarkets Price Beer During Periods of Peak Demand? Evidence from Game Weeks of the German Bundesliga," (with Janine Empen). *Southern Economic Journal* 81(3), January 2015, pp. 679-696.

"Potential Economic Impacts of Environmental Flows Following a Possible Listing of Endangered Texas Freshwater Mussels," (with Brad Wolaver, Cassandra Cook, David Sunding, Bridget Scanlon, Michael Young, Xianli Xu, and Robert Reedy). *Journal of the American Water Resources Association* 50(5), October 2014, pp. 1081-1101.

"Social Networks and New Product Choice: Peer Effects in an Incentive-Compatible Choice-Based Conjoint Experiment," (with Timothy J. Richards and William Allender), *American Journal of Agricultural Economics* 96(2), March 2014, pp. 489-516.

"Environmental Policy with Collective Waste Disposal," (with Thomas Sproul, David Sunding and David Zilberman), *Journal of Environmental Economics and Management* 66(2), September 2013, pp. 337-346.

"How Do Supermarkets Respond to Brand-Level Demand Shocks? Evidence from the German Beer Market," (with Janine Empen), *American Journal of Agricultural Economics (Proceedings)* 95(5), October 2013, pp. 1223-1229.

"Slotting Allowances and Variety Provision in Supermarket Retailing," (with Robert Innes), *American Journal of Agricultural Economics (Proceedings)* 95(5), October 2013, pp. 1216-1222.

"How Does Advertising Affect Market Demand? The Case of Generic Advertising," (with Kyle W. Stiegert and Timothy J. Richards), *Economic Inquiry* 51(2), April 2013, pp. 1183-1195.

"Rivalry in Price and Location by Differentiated Product Manufacturers," (with Timothy J. Richards and William J. Allender), *American Journal of Agricultural Economics* 95(3), April 2013, pp. 650-668.

"Network Externalities in Supermarket Retailing," (with Timothy J. Richards), *European Review of Agricultural Economics* 40(1), February 2013, pp. 1-22 (***lead article***).

"Emissions Standards and Environmental Quality Standards with Stochastic Environmental Services," (with Till Requate), *Journal of Environmental Economics and Management* 64(3), November 2012, pp. 377-389.

"Obesity and Hyperbolic Discounting: An Experimental Analysis," (with Timothy J. Richards), *Journal of Agricultural and Resource Economics* 37(2), August 2012, pp. 181-198.

"Commodity Price Inflation, Retail Pass-Through and Market Power," (with Timothy J. Richards and William J. Allender), *International Journal of Industrial Organization* 30(1), January 2012, pp. 50-57.

"Spatial Competition in Private Labels," (with Tim Richards and Paul Patterson), *Journal of Agricultural and Resource Economics* 35(2), August 2010, pp. 183-208.

"Second-Best Tax Policy and Natural Resource Management in Growing Economies," (with Steve Cassou, Arantza Gorostiaga and Maria Jose Guitierrez), *International Tax and Public Finance* 17(6), December 2010, pp. 607-26.

"SO_2 policy and input substitution under spatial monopoly," (with Shelby Gerking), *Resource and Energy Economics* 32(3), August 2010, pp. 327-340.

"Variety Competition in Retail Markets," (with Timothy J. Richards), *Management Science* 55(8), August 2009, pp. 1368-76.

"Excise Taxes with Multi-Product Transactions," *American Economic Review* 99(1), March 2009, pp. 458-71.

"Vertical Restraints and Horizontal Control," (with Robert Innes), *RAND Journal of Economics* 40(1), Spring 2009, pp. 120-43.

"Informative Advertising in Concentrated, Differentiated Markets," *International Journal of Industrial Organization* 27(1), January 2009, pp. 60-69.

"Unintended Consequences: The Spillover Effects of Common Property Regulations," (with Gordon Rausser, Marty Kovach, and Ryan Stifter), *Marine Policy* 33(1), January 2009, pp. 24-39.

"Marketable Permits, Low-Sulfur Coal, and the Behavior of Railroads" (with Shelby Gerking), *American Journal of Agricultural Economics* 90(4), November 2008, pp. 933-50.

"Fast Food, Addiction and Market Power," (with Timothy J. Richards and Paul M. Patterson), *Journal of Agricultural and Resource Economics* 32(3), December 2007, pp. 425-47.

