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NEW APPROACHES AND INNOVATIVE TECHNOLOGIES TO IMPROVE WATER SUPPLY

HEARING

BEFORE THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED FOURTEENTH CONGRESS

SECOND SESSION

APRIL 20, 2016

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SECOND SESSION

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C O N T E N T S

NEW APPROACHES AND INNOVATIVE TECHNOLOGIES TO IMPROVE WATER SUPPLY

WEDNESDAY, APRIL 20, 2016

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
Washington, DC.

The committee met, pursuant to notice, at 10:01 a.m. in room 406, Dirksen Senate Building, Hon. James M. Inhofe (chairman of the committee) presiding.

Present: Senators Inhofe, Boxer, Capito, Crapo, Fischer, Rounds, and Gillibrand.

OPENING STATEMENT OF HON. JAMES M. INHOFE, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator INHOFE. Meeting will come to order. We apologize for being a few minutes late. We had a vote at 10 o'clock. So that is our daytime job, and we have to do it.

Drought conditions are still—well, they have and they still affect many regions of the country. California and Oklahoma have been dramatically affected. This morning we have witnesses that represent Orange County, California, promising new technologies of desalination, and the U.S. Army Corp of Engineers.

For the vast majority of the past 6 years, Oklahoma suffered from a devastating drought event that had nothing to do with global warming, I might add. As the drought reached its worst in the summer of 2014, more than 60 percent of Oklahoma was in the U.S. Drought Monitor's "extreme" category. More than 30 percent of the State's land area was experiencing "exceptional" drought or worse category.

Communities were rationing water. Some communities in the hardest hit areas looked to re-use of wastewater and tapping unconventional sources or those of marginal quality for non-potable uses in order to free up more valuable fresh water supplies.

Evaporating lakes and ponds in Oklahoma forced cattlemen to sell their herds and oil companies to search for increasingly expensive alternatives to continue production.

Abundant rainfall to excessive flooding conditions occurred nearly a year ago which caused dangerous situations throughout Oklahoma but greatly improved our water supply, at least for the time being.

Our water supplies are also overtaxed with old and often failing infrastructure not able to keep pace with demand. These problems affect communities all across the Nation. It is not exaggerated to

say that water supply issues limit growth and impose a very real threat to local and regional economies and people's quality of life.

However, in Oklahoma, the communities have started planning with business groups, agricultural interests and the energy sector on the local level to develop regional water action plans to resolve their mutual water problems. The foundation of the water action plan model demonstrates that water, as the key element in the State and local economies, it focuses on unifying and enforcing stakeholders to develop near-, short- and long-term regional strategies to maximize reliability and diversify the supply of water.

The severe drought conditions Oklahoma encountered forced us to identify new sources of groundwater and further develop our existing underwater supplies to address our over-reliance on surface water, to build infrastructure and pipelines to reliable underused water resources, building new wells—we have tried it all. City planning and regional planning have been the most efficient way of preparing to address the water supply problems, but there are supportive roles for State and Federal Government to assist our communities, and there are roles for corporate citizens as well.

For example, one area in Oklahoma hardest hit by the drought is the city of Enid, Oklahoma. One innovative example by the Koch Industries' is their nitrogen plant, one of the largest fertilizer production plants in North America, uses the city of Enid's treated wastewater for in-plant cooling water. Eventually, this re-use project will free up almost 5 million gallons of water each day. That's almost one-half of Enid's total current usage.

The Federal Government can have a role to play in assisting the regional infrastructure planning among States. An example of that are the chloride control actions on the Red River between Oklahoma and Texas. These projects were specifically authorized by Congress dating back to 1966, with chloride control studies beginning at the Red River as early as 1959.

Chloride control actions in Oklahoma and Texas have and will provide new drinking water supplies, increase agricultural irrigation and improve downstream water quality. In fact, Mr. Dalton, I am currently working with the Corps, their Tulsa district office, to develop a general reevaluation and review and record a decision for the Elm Fork Chloride plant in Oklahoma.

At one point, some reservoirs in Oklahoma were less than 20 percent capacity. Now, many are nearly full with multiple year supply. Although, presently the drought has subsided, plans must continue, too, so that we know it is going to be coming back.

It is kind of funny, when we talk about this issue, for me anyway. This was an issue in Oklahoma way back when I was in the State legislature. The big issue at that time was transporting the water from eastern Oklahoma to western Oklahoma. It was really a situation that made everybody mad. So this is not a new situation, and it is not just local to Oklahoma. It is across the Nation.

Senator Boxer.

[The prepared statement of Senator Inhofe follows:]

STATEMENT OF HON. JAMES M. INHOFE,
U.S. SENATOR FROM THE STATE OF OKLAHOMA

Drought conditions have affected and still affect many regions of the country. California and Oklahoma have been dramatically affected. This morning we have

witnesses which represent Orange County, California, promising new technologies in desalination, and the U.S. Army Corps of Engineers.

For the vast majority of the past 6 years, Oklahoma suffered from a devastating drought event. As the drought reached its worst in the summer of 2014, more than 60 percent of Oklahoma was in the U.S. Drought Monitor's "extreme" category. More than 30 percent of the State's land area was experiencing "exceptional" drought, the worst category. Communities were rationing water. Some communities in the hardest hit areas looked to re-use of wastewater and tapping unconventional sources or those of marginal quality for non-potable uses in order to free up more valuable fresh water supplies. Evaporating lakes and ponds in Oklahoma forced cattlemen to sell their herds and oil companies to search for increasingly expensive alternatives to continue production.

Abundant rainfall to excessive flooding conditions occurred nearly a year ago which caused dangerous situations throughout Oklahoma but greatly improved our water supply, at least for the time being.

Our water supplies are also over-taxed with old and often failing infrastructure not able to keep pace with demand. These problems affect communities all across the Nation. It is not exaggerated to say that water supply issues limit growth and pose a very real threat to local and regional economies and people's quality of life.

However, in Oklahoma, communities have started planning with business groups, agricultural interests, and the energy sector on a local level to develop regional Water Action Plans to resolve their mutual water problems. The foundation of the Water Action Plan model demonstrates that water is the key element in State and local economies. It focuses on unifying and forcing stakeholders to develop near-, short- and long-term regional strategies to maximize reliability and diversify the supply of water.

The severe drought conditions Oklahoma encountered forced us to identify new sources of groundwater and further develop our existing underground supplies to address our over-reliance on surface water, build new infrastructure and pipelines to reliable and underused water sources, build new wells, improve and refurbish existing reservoirs, and change water use ordinances to encourage or require more water conservation.

City planning and regional planning have been the most efficient way of preparing and addressing water supply problems, but there are supportive roles for State and the Federal Government to assist our communities, and there are roles for our corporate citizens as well.

For example, one area in Oklahoma hardest hit by drought is the city of Enid, Oklahoma. One innovative example by the Koch Industries' nitrogen facility, one of the largest fertilizer production plants in North America, uses the city of Enid's treated wastewater for in-plant cooling water. Eventually, this re-use project will free up almost 5 million gallons of water each day—that's almost one-half of Enid's total current usage.

The Federal Government can have a role to play in assisting in regional infrastructure planning among States. An example of that are the chloride control actions at the Red River between Oklahoma and Texas. These projects were specifically authorized by Congress dating back to 1966 with chloride control studies beginning at the Red River as early as 1959. Chloride control actions in Oklahoma and Texas have and will provide new drinking water supplies, increased agricultural irrigation, and improved downstream water quality. In fact, Mr. Dalton, I am currently working with Corps' Tulsa District Office to develop a general reevaluation review and record of decision for the Elm Fork Chloride Control Plan in Oklahoma.

At one point, some reservoirs in Oklahoma were less than 20 percent capacity. Now, many are nearly full with multiple years' supply. Although presently the drought has subsided, plans must continue so our communities are prepared for both uncertainties but for growth as well. I look forward to hearing from our witnesses this morning and new opportunities.

OPENING STATEMENT OF HON. BARBARA BOXER, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Senator BOXER. I really want to thank you so much for this hearing. We have some contentious hearings, I do not think this one will be such. Because we are going to discuss innovative technologies to improve water supply. This is something very dear to me and significant for my home State of California.

I tell you, I have gotten into some pretty heated conversations, I was telling the Chairman, in my State, because I really do support these technologies. Others just turn away, say, it is too expensive, or we shouldn't do this. There could be unlimited supplies of water for growth and all the rest.

To me this is a moment in time—whether we believe climate change is causing these droughts or not, what is the difference? We don't have to fight about that. The fact is we are dealing with these droughts.

And so I know this issue is dear to me, as I see what is happening. Even though we have had El Niño this year, it didn't live up to expectations. It certainly has done a lot to help us. But we know we are looking at long-term problems. We have horrible arguments between all the stakeholders, whether between the agricultural people and the fishing industries, and the urban users and the suburban users. And they fight all the way to the courthouse door.

And Mr. Chairman, you and I know when you get to the courthouse door one thing happens: delay, confusion, we don't know the rules of the game. We need to have a water supply that is there for us.

