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Session 2: Scarcity Beyond the Farm Gate

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Thank you so much, it's great to be back in Kansas City after number of years of not having come here. The driver last night pointed out the new free streetcar service that you've gotten in the city. So the streetcar is priced free. I went and took a ride on it early this morning, and it was priced free so that we increase ridership in the city and get it to be more fully utilized resource. For those of you in the room who work on water as most of your profession will recognize that paradigm— pricing a resource well below cost in order to get it actively used and spread economic development in the area. What we haven't done such a good job on, that you may do here in Kansas City with your streetcar, is make a transition to pricing that reflects changing scarcity values over time, and this signals the value of that resource across multiple types of use.

So my job is to provide an overview of points that will lead to a fruitful discussion on other water using sectors, how their water needs and their adaptations to water scarcity have implications for the agricultural sector. And so thinking about who those key non-agricultural sectors are, there is of course the urban sector which would include small businesses, commercial uses, small industry, and residential use within urban areas. The energy sector, very important, I'll emphasize, because any time that we managed to reduce energy consumption where very likely also reducing water consumption in that region. So considering the impacts between water and energy, often referred to as a water-energy nexus, is an important part of our responsibility in thinking about implications for agriculture and addressing opportunities to reduce water consumption in different regions.

So the energy sector doesn't look like a big chunk when we look at the pie charts in a few minutes, and it's very important that it has very direct linkages to water consumption.

*Please see the corresponding paper and/or presentation available at www.kansascityfed.org/publications/research/rscp/rscp-2016 for additional detail and referenced charts.

Industrial sector, which of course is a very broad category, including mining, manufacturing, and all kinds of other industrial operations. Then the environmental sector also won't show significantly on the water withdrawal graphs, that you have in your handouts, but the environmental sector is incredibly important in driving policy and creating different kinds of constraint of water use and all the other sectors, hopefully in general, to support public values related to habitat, clean water and water for recreation.

I'll talk a little bit about adaptation, so scarcity at the general level. We have several other experts on this panel who think hard about municipal and industrial water uses, and will also talk about adaptation. And then I'll also be again emphasizing the theme of water trading as an adaptation mechanism, the ways in which that's influenced agriculture especially in the Western United States where trading is active and has made some interesting changes in incentive signals related to water use. And then simply concluding with the little few thoughts on navigating the changing water future.

So I learned to my dismay that the printouts actually had some problems, but we are, we were able to correct them and show a graph version here in terms of different water using sectors. Okay, water withdrawal by category, pie charts in the world, if you look at U.S. versus the world, you notice agriculture is a much smaller subset of water withdrawals than it is globally. The urban sector is somewhat similar in percentage. Energy sector is broken out in the data that we have at the national level in the United States. Not so for the world sector; to have that level of detail, you'd have to go into much smaller subregions on the world scale. But you can see kind of a general configuration. Urban sector is small as a portion of the pie, but of course important for social stability, for the economic engines that drive those urban areas. And the industrial sector differs quite a bit both in its nature and the amount of water withdrawals it accounts for in the US versus the world.

Water withdrawals by categories in Federal Reserve Bank districts, I picked this to think about of how different parts of the United States differ from one another. We've got

Federal Reserve District 10 which we are sitting in, Kansas City as its headquarters, with urban you said only 4 percent; and then the area that represents the urban Southwest, California, the Pacific Northwest, District 12 has urban use rates of 14 percent of the total. Again, the green area on these graphs isn't large relative to the blue area representing agriculture, but the fact that we have proportionally 3.5 percent more urban water use in some parts of the United States than others has a huge amount of implication for competition for water in the ways that that might be communicated to agriculture. Water use by sector— again, this one focusing on the United States, and this is a very broad brush overview. One of the interesting things we see here is changes in the thermal electric sector, that's the light orange on the bottom of the graph, the way water is been used in that sector over several decades. That's mostly power plant cooling water. Now especially in areas where water costs are increasing, water values are increasingly transmitted through different kinds of incentive signals. There's a lot more emphasis on using that cooling water multiple times and having finer tuned more water, more intensive technologies for recycling cooling water.

You notice the declining per capita use in the United States that began way back in the 1980s is driven by a number of factors, including declining per capita use in the municipal areas, partly that's due to new housing stock, different landscape preferences, also changes in agriculture and in industrial water use. So we have declining per capita use in the United States, and declining use, you can specifically see in the thermal electric sector, and also to a certain degree in the municipal sectors. So this graph is meant to remind you of the point that several other speakers have already raised. As we look at adaptation mechanisms, we want to think about, are we creating net new water available for other uses, or are we merely changing the amount of water that has to be applied but were not increasing the amount that's made available downstream? So I guess the key point here is that water savings approaches, as we call them, it might not free up water for other purposes.

As we think about adaptations, we want to focus where possible on reducing water consumption; we want that water to be available for habitat, that water to be available under a voluntary agreement with an irrigation district or an individual farmer to be able to, for urban use, during a drought for instance. How do we reduce the consumptive aspect of water, not merely the withdrawals aspects? And conveniently, most water data at state, federal, national scales is available on water withdrawals. This is something we're working on in the United States and elsewhere in the world, how can we more carefully account for the consumptive portion of water use and track that when water moves to new uses? Most of our state water, change of water right processes in the United States will look at the consumptive use carefully when a water right is formally changed. This change of water right processes tend to be slow and cumbersome. They're good for permanent transfers like when a city needs a block of water to support urban growth over the long haul, but I would argue that a lot of the economic resilience and the benefits of the ability to adapt to water scarcity comes from short-term transfers made with a little bit of lead-time. For example, in our basins around the world that rely on snowpack, we see in April we've got a lousy snowpack. What are the arrangements we can make in April and May so that the high-value water users can make it through the summer without a lot of economic loss and damage in their regional economies? So as we think about this temporary and intermittent transfers, to keep local economies robust, we've got to be thinking about water savings in terms of withdrawals, and consumption.

So adaptation to scarcity, the water conserving practices and technologies available in the various major industrial uses, as well as in your urban use, and of course as well as in agriculture, are always evolving. They are numerous, they differ by sector, they differ by part of the world. For me as an economist, what I think really is worth focusing on in this group is the incentives that drive those adaptations. What is it that makes a group invest in a different kind of urban water recycling technology? There all the capital expenses. Go

through the process of getting a new plant permitted. What kind of incentives does it require to stretch a region's water supplies in a different way?

So not focusing on the practices and the technologies in this talk, I mentioned them a little bit in the paper, some of the other panelists for the other sessions will also have something to say about that. I would say their incentives are the key. And this little diagram at the bottom is probably familiar to most of you who were dragged through one or two microeconomics classes. When water demand in the region, for example, is moving upward and outward, usually you'd expect price to adjust to reflect that. If you have a system of allocating and managing water where price doesn't reflect the increased value of the water, that's going to have to come out in some other form of incentive. So if water costs and prices don't reflect scarcity, we've got an issue and it's going to have to be some other mechanism that decides who gets water, those existing what I would call now artificially low prices that aren't reflecting scarcity.