"Green Markets, Eco-Certification, and Equilibrium Fraud" (with David Zilberman), *Journal of Environmental Economics and Management* 52(3), November 2006, pp. 627-44.

"Rivalry in Price and Variety among Supermarket Retailers," (with Tim Richards), *American Journal of Agricultural Economics* 88(3), August 2006, pp. 710-27.

“Naked Slotting Fees for Vertical Control in Multi-Product Retail Markets,” (with Robert Innes), *International Journal of Industrial Organization* 24(2), March 2006, pp 308-18.

“The Transition from Dirty to Clean Industries: Optimal Fiscal Policy in a Two Sector Model of Endogenous Growth,” (with Steven Cassou), *Journal of Environmental Economics and Management* 48(3), November 2004, pp. 1050-77.

“Vertical Structure and Strategic Environmental Trade Policy,” (with Till Requate), *Journal of Environmental Economics and Management* 47(2), March 2004, pp. 260-69.

“Slotting Allowances as a Facilitating Practice by Food Processors in Wholesale Grocery Markets: Profitability and Welfare Effects,” *American Journal of Agricultural Economics* 85(4), November 2003, pp. 797-813 (***lead article***).

“Public Goods and the Value of Product Quality Regulations: The Case of Food Safety,” (with David Sunding, and David Zilberman), *Journal of Public Economics* 87(3-4), March 2003, pp. 799-817.

“An Empirical Test of the Rent-Shifting Hypothesis: The Case of State Trading Enterprises,” (with Kyle Stiegert), *Journal of International Economics* 58(1), October 2002, pp. 135-57.

“Strategic Environmental Policy and International Trade in Asymmetric Oligopoly Markets,” (with Yann Duval), *International Tax and Public Finance* 9(3), May 2002, pp. 259-71.

“Product Liability, Entry Incentives and Market Structure,” (with David Sunding), *International Review of Law and Economics* 20(2), June 2000, pp. 269-83.

“Vertical Coordination, Antritrust Law, and International Trade,” (with Kyle Stiegert), *Journal of Law & Economics* 43(1), April 2000, pp. 143-56.

“Does Market Timing Contribute to the Cattle Cycle,” (with Terry Kastens), *American Journal of Agricultural Economics* 82(1), February 2000, pp. 82-96.

“The Comparative Incidence of Specific and Ad Valorem Taxation in Noncompetitive Environments,” *Economics Letters* 63(2), May 1999, pp. 235-38.

“Tax Incidence under Oligopoly: A Comparison of Policy Approaches,” *Journal of Public Economics* 71(2), February 1999, pp. 233-46.

“Demand Shifts and Market Structure in Free-Entry Oligopoly Equilibria,” *International Journal of Industrial Organization* 17(2), February 1999, pp. 259-75.

“Returns to Public Investments in Agriculture with Imperfect Downstream Competition,” (with David Sunding), *American Journal of Agricultural Economics* 80(4), November 1998, 830-38.

“Taxation, Fines, and Producer Liability Rules: Efficiency and Market Structure Implications,” *Southern Economic Journal* 65(1), July 1998, pp. 140-50.

"Subsidies in Oligopoly Markets: A Welfare Comparison between Symmetric and Asymmetric Costs," (with Rickard Sandin), *Public Finance Review* 25(6), November 1997, pp. 660-68.

"The Effect of Farm Supply Shifts on Concentration and Market Power in the Food Processing Sector," (with David Sunding), *American Journal of Agricultural Economics* 79(2), May 1997, pp. 524-31.

Articles Submitted to Refereed Journals

"Optimal Deterrence of Environmental Accidents Under Oligopoly," (with Harrison Ridland and David Sunding), March 2023.

"Spatial Procurement of Farm products and the Supply of Processed Foods: Application to the Tomato Processing Industry," (with Aric Shafran and Ethan Ligon), resubmitted on request of the editor of the *Review of Industrial Organization*, June 2022.

Working Papers

"Food Banks and Food Waste," (with John Lowrey and Timothy Richards).

"Sequential Pricing in Platform Markets: Implications for Antitrust," (with Philippe Bontems and Jason Lepore).

"Can Consumer Boycotts Backfire When Retailers Mediate Sales? The Case of Microbead Toothpaste," (with Jackie Doremus and Timothy Richards).

Work in Progress

"Environmental Policy through Permitting and Licensing," (with Cyrus Ramezani and David Sunding).

"Vertical Integration in Oligopoly Supply Chains," (with David Zilberman).