Now, I am so pleased to have Denis Bilodeau here from the Orange County Water District. I am really happy to see you, Denis, because you have been engaged in the development and implementation of water supply technologies for many years.

Orange County, my latest notes say, tell me if I am wrong, is the sixth largest county in our Nation. We have 2.4 million people just in Orange County alone. Is that about right?

Mr. BILODEAU. We have 2.4 million in our service area; there are 3.2 million in total in Orange County.

Senator BOXER. Three point two million, 2.4 million in your service area. So we are literally talking about making sure people can live comfortably and have the water that they need.

This severe drought has forced our Governor to declare a drought state of emergency. We have water restrictions. Again, even though El Niño has done better up north, it has not done that well down south. We know that we can expect more droughts in the future.

So we do face many challenges associated with this ongoing drought, including over-tapped aquifers, mandatory water restrictions, threats to our Bay-Delta ecosystem, to our fisheries, to our agriculture. When you mention water in California, everybody's back goes up because there are so many arguments going on over diminishing resources.

My view as a United States Senator is I do not take sides between the jobs in the fishing industry and the jobs in agriculture; they are all jobs. I don't take sides; I am trying to get everyone to the table. I believe—that is why I am so proud that my Chairman shares this, that we need to look at ways to avoid these terrible battles. That means a bigger water supply.

When you get into where do you put in a dam, that starts the march to the courthouse door. But if we were to be able to move forward with desal, move forward with recycling, move forward with conservation that makes sense, we don't have to fight over these supplies. We need to work together to expand the pool by

using our water more intelligently and making sure we can tap into these technologies.

So we are very fortunate, Mr. Chairman, to have two excellent witnesses. We probably have three excellent witnesses. I know two of them who will offer thoughts on how the Government can help. The Orange County water district will explain how it converted wastewater into 100 million gallons per day of clean safe drinking water, enough for 850,000 people.

Mr. Price will talk about his experiences with desal in the Middle East, particularly in Israel where so much truly innovative water supply activity is occurring. So when people look at desal and they say, oh, what are you thinking, they should just talk to the folks who have been living with this technology for a very long time.

I am also pleased that the Corps is here, because they have such an important responsibility for managing water around the country. The Corps operates 30 dams and reservoirs just in California. These reservoirs serve critical water supply needs. The Corps must employ the latest technologies to ensure these reservoirs are operated efficiently and can meet the growing water supply challenges.

I think today we can look for these opportunities to invest in new technologies. We can also learn from our international partners, such as Israel, who has confronted these supply challenges.

In closing, I would say this we have a chance in this WRDA bill to make some more history, Mr. Chairman, to take a look at this and start a new way of looking at water supply. Because drought faces us; it always has, and it always will. It could get worse. We are not sure, but we can't take a gamble on water supply.

Thank you.

Senator INHOFE. One thing, Senator Boxer, that neither one of us mentioned is the significance of the water in terms of our military. It happens that right now in the audience we have Bill Burgess and several of them from the city, from Fort Sill, which is the city of Lawton. Right next door to it is Altus Air Force Base. And it is something that really is critical. Because the needs of those two, we have gotten to the point of where they would almost have to shut them down from time to time. That is a huge issue also it is affected by this.

We welcome you to observe. You are observing a hearing where Barbara and I love each other. We don't have any disagreements. That is rare. But I hope you enjoy it.

We have three witnesses.

Senator BOXER. Remember this moment.

[Laughter.]

Senator INHOFE. We have three witnesses. Mr. Denis Bilodeau, First Vice President and Director of the Orange County Water District, as Senator Boxer said. Mr. James Dalton, we know him, Chief, Engineering and Construction, U.S. Army Corps of Engineers. Mr. Kevin Price, Senior Science and Technology Advisor in the Middle East Desalination Research Center.

So we welcome all three of you here. We will start with you, Mr. Dalton, and we will kind of work down. Try to keep your opening statements to close to 5 minutes. You are recognized.

STATEMENT OF JAMES DALTON, CHIEF, ENGINEERING AND CONSTRUCTION, U.S. ARMY CORPS OF ENGINEERS

Mr. DALTON. Thank you, Chairman Inhofe, Ranking Member Boxer, and other distinguished members, thank you for the opportunity to present information about the U.S. Army Corps of Engineers Civil Works program activities related to drought and drought technologies.

I would like to briefly discuss drought in general terms and then provide some information on the actions that we have taken with respect to drought, and finally touch on drought technologies we are investigating.

Drought, of course, is a deficiency in precipitation over an extended period, usually over weeks, months, or years, resulting in water shortage causing adverse impacts on vegetation. But drought is a lot more complex than just the lack of water. Drought is a relatively common weather related phenomenon in North America and occurs to some extent every year in some parts of the U.S. It affects our agricultural water supply and many other aspects of our well-being.

The Corps performs water management activities at its reservoirs consistent with the project specific, congressionally authorized purpose or purposes for each reservoir.

Two missions we often balance competing needs during periods of drought are flood risk management and water supply. It is important to keep in mind that most dams in the current drought areas are solely authorized for flood risk management.

For instance, as Senator Boxer just mentioned, the Corps operates about 30 dams in California. Seventeen of those are mostly for single purpose flood risk management, and 13 have multiple purposes.

Generally speaking, the Corps will not construct a project solely for water supply but may include water supply as a purpose in a project constructed primarily for one or more of the three mission areas of the Corps of Engineers, which are flood and storm damage risk reduction. No. 2, commercial navigation and No. 3, for aquatic ecosystem restoration.

The Corps water supply authorities recognize that the States and non-Federal entities have the primary responsibility in the development and management of their water supplies. Water rights, of course, are the responsibility of the States. The Corps does not own or sell water.

Water supply storage in a Corps reservoir may be a key component of the water supply plans for non-Federal entities. So non-Federal entities that do not have storage in a Corps reservoir may request that the Corps study and consider reallocating existing storage from another authorized purpose to water supply.

Corps reservoirs are operated according to water control manuals, which by policy include reservoir rule curves, and where appropriate it includes drought contingency plans. The purpose of the drought contingency plans is to provide a basic reference for water management decisions and responses to a water shortage in a basin due to drought.

The Corps is working on methods and Web tools to assist in understanding the projected droughts and how will this impact Corps

projects. The results of this work will serve as a guide for developing a strategy to update the existing drought contingency plans.

The U.S. National Climate Assessment, published in 2014, reported that climate is changing and is projected to continue to change. The expected changes vary regionally and include warming temperatures, resulting in altered precipitation patterns, increasing heat waves and changing snow patterns and droughts.

There are two current efforts that we have underway to try and assist with our ability to manage water resource for climate preparedness and resilience. The first effort is developing and implementing methods to update our drought contingency plans to account for climate change. A second method is to enhance reservoir sediment information to assist in climate preparedness and resilience by helping to identify current and future reservoir sediment volumes, which can affect food and water supply.

And a third effort we have ongoing is the Forecast-Informed Reservoir Operations research at Lake Mendocino, which is a pilot study that would use atmospheric river forecasting to inform water management decisions in a manner which reflects current and forecasted conditions. The results may indicate whether this technology can be applied in actual operations of certain projects.

In summary, the combinations of water control manuals and deviations that we can have with those manuals provide a great deal of flexibility to respond to short- term or long-term needs based on best available information and science consistent with each project's congressionally authorized purposes.

Thank you.

[The prepared statement of Mr. Dalton follows:]

DEPARTMENT OF THE ARMY

U.S. ARMY CORPS OF ENGINEERS

COMPLETE STATEMENT

OF

MR. JAMES C. DALTON PE, SES,

CHIEF, ENGINEERING AND CONSTRUCTION

BEFORE

THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

ON

New Approaches and Innovative Technologies to Improve Water Supply

APRIL 20, 2016

Thank you Chairman Inhofe, Ranking Member Boxer, and distinguished members of the Committee for the opportunity to present information about the U.S. Army Corps of Engineers (Corps) Civil Works Program activities related to drought and drought technologies.

I'd like to begin my statement with a short discussion about drought in general, and then tie this topic into the Corps mission and operations. Then, I'll provide some information on the actions that we have taken with respect to drought in the past, followed by some current efforts, touching on drought technologies that are being investigated for future implementation.

DEFINITIONS OF DROUGHT

Drought is a deficiency in precipitation over an extended period, usually over weeks, months, or years, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people. It is a normal, recurrent feature of climate that occurs in all climate zones, from very wet to very dry. Its impacts vary from region to region, and differ even within the same region based on the way that the affected people in the area use the water. Drought can, therefore, be difficult for people to understand as it is a lot more complex than just the lack of water.

Droughts are significant meteorological, social, and economic events in most parts of the world. Drought impacts include reduced water supplies, loss of soil by wind erosion and subsidence, saltwater intrusion into freshwater aquifers, an increased risk of fires, decreased water quality, other adverse ecological effects, and associated economic losses. A drought lasting from one to three months is considered short-term; a drought lasting from four to six months is considered intermediate; and a drought lasting more than six months is considered long term.