So other kinds of incentives that signal water scarcity, one thing economists would love to be able to do is be able to gradually alter water rates over time in a way that sends the scarcity signal that is simply a signal about covering the cost of infrastructure, the energy, and other costs to deliver water. But water costs are paid by end-users in lots of different ways. Many farmers are drawing from private wells. Those costs rely on energy costs. Urban water users pay water bills, many of us in the room get a water bill. There's been some very good studies that show that most of us don't know how to interpret our water bill, and couldn't really say what an additional unit of use within a particular month would cost us so that we could make a decision on whether it's worth it to be using water in that particular way.

So water costs paid by end-users can be useful as a policy instrument to send scarcity signals in certain circumstances, but those circumstances are relatively rare. They're relatively rare in the urban sector; most water utilities change their rates because they've got

to think carefully about the revenue stability, but not really thinking about shifts in water supply and demand in their region, try to signal that kind of scarcity. In my view, that's the best kind of mechanism for signaling scarcity that's changing over seasons and water years in a region, whereas if you do have active trading and water entitlements in a region, and the value of that water goes up and down over time reflecting wet and dry years, reflecting the entrance of a new major water user in the region. And that happens in some areas in the United States.

A third category I've labeled on this slide is all these non-priced mechanisms. We pay for water, but we pay for it lots of different ways. We pay for it through a lot of new mandatory cut back regulations, the kind of things that ask you to water your lawn only every other day or several times a week instead of every day, or regulations for industry, other water users, sometimes through agriculture as well. There is a lot of litigation involving water. I take that as an important signal of scarcity. Additional administrative proceedings debating who's got access to the water under what conditions, when do they have to relinquish some of it for endangered species, and political maneuvering, and civil unrest I think we can't underestimate as a source of tension and a high cost when it comes to water. This particular photo is one of my students brought to my attention and this is in Lima, Peru. It's called the wall of shame which is a very strong name for a structure, but it represents two different parts of the city, one of which has no indoor plumbing, the other which is a relatively affluent area with lots of nice landscaping and the ability to use a fair amount of water in a residential setting. Where you have situations where there's a lot of disparity in access to water in the same area, that leads to a lot of hidden costs— costs for business, costs to society, and the functioning of civil discourse and decision-making as well.

I think one of the things that's come out of the California drought, we may hear a little bit more about this from Ellen, is the public and elected officials became much more aware of the very differential impacts of drought, and the hardships created by droughts, on poor

income and largely minority communities versus on larger, wealthier areas. We could have figured that out if we thought about it ahead of time, but the drought really made it clear that one of the things we needed to think about in addressing water scarcity, and thinking about the values signal that's transmitted for water, is some of these disparities in access, just as we were talking about with food. People in different parts of the world want the kinds of conveniences related to water that some of us, certainly myself, take for granted on an everyday basis. I would consider these incentive-like signals.

I have a file on my computer, it's called "Paying for Water," and you to think it would be one of the databases that I have with other names, about water prices over time and how they've changed over several decades, prices at which water traded, what contributes to the changes in those trading prices. But that failed, "Paying for Water," is the other ways we pay for water. Sometimes it's cost of human health, sometimes it's in the course of civil unrest, whereas between different jurisdictions. So I'm going to argue that will be paying for water in regions where we have water scarcity, and it's up to us to configure how we make those payments, and we come up with sort of an orderly system that signals that through financial incentives, or is it going to be coming out in other avenues.

I happened to be in Barcelona when the tankers had to deliver water to the city because their reservoir levels were too low to put water into the city water delivery system. That was in 2008, and that was also a time when they were having a lot of protests over the potential to build a pipeline that would affect a major river system in that part of Spain, on the Catalan, Catalonia, Catalan, and the Ebro River pipeline conflict. So this was a relatively benign conflict; it certainly shut down business and affected business activity during the days that it was going on. But it's these kinds of conflicts and civil unrest that take a more serious turn, that drive me to think about, can we use the economic mechanisms that we've had in a more clear, more workable fashion so that we avoid these other kinds of disruptions.

So water trading is an important scarcity adaptation mechanism, especially for the urban sector, the industrial sector, the energy sector and the non-agricultural sectors. I would argue that by thinking about capital, water and exposure to risk, and this is already come up in a clear way during some of the previous questions in this conference, we can do better in creating resilient local economies. Regional economies are interdependent; most farm households in the United States and other parts of the world also depend on a thriving nonfarm economy. Sometimes it's because household members have jobs in those other economic sectors; others simply the goods and services that are provided between the farm and nonfarm sectors in a region. So the regional economic interdependence leads me to think we need to do a better job at communicating value signals across the water using sectors.

Long term water trading agreements, that is agreements that are set up to go over decades in which water moves out of agricultural use temporarily and under specific water supply circumstances, are one of the things that I would argue are most useful in terms of stabilizing water supplies for off farm water users such as cities and major industries. And those can be structured also to stabilize variation in net farm revenues. In other words, the payments occur in different ways depending on whether or not it's a year in which the water is actually not being consumed by crops, and the payment is made in years in which it is being consumed by crops. So there could be stability; there are some really nice studies on risk management and farm revenues with these kinds of contracts, and they certainly have an impact in terms of risk for water supplies in other sectors. In the paper, I called those, they have several different names; some days we call them dry year option contracts, contingent contracts, water being used on a temporary and intermittent basis to get a regional economy through what would otherwise be a much more devastating hardship due to drought. So I view the ability to make these specialized kinds of arrangements as a pressure relief valve in a regional water system, interacting between the farm and the

nonfarm sector.

We do have water transactions throughout the Western United States, mostly in isolated pockets where water of particular types of entitlements are traded in specific geographic areas. But I thought those of you who don't make your living thinking about water every day might have interest in seeing some kind of transaction patterns. There are a lot of good statistical models that describe these and how prices work in these different areas. But one thing you'll notice is the environmental volume is kind of the brownish orange at the bottom of these bars. Look how it's grown over the years 1987 through the end of this particular database time period 2010, grown quite a bit, municipal participation. These are leases, by the way, meaning these are short-term transactions; they're not permanent changes in the ownership of a water entitlement. The environmental sector has become much more important over these periods, and the volume changes year-to-year. These happen to be seven particular states in the United States, the Colorado River basin in this case but one could create, and in fact I have similar charts, for all of the states in the West. These in particular are interesting and this is a basin that I work quite a bit in and it's done some great innovative things with regard to sharing risk, and risk of exposure to water supply shortages and money.

So water trading in the Western United States is characterized by a few dozen active areas. These areas primarily started out because cities were growing rapidly; sometimes they permanently bought out farming land back during the 1950s. It was most common to buy large tracts of farmland and transfer the water entitlements for urban use, which generated a lot of ill feeling and economic change in the areas where those occurred. But that was part of the initial impetus for water trading in the Western United States, and then high-value agriculture, another impetus for developing active trading mechanisms, environmental needs, including water quality, endangered species, and habitat needs, the need to meet interstate compact obligations. And tribal water settlements is another important impetus in

the Western United States where you have a tribal reservation with a clear legal entitlement to water that hasn't yet been satisfied in terms of wet water. That can be an impetus for water trading.