"Capacity-Setting Games in Differentiated Product Oligopoly," (with Jason Lepore).

"Product Quality Choices with Umbrella Brands," (with Robert Innes and Vincent Requillart).

Other Research Publications

"Food Waste: Farms, Distributors, Retailers, and Households," (with Tim Richards and Brian Roe), in C. Barrett and D. Just (Eds.), *Handbook of Agricultural Economics*, Vol. 6, North-Holland: Elsevier, June 2022, pp. 4653-4703.

"Economic Impact of Offshore Wind Farm Development on the Central Coast," (with Chris Almacen, Cyrus Ramezani, and Ben Stephan), February 2021.

"Economic and Fiscal Impacts of the Morro Bay Offshore (MBO) Wind Farm," May 2018.

"Keys to Estimating Damages in Deceptive Pricing cases," (with Dan Werner), *Law360*, Lexis-Nexis, September 22, 2017: https://www.law360.com/articles/966658/

"Economic and fiscal impacts of the Topaz Solar Farm," (with Mark Berkman), *The Battle Group*, March 2011.

"Economic Benefits of Expanded Groundwater Storage in the Central and West Coast Basins of Southern Los Angeles County," (with David Sunding and Newsha Ajami), in Angelos Findikakis and Kuniaki Sato (eds.) *IAHR Monograph on Groundwater Management Practices*, Leiden, Netherlands: CRC Press/Balkema – Taylor & Francis Group, 2011, pp. 157-77.

"Backwards Linkages and Strategic Firm Behavior: An Application to International Trade," (with Kyle Stiegert), in G. Galizzi and L. Venturini (Eds.), *Vertical Relationships and Coordination in the Food System*, Heidelberg: Physica-Verlag, 1999, pp. 113-28.

Hamilton, Stephen F. Book Review of Perloff's *Microeconomics*, in the *American Journal of Agricultural Economics*, November 1999, 81(4), pp. 225-26.

PRESENTATIONS

Selected Conference Presentations

"Optimal Deterrence for Environmental Damage under Asymmetric Information," American Agricultural Economics Association Annual Meeting, August 2022.

"Food Banks and Retail Margins," American Agricultural Economics Association Annual Meeting, August 2021.

"Food Banks and Food Waste," Allied Social Science Association Annual Meeting, January 2020.

"Retail Price Discrimination and Food Waste," 10th Conference on Industrial Organization and the Food Industry, June 2019.

"Keeping Food out of Landfills," ***Keynote Address***, *TRANSFORuM: Industry Pioneers & Visionaries,* Waste Expo, May 2019.

"Retail Price Discrimination and Food Waste," 17th Annual International Industrial Organization Conference, April 2019.

"Food Waste in Upstream and Downstream Markets of the Food System." American Agricultural Economics Association Annual Meeting, August 2018.

"Food Waste and the Sharing Economy." American Agricultural Economics Association Annual Meeting, August 2018.

"Food Waste and the Sharing Economy." Allied Social Science Association Annual Meeting, January 2018.

"Retail Market Power in a Shopping basket Model of Supermarket Competition." American Agricultural Economics Association Annual Meeting, August 2017.

"Pricing Complementary Products." American Agricultural Economics Association Annual Meeting, August 2016.

"Online Attribute Search and Retail Prices." American Agricultural Economics Association Annual Meeting, July 2015.

"Investment Incentives and Environmental Permit Uncertainty." Western Economic Association International 89th Annual Conference, June 2014.

"Environmental Policy with Collective Waste Disposal," 29th Annual Conference of the European Association of Environmental and resource Economists, Toulouse France, June 2013.

"Oligopoly Intermediation, Strategic Pre-Commitment and the Mode of Competition," ***Keynote Address***, 3rd GAEL Conference, Product Differentiation and Innovation, Grenoble France, June 2013.

"How do Supermarkets Respond to Brand-Level Demand Shocks? Evidence from the German Beer Market." Allied Social Science Association Annual Meeting, January 2013.

"Slotting Allowances and Variety Provision in Supermarket Retailing." Allied Social Science Association Annual Meeting, January 2013.

"Social Networks and New Product Choice." American Agricultural Economics Association Annual Meeting, August 2012.

"Oligopoly Intermediation, Strategic Pre-Commitment and the Mode of Competition." Western Economic Association International 87th Annual Conference, June 2012.