Although the type and severity of drought varies from place to place, it is generally characterized by below-normal precipitation over a period of months to years relative to the local normal condition. Drought intensity can be exacerbated by high evaporation rates due to excessive temperatures, high winds, lack of cloudiness and/or low humidity, decreased soil moisture, and falling water tables.

Droughts can be classified into three types:

- *Meteorological drought* is a period of months to years in which precipitation is below normal. It can be accompanied by above-normal temperatures and other factors such as increased wind and lower relative humidity. Meteorological drought can precede and cause the other two types of drought.

- *Agricultural* or *soil-moisture drought* results from a moisture deficiency in the shallow plant root zone, reducing crop production and plant growth. Agricultural

drought can result from below-normal precipitation, above-normal evaporation, or intense but less-frequent precipitation events. Susceptibility to soil-moisture drought can depend on crop or vegetation type.

- *Hydrologic drought* refers to a period when river streamflow and water storage in aquifers, lakes and reservoirs fall below long-term mean levels due to the amount and/or spatial and temporal distribution of precipitation. Hydrologic drought can have long-term effects on regional and local surface water and subsurface water supplies.

Drought is a relatively common phenomenon in North America, and occurs to some extent every year in some part of the United States. Weekly drought information is available in the U.S. Drought Monitor web site and it is produced jointly by the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, and the National Drought Mitigation Center at the University of Nebraska-Lincoln.

CORPS MISSIONS AND OPERATIONS

As a water resources management agency, the Corps is concerned with hydrologic drought. On a regular basis, we monitor for conditions that might lead to or enhance meteorological drought, and use up-to-date information developed by other Federal and state agencies about agricultural drought. The Corps performs water management activities at its reservoirs consistent with the project-specific, congressionally authorized purpose or purposes for each reservoir. These purposes may include navigation, flood risk management, hydroelectric power generation, water supply, and recreation. The Corps must operate according to the authorities Congress has given us, along with all other applicable laws, regulations and Executive Orders. Generally, alternate water uses across purposes are studied during the feasibility study stage of a project, and serve as the basis for the project's initial congressional authorization. We conduct these studies with the participation of States, Tribes, local governments, various federal agencies, other stakeholders, and the public.

Here, I will focus on two missions where we often balance competing needs during periods of drought: flood risk management and water supply, along with emergency response, which addresses components of each. It is important to keep in mind that most of the dams in the current drought areas were authorized solely for flood risk management. For example, in California, the Corps operates 30 dams, of which 17 have a single purpose for flood risk management, and 13 have multiple purposes.

One important factor that must be considered when adjusting operations during drought to enhance water supply is the potential for the occurrence of one or more intense rainfall events during a drought. Flooding and drought can occur simultaneously in a region. For example, in the Lower Mississippi Valley in 2011, flooding due to large winter headwaters snowpack and heavy rains in the Midwest coincided with extreme drought in Tennessee, Arkansas, Mississippi and Louisiana. Over Memorial Day

weekend in 2015, intense rainfalls occurred in Texas, causing some reservoirs with low pool elevations due to drought to rise into and beyond the top of the flood pool elevation. As a result, water control operations during drought must take into account the potential for a rapidly occurring flood situation.

Flood Risk Management

Although the Corps involvement in studies in response to flooding dates back to the 1850's, the Congress first authorized the Corps to construct projects for flood control in the Flood Control Act of 1917, which is often considered the foundation of what we now call flood risk management activities. Later, the Flood Control Act of 1936 declared flood control to be "a proper activity of the Federal government in cooperation with States, their political subdivisions, and localities thereof," which shall be prosecuted by the Army Department under direction of the Secretary of the Army and supervision of the Chief of Engineers.

Water Supply

Generally, the Corps will not construct a project for water supply, but may include water supply as a purpose in a project constructed primarily for one or more of the three main mission areas of the Corps, which are: flood and storm damage reduction, commercial navigation, and aquatic ecosystem restoration. The Flood Control Act of 1944 and the Water Supply Act of 1958, as amended[1] are the primary water supply authorities of the Corps. These statutes give the Corps authority to also use its reservoirs for municipal and industrial (M&I) water supply storage (the Water Supply Act of 1958), for withdrawals of surplus water (Section 6 of the Flood Control Act of 1944), and for agricultural water supply storage in limited circumstances (Section 8 of the Flood Control Act of 1944). Currently, 136 Corps reservoirs in 25 states provide 9.8 million acre-feet of storage for M&I water supply; and 39 Corps reservoirs in 12 states provide water for irrigation. The Corps is authorized to assist states and local interest in their water supply planning process (such as under Section 22 of the Water Resources Development Act of 1974 -- Planning Assistance to States).

The Corps water supply authorities recognize that states and non-federal entities have the primary responsibility in the development and management of their water supplies. The Corps may only participate in developing water supplies at a Corps project when certain conditions of non-federal participation are met, such as bearing the full financial burden of water supply. Water rights are the responsibility of states – the Corps does not own or sell water. Under applicable law, the Corps has the flexibility to accommodate the needs of state and local interests for water supply, in furtherance of, and not in conflict with, state water rights.

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[1] E.g., Section 932 of the Water Resources Development Act of 1986, amends the Water Supply Act of 1958, applicable only to Corps projects.

Emergency Management

The Corps was given authority to provide disaster preparedness and emergency operations by Section 5 of the Flood Control Act of 1941, as amended, commonly known as Public Law (PL) 84-99. The 1955 Emergency Flood Control Funds Act and the Disaster Relief Act of 1974 broadened and defined federal responsibilities for providing disaster assistance, assigned responsibilities to agencies, and established coordination among federal agencies.

In areas designated as drought distressed, the Corps has limited authority under Section 5 of PL 84-99 to assist a state with the transportation of water for human consumption, but not the purchase or storage of water. Transportation is normally provided by tank trucks or small diameter pipelines, but all potential methods are considered. The Corps may also assist in well drilling at 100% sponsor cost if wells are not commercially possible. Assistance will only be provided to meet minimum public health and welfare requirements. Criteria that must be met include:

- Gubernatorial declaration of drought-distressed area.
- State and local agencies must make full use of their own resources, including the National Guard.
- Reasonable rationing and conservation measures have been implemented.
- A permanent solution is being actively pursued at the local level.
- Requests for assistance to the Corps must be initiated by the Governor or his/her authorized representative.

THE CORPS AND DROUGHT

The Corps has played a major role in federal response to drought since the drought of the late 1970s. It was at this time when the Director of the Corps Institute for Water Resources was asked by the White House to lead a drought study task force and produced the Presidential Drought Appraisal Study in 1977. This study led to the development of Corps guidance for drought contingency plans, which I will discuss in more detail below. Following the severe western drought of the 1980s, Congress authorized the Corps to lead a collaborative nationwide survey to find ways to improve water management during droughts. This National Drought Study resulted in a number of reports, including a report to Congress.

Despite lessons learned in earlier droughts and incorporated in federal, state and local planning, the findings of the National Drought Study indicated that the droughts of the late 1980s and early 1990s caused persistent and widespread conflicts among water users. The study broadly characterized drought responsibilities as follows:

- Federal agencies are responsible for ensuring that the authorized purposes of federal reservoirs are met.

- State agencies are responsible for defining different stages of drought and appropriate state-level responses, including invoking the emergency response powers of the governor. In some cases, states can prioritize water allocation by the type of use.
- Local (county, city or water utility) agencies are responsible for planning and implementing drought response measures at the local scale.

The basic division of responsibilities listed above has evolved over time, especially with the establishment of the National Drought Resilience Partnership (NDRP) in 2013 under the President's Climate Action Plan, which was reflected in the Presidential Memorandum: Building National Capabilities for Long-Term Drought Resilience signed in March 2016.

The 2012 drought, which continues today, affected about two-thirds of the continental United States and has caused large agricultural losses and increased occurrences of wildfires.

Although this discussion focuses on Corps actions related to flood risk management and water supply, drought affects all of our operations. For example, in late 2012-2013, prolonged drought conditions on the Mississippi River affected barge traffic downstream of St. Louis. To facilitate the movement of this traffic under the then occurring low flow conditions, the Corps increased routine and emergency dredging, and removed limestone "rock pinnacles" in two reaches of the river. The costs of all these measures were borne entirely by the Corps. The rock removal also improved our ability in the future to facilitate navigation in these two reaches during low-flow periods.

Reallocation Studies

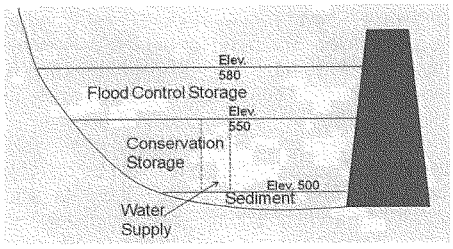
In some situations, water supply storage in a Corps reservoir is provided or can be made available to a non-Federal entity to augment its municipal and industrial (M&I) water supply. Non-Federal entities that do not have storage in a Corps reservoir or would like to increase their storage may request the Corps to study and consider reallocating some of the existing storage from another authorized purpose to water supply. Depending on the impact of the requested reallocation, Congressional reauthorization of the project may be required.