Pricing and volume patterns in these areas are rational; that is, you see much more volume traded, higher prices in dry periods. Those trading prices reflect real estate markets, they reflect profitability patterns in agriculture such as changing crop prices, they also reflect changing energy prices. Outside of these active areas, we have sporadic trading and irregular pricing patterns.

Thinking about a changing water future, certainly we need to place emphasis on improving our existing water trading institutions, especially their ability to be responsive in the short term to avoid crises that we can see in April are going to be occurring in a hot, dry summer. What are we going to do, how can we reduce the damage that that situation would otherwise cause in the regional economy? Custom crafted water banks, we have some of them, well you have them all over the West now, operating sometimes within very cumbersome state and federal regulatory systems, have been able to solve local problems in an innovative way. They provide alternatives to farmland buy-in dry programs, they provide streamlined procedures for temporary and immediate water trades. I would say that I'm optimistic. I started working for the California Department of Food and Agriculture on water transfers in agriculture in 1978, and I've seen so much positive change in water policy, and the ability to communicate water scarcity through economic signals, and of course changes in technology regarding water use. So I'm an optimist about navigating this changing water future, but I think it's got to be done through an incentive system. These are some of the generations that we need to think about in being brilliant and innovative in these trading systems. Thank you.

Discussant: Bradley Udall
Senior Water and Climate Research Scientist
Colorado State University

Good afternoon everyone. It's an honor to be at the Federal Reserve. It's an institution which I hold in the highest respect and regard. I want to thank Dr. Colby for writing that paper. It's a really well done job, and has a great set of references in it. I want to talk about each one of her sections in her paper. She talked about water use scarcity and competition; she talked about adaptation options; and the third part was about potential effects on the farm sector. So there are three points I want to make. I want to talk about climate change as it affects scarcity, and I've spent the last 15 years of my life looking at the connection between climate change and water resources. I want to talk about the critical difference in the solutions that are needed for consumptive uses versus non-consumptive uses, and many of these alternative uses outside of ag are actually non-consumptive uses and there is some interesting suggestions about how to solve those problems that don't apply to the ag sector. Then finally, I want to talk about ag's role in providing solutions.

I looked up the Wikipedia page on Fed Speak. Have any of you seen that page on Fed Speak, also known as Green Speak in honor of former Chairman Alan Greenspan. And Chairman Greenspan once said that when he spoke he tried to mumble with great incoherence. You may also remember he testified in front of a senator one time, and the senator said, "I understand you, Chairman Greenspan." And Greenspan said, "If that's the case, then I misspoke." I'm actually going to try and do the opposite about that with respect to climate change in my opening point here. Bonnie's first sentence in her paper talks about climate change, her first sentence. The second sentence in this document implicitly talks about climate change. I actually had to stop working on climate change for a few years because it was so depressing. I'm now back in it because there are solutions at hand that are

optimistic. We actually can fix this. We've had a lot of discussion today about climate change, and Paris even came up. So I'm now an optimist about it. But the reason I originally focused on it is the connection between climate change and water. There is no greater impact that climate change has that is on water resources. If you add energy to the Earth's system, you're going to change the water cycle. It's energy that drives that water cycle. So you're going to end up with more floods and more droughts, changes in water quality, changes in runoff timing, reductions in snowpack. You get the whole litany of changes, and arguably it's the most important set of changes that come out of climate change at us.

There's a term now, stationarity is dead with respect to our water records, with regard to our ability to use the past to predict the future. The story I like to tell best is about British Airways Flight 9. In 1981, this 747 was at 37,000 feet at night over Indonesia and it had the unfortunate occurrence of flying under cloud of volcanic ash. It's the first time this had ever happened to an aircraft. The result was that all four engines shut down, and after four minutes, the captain came on and he said, "Ladies and gentlemen, this is the captain speaking. We have a small problem. All four engines have stopped. We are doing our damnedest to get them restarted; we hope this does not cause you too much distress." I like to tell that story because it's an example of stationarity is dead, right? The past is no longer a guide to the future. And that's what's going on with water resources. All these records that we have that tell us how much water, in what form, what timing, as we perceived in the 21st century, those records are less and less valuable to us, and that's what makes climate change and water so daunting and so difficult to solve.

You know, I just like to put out a plug here for the Federal Reserve, which is, because of all the discussion here on climate change and ag, maybe another seminar that you hold, another workshop like this should be done on ag and climate change. The University of Nebraska at Lincoln right now has a great document out. My own institution CSU is actively getting into this field, and we call it "Climate Smart Ag," and it's a generic term out there,

how does agriculture adapt.

So my second point is going to be about adaptation methods for water scarcity. Bonnie talked a lot about withdrawals, that's the data we have. We have data on withdrawals, and not very good data on consumption. And the fact that we don't know about consumption, the fact that water gets recycled multiple times, if you're in Mississippi downstream, you're drinking somebody else's sewage. Let's be blunt about it. We have utilized natural methods to purify that water, and that's what goes on in the water cycle. It makes accounting very difficult. If you are a city though, most likely a large portion of your use is not consumptive. That water is actually going to get recycled at some other point in time.

That to me gives me some ideas about solutions for this. In the western U.S. now we have two great examples of cities trying to recycle water at a higher rate than naturally occurs. Aurora in Colorado actually built about a $300 million plant. They didn't go quite to direct potable reuse, but they could have if they wanted to. And Orange County has something very similar in California. We have the ability to actually speed up this natural recycling of water. That's not an ability we actually have in the ag sector, right? In the ag sector when you consume water, it's a zero-sum game, and that's where you end up with markets, and all kinds of dry year options and other abilities to try and change a zero-sum game into at least a game where people don't feel like they lose as much and gain as much. So I'm just going to suggest that potentially on the non-consumptive side, we begin to think about other solutions—solutions that allow us to speed up this natural recycling that happens much quicker.

I also want to talk briefly about this notion, the false lure of efficiency, right? Because of the recycling that goes on in water use, there's been this idea for years that somehow if you make one far more efficient that that benefits everybody else without understanding the downstream effects. Now we now know that there are multiple papers out there that if you

install sprinklers, or if you install drip, often times what actually happens to that farm is the consumptive use on that farm goes up, and there's a couple of reasons why that happens if you think it through. One is you remove the labor constraint. All of a sudden you can flip a switch and deliver water as opposed to having to go out and flood irrigated, hire somebody to go out and flood irrigate. And another reason that goes on is you remove a spatial distribution issue. More often than not when you flood irrigate, you under irrigate one part of the field and you over irrigate another. When you install some sort of technological "efficient" solution, all of a sudden that problem goes away. If yields go up using some kind of efficiency technology, your first guess should be used more water. It shouldn't be that somehow you made water appear magically.