"Slotting Allowances and Product Variety in Supermarket Retailing." Industrial Organization and the Food Processing Industry, INRA-IDEI, Toulouse, France, June 2012.

"Emissions Standards and Ambient Environmental Quality Standards in Stochastic Receiving Media." Allied Social Science Association Annual Meeting, January 2011.

"Slotting Allowances and Product Variety in Supermarket Retailing." American Agricultural Economics Association Annual Meeting, July 2010.

"Long-Run Contracts, Conjunctive Use, and Imported Water Demand." Berkeley Water Consortium, University of California at Berkeley, November 2009.

"How Does Advertising Affect Market Demand? The Case of Generic Advertising." American Agricultural Economics Association Annual Meeting, July 2009.

“Advertising and Market Power.” Western Economic Association International 83rd Annual Conference, June 2008.

“Comparative Statics Effects for Supermarket Oligopoly with Applications to Sales Taxes and Slotting Allowances.” American Agricultural Economics Association Annual Meeting, July 2007.

“Can Manufacturers of National Brands Control Retail Prices of Private Labels?” American Agricultural Economics Association Annual Meeting, July 2006.

“Retail Competition in Prices and Varieties.” American Agricultural Economics Association Annual Meeting, July 2005.

“From Green Markets to Black Markets: Environmental Regulations and the Emergence of Illicit Activities.” Food System Research Group, University of Wisconsin, Madison, WI, June 2005.

“Variety Competition in Retail Food Markets.” Industrial Organization and the Food Processing Industry, INRA-IDEI, Toulouse, France, June 2004.

“Advertising in Differentiated Markets.” Food System Research Group, University of Wisconsin, Madison, WI, June 2003.

“Retailer Contracting.” American Agricultural Economics Association Annual Meeting, July 2002.

“Vertical Structure and Strategic Environmental Trade Policy.” World Congress of Environmental and Natural Resource Economists, Monterey, CA, June 2002.

“Facilitating Practices by Food Processors in the Retail Grocery Market: Channel Profitability and Farm Surplus Effects of Off-Invoice Fees.” American Agricultural Economics Association Annual Meeting, August 2001.

“The Transition from Dirty to Clean Industries: Optimal Fiscal Policy in a Two-Sector Model of Endogenous Growth,” International Dimension of Environmental Policy Conference, Dutch Science Foundation/EURESCO, Kerkrade, Holland, October 2000.

“Pollution Abatement Regulation, Property Rights, and the Political Economy,” Western Economic Association International 75th Annual Conference, June 2000.

“Trade, Environmental Externalities, and Taxes in Unions, Federations, and Free Trade Areas,” American Agricultural Economics Association Annual Meeting, August 1999.

“Taxation, Fines, and Producer Liability Rules: Efficiency and Market Structure Implications,” American Agricultural Economics Association Annual Meeting, August 1998.

“Asymmetric Pricing and a Test for Market Power in the International Durum Wheat Market,” American Agricultural Economics Association Annual Meeting, August 1998.

"Beating the Cattle Cycle," Cattle Profitability Conference, Kansas State University, August 1997.

"Returns to Public Investments in Agriculture with Imperfect Downstream Competition," American Agricultural Economics Association Annual Meeting, August 1997.

"Backwards Vertical Contracts and the Strategic Trade Implications of Antitrust," American Agricultural Economics Association Annual Meeting, August 1997.

"Vertical Coordination and Export Promotion in International Wheat Markets," American Agricultural Economics Association Annual Meeting, August 1997.

"Product Liability, Entry Incentives and Market Structure," Western Economic Association International 72nd Annual Conference, July 1997.

"Backwards Linkages and Strategic Firm Behavior: An International Trade Application," Vertical Relationships and Coordination in the Food System Conference, Italy, June 1997.

"The Effect of Farm Supply Shifts on Concentration and Market Power in the Food Processing Sector," American Agricultural Economics Association Annual Meeting, August 1996.

Other Invited Presentations

California Polytechnic (2), Cornell University, Economic Research Service (ERS), Iowa State University, Kansas State University, Northeastern University, Oregon State University, Politecnico di Milano, Purdue University (2), Stockholm School of Economics, Toulouse School of Economics (3), University of Arizona (3), University of the Basque Country, University of California at Berkeley (5), University of California Davis (3), University of California Merced (2), University of California Santa Barbara (3), University of Central Florida (2), University of Heidelberg, University of Kiel, University of Maryland, University of Massachusetts, University of Nebraska (2), University of South Florida, University of Wisconsin (3).