The Corps may conduct a water supply reallocation study in response to such a request. If the Corps determines based on this study that the requested reallocation is feasible given other authorized purposes for the reservoir, the non-Federal entity must enter into a water supply agreement before the Corps can reallocate the storage. These agreements require the local sponsor to repay the U.S. Treasury both the updated cost of storage (or, when higher, foregone benefits or revenue) and the annual operation and maintenance costs associated with that storage.

Water Management

Corps reservoirs are operated according to water control manuals, which by policy include reservoir rule curves and, where appropriate, include Drought Contingency Plans (DCPs). The purpose of a DCP is to provide a basic reference for water management decisions and responses to a water shortage in a basin due to drought. DCPs outline the process for identifying and monitoring drought at a facility, inform decisions by Corps water operations staff to reduce drought effects, and define the coordination that the involved Corps District or Districts take to manage the water resources. Because of the duration of a drought is unknown while the drought is occurring, and other uncertainties of the specific problems that may result, DCPs specify a minimum suite of actions that must be carried out related to water control, leaving open opportunities for additional action as the situation warrants, for example, through deviations.

In general, water control manuals and rule curves include consideration of monitored meteorological data, including snowpack, in operational decision making. A water control manual generally describes how a reservoir will be regulated by managing water elevations between conservation storage and flood control storage, as shown in the figure below. These manuals incorporate allowable flexibility for a broad variety of runoff and climatic conditions to address the authorized project proposes. A water control manual regulates the project over the entire regime of pool elevations and conditions. The manual does this through a water control plan, which includes schedules for project regulation under a range of water conditions, provisions for collection and dissemination of data, guidelines for preparation of detailed operating guidelines to assure project safety, and actions to fulfill regulatory requirements.



Over time, Corps water management operations have proved reliably robust to observed changes in flow patterns, which have resulted from changes in land-use and land cover, as well as observed climate variability and associated changes. When combined with the deviation process (described in more detail below), there is a great deal of flexibility to respond to short-term and long-term needs based on best available information and science.

It is important to note that the Congressionally-authorized purpose or purposes of a dam, and the associated reservoir rule curves for operating the dam, are the primary

drivers of water management. Dams with a primary purpose of flood risk management, or with multiple purposes including flood risk reduction, retain a certain volume of the pool to provide flood storage capability that minimizes downstream flooding. Some dams also have an exclusive flood storage capacity that may only be encroached for the purpose of flood storage.

Corps Deviation Process

Water control manuals contain a provision authorizing the operating District or Districts of the Corps to deviate temporarily from operations prescribed in the project's approved water control plan. Deviations may be pursued when necessary to alleviate critical situations or to realize increased benefits during an operation season, without significantly affecting the fulfillment of the project's authorized purposes. These deviations are intended to address special and unique circumstances including dam safety issues, drought, flood, and other issues. The basic tenets of deviation must be adhered to for safe operation and include: operational and structural integrity of the facility components, not endangering the dam, mitigating the risk of downstream flooding, not unnecessarily storing water in the pool, and not compromising the safety of persons or property downstream.

Deviations are grouped into three categories: emergency, unplanned, and planned deviations.

- *Emergency deviations* from the approved water control plan are required to mitigate an immediate threat to public health and safety, property, project or the environment.
- *Unplanned deviations* deal with a wide range of unplanned occurrences that are not considered emergencies. The need for unplanned deviations can arise due to unforeseen conditions that do not allow sufficient time for a full analysis prior to deviation. These could include construction, maintenance, inspection, or flood control needs.
- *Planned deviations* consist of other deviations not addressed by an emergency or unplanned deviation. Planned deviations could be minor or major. Planned deviations for dams classified as Dam Safety Action Classification (DSAC) 1, 2 and 3 have a higher risk, and shall comply with Engineer Regulation (ER) 1110-2-1156, chapter 24 – Dam Safety Considerations for Storage Allocation, Reallocation, and Related Studies. A major deviation that would result in increased water storage at a DSAC 1, 2 or 3 dam requires approval by Corps Headquarters.

For dams that do not typically store water, the Corps can consider temporary deviations from authorized flood operations in response to drought conditions. Temporary deviation processes incorporate environmental compliance, ensure that dam safety guidelines are met, and evaluate associated flood risk management issues. Should a

significant precipitation event occur that triggers a deviation request, the Corps is prepared to issue a timely response.

Corps Drought Contingency Plans

Following the Western droughts of the 1970's, the Corps published ER 1110-2-1941, titled "Drought Contingency Plans" in 1981. Systematic preparation of DCPs was last undertaken in the 1980s and early 1990s, though some DCPs were finalized in 2011 and others are currently in the planning stage. The National Inventory of Dams reports that the Corps operates and maintains 707 dams at 557 projects, including 173 dams with navigation locks. DCPs are typically only completed for projects with controllable storage, and thus are not developed for most of our lock and dam projects, nor the approximately 10% of the dams at Corps projects that do not maintain normal storage levels and typically have dry reservoirs.

A team was formed to assess the current status of DCPs and to develop methods to update DCPs to account for a changing climate. The team identified and reviewed 142 DCPs covering 301 projects, representing approximately 95% of projects which require a DCP. A summary report compiled as part of this effort contains an overview of climate, climate change, and drought in the United States to aid in planning for current and future droughts at Corps projects. The team is working on methods and web tools to assist in understanding of projected hydrologic droughts (i.e., projecting future areas that will likely experience droughts due to decreased precipitation) and how these will impact Corps projects. The results of this work will serve as a guide for developing a strategy to update existing DCPs. The team is also conducting pilot studies testing methods and processes to update DCPs to account for changing climate. Pilots are planned or underway in the Lakes and Rivers Division, Mississippi Valley Division, Southwestern Division, South Pacific Division and Northwestern Division.

CURRENT EFFORTS AND DROUGHT TECHNOLOGIES

The U.S. National Climate Assessment published in 2014 reported that the climate is changing and is projected to continue to change. The expected changes vary regionally and include warming temperatures, resulting in altered precipitation patterns, increasing heat waves (particularly in the West), changing snow patterns and droughts. Increases in summer drought are likely across the northern tier of states, including the Northeast, Northwest and Alaska, while increases in drought are likely in the southern Plains, Southeast and Hawaii. The already arid Southwest is anticipated to see large increases in drought frequency and severity. The Midwest and northern Plains, however, are anticipated to experience little change in drought frequency, and reductions in drought are anticipated in northern portions of these regions.

Two current efforts underway enhance our ability to manage water resources for climate preparedness and resilience. The first effort is developing and implementing methods to update drought contingency plans to account for climate change. The objective of the second is to enhance reservoir sediment information to assist in climate preparedness and resilience. The reservoir sediment information can help identify current and future reservoir sediment volumes, which can affect flood and water supply storage.

The Forecast-Informed Reservoir Operations (FIRO) research in Lake Mendocino is a pilot study that would use atmospheric river (advanced hydro-meteorological) forecasting data to inform water management decisions in a manner which reflects current and forecasted conditions. The study was scoped in 2014, and began in 2015. The research is projected to be a five-year effort, and the results may indicate whether this technology can be applied in actual operations of certain projects. The Corps is participating on this pilot project with a consortium led by Scripps Center for Western Weather and Water Extremes, along with the Sonoma County Water Agency, California Department of Water Resources and State Climate Office, Bureau of Reclamation, NOAA's National Weather Service, Earth Systems Research Laboratory, and Restoration Center, USGS, and the private sector.

Improved short-term and long-term weather forecasts would improve our confidence in the range of appropriate adjustment of operations in the future. Weather forecasts are the responsibility of the National Weather Service. The Corps is participating in efforts to better understand capabilities in improved forecasting.

SUMMARY

The hydrological processes that influence droughts and floods are complex. The Corps water management operations, nationally, have endeavored to account for these complexities, with the result that operations have proved reliably robust to extreme events of flood and drought. The combination of water control manuals and deviations provides a great deal of flexibility to respond to short-term and long-term needs, based on best available information and science consistent with each project's congressionally authorized purposes.

Thank you for the opportunity to be here today and I look forward to your questions.

Senate Environment and Public Works Committee
Hearing entitled, "New Approaches and Innovative Technologies to Improve Water Supply."
April 20, 2016
Questions for the Record
Mr. James Dalton

Chairman Inhofe:

1. Mr. Dalton, as I mentioned during the hearing the legislative goal of chloride control is to reduce natural occurring chlorides in the Red River so water can be used for agricultural, municipal, and industrial uses. Southwest Oklahoma has been in drought conditions for a number of years. Multiple studies and designs have been completed over the previous 40 years for chloride control in Area 6 of Southwestern Oklahoma. Chloride control has been authorized in previous WRDA bills specifically for the Area 6 site. Chloride control is addressed in the current WRDA bill as well. However, no construction has occurred in Oklahoma despite construction for chloride control at nearby Texas sites. Recently, local leaders submitted the enclosed agreement to the Corps of Engineers District Office in Tulsa to finally formalize moving forward. What needs to occur specifically from the Corps of Engineers to make projects in Area 6 a reality? I'm looking for a step by step description and timing estimates.