Let me end and talk a little bit about ag's role in providing solutions. I bet everybody in the room knows Willie Sutton's famous line about robbing banks. "Why'd you do it? That's where the money is." So in my state, if you're a non-ag user, and you want water, where are you going? You're going to ag to find that water. That's what's going on everywhere. Where I live, ag has 70 or 80 percent of the water. That's where people are going to start looking for where the opportunities are. And the ag sector thus has a very interesting opportunity. Bonnie says in her paper, "The record of water transactions in the western U.S. demonstrates that agricultural sellers and leasers typically command a price that far exceeds the net returns of nonfarm water use." So there is an opportunity there. She also says, "The agriculture sector has a unique opportunity to play a leading role in shaping adaptation to water scarcity."

In some work that I've been doing recently, there are four ways you can come up with water out of the ag sector. One of them is deficit irrigation. In the case of hay crops in the West, which are a predominant use of water in the upper Colorado River basin, something like 90 percent of water in the upper Colorado River basin goes into growing hay, both alfalfa and other grasses. You can deficit irrigate, you can actually cut off midseason and

decide to supply that water somewhere else. That's one option. You can do regulated deficit irrigation, which is a fancy term, for example, growing wine grapes or certain tree crops where you literally water them at certain times of the year and not at others, and you come up with a higher quality crop. So deficit irrigation is one possible way to come up with water. A second way is crop switching. That NGO community in the Colorado River basin is very interested in trying to figure out how to facilitate crops switching with agricultural producers. This is a big lift. You get to change a farmer's entire value system when you do this, and it's not easily done. If the NGO community is interested, especially with regard to alfalfa that's a perennial, that certain parts of the West use 8 or 10 feet of water every year. Could you switch that into some other crop, monetize the water savings, and then continue to grow something else? There are a number of examples of temporary fallowing in the West, Palo Verde Irrigation District on the Colorado River does it. In my state, there is an entity called Super Ditch, which is a conglomeration of about 10 different ditches that's trying to do what we call some rotational fallowing where people won't grow for a year or two in lieu of payments from cities. You can also pursue this efficiency game that I spoke about earlier, but you've got to be careful with what you do because you may very well facilitate increase consumptive use, and you may end up with less water than you have.

Let me end with a case study that actually I don't think has been publicized anywhere, and it's on the South Platte in Colorado, so Eastern slope. Xcel Energy, a large energy provider in numerous states, in our 2002 drought ran out of water in the wintertime. They had never run out of water in the wintertime. The river had previously operated as a free River, you could take whatever you wanted. This is a huge power plant they were trying to get water for. It's a 550 watt, coal-fired power plant, very important to their grid. In 2005, they entered an agreement with what's called the North Sterling Irrigation District, a 25 year agreement that had a small annual charge that went to each irrigator, and then should they decide to invoke this dry year option, about a $425 per acre foot charge. To date, that dry

year option has never been exercised, and the farmer in this irrigation district is now $1.6 million for the better. It's not a bad deal. Xcel gets the reliability they need for the dry year, and the farmers get money for whatever they want to use it for.

So let me conclude with my three points. One, climate change, it's a really big deal when it comes to water resources; it's a big deal with regard to ag. Solutions are at hand; that's a whole other discussion out there, but it's a big deal. You've heard it today from multiple people. Let me make one other quick point on here because I spoke recently at a conference where everybody was talking about climate change, and as soon as I said humans cause climate change, that's when the controversy arose. Scientists have spoken. We know humans are causing this. So let's be on the same page on that. Two, consumptive versus non-consumptive uses. I think it helps to separate those two out and to think about recycling, especially with regard to non-consumptive uses. Finally, agriculture has got to be at the center of solving these problems for these other industries. For example, Florida 14 percent urban, 9 percent energy, but ag has the water and in a healthy, effective government area, we would get ag at the table and figure out how to make a better world for everybody. So with that, I will leave you and I appreciate your time.

Discussion with Bonnie Colby and Bradley Udall
Moderator: Craig Hakkio
Senior Vice President and Special Advisor on Economic Policy
Federal Reserve Bank of Kansas City

Danny Kluthe, Lower Elkhorn Natural Resource District: Brad, I find it kind of interesting, Nebraska has got tremendous aquifers, but back in the 70s they introduced to the Natural Resource District. There is probably 30 some Natural Resource District's, and our job is to monitor and protect groundwater. Now other states can look at us and see what we're doing, but you say going after ag is a good place to look for water. When we are monitoring, and we collect data both spring and fall, we've got a really good handle on what are groundwater is doing. When there's a shortage of groundwater, we allocate, the irrigators get allocated. They've got meters on, and we take care of our groundwater. That's why Nebraska has got the unique and tremendous aquifers that we've got. My question is why don't other states maybe take a look at what Nebraska is doing with the NRDs and maybe follow suit?

Bonnie Colby: I'll put in a plug for the NRDs as well as several of them in the state, a number now, maybe even half a dozen have very innovative trading programs within the NRDs that allow for voluntary movement of water in a way that reduces the impact of dry years, having that downstream compact call facing your area. So it's a good question why there isn't more. I can speak for Arizona in that we chose to regulate highly intensive urban areas, the state and agriculture right around them, and we thought the problem would never spread to outer areas of the states. So in the unregulated part of our state we now have severely declining groundwater levels, investors coming in planting alfalfa from all over the world. So when you want to go into more tightly managed water, you want to think a long ways ahead about whether it ought to be statewide which is what you've done in Nebraska,

although I know that your constraints vary by district on whether you think you can limit it to just specific areas that are currently facing a lot of competition for water.

Bradley Udall: I'm not an expert on the High Points aquifer, but there is one place that the water table is not declining, and it's in the Sand Hills in Nebraska, right? So one place where it's being managed at least for the long-term, whether or not that's a good thing is another matter. If you want to mine it, for example.

Danny Kluthe: Basically, over all of Nebraska it's being managed very well. And when you talk about water banking, I heard a number of the speakers talk about water banking, we are discussing that at quite length, and water banking is awesome and I think we've got to be careful that when farmers want to use that as an income to sell it to somebody, you've got to be very careful that the person who's buying it, that they are not in an area that's already over appropriated. So there's, you know, it's probably a great tool to use, but we've got to be foresighted to find out that we aren't letting something happen that's going to make things even go further south. All of these speakers today were tremendous, a lot of great insight into water, and water is important. People think it's infinite, but it's not. It's finite. So keep up the good work, but I think we've got our work cut out for us when we talk about protecting water and especially groundwater.

Maureen McCarthy, University of Nevada: Bonnie, a question for you. The water trading I think that you discussed and presented in your paper was used by prior appropriations as a method of stimulating the movement of water from senior water rights to junior water rights. So my question to you would be, is it sustainable in areas that don't have that level of prior appropriations? And then, also following on that, is the concept of the beneficial use. Do you see us getting away from the prescriptions of beneficial use so that we can address things like a consumptive versus non-consumptive uses?