RESEARCH AND INSTRUCTION GRANTS

Principal Investigator, Vistra Corp., $58,974, "Economic Impact of Vistra's Battery Energy Storage Systems (BESS) in California," 2022.

Principal Investigator, REACH dba the Hourglass Project, $74,998, "Economic Impact of Offshore Wind Power Development on the Central Coast," (with Cyrus Ramezani), 2020-2021.

Principal Investigator, Agriculture and Food Research Initiative, USDA-NIFA 2019-05808, $498,223, "Food Banks, Food Retailing and Food Security," (with Craig Gundersen and Timothy J. Richards), 2020-2022.

Principal Investigator, Agriculture and Food Research Initiative, USDA-NIFA 2018-08525, $499,973, "Immigration Reform and Labor Shortages," (with Jennifer Ifft, Timothy J. Richards, Aric Shafran and Kathryn Vasilaky), 2019-2021.

Principal Investigator, Agriculture and Food Research Initiative, USDA-NIFA 2018-08126, $498,434, "Big Data and Food Loss Mitigation in the Supply Chain," (with Miguel Gomes and Timothy J. Richards), 2019-2021.

Principal Investigator, Trident Winds, LLC, $25,309, "Economic Impact Analysis of the Proposed Morro Bay Offshore (MBO) Wind Farm," 2017-2018.

Principal Investigator, Agriculture and Food Research Initiative, USDA-NIFA 2016-09921, $498,438, "Commercial Peer-to-peer Mutualization Systems (CPMS) to Eliminate Food Waste," (with Elliot Rabinovich and Timothy J. Richards), 2017-2018.

Principal Investigator, Department of the Interior - Bureau of Ocean Energy Management, $749,999, "Scenarios for Replacing Conventional Energy with Offshore Renewable Energy along the Central California Coast," (with Benjamin Ruttenberg, Crow White, Ryan Walter, and Susan Zaleski), 2016-2019.

Principal Investigator, Texas Comptroller, $247,306, "An Evaluation of Potential Economic Impacts Resulting from Flows for Freshwater Mussels: An Update Using Best Available Science and Modeling," (with Brad Wolaver, Brian Perkins, and Sam Vaugh), 2016-2017.

Principal Investigator, Agriculture and Food Research Initiative, USDA-NIFA 2015-07543, $482,831, "Online Retailing and Local Food," (with Miguel I. Gomez, Elliot Rabinovich, and Timothy J. Richards), 2016-2017.

Principal Investigator, California Air Resources Board, $249,983, "The Impact of AB32 on the Competitiveness of California Food Processing Industries," (with Ethan Ligon and Sofia Berto Villas-Boas), 2013-2014.

Principal Investigator, Element Power Solar Company, $25,000, "Economic Impact Analysis of the Proposed California Flats Solar Project," 2012-2013.

Principal Investigator, Agriculture and Food Research Initiative, USDA-NIFA 2011-02763, $387,365, "Consumer Search and Retail Pass Through: Implications for Food Price Inflation," (with Timothy J. Richards), 2011-2013.

Principal Investigator, Agriculture and Food Research Initiative, USDA-CREES 2010-65400-20441, $309,377, "Farm-Retail Price Transmission in Multi-Product Retail Environments," (with Timothy J. Richards), 2010-2011.

Principal Investigator, Agriculture and Food Research Initiative, USDA-CREES 2010-65400-20487, $268,068, "Equilibrium Price and Design of New Food Products in a Social Network," (with Timothy J. Richards), 2010-2011.

Principal Investigator, University of Wisconsin Madison P685510 (USDA Prime 2006-34101-18999), $35,839, "Pricing Relationships in the Food Retail Sector," 2006-2008.

Principal Investigator, University of Wisconsin Madison P685661 (USDA Prime 2005-34101-15664), $16,489, "Price and Advertising Relationships in the Food Retail Sector," 2005-2006.

Principal Investigator, U.S. Department of Agriculture, National Research Initiative Competitive Grants program, $180,697, "Competitive Interactions Among U.S. Retailers: A New Approach," (with Timothy J. Richards and Paul Patterson), 2005-2006.

Principal Investigator, University of Wisconsin Madison P622753 (USDA Prime 2004-34101-14559), $28,434, "Variety Competition in Retail Grocery Markets," 2004-05.