Answer: Mr. Chairman, the first step to moving forward with construction of the Red River Chloride Control Project (RRCCP) - Area VI project would be to complete a General Reevaluation Report (GRR) that would identify a project scope that is technically sound, economically justified and environmentally acceptable. With the identification of the Lugert-Altus Irrigation District as the potential non-Federal sponsor, the RRCCP – Area VI GRR meets the requirements to compete against many other worthwhile studies for funding. The following steps would be the optimum schedule to initiate construction:

D1. When funding for the GRR is provided,, the first step would be to execute a Feasibility Cost Sharing Agreement with the Lugert-Altus Irrigation District to fund 50 percent of study costs.

2. The GRR study would be scheduled to be completed in 3 years.

3. Following completion of the GRR, final design could be initiated under the Preconstruction Engineering and Design (PED) Phase, as additional construction authorization is not required. The PED phase usually takes up to three years to complete the final design for the first contract; the exact schedule for this effort would depend on the project specific features.

4. Once the PED phase is completed, the project is ready for construction.

Senator INHOFE. Thank you, Mr. Dalton.
Mr. Bilodeau.

STATEMENT OF DENIS R. BILODEAU, P.E., FIRST VICE PRESIDENT AND DIRECTOR, BOARD OF DIRECTORS, ORANGE COUNTY WATER DISTRICT

Mr. BILODEAU. Thank you Mr. Chairman, Ranking Member Boxer and members of the committee. I am Denis Bilodeau, and I am the First Vice President of the Board of Directors of the Orange County Water District. I am deeply honored to appear before you today to discuss the most pressing issues of our time: the provision of safe and reliable water supply.

The Orange County Water District is located in Fountain Valley in Southern California and provides groundwater to Orange County, including 19 cities and water agencies serving 2.4 million people. Since 1933, we have taken great pride in advancing the development of sustainable water supplies.

In Orange County we live in a desert. The base flow of the Santa Ana River, our main source of surface water, continues to decline. Imported water supplies from Northern California and Colorado are restricted.

In the late 1980s we recognized that to preserve our region's economic and social vitality, the challenges of groundwater depletion, seawater intrusion and unreliable surface water demanded an innovative solution. This initiative grew into the Groundwater Replenishment System, which is a joint project between my district and the Orange County Sanitation District.

The GWRS is the world's largest advanced water purification system for potable re-use. It takes treated wastewater that otherwise would be sent to the Pacific Ocean and purifies it using a three-step advanced process. This treatment and purification process produces high quality water that exceeds all State and Federal drinking water standards.

We are currently producing 100 million gallons a day which is about 25 percent of our water supply. Our next and final planned expansion will provide an additional 30 million gallons a day.

Senator Boxer, it was during your term on the Senate Appropriations Committee that you were able to secure our first Federal appropriation toward construction of the GWRS. Over a 5-year period, $20 million in Federal funding from the Bureau of Reclamation's title XVI program leveraged over $72 million in State, local and private funding to provide for the overall $481 million construction of the Groundwater Replenishment System. We greatly appreciate that. The GWRS has allowed our region to take control of our future.

There is no one size fits all solution to water re-use. The GWRS establishes a technology foundation to design and build innovative approaches to sustainable water needs. Therefore, I encourage the committee to include funding for water re-use in the WRDA reauthorization.

Second, our district is currently exploring purchasing more than 50,000 acre-feet per year of desalinated sea water or enough water for more than 400,000 people from the purposed Huntington Beach desalination project as a way to increase local water supplies. The

proposed project will be built and operated by Poseidon Resources in the city of Huntington Beach. The project is scheduled for final hearing before the California Coastal Commission later this year. If approved by the Coastal Commission my board will consider moving forward with a purchase agreement for the water. The largest hurdle we face, of course, is the economics of ocean desalination.

Finally, one of the most cost effective solutions that we avail ourselves involves water conservation. Conservation through reduced demand is not going to solve our overall need to assure that we have adequate water supplies. In order to supplement our conservation program, my district entered into a collaboration with the U.S. Army Corps of Engineers, who have been a great partner, to leverage the investment that our region and the Corps made in the construction of Prado Dam on the Santa Ana River. Rather than using Prado Dam for a single purpose flood protection, we recognized the potential of conserving water at Prado during storm events that could subsequently be recharged into our aquifer for future use. The alternative would be to lose this water supply as it coursed down the Santa Ana River to the Pacific Ocean.

Senator Boxer, you were instrumental in assisting us in our negotiations with the Army Corps, and this year we have already accrued 31,000 acre-feet of water due to your efforts.

Mr. Chairman, we appreciate your efforts for an orderly passage of the WRDA bill. We have provided suggested policy to facilitate enhanced conservation of Corps facilities. Our recommendations to the committee arise from our experiences over the past few years working with the Corps to implement a long-term agreement to store water with a priority placed on public safety in an environmentally protective manner. Simply stated, a clear statement on the priority to approve and implement water conservation activities needs to be made a part of the reauthorized WRDA.

Also, we need a clear statement to ensure that costs are fairly allocated by guaranteeing that only the separable costs attributable to the water supply conservation is allocated to the local water agency.

The ability to facilitate an expeditious and equitable agreement may seem like an obvious approach to implement an innovative and cost effective solution. But we need a strong statement on the matter as part of the reauthorization of WRDA. We stand ready to support the committee to this end.

Again I thank you for the opportunity to appear before you today.

[The prepared statement of Mr. Bilodeau follows:]

ORANGE COUNTY WATER DISTRICT
Orange County's Groundwater Authority

TESTIMONY

OF

MR. DENIS BILODEAU

FIRST VICE PRESIDENT
AND
MEMBER
BOARD OF DIRECTORS

ORANGE COUNTY WATER DISTRICT
FOUNTAIN VALLEY, CALIFORNIA

PRESENTED BEFORE

COMMITTEE ON ENVIRONMENT

AND PUBLIC WORKS

WASHINGTON, D.C. 20510

APRIL 20, 2016

P.O. Box 8300,Fountain Valley, CA 92728-8300 • 18700 Ward Street, Fountain Valley, CA 92708 (714) 378-3200 Fax (714) 378-3373 www.ocwd.com

Chairman Inhofe, Ranking Member Boxer and members of the committee, I am Denis Bilodeau and I appear before you as the first vice president, an elected member of the board of directors, for the Orange County Water District (OCWD) located in Fountain Valley, California. I am deeply honored to appear before you to discuss one of the most pressing issues of our times: the provision of safe and reliable water supply. OCWD is located in Southern California and provides groundwater to 19 cities and water agencies in northern and central Orange County. They are the cities of Anaheim, Buena Park, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, La Palma, Newport Beach, Tustin, Orange, Santa Ana, Westminster, Seal Beach; and the following agencies: East Orange County Water District, Golden State Water Company, Irvine Ranch Water District, Mesa Water District, Serrano Water District, and Yorba Linda Water District. Together they serve more than 2.4 million citizens and businesses within the sixth largest county of the nation by population. This distinction is important as it drives our priority to find sustainable water supplies for our growing region.

Since 1933, OCWD has taken pride in advancing the development of sustainable water supplies to address a growing population and precipitation pattern changes. This commitment is demonstrated vividly by our recently expanded Groundwater Replenishment System (GWRS). The GWRS is the world's largest advanced water purification system for potable reuse. It takes treated wastewater that otherwise would be sent to the Pacific Ocean, and purifies it using a three-step advanced process.

OCWD is pleased to be part of today's hearing into the implications associated with an uncertain water supply future and how, as a nation, we must respond to this challenge. We all know the statistics that illustrate how scarce our freshwater supplies are becoming. Parenthetically, I must add that this challenge is both economic and social and has global implications associated with national security. Simply stated, drought, population increases, pollution and other factors impacting water supplies threaten our quality of life. If we lack a reliable supply of water, the impacts on food production, industrial production and recreational activities are dramatic, with reverberations to our domestic economy.

Today, I would like to address these issues by discussing how OCWD and its partner, the Orange County Sanitation District (OCSD), have developed a sustainable response to the drought conditions that we have experienced for almost a decade and the incredible severity of the drought during the past five years. I want to emphasize that the past winter's El Niño has only served to validate the programs and projects that OCWD has pursued. El Niño brought near record snowpack and almost brimming reservoirs to northern California. But in our region, the record

rainfall we anticipated did not occur.

Clearly, the new normal of rainfall and snowfall events, along with accelerated evaporation and melting, means that it is necessary to develop and implement innovative water development approaches. It has often been stated that California has always met challenges and succeeded, defying the conventional wisdom that our state is too big and the problems are too big to find a long-lasting solution. In the case of water supply, OCWD and our partner agency, OCSD, have taken a big problem, challenging meteorological conditions, and designed a solution that delivers long-term water security for our region that can be replicated throughout the arid and semi-arid regions of our nation and the world.

In Orange County, our climate is becoming more arid. The base flow of the Santa Ana River, our main source of surface water, continues to decline. Imported water supplies from Northern California and the Colorado River are restricted. We expect droughts to occur three out of every 10 years. Population growth within our region is expected to increase and so will water demands. There was and is a need to address these multiple challenges.