Bonnie Colby: So the first question, does water trading make sense where there is not a prior appropriations system? I would say absolutely yes, the economic impetus for

water trading comes from a different tolerance and different degree of cost from being exposed to a water shortage. So even where there is not a difference in seniority and the water entitlements themselves, where you have different types of water users including different kinds of crops. For example, orchards versus some annual row crops. There can still be a strong incentive for trading to occur even just within the agriculture sector. That difference in the costs of what a user bears from exposure to shortage is part of what drives the impetus, especially for trades like the one Brad described with the power plant in the irrigation district. That attempt to build more reliability for the non-agriculture water user in that case, and the revenue stream is stable, the revenue stream for the irrigation water users.

So your second question is about beneficial use. It's true in some parts of the world, and you will hear a lot more about this from Mike, that when there's enough economic benefit created through trading, water users can be willing to move to a different kind of entitlement and water accounting system. They can see that the benefit for the regional economy, and the resilience built in, would or maybe able to get away to some degree from strict reliance on beneficial use. So, we see that actually within water trading systems in the Western United States within some of these local water trading areas. They're doing a different kind of accounting which is how I'm interpreting your question about beneficial use.

Bradley Udall: Let me try and channel Ellen Hanak who I think has written on this. And Ellen, you can correct me because you get a chance to come up. But beneficial use is one of the great tools that prior appropriation has because you can change the definition of it. You can say that some existing uses are wasteful and no longer beneficial, and we don't have that kind of tool with much in prior appropriation. So it's something I would not want to easily give up. Ellen, I'll hear from you later.

Audience Question: So, when you're talking about water transfers, in addition to the impacts to agriculture directly, a goodly portion of that water if it's flood irrigated, goes back

into groundwater recharge. There's a potential for substantial environmental impact of those water transfers as we've seen in the Central Valley, where we can switch either over to more drip irrigated systems in orchards, where we're now expanding the number of acres and were not actually saving water, but we are seeing substantially less recharge of groundwater resources. How do you deal with that when you look at best uses of water and transfers, particularly from agate to urban?

Bonnie Colby: So that's again where we want to pay attention to what a lot of the speakers, including Brad and I both, recognize as you need to look at the consumptive use patterns, what is returning to the aquifer, returning to the downstream surface water system when that farmer changes technology. And water moving outside the watershed where it was originally used in agriculture, of course, is another interesting example, and I think you were referring to that as well. By the way, I would simply say that Chris's job in office exists within USDA is one of the reasons I am optimistic about our ability to solve some of our natural resource problems. There's a specific emphasis on use of incentives, and voluntary trading agreements.

Bradley Udall: The engineer in me would say, to the extent we can, we want to do a full water balance on the transaction in both space and time. And one of the trickiest aspects of Western United States water are these return flows that can show up months after the water was actually diverted. And is that a good, or is it a bad? It depends on your perspective, but you need to account for it in the mass balance.

Panelist: Ellen Hanak
Director
Public Policy Institute of California

Good afternoon. So now, instead of what I was going to talk about, I'm going to talk about beneficial use. I want to thank you first for the invitation to be here. My husband works at the San Francisco Fed, and he was very excited about my coming out here. My first time in Kansas City. So what I thought I do is really kind of focus on the really non-ag part of the economies, and I can do that best by talking about advanced economies, especially California and other western states a bit, Australia, Spain, and the sort of places that have pretty high per capita incomes. I think you'll see quite different challenges in the urban sectors in developing countries where water and sanitation systems in urban areas are challenged in many, many ways that we don't have challenges. We don't have those basic challenges. So thinking about water scarcity in places that are water scarce, and that are used to droughts, and that have variability in their precipitation.

I have five points for you, and my first one is that places like this tend to be pretty well able to handle drought. It doesn't mean they can't get better, they can. And a worse drought can really challenge the system, but it's not a big surprise. So just as a comparison, if you look at the southeast of the U.S. back in the mid-2000's, those of you that remember, Atlanta, Charlottesville, places like that, were in terrible shape, it's because they're not really used to having droughts. So they just did not have a lot of drought planning and drought resilience plans, they didn't have a lot of supply redundancies. Western states tend to have that at this point, and that's true in Australia now. They went through much bigger drought; the millennium drought was longer than they'd been used too so it taxed them and it kind of led to some needs for initial investments and innovations. But that's the basic idea which is why even though the New York Times told you many, many times during the California

drought that the economy was going to collapse, it didn't, and you heard from Chris who was summarizing a little bit on California agriculture which really does need a lot of water, even the ag sector managed to adapt without a whole lot of loss of ag GDP, probably 1 to 2 percent of ag GDP was lost.

In the urban sector, gangbusters, yes we do depend on water, but not in a highly intensive way for most of our activities. That's been partly the shift in a lot of water scarce places toward nonfarm activities that are not highly water consuming. And then, there has been a lot of planning and redundancies and sort of the idea of, now I'm getting to point to, supply portfolio approaches. So a little bit not as sophisticated as what you all who are in the banking sector do, but really thinking about risk return, or in this case, costs versus reliability. So urban areas have a pretty high willingness to pay, and ability to pay, and they've invested in a lot of stuff. So in California, we had a big drought from 1987 to 1992, and that was kind of a wake-up call for the next generation drought resiliency investments. You saw massive investments in additional local and regional storage both above ground, below ground, the ability to store and conserve water, urban areas are able to do that under our water laws, so a lot of investments in reducing indoor water use. In particular, getting water in the ground and getting it into some above-ground reservoirs, and a lot of investments in redundancies in terms of regional interconnections. So, ability therefore, if one supply sources out, you can share with your neighbor and that all works out, and basically really stretching the supplies and diversifying that way.

Then in some places, recycled water use. I'm going to differ with Brad here because I think actually where recycling makes more sense for urban areas, is when it is a consumptive use that's lost. So California happens to have most its population on the coast. That's the really valuable savings because you're keeping the water that you're already highly treating in order to not pollute the ocean, you're treating it a bit more, you're getting it in the ground or into storage, and you're reusing it. The folks that are doing it upstream, and probably the

folks that are doing it in Aurora, they are actually robbing their downstream neighbors often of water supply. So Orange County gets less water now because the folks upstream on the Santa Ana are recycling. That doesn't mean it's not a good strategy from other perspectives, but you have to think about the consumptive use aspect of that.

Second, what you're also seeing is industries that are water intensive investing in needing less water. So you've seen this in the energy sector with a move from the once through cooling to multiple recycling, dry cooling, or sort of what is it called, wet cycle, there is some other reuse kind of technology with that. You're seeing it in the brewing sector in California where the craft breweries for example who are often located in places that don't have a whole lot of water supplies, they have incredibly sophisticated processes for basically reusing as much of the process water as they can, and they can sell that as green water efficient. So there can be some premium on there, you know they can recoup that cost.