Principal Investigator, University of Wisconsin Madison P540503 (USDA Prime 2001-34101-10526), $44,632, "Advertising Agreements in a Market with Differentiated Products and Imperfect Competition," 2002-2004.

Principal Investigator, University of Wisconsin Madison P540433 (USDA Prime 2001-34101-10526), $28,978, "Retailer Contracting," 2002-2003.

Principal Investigator, U.S. Department of Agriculture, National Research Initiative Competitive Grants program, $98,130, "Empirical Tests of STE Leadership Behavior in International Grain Markets," with Kyle W. Stiegert, 2001-2003.

Principal Investigator, California Tree Fruit Agreement, $11,129, "Evaluating a Grading System: California Soft Fruit," June 2000-2001.

SERVICE CONTRIBUTIONS

National Committees and Leadership

Galbraith Award Committee, American Agricultural Economics Association, 2017-present.

Publication of Enduring Quality Award Committee, American Agricultural Economics Association, 2018-present.

Annual Award Committee, American Agricultural Economics Association, 2015-2019.

Trust Committee, American Agricultural Economics Association, 2016-2018.

Chair, Quality of Research Discovery Award Committee, American Agricultural Economics Association, 2013-2016.

Outstanding Published Research Committee, Western Agricultural Economics Association, 2015.

Reviewer, selected paper program, American Agricultural Economics Association annual meeting, 2005.

Best Article Award Committee, American Agricultural Economics Association, 2001-05.

Outstanding Masters Thesis Award Committee, American Agricultural Economics Association, 2001-04, 2013-2015.

Topic Leader for selected paper sessions in Environmental Economics, American Agricultural Economics Association annual meeting, August 1999.

Panel Member, Sustainable Management Panel, Tallgrass Prairie National Preserve (Strong City, KS), U.S. Department of the Interior, National Park Service, 1998.
Co-Chair, Western Agricultural Economic Association annual meeting, 1997.

Ad Hoc Reviewer: *Agricultural and Resource Economic Review, Agribusiness: An International Journal*, *American Journal of Agricultural Economics, American Economic Review, American Economic Journal –Policy, Applied Economic Perspectives and Policy, B.E. Journal of Economic Analysis and Policy, B.E. Journal of Theoretical Economics, Canadian Journal of Economics, Contemporary Economic Policy, Economic Geography, Economic Inquiry, Economic Theory Bulletin, Economics Bulletin, Economics Letters, Environmental & Resource Economics, European Economic Review, European Review of Agricultural Economics, Food Policy, Games and Economic Behavior, International Economic Review, International Journal of Economics and Business, International Journal of Industrial Organization, International Tax and Public Finance, Journal of Agricultural and Applied Economics, Journal of Agricultural & Food Industrial Organization, Journal of Agricultural and Resource Economics, Journal of the Association of Environmental and Resource Economists, Journal of Cleaner Production, Journal of Economic Education, Journal of Economics, Journal of Economics & Management Strategy, Journal of Environmental Economics and Management, Journal of Food Products Marketing, Journal of Industry, Competition and Trade, Journal of the Political Economy, Journal of Public Economic Theory, Journal of Public Economics, Journal of Public Policy and Marketing, Journal of Regulatory Economics, Journal of Retailing, Journal of Retailing and Consumer Services, Journal of Wine Economics, PLOS One, Proceedings of the National Academy of Science, Public Finance Review, Managerial and Decision Economics, Management Science, RAND Journal of Economics, Resource and Energy Economics, Review of Economic Studies, Review of Industrial Organization*

University and College
Faculty Council, Orfalea College of Business, Cal Poly, 2023-present
Distinguished Scholarship Committee, Cal Poly, 2022-present
Chair, Graduate Program Committee, Orfalea College of Business, Cal Poly, 2021-2023
Dean Search Committee, Orfalea College of Business, Cal Poly, 2020-21
Graduate Program Committee, Orfalea College of Business, Cal Poly, 2020-21
Faculty Affairs Committee, Orfalea College of Business, Cal Poly, 2007-2009, 2016-2009.
Chair, Dean Search Committee, Orfalea College of Business, Cal Poly, 2014-2015
Graduate Programs Committee, Orfalea College of Business, Cal Poly, 2004-05.
Research Incentive Award Committee, College of Business, UCF, 2003-04.
Promotion and Tenure Committee, College of Business, UCF, 2001-04.
Conference Organizer, New Perspectives in Environmental Economics, UCF, November 2001.
Faculty Advisor, UA Cycling Club, 2000-01.
KSU National Wheat Research Center Proposal Committee, 1998-99.
College of Agriculture Honors Advisory Committee, 1997-99.
KCARE Water Quality Committee, 1996-99.
KCARE Water Management Committee, 1996-99.