In the late 1980s, OCWD recognized that to preserve our region's economic and social vitality, the challenges of our groundwater depletion, seawater intrusion and unreliable surface water supplies demanded an innovative solution. OCWD implemented an aggressive program to develop a novel water treatment process with our sister agency, the Orange County Sanitation District. This initiative grew into the Groundwater Replenishment System (GWRS).

Unlike traditional approaches to water treatment, our approach recognized that wastewater is a valuable resource. The ability to design a technological approach that would capture this resource, remove the impurities and recycle it back into the environment would address multiple needs ranging from supplementing water supply to protecting our natural resources.

The GWRS takes treated wastewater from OCSD that otherwise would be discharged into the Pacific Ocean. It implements a sophisticated process to purify this water. The process involves using a three-step advanced treatment process that consists of microfiltration, reverse osmosis, and ultraviolet light with hydrogen peroxide. This treatment and purification process produces high-quality water that exceeds all state

and federal drinking water standards. Let me emphasize this point. OCWD is able to exceed public health standards in developing a sustainable water supply.

It was during your tenure on the Senate Appropriations Committee, Senator Boxer, that you were able to secure the first federal appropriation towards construction of GWRS. Over a five-year period, $20 million in federal funding from the Bureau of Reclamation's Title XVI program leveraged over $70 million in state, local and private funding to provide for the $481 million construction cost of the GWRS.

The GWRS has allowed our region to take control of our future. However, this effort has been achieved in a partnership with federal and state agencies that provided vital assistance in making this project a reality. Today, the partnership is responsible for delivering enough drinking water for 850,000 people with a production of 100 million gallons of water per day.

As much as the GWRS is providing an important water supply, locally it sends an important message to other water scarce regions of the nation and the world. The GWRS is a project based upon a local solution grounded in local control, reliability and a high- quality water supply. The opportunity to implement a proven approach like the GWRS can return important dividends to political and economic security needs.

There is no one-size-fits-all solution to water reuse. The GWRS establishes a technology foundation to design and build individual approaches to sustainable water supply needs. Determining if and how your reused water becomes part of the drinking water supply depends on water needs of a specific community, water sources, public health regulations, costs, and the types of water infrastructure in place, such as distribution systems, man-made reservoirs or natural groundwater basins.

As the state of California and the entire west faces severe drought conditions, increased attention must ultimately turn to locally developed projects and programs like the GWRS that provide reliable water supplies.

When we think about water supply needs and ways in which to reduce tensions that arise from constrained potable water supplies, the ability to share experiences and promote collaboration is important. OCWD shares its knowledge of advanced water purification technology. By example, we helped Singapore to enhance its own national

water security. Today, Singapore is considered a shining example of how a nation state can effectively meet its water scarcity challenges.

Even in recent years, the country of Singapore has been principally reliant on water from Malaysia. With political differences between the nations and the expiration of long- term agreements for water transfers between Malaysia and Singapore, the Public Utilities Board of Singapore (PUB) was tasked with finding ways to make Singapore more water self-sufficient.

The Singapore PUB reached out to OCWD to learn about the technology that the District used to purify wastewater back into the groundwater supplies. Water leaders from Singapore visited OCWD to see what we were doing to recycle and purify wastewater and how we were communicating with the public to bolster public support for potable reuse.

Working with the information gained from OCWD's successes, Singapore developed both purified water, which they call NEWater, and seawater desalination to diversify their portfolio of available water sources for the drinking water system and to protect against depletion of their reserves during periods of drought or interruption of imported supplies.

Singapore also recognized the critical role this water supply provides to its industrial economic engine. It built a secondary water distribution system to enable it to serve high-purity water to high-technology customers, such as wafer fabricators and circuit board manufacturers who need higher purified water for their manufacturing processes. This system of high-purity recycled water distribution helped to make Singapore a desirable place for valuable industrial customers to locate manufacturing facilities. Most of the NEWater produced in Singapore is used by industrial customers.

The contributions that OCWD has made to advance the technological capabilities of developing safe and sustainable water supplies was recognized at the 2014 Singapore International Water Week. The Lee Kuan Yew Water Prize was presented to the Orange County Water District. This distinguished prize honors outstanding contributions by individuals or organizations toward solving the world's water problems by applying innovative technologies or implementing policies and programs that benefit humanity.

This prize is a tremendous achievement for OCWD and we are proud to serve as a global leader in the water industry. Greater investments must be made to implement similar projects around the world. We must continue to create opportunities for water experts to engage with one another and exchange information to keep pushing the envelope and develop new and innovative solutions to global water problems.

The Singapore/Orange County Water District's example is that of a technology transfer and collaboration to solve global water supply and quality problems. This kind of collaboration delivers tangible benefits in the form of improved quality of life, robust economic activity, public health improvements, and long-term socio-economic stability. The lessons that OCWD has learned in its decades of developing and implementing responses to water scarcity demands a meaningful partnership among various local, regional, state, national and international agencies to ensure the development of sustainable water supplies that, in turn, will reduce, if not eliminate, the potential for conflict related to unreliable water supplies.

I would note that Senator Boxer has sponsored Water in the 21st Century Act (S. 176). OCWD supports this legislation. It offers a framework to advance innovative solutions from water recycling to desalination to water data collection and energy efficiency among other initiatives. We recommend this committee act on S. 176 to provide an important catalyst to advance alternative water supply projects as well as better informing federal, state and local water resources managers.

The GWRS is one of our proudest achievements in the effort to develop sustainable and safe water supplies. However, it is only one facet of a program to safeguard our region from economic and social disruptions attributable to a changing climate that is the new normal.

One of the most cost-effective solutions that we avail ourselves of involves water conservation. We have an aggressive education program to let our citizens understand how they can be part of the solution. Some of the activities we have implemented include:

Conservation through reduced demand is not going to solve our overall need to assure we have adequate water supplies. In order to supplement our conservation program, OCWD collaborated with the U.S. Army Corps of Engineers to leverage the investment that our region and the Corps have made in constructing Prado Dam. Rather than use

Prado for a single purpose, flood protection, we recognized the potential of conserving water at Prado during storm events that can be subsequently recharged into our basin for future use. The alternative would be to lose this water supply as it courses down the Santa Ana River and into the Pacific Ocean due to Senator Boxer's leadership and this committee's actions, we have relied on annual deviations to permit OCWD and the Corps to capture stormflows for treatment and use to offset demand on imported water supplies.

We understand that the committee is in the midst of reauthorizing the Water Resources Development Act (WRDA). OCWD provided suggested policy to facilitate enhanced conservation at Corps facilities. Our recommendations to the committee arise from our experiences over the past few years working with the Corps to implement a long-term agreement to store water with a priority placed on public safety and in an environmentally protective manner. Simply stated, a clear statement on the priority to approve and implement water conservation activities needs to be made as part of a reauthorized WRDA. This is the case because OCWD has spent too many months beyond our original understanding of the process duplicating studies and awaiting approvals. We also need a statement on the priority to ensure that costs are fairly allocated by guaranteeing that only the separable costs attributable to the water supply conservation allocated to the local water agency. The ability to facilitate an expeditious and equitable agreement to implement an innovative and cost-effective solution with high returns and benefits to the public, but we need a strong statement on the matter as part of the reauthorization of WRDA. We stand ready to support the committee to this end.

Related to the opportunities to advance meaningful stormwater capture is the vital role that real-time monitoring and evaluation can serve in the management of existing facilities. At the state level, many local agencies rely upon advanced monitoring technologies to better inform water managers in decision-making on the retention and release of water from reservoirs. If this sophistication was required at federal facilities, we would likely improve our ability to develop water supply without adverse impacts to the environment and public safety. To this end, we encourage the committee to direct the use of modern forecasting technologies to advance the conservation of our water supplies.

Another opportunity that offers a meaningful contribution to our mutual interest in finding immediate and long-term water supply solutions in an era of changing hydrological conditions is desalination. When we speak of desalination, we need to be

clear that there is a real need to commit resources to research and technology development. Examples from Israel, clearly demonstrate the return on such investments. We must also understand that desalination as a source of water supply carries different challenges depending upon whether it is coastal or inland.

From OCWD's perspective, we believe that coastal desalination might serve an important asset in our arsenal of water supply solutions. However, as an agency that must address the needs of our ratepayers, the challenge for OCWD and other agencies is the cost of desalinated water. As the San Diego plant has illustrated, there are solutions that can be put in place to protect the ratepayers. But it requires careful review and approvals for any proposed project because desalinated water supplies carry a cost beyond traditional sources. Given the new realities that we face in securing a safe and reliable water supply, we cannot turn away from this potential opportunity. This is why OCWD is currently exploring the opportunities and costs of a desalinated water supply.

Whether you support desalination or are on the fence, one important step that we should pursue is a commitment to drive down the costs of producing such a supply. We have seen important advances in driving down the costs on an acre-foot basis over the past several decades. But we can do more. From bringing clarity to the permitting process to reducing the costs of producing water and disposing of the byproducts produced during the treatment process, we can find ways to make desalination more attractive to meeting emergency and long-term water supply needs.