Third point is that droughts do provide opportunities to get better at this, and what we're seeing in the California drought are a couple of things. One very interesting thing is in our energy sector where they had thermal electric cooling, and they had not really been looking at their supplies partly because we hadn't had surface water curtailment in a long time in California. So this was a time when there really wasn't water available for them to access, and a lot of concerns about how do you deal with this? So emergency measures were taken to make sure everybody got their water to keep the power plants able to cool. But what's been happening also is more strategic planning about getting on recycle water uses.

What you're seeing in the urban sector, some additional investments in this sort of broadening portfolio, but also I think the big frontier now is going to be figuring out how to have a better pricing strategy, because a lot of them have been in the red. There was so much conservation, partly motivated by a statewide mandate that many of them would not probably have gone that far in conservation on their own based on their local conditions, but what they found was that a lot of the sales went down far below fixed costs and the

ability to cover fixed costs. So now they're having to sort of reboot and figure out how do we still provide pricing incentives and be able to cover our fixed costs, which in the water sector in the urban areas is 70-80 percent typically of total costs. So you have this trade-off between providing price incentives and covering your bottom line.

Fourth point is water vulnerability. You do see it in some places, and one of the speakers mentioned—Bonnie, I think you mentioned this already— you are seeing it not in the big urban areas, you're seeing it in small rural communities. This is where you see stories in the news, "East Porterville in Torre County bought all these dry domestic wells." Small communities, we counted I think about over 100 small systems where they were mostly groundwater dependent, mostly shallow well dependent, where it's dry, the aquifer, the water table is falling, and on top of that people are pumping a lot out of the ground extra in order to keep agriculture production going. So these are shallow wells that are not going to fill up with water anytime soon, and so the shor-term solution to this has just been tracking water and getting water to them, but the longer term solution is really about water solutions for these communities that are more durable and I will say that it's not just a water supply issue, it's often a water quality issue, it's often a sanitation issue, and these are places that cannot pay for it themselves because the combination of low incomes but also zero in scale economies. So, figuring out ways to do that is a real challenge. It's not a large population in the scheme of things, but it is a real human rights issue. I think this is, when we looked Westwide, we weren't seeing that as much in the Westwide drought, but I think you see it definitely in tribal areas, and you're going to see it in a bad long drought in other places as well, in small communities.

And then the fifth and last, and this is been mentioned a bit, and I think it kind of came up in one Mike Young's comments earlier, the environmental impacts of water scarcity —I'm talking ecosystem impacts. This is really more sort of a luxury problem to have compared to a lot of the developing country issues that we've been talking about today.

But in advanced economies, the environment is a normal good; it's something that people care about more as incomes go up; and we have in the American West for example a lot of conservation values and a lot of aquatic ecosystems that need water. And during droughts, these are systems that already have had a lot of water diverted away from them during normal times just because of all the use in agriculture, and to some extent in urban areas, and then in dry times they can really get shorted very significantly.

What we're seeing in terms of conflicts are often not urban/ag, but ag/environment over just the scarce drops of water that are available in some systems right now. That's been the big fight in Congress over the last few years, is whether Congress should legislate something about how we regulate certain environmental flow requirements. And I'll just say in terms of just bringing it back to climate change that rising temperatures is making this more complicated. So what we're seeing across the West—California and the Pacific Northwest—is that keeping water cold for salmon is becoming way more expensive in terms of the amount of water that you've got to store for that. So that's going to be a space to watch in terms of how we navigate that. Thank you.

Panelist: Les Lampe
Former Vice President and Director of Water Resources
Black & Veatch

When it was mentioned I will give a global perspective, I'll just give a little bit of background in terms of my perspective over my career, and try to focus it down into some practical examples.

So adaptation. And with the theme being the climate change, being right here, you know, water is driven by crisis. We know that and it's a matter of whether it's an immediate crisis, you're running out of water, or a long-term crisis for a prolonged drought. You know, we're all here, and what we're trying to do is trying to say, okay, we know there's a crisis, we know it's coming, what can we be doing? But nobody really does anything until it really grabs you. You saw that in the 1950s in the middle part of the country where there was a drought throughout the whole area and a lot of response to it.

As a matter of fact, if you went a few blocks back to the north of here, you would see that there was Union Station just past that Liberty Memorial, you can see right out the window, was underwater in 1951. Huge flood. And the response to that, all kinds of reservoirs were immediately funded upstream from here to control that flooding. But what happened right after the 1951 flood? The drought of 1952 to 1957. Just a terrible drought in the middle part of the country—Texas, Oklahoma, Kansas, up into Nebraska, this whole part of the country had that. So immediately, there was the 1958 Water Supply Act. It allowed entities to sponsor the separable costs to build in water supply storage into federal entities. The state of Kansas jumped all over that and built water supply storage in every federal reservoir, a wonderful thing to do, and that's what a lot of entities did around here. You had those crises that you were dealing with at that time. The 60s on the East Coast, the 70s in California and the UK, internationally I've seen things where it's driven by politics

in Singapore where they import 80 percent of their water from Malaysia, they've developed ocean desalting, new water which is reuse local catchments, and trying to use everything they can from this small island in local catchments. Hong Kong, importing water from mainland China, driven by that to looking at ocean desalting; 85 percent of their toilet flushing comes from ocean water. Things like that.

The one that I think is most relevant here, and I'm going to drill down to a local example, is Australia, and will have a whole session on that tomorrow, but I had a considerable amount of work with the Water Corporation of Western Australia. Any of you that have looked at it, there's kind of an iconic figure that shows the average runoff into the surface water supply system for the Water Corporation. Water Corporation only has like three million people that it serves, it took about a third of the area of the United States, it's just huge geographically. But what happened is that you looked in the 70s, and they were having a full amount of inflows; the 80s it went down to half of that amount of inflow; the 90s it was like 20 percent of that amount of inflow; and by the year 2000, the millennial drought in Australia, they were convinced that they were not going to be a surface water supply system anymore. They developed a Water Forever program, tons of water conservation, they have reuse, they have some local groundwater supplies, two ocean desalting plants, developing a third, and so that's the kind of portfolio and adaptation that we're talking about in terms of dealing with crisis. It should also be mentioned in Australia, just in terms of an example, all the cities are on the coast. So every major city developed an ocean desalting plant. Huge amount of cost, huge energy use, but for a lot of them it's recovered somewhat to where those plants sit somewhat idle. That's another lesson that could be learned in terms of you want that resilience, you want that reliability, but at what cost? Black and Veatch was involved in the Bundamba plant which was in southeast Queensland, and we were convinced just because of the accelerated schedule that that plant cost about 2 to 3 times what it would've had to have cost under a more normal planning

scenario.