Department
Curriculum Committee, Economics Department, Cal Poly, 2004-present.
Assessment Committee, Economics Department, Cal Poly, 2007-present.
Faculty Search Committee, Economics Department, Cal Poly, 2021-22.

Director of Graduate Studies, Economics Department, Poly, 2016-2019.
Faculty Search Committee, Economics Department, Cal Poly, 2015-2016.
Faculty Search Committee, Economics Department, Cal Poly, 2013-2014.
Faculty Search Committee, Economics Department, Cal Poly, 2007-2008.
Chair, Faculty Search Committee, Economics Department, Cal Poly, 2006-2007.
Faculty Search Committee, Economics Department, Cal Poly, 2005-2006.
Faculty Search Committee, Economics Department, Cal Poly, 2004-05.
Director of Graduate Studies, Economics Department, UCF, 2001-04.
Ph.D. Program Committee, Economics Department, UCF, 2002-04.
Graduate Committee, Economics Department, UCF, 2001-04.
Chair, Faculty Search Committee, Economics Department, UCF, 2002-03.
Seminar Committee, Economics Department, UCF, 2001-02.
Faculty Search Committee, Economics Department, UCF, 2001-02.
Graduate Committee, UA, 2000-01.
Seminar Committee, Co-Chair, UA, 1999-2000.
Graduate Committee, 1998-99.
General Preliminary Examination Committee, 1998-99.
Natural Resources Preliminary Examination Committee, 1998-99
Research Alliance, Farmland Industries, Inc., 1998-99.
Senior Advisor, Agricultural Economics / Agribusiness Club, 1998-99.
Agricultural Economics Graduate Program Committee, 1998-99.
Junior Advisor, Agricultural Economics / Agribusiness Club, 1997-98.
Seminar Committee, 1997-98.
Office of Local Government Extension Assistant Search Committee, 1997.
Seminar Committee Co-Chair, 1996-97.

INDUSTRY CONSULTING AND LITIGATION EXPERIENCE

Consulting experience (1994 – present) in the measurement of economic damages, complex litigation, antitrust, market analysis of regulated industries, economic feasibility studies, environmental and land use regulation, forensic economics, groundwater basin management, and portfolio investment modeling.

Appendix B

Testimony in the Past Four Years

Testimony in the Past Four Years

Josephine Loguidice and Emilie Norman v. Gerber Life Insurance Co., No. 7:20-cv-03254-KMK, (S.D. New York)

- Expert Declaration for Rebuttal of Class Certification
- Deposition

Robin G. Thorton et al. v. The Kroger Co., No. 1:20-CV-1040 JB/LF, (District of New Mexico)

- Expert Declaration for Rebuttal of Class Certification

Metrolink Train Accident Cases (Consolidated), No. BC607964 (Cal Sup, L. A.)

- Expert Declaration
- Deposition

Autumn La Macchia, Laci La Macchia v. Ramiro Guzman Rojas et al., No. 21-cv-001324, (Cal Sup, Monterey)

- Expert Report
- Deposition
- Trial Testimony

David Moore D/B/A Moore Family Farms, et al. v. C.H. Robinson Worldwide, Inc., No. 20-cv-252 PJS/HB, (District of Minnesota)

- Expert Report
- Deposition

In Re. KIND LLC "Healthy and All Natural" Litigation, No. 15-MD-02645-WHP, (S.D. New York)

- Expert Declaration for Class Certification
- Deposition
- Expert Declaration for Damages
- Deposition

Kathleen Smith et al. v. Keurig Green Mountain, Inc., No. 18-CV-06690-HSG, (N.D. Cal.)