Over the past several years, we have witnessed a growing appreciation of the role of energy efficiency. As we seek to find ways to reduce the cost of innovative technologies, we should not overlook the value in reducing water production, treatment and conveyance costs through energy efficiency. The ability to develop energy savings can serve to advance technologies that today might be considered unaffordable. To this end, we would recommend that we provide tax credits, for example, to make investments in energy efficient technology development and commercialization.

The priority to develop alternative water supply solutions can be aided through informed decision-making on how to invest in the numerous solutions that we are discussing today. One area that holds promise is the field of analytics. The opportunity to collect data and analyze it to determine how water demand impacts

water supply holds the promise of better informing our water managers when decisions on investments are made. We recommend that the committee consider supporting initiatives that would enhance our understanding of how water supplies are utilized, what the metrics tell us about solutions that can address such demands and what kind of mix of conservation, technology and education can deliver meaningful outcomes for our water supply reliability needs. The use of analytics to help guide decisions may benefit the effort to select a portfolio of solutions that advance the needs of a particular region.

I would like to close with one other thought. Often, we in the water industry tend to see innovation within the context of advancing technologies. However, OCWD has learned that a critical component of innovation is education. Our future opportunities to find innovative solutions will depend on the understanding of our communities about the importance of innovation in securing our water future. This was clearly the situation when we successfully constructed and began operating the GWRS. We would urge you to provide for adequate support of education needs going forward so that the public appreciates and better understands the value of our investments in water supply innovation. At OCWD, we recently completed the construction of an educational platform that offers visitors a comprehensive presentation of the water cycle, technology advancements and the overall value of water to our economic, environmental and recreational needs. While technology can deliver solutions, one of the greatest resources we have in meeting the new normal of water supply is an educated public.

Again, OCWD deeply appreciates the opportunity to appear before you today. We look forward to working with you to advance the adoption of innovative solutions to our water resources needs. I would be happy to respond to any questions you may have.

Senator INHOFE. Thank you very much.
Mr. Price.

STATEMENT OF KEVIN PRICE, SENIOR SCIENCE AND TECHNOLOGY ADVISOR, MIDDLE EAST DESALINATION RESEARCH CENTER

Mr. PRICE. Chairman Inhofe, Ranking Member Boxer and members of the committee, I am Kevin Price, Senior Science and Technology Advisor to the Middle East Desalination Research Center in Muscat, Oman.

My passion throughout my career has been the application of new technology to the purification of nonconventional waters to increase water supplies, reduce the risks of drought, increase jobs and standards of living and to assist in resolving conflict around the world. I will focus my remarks on desalination and indirect and direct potable water re-use.

Early in my Bureau of Reclamation career, I was responsible for the desalination research portion of the Science and Technology Agreement with Israel. During one of my trips, I was asked by a television reporter why someone from the U.S. was attending the Israel Desalination Society meeting. I explained that the problems and solutions Israel was currently solving would be important to the U.S. as it faced similar problems in the future.

I currently work for MEDRC, which is an international institution created in 1996 as part of the Middle East Peace Process and is hosted by the Sultanate of Oman. Members of MEDRC include the Palestinians, Jordanians and Israelis as well as the U.S. Department of State. MEDRC works to address two grand challenges: water and peace. This is done through capacity building in training and research.

There is an important technical distinction that must be made before proceeding with my remarks. Water purification means a number of things depending on the audience. Regulatory frameworks around the world describe what needs to be removed from water and to what levels. For many, this means removing suspended particles, bacteria, viruses and very large molecules through helping the particles to stick to each other followed by filtration. This will not work with many non-conventional sources, because a major portion of the contaminants is dissolved, not suspended as particles in the water.

Desalination or the removal of dissolved materials is a fundamentally different process than filtration. Desalination is also a critical component of indirect and direct potable water re-use.

No longer is it necessary to think of drinking water, wastewater and impaired water as separate entities. They are all water, waiting to have the containments removed to the desired level. Among the 21st century technologies are microfiltration, ultrafiltration, reverse osmosis, membrane bioreactors, humidification-dehumidification, capacitive deionization, closed circuit desalination, forward osmosis and a whole bunch of other technologies that people continue to develop.

The lessons learned in Israel have consequences for the U.S. especially in the drought plagued areas near the sea. Israel's water supplies have been limited from its creation. They have had to

learn how to conserve through public education, reducing water losses and appropriate pricing. Because the need for new sources was so immediate, they knew membrane technology, which was invented and commercialized in the U.S., would work and decided to move forward using desalination without perfect information. They had good knowledge from the experience of others and their own research on how to manage the environmental effects of desalination such as optimizing energy use, reducing chemical addition, reducing entrainment and impingement of intakes, and mixing of the outfall concentrate back into the ocean.

In discussing this with Oded Fixler, the Deputy Director General of the Israel Water Authority, he said that technology is only technology, and it already works. The real issues are broader such as who owns the water, the cost of water, whether or not the cost is appropriate for crops and which crops, and who will subsidize. By developing desalination as a part of their integrated water resources, Israel was also able to develop an industry that can now compete internationally. It is important to note the differences between and a State like California. Not only is the control of water highly fragmented in California, the State is much larger than Israel. Israel has a population of around 8 million in 8 million square miles. California has a population of around 39 million in 164,000 square miles. In addition, the opportunities to move water throughout Israel are much greater than in California.

Some of the lessons I learned with my colleagues while I was in Reclamation for generating innovation and unsolicited proposal request for broad boundaries generates unexpected ideas and proposals. Innovation should follow progression related to risk taking and project size. Consistent funding at low levels is better than higher levels of inconsistent funding.

It is imperative to have strong initial and periodic technical reviews combined with freedom to accept risk when studying the unknown. If research is to solve problems and meet needs, a strong technology transfer must exist to pull innovations from the laboratory into use. When moving technology to rapid implementation, demonstration provides the opportunity to involve all parties at an early stage.

Mr. Chairman, this concludes my remarks. More detail can be found in my written statement, and I would be pleased to answer any questions at this time.

[The prepared statement of Mr. Price follows:]

Statement of M. Kevin Price
Senior Science and Technology Advisor
Middle East Desalination Research Center, Muscat, Oman
Before the
Committee on Environment and Public Works
United States Senate
New Approaches and Innovative Technologies to Improve Water Supply
April 20, 2016

Chairman Inhoff, Ranking Member Boxer and members of the Committee, I am Kevin Price, Senior Science and Technology Advisor to Middle East Desalination Research Center (MEDRC) in Muscat, Oman. I am pleased to discuss new approaches and innovative technologies to improve water supply. My passion is the application of new technology to the purification of nonconventional waters to increase water supplies, reduce the risks of drought, increase jobs and standards of living, and to assist in resolving conflict around the world. I will focus my remarks on desalination and indirect and direct potable water reuse.

I retired from the Bureau of Reclamation (Reclamation) after 30 years, where I started as a researcher on the Yuma Desalting Plant and later managed water treatment engineering and research. Part of my responsibilities included managing the internal research and external research authorized by the Water Desalination Act of 1996 also known as the Paul Simon Act. My responsibilities included managing the research portion of Reclamation's water reuse program. Early in my career, I was responsible for the desalination research portion of the S&T agreement with Israel. During one of my trips, I was asked by a television reporter why someone from the U.S. was attending the Israel Desalination Society meeting. I explained that the problems and solutions Israel was currently solving would be important to the U.S. as it faced similar problems in the future.

I currently work for MEDRC which is an international institution created in 1996 as a part of the Middle East Peace Process and is hosted by the Sultanate of Oman. Members of MEDRC include the Palestinians, Jordanians, and Israelis as well as the U.S Department of State. Part of my duties as a Reclamation employee was helping in the design and implementation of MEDRC. MEDRC works to address two grand challenges: water and peace. This is done through capacity building in training and research.

There is an important technical distinction that must be made before proceeding with my testimony. Water purification means a number of things depending on the audience. Regulatory frameworks around the world describe what needs to be removed from water and to what levels. For many, this means removing suspended particles, bacteria, viruses, and very large molecules generally through helping the particles to stick to each other followed by filtration. This will not work with many nonconventional sources, because a major portion of the contaminants is dissolved, not suspended as particles in the water. Desalination or the removal of dissolved materials is a fundamentally different process than filtration. Desalination is also a critical component of indirect and direct potable water reuse.

Conventional water treatment was described as early as 2000 BC with very simple municipal treatment beginning in the early 1800's. Chemical treatment with coagulation/flocculation and chlorination started in the late 1800's and early 1900's. Comprehensive regulations and standards in the U.S. weren't developed until the 1970's. Today, treatment can be to standards better than drinking water quality (think microelectronics, pharmaceuticals, boiler feedwater), which allows us to treat to the intended use. No longer is it necessary to think of drinking water, wastewater, and other impaired water as separate entities; they are all water waiting to have the containments removed. Among the 21st century technologies are: microfiltration (MF); ultrafiltration (UF); reverse osmosis (RO); membrane bioreactors (MBR); electrodialysis reversal (EDR); thermal processes including multistage flash (MSF), multi-effect distillation (MED), vapor compression (VC), humidification/dehumidification; capacitive deionization (CDI); closed circuit desalination; solvent extraction; forward osmosis (FO); pressure retarded osmosis (PRO); reverse electrodialysis (RED); membrane distillation (MD); adsorption, ion exchange, advanced oxidation; and others. Many of these technologies depend on separations driven by pressure, electrical attraction, heating/freezing, adsorption, and incremental improvements in existing technology. Another important opportunity in the 21st century is information driven technology ranging from optimization of treatment facilities to information on the quality, quantity, and individual use of water resources.