What I want to turn to now, and we've talked about it a little bit, is the Colorado River system. In the year 2000 there was excess flows, they had negotiated an excess flow allocation agreement, and by the year 2007, they had negotiated as shortage agreement. But those intervening years were so dry and it persisted that much that they had to turn from excess to a shortage agreement, and how do you allocate shortages? And the trigger, interestingly enough, they have to start reducing water use for Nevada and Arizona is elevation 1075 in Lake Mead. Right now it's at 1072. It's at 36 percent of capacity. So to me, the Colorado River system, where most droughts are relatively quick, unlike in the eastern part of the country it will be a one year drought, maybe 14 months or something like that. The Colorado's River system, they have been in low flows for 16 years now, and it's like watching a train wreck in extremely slow motion. We see it's coming, you know it's happening, but how do you deal with it? The interesting thing about that to is that over that period of time, you know, the Colorado River system has 60 million acre feet of storage, and an average flow of only 15 million acre feet. So they are the only system in the world that has four years of storage available. That's what gives them that ability to say, well gee, maybe next year will be a little bit wetter, and it keeps going down and down and down.

I was fortunate enough to be hired by the seven Basin states through my firm Black and Veatch, and be the project manager for an augmentation study. We looked at a variety of things: Reuse, particularly in Southern California where there is still tons of water going out into the ocean; Basin imports, kind of that political very difficult thing; coal bed methane water; reduced water use from power plants; vegetation control; cloud seeding; ocean imports, like bringing water from Alaska; ocean desalting; conjunctive use with groundwater, the banking type of situation; brackish groundwater, which is most feasible at the Yuma desalting plant in southwest Arizona, and it's being implemented; storm water reuse; and control of reservoir evaporation. Some have some potential to it, but a lot of them

were just kind of like, "Huh? Really? You're going to look at this stuff?" What was not on the table for that particular study was water use efficiency, water conservation, transfers of ag to urban, you know that was sacred, you know we weren't going to look at that, and you weren't going to look at the salt and sea. There was half 1 million acre feet to 700,000 acre feet of ag drainage water flowing in there every year, much higher quality than ocean water that could be desalting and reused, but it's a whole problem of its own dealing with that.

Now there are some Band-Aids that have been done; there's a lot of progress on the Yuma desalting plant, probably creating 80,000 acre feet of water a year with the brackish groundwater mound in southwest Arizona. There is the Carlsbad ocean desalting plant in Southern California producing 50 mgd, roughly 50,000 acre-feet, but those are Band-Aids. The deficit in the Colorado River system will be in the millions of acre-feet per year, where they think the average flow right now is 15 million acre-feet, and I don't think it's that high. You know, you're looking at deficits of 3 to 4 million acre-feet a year, and how do you deal with that?

Where I'm going on this is there's a system that's just been implemented called the Pilot System Conservation System where the major entities, Denver Water, Central Arizona Projects, Metropolitan Water Districts, Southern Nevada Water Authority have contributed money along with the Bureau of Reclamation to go out into the market and say, "Who's willing to not use water and conserve water for the system?" They've gone out and have an initial $9.5 million dollars that's been expended, saving 62,000 acre-feet per year, and the beauty of it legally is you can't the Nevada Water Authority of Las Vegas to pay for water in Colorado, and have under a water right standpoint, a legal standpoint, particularly a public perception standpoint that won't work. So this is system water, it just blows into the system maintains the water level in Lake Mead. I think that's the window to the future for the Colorado River system in terms of using market mechanisms to solve their water problems. The beauty of it to is that the average cost of this water is hundred and $150 per acre foot.

The cheapest of the 160 options looked at in the Basin study was the Unity salting plant that had between $5-600 an acre foot, and right now because that ocean desalting plant being funded by the San Diego County Water Authority is $2,500 an acre foot. Translate that down into cost per thousand gallons per user, and you can see that a lot of these solutions are extremely expensive, and that's where I think this market mechanism getting out there, willing buyers, willing users, and saying, "Are you willing to forgo your use to allow the system to be whole," is what I see is a favorable window to the future. That's my remarks. Thank you for your patience at this time of day to allow me to present that.

General Discussion
Moderator: Craig Hakkio
Senior Vice President and Special Advisor on Economic Policy
Federal Reserve Bank of Kansas City

Dave Anderson, New Vision Group: Just a quick question for Les. What is the short-term and the long-term impact of the Colorado River system? What it sounds like is there is a huge deficit there. Is the train wreck continuing?

Les Lampe: It's my perception, and not everybody would agree with this, but yes the train wreck is continuing. The water managers in the Colorado system are a fascinating group and very innovative, and they've done a lot of things. They had banking among the states, Arizona, California, and Nevada, they have what they call an intentionally created surplus where you can conserve water and save it in Lake Mead, things that were not allowed before. They are allowing Mexico to store water in Lake Mead, and they're doing all kinds of innovative things to get around this issue that they have. But given that, I still see that there is just a huge, profound shortage of supply that's coming down the road, that will take even more dramatic measures. That's where I like this idea of essentially 50,000 of the 62,000 acre-feet thus far contracted were from ag. You don't want to necessarily say were taking water away from ag, but it's a market mechanism to say, from the lower value uses to somebody willing to pay for it, what's the way of going to make it happen. So I think that's the potential solution out there to make the system whole.

Ellen Hanak: I'll just add to that since you mentioned the $150 an acre, foot figure, a lot of that is being paid to irrigated agriculture that that returns for growing alfalfa in that region, or maybe $10-15 per acre foot of consumptive use, so that's a nice positive on the farm accounting ledger.

Bonnie Colby: Maybe just one less thing. We just got some data from the Bureau trying to

update the information from their Basin study from 2012 they were doing their projections based on water use data up to 2008, and were looking forward, and basically at that point you said started to come down some, but they weren't confident in that trend. So the projections that you probably have seen, you have the demanded red going up way, you're likely to be far exceeding supplies. Use has continued to come quite a bit down. So now there's really no very good match between the demand projections and use. Economists will look at the earlier thing and say, "It's not possible for demand ultimately to exceed supply on a long-term basis, so it's going to have to come down." The question is just, you know, what could be on the table at that time, and how do you get the conversation to move toward different kinds of creative demand management?

Steve George, Fremont Farms: In addition to agricultural, were there any other significant users of this market mechanism? Was there anything in terms of industrial use or municipal use? Or was it almost 100 percent ag?

Les Lampe: It was 58,000 acre-feet out of the 62, and I just have a little summary here in front of me. There's some recovery of wastewater effluent that was otherwise lost and being used to recharge the aquifer that's tributary to the river. And then there's another one that's of TON Central Arizona Project, and I'm not sure what that is. That may well be ag water but I'm not sure. So the huge majority of it is ag water, but there are some other things that could be considered in that regard. Part of the difficulties for municipalities and industries, you know, at that price level, it's not worth it for them to enter into it.

Steve George: And then also just curious whether that was actually verified that these agricultural users actually had previously used their water allocation, or they were just giving up their allocation rights they had when they might not have been using the water in the first place, and you're paying for water that hasn't even been used.

Les Lampe: There are protocols, true, that each of the state water agencies try to assure that. Of course, you're always in the water right system in terms of any water right holder, have

they really been using that water or not, or is it unused water that they're giving up anyway. To a certain extent, it could well be that as long as it creates nonuse, and allows water to stay in the system, you know, you're wanting it to actually being given up water use, but if it's a water right that they're still sequestering, maybe it's having the same effect.