- Expert Declaration for Class Certification
- Expert Declaration on Damages

James Jackson v. Connor Johnson et al., No. 17-08593, (Cal Sup, San Luis Obispo)

- Expert Report

In Re. FieldTurf Artificial Turf Marketing and Sales Practices Litigation, No. 17-2779-MAS- TJB, (Dist. New Jersey)

- Expert Declaration
- Deposition

Chris Goldie, Steven Goldie and Shasta Teekat v. Reynolds Resorts Partners, LLC, No. 30-2017-00951303-CU-BT-CJC, (Cal Sup, Orange)

- Expert Report
- Deposition
- Trial Testimony

Richard Best Transfer, Inc. v. Mahlenium Insurance Services, Inc., No. 18 CE CG 02797, (Cal Sup, Fresno)
- Expert Declaration
- Deposition

Jijun Yin v. Aguiar, SCWC-15-0000325, (Hawaii Sup)
- Mediation Brief

Michael Hester et al. v. Walmart, Inc., No. 5:18-CV-05225, (W.D. Ark.)
- Expert Declaration

T.N. Cattle Co., Inc. v. National Audubon Society, 2:19-AT-00085 (E.D. Cal.)
- Mediation Brief

Kara Flick v. Francisco Javier Reyes et al., No. 17-cv-03850 (Cal Sup, Santa Barbara)
- Expert Report
- Deposition
- Trial Testimony

Calftech Corp. v. Zoetis, Inc. and Nutrius, LLC, No.: VCU273468 (Cal Sup, Tulare)
- Expert Report
- Deposition

Kathleen Holt, et al. v. Foodstate, Inc., No. 1:17-cv-00637-LM (District of New Hampshire)
- Expert Declaration

Diane Hultquist v. State Farm Mutual Automobile Insurance Co., No. 55-1627-5M1 (Cal. Sup, Santa Barbara)
- Expert Report
- Deposition
- Arbitration Testimony

Matthew John, et al. v. Am Retail Group, Inc., et al., No. 17-cv-727-JAH-BGS (S.D. Cal)
- Expert Declaration

Tess Trudgeon v. Santa Margarita Adventures, No. 15-cvp-0242 (Cal. Sup, San Luis Obispo)
- Expert Report
- Deposition

Appendix C

Materials Relied Upon

Materials Relied Upon[1]

Legal

First Amended Application to Transfer Water from Edwards County, Kansas to the Cities of Hays and Russell, Kansas. *In the matter of the application of the Cities of Hays and Russell, Kansas for approval to transfer water from Edwards County pursuant to the Kansas Water Transfer Act*, Pursuant to K.S.A. 82a-1501, *et seq.* (May 20, 2019) and related exhibits.

K.S.A. § 82a-1501(a)(1).

K.S.A. § 82a-1502(a).

K.S.A. § 82a-1502(c)(3)

Master Order Contingently Approving Change Applications Regarding R9 Water Rights. *In the matter of the City of Hays' and the City of Russell's Applications for Approval to Change the Place of Use, the Point of Diversion, and the Use Made of the Water Under an Existing Water Right* (Mar. 27, 2019).

Relevant Produced Documents

Basara, Jeffrey. "Drought Impacts and Risk to Water Resources in the Smoky Hill Watershed." (May 11, 2023).

Declaration of Kevin D. Waddell relating to probable construction costs (March 9, 2023).

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Letter from Paul McCormick (Burns & McDonnell) to Toby Dougherty (City of Hays), *Re: R9 Ranch Conceptual Development Summary* (May 7, 2015).

Letter from the Cities to David Barfield and Brent Turney, *Re: Hays/Russell Water Transfer – Change applications for water right files numbered: 21,729; 21,730; 21,731; 21,732; 21,733; 21,734; 21,841; 21,842; 22,325; 22,326; 22,327; 22,329; 22,330; 22,331; 22,332; 22,333; 22,334; 22,335; 22,338; 22,339; 22,340; 22,341; 22,342; 22,343; 22,345; 22,346; 27,760; 29,816; 30,083; and 30,084* (June 25, 2015).

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[1] In preparing my report, I relied upon the documents listed here along with any items cited or referenced in the body and footnotes of my report.

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Memorandum from Jeff Crispin, Director of Water Resources, *Water Production Cost Per Year – City of Hays* (Apr. 6, 2021).

Memorandum from Jeff Crispin, Director of Water Resources, *Water Usage by Customer Class* (Feb. 5, 2021).

Memorandum from Jon Quinday, City Manager, *Water Usage by Customer Class* (Feb. 4, 2021).

Memorandum from Jon Quinday, City Manager, *Water Usage by Customer Class* (Feb. 10, 2021).

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"Sales Tax Receipts, City of Hays, General Fund 1.25%." *City of Hays* (2018-2022).

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