It is important to acknowledge the role the U.S. government played in the development and maturation of these technologies starting with the Saline Water Act of 1952. The Office of Saline Water and later the Office of Water Research Technology in the Department of Interior operated from 1952 through 1982. In 1952, seawater desalination cost $34 per thousand gallons compared to today at $2 to $4 per thousand gallons. There were demonstration facilities in New Mexico, Texas, South Dakota, California, and North Carolina looking at different technologies for brackish and seawater desalination. A number of companies were spun off from the program. From an investment of over $2 billion in todays dollars, over 1200 research reports were generated describing new findings. During this period electrodialysis was commercialized; significant improvements were made to thermal desalination; new knowledge was developed in materials and physical chemistry; membranes were created and commercialized; large-scale demonstrations were carried out; and large-scale designs were completed although never built. In 1965, the first international Symposium on Desalination was hosted in Washington, DC and chaired by the Secretary of Interior, Stewart Udall.

So where are we today? Statistics from Miriam Balaban the Founder and Editor in Chief of several desalination journals show the decline of research papers from the U.S., since the days of U.S. government support. For the period of 1966 to 1975, 539 papers were published from around the world with 235 or 44% coming from North America. For the period 2009 to 2013, 5884 papers were published from around the world with 242 or 4% coming from North America. The biggest increases were for the Asia Pacific region with 42% of the total, Europe with 26%, and the Middle East with 18%. The increase in papers coincides with the increased funding for desalination research from Singapore, Korea, Japan, China, Australia, Israel, the Gulf States, and Europe.

The research investments in other parts of the world were for a number of reasons. In some cases, it was for national security so a nation would not be dependent upon an unfriendly, or even a friendly neighbor, for their water supply. Some countries are seeing increased drought due to climate variability. In other cases, it was to support improved efficiency and to reduce future costs of the large investments already made in desalination and reuse facilities. Then there are the countries who have combined a national need with the opportunity to expand their new capabilities into the international market for their private sector. Many of these technologies are built on membrane separation that was invented in the U.S.

Before discussing some of the lessons learned in Israel and how the U.S. can pursue innovation, advanced water treatment is the most expensive alternative. By definition, it takes energy to remove impurities from water. All countries must look to conservation, managing leakage, appropriate pricing, recycling, management of water for agriculture, which are less expensive, less energy intensive, and more environmentally friendly. This does not mean that desalination should not be a component in a balanced water portfolio. Desalination balances the risks of depending wholly on sources affected by drought, climate variability, or non-sustainable groundwater supplies.

The lessons learned in Israel have consequences for the U.S. especially in drought plagued areas near the sea. Israel's water supplies have been limited from it's creation. They have had to learn how to conserve through public education, reducing water losses, and appropriate pricing. Because the need for new sources was so immediate, they knew the technology already would work and decided to move forward using desalination without perfect information. They had good knowledge from the experience of others on how to manage the environmental effects of desalination such as reducing chemical addition, reducing entrainment and impingement of intakes, and mixing of the outfall concentrate back into the ocean. In discussing this with Oded Fixler, the Deputy Director General of the Israel Water Authority, he said that technology is only technology and already works. The real issues are broader such as who owns the water, the cost of water, whether or not the cost is appropriate for crops and which crops, and who will subsidize. By developing desalination as a part of their integrated water resources, Israel was able to develop an industry that can now compete internationally. I found it interesting that Israel has removed a significant amount of bureaucracy by centralizing control over water resources. One outcome of this is one set of municipal water prices for the country. Previously, Mekorot delivered water to the cities and then each city sold the water. In some cases, water prices were used to fund subsidize municipal programs. It is important to note the differences between Israel and a state like California. Not only is the control of water highly fragmented in California, the state is much larger than Israel. Israel has a population of around 8 million in 8 million square miles. California has a population of around 39 million in 163,600 square miles. The opportunities to move water throughout the country are much greater than in California.

The broad goals of an advanced water treatment research program supporting innovation should be: (1) to lower the financial costs of desalination so that it is an attractive option

relative to other alternatives in locations where traditional sources are inadequate, and (2) understand and reduce the environmental impacts of desalination and develop approaches to minimize these impacts relative to other water supply alternatives. Much more information on this can be found in the 2008 National Academy of Sciences report, *Desalination*.

Innovation in desalination and advanced water treatment should follow a progression related to risk taking and project size. The Water Desalination Act of 1996 is a good example describing this progression needing one or two updates. Research funds should be available for basic research encouraging experts from other fields who may never have thought about purifying water at the molecular level. The next stage is in the laboratory where conditions can be controlled and factors that influence the process can be studied and modeled. Once the laboratory or bench scale stage is successful, it is necessary to carry out pilot scale testing in the real world at a test site. Many factors that might influence the process can only be studied under real conditions. Once pilot scale testing is successful and before building a full scale facility, a demonstration facility should be tested. The size of the demonstration scale may be one or two orders of magnitude smaller than full scale. While this is more expensive than the earlier stages, it is less expensive than full scale and helps to mitigate the risk of being the first ever tested. The demonstration scale also allows bringing in a local utility, a local engineering firm, a local university, various vendors interested in the new technology, the local politicians, and the regulators. While a demonstration mitigates risks it also provides for capacity building, public outreach, and acceptance. Throughout the research progression, investments have to be made to streamline technology transfer to ultimately commercialize the process.

One new tool not in the Desalination Research Act of 1996, that is gaining a lot of attention and success, is the use of crowd sourcing. While the use of challenges and prizes is not new it is receiving a significant amount of renewed attention in advanced water treatment. The expectation is someone who may never have heard about advanced water treatment has a new solution and is motivated to compete for a prize.

To end my testimony, I will list the lessons learned by one of the most experienced desalinators in the business, Dr. James Birkett in *Desalination at a Glance* published by the International Desalination Association, and lessons I learned with my colleagues while working at Reclamation.

- It will be simple and must be capable of high throughputs.
- It will be fast. The time the feed water stays in the system must be short and is on the order of seconds for reverse osmosis. Because rivers of water are being treated, slower process mean more equipment and greater cost.
- It will operate at high recovery. This means a large majority of water entering the treatment system leaves as purified water lessening the volume of concentrate and reducing the amount of water being pumped through the system.
- It will be reliable. The size of the plant has to be increased to account for when it is not operating leading to higher costs. If storage of purified water is limited it is even more important to minimize outages.

Some of the lessons I learned with my colleagues while I was at Reclamation:

- Institutional/political needs create significant technical opportunities,
- For generating innovation, unsolicited proposal requests with broad boundaries generates unexpected ideas/proposals,
- Consistent funding at low levels is better than higher levels of inconsistent funding,
- It is imperative to have strong initial and periodic technical reviews combined with freedom to accept risk when studying the unknown,
- Outside advisors and reviewers of a program are essential to assist in testing ideas, bringing diversity of experiences and ideas,
- If research is to solve problems and meet needs, a strong technology transfer program must exist to pull innovations from the laboratory into use,
- When moving technology to rapid implementation, demonstration provides the opportunity to involve all affected parties at an early stage.

Senate Environment and Public Works Committee
Hearing entitled, "New Approaches and Innovative Technologies to Improve Water Supply."
April 20, 2016
Responses for the Record
Mr. Kevin Price

Chairman Inhofe:

1. **Mr. Price, I greatly appreciate your testimony before the Environment and Public Works Committee on drought technologies. Your testimony informed the Committee and has resulted in new legislative language in the WRDA legislation reported from the Committee and being considered in the Senate. Your comments concerning chloride control were especially important to me. Chloride control is the likely means to address increasing drinking water and irrigation supply in regions of Oklahoma directly affected by drought for many years. Can you direct me to further resources identifying the latest chloride control technologies to ensure that community leaders in Southwestern Oklahoma and the local Army Corps of Engineers are pursuing the most cost efficient and promising technologies?**

Response:

Chloride control can be achieved by reducing the water that is dissolving the salts buried in the ground and/or through treatment of the contaminated water when it reaches the surface. Once the salt is dissolved in the water, it takes a financial commitment to build and operate facilities to remove the salt to levels fit for agricultural or municipal purposes. In addition, since this is an inland situation, there are increased costs for sustainable methods to dispose of the salt once it is removed.

Some of the resources community leaders and the Army Corps of Engineers might consider using, include the private sector, public sector, academia, and non-profit associations. Many engineering companies that design water treatment systems also have desalination expertise. They can help provide a client with the best available technology at the best prices. Both the Army Corps of Engineers and the Bureau of Reclamation have expertise to understand the benefits and limitations of these technologies. Many of the local universities have