Audience Question: Do you have any other examples of the market-based mechanism being used other than the Colorado River?

Les Lampe: Well, I think, and I'll turn it over to the others, but that's what Bonnie's whole background was on. In Colorado, where they were talking about particularly in the Front Range, where you've taken ag to urban use, there's been a huge amount in that, and I'm sure Bonnie has other examples.

Bonnie Colby: Yes, there are at least two dozen active trading areas around the Western states, most of them started out grouped around rapidly growing cities that were permanently buying farmland. Now there's a lot of innovative leasing, other short-term contractual arrangements as Brad described where you use the water on a temporary basis during a particularly water scarce season or water year. This is not to say we have well-functioning water markets; I don't even like to use the term water markets because people think of the stock market, and the urban housing market, and most of our water trading systems don't resemble those.

Ellen Hanak: Maybe just one thing to add about this is that the water markets that one observes, ag is the major source, not the only source, sometimes urban areas will have water that they don't need and they haven't grown into. But ag is also a major buyer in some places, and so in California that's been a very important tool along with the additional groundwater pumping, is water trading in order to keep the higher revenue and permanent crops, and my understanding is that up in Washington state too, they have been trying to do this where there is also diverse agriculture where you've got some fruits and vegetables next to some field crops, and so with the curtailments that they've had, in an effort to get markets going

for that purpose.

Brad Udall: You know, I've heard in Southern California the largest water proprietor there, Metropolitan Water District of Southern California, actually decided to get out of the market of buying water recently in the California drought because they were competing with perennial high-value crops, and Richard Howitt may in fact talk about this tomorrow. It was A) expensive, and B) they didn't like the social problem of trying to compete with ag in this case, on these trees that would otherwise die if they didn't get water. It's an interesting case of ag coming of age in certain areas, of actually being able to outcompete municipal users. Who would've thought that that would ever happen?

Derek Sawyer, central Kansas: Kansas is a first in time, first in right appropriation state, and so keeping that in mind, I thought your [Ms. Colby's] streetcar comparison was pretty ingenious when you opened. And then the more I thought about it, coming from my area, the water we actually pay for is included with the land purchase. That's the way we trade a lot of water rights in our area is actually the trading of land. With that in mind, we're looking at a situation now that's not too far from home with the city that's in a very marginal water area, looking to expand where they can get water from. They purchased a big ranch 100 miles from where they are, and transporting—it's the city of Hayes, I think from your smile you know— but how do you justify or how do you look at a situation when a city is buying land and using, you know they bought a senior water right, transporting all of that water completely out of the Basin, how do you look at that, and how do you look at policy as far as justifying that transfer?

Ellen Hanak: Each western state has its own policy that relate to buying up farmland and transferring the water out of Basin. Some make it very difficult, many don't. Obviously, it's going to change the agricultural structure in your area, and of course what you run into in the agriculture sector is the farmers who sold typically do very well. The returns are much higher than they were earned growing crops both in temporary transfers and leasing water,

and permanent sales of the land, but then you've got that reduced irrigated acreage and the impacts for the agricultural infrastructure. This is a policy decision that every state has handled differently. I know Kansas is working with innovations on the water banking, live in select areas, where the water would stay within—we talk about watersheds, but we can talk about regional economies as sort of that money shed, where you want the benefits from using that water to stay in the broad area where it's generating jobs and economic activity, even though not in agriculture to the same degree. So this is a tough issue, and it's one that's been handled quite differently in every jurisdiction I'm aware of.

Les Lampe: If I can add, offer some brief comments on that. In my limited experience in Hayes, Kansas, it's the Bermuda Triangle of water supply. They were 60 miles from Edwards County where they bought the ranch, from the Ogallala and High Plains aquifer, from Kanopolis Reservoir back to the east where there is a more prolific water supply. They had no groundwater, the Smoky Hill River which flows right by Hayes, was in the late 80s completely dry. Cedar Bluff Reservoir just upstream was essentially dry, and they were in this mode of where in the world can we go? They implemented a banking plan where they're taking their reuse to charge the Luvia aquifer from the Smoky Hill River, and I'm not even sure at this point whether or not they are active in terms of supply in Edwards County, and you'd have to fill me in, Derek, in terms of the status of that. But there is a Water Transfer Act in Kansas, because it was going from the, in Kansas it's called the Arkansas River Basin, every other state it's the Arkansas River Basin, to the Kansas River Basin and they had to comply with that to make the transfer work.

Jay Rempe, Nebraska Farm Bureau: Bonnie, I was wondering if you could expand a little bit on your discussion you just had about trying to protect regional economies. Often times when water markets and transfers come up in Nebraska, the issue of externalities come up. Are there some ways that some of these markets and trading schemes are dealing with that is one question? And then the second question is, Brad, you mentioned return flows, and that's

a tricky area. We have some areas where farmers are adopting sort of pivot technology that's affecting return flows downstream, and the folks downstream aren't too happy with that. Some things that are going on in markets where people are actually paying others not to be more efficient, to protect those return flows.

Bonnie Colby: I'll start with the first question, and then turn it over to you. So juris government, jurisdictions, mostly states, at least in the United States, where there are payments to the area often in a county where the water is being exported out of, or where the county has a certain amount of voice in the process whether the transfer is approved. There are areas where the party who are acquiring the water and importing it out of the area where it used to be used in farming creates economic development and other kinds of funds to help with economic transition. I think especially in a group like this that has so many people in banking and finance, it's important to keep in mind that probably what we want to focus on is not how irrigated acreage is changing, but how the robustness of the economy of the area is being protected. In that case, you could have parties reducing, paying for reduced consumptive use and water, but there's still active agriculture and maybe even by the same farms who have let some of that water become available for other uses. So I guess what I'm encouraging in the conversation is a focus on a different metric, not changing irrigated acreage and keeping up the value in economic production in the area, both in crop production and in the other sectors, because our regional economies are very interdependent. I'll put that as another item for discussion.

Brad Udall: Yeah, I'm not aware of cases where return flows are being protected with sprinklers. I will point out a case that was before the Supreme Court on Tongue River of Montana/Wyoming, the upstream diverters moved the sprinklers downstream, state complained, Supreme Court upheld the upstream use of sprinklers because the compact wasn't specific enough to prevent that increased water use. In our state one other case that's interesting is on the Arkansas, where there is another compact. Our state engineer is very

suspicious of Colorado River farmers installing sprinklers, because of the return flow issues into Kansas. We've been sued and have lost multiple times on this, and so are state engineers are obviously quite cautious about it. So the known impact of sprinklers is common. I'm going to mention one other thing. Drip, it's interesting, the journalists John Fleck told me about the chili growers in Hatch, New Mexico who converted to drip, and you know what happened to the furrow that used to be used for floodwater? It's gone, it now has chilies planted in it. So now you've expanded the acreage effectively in that same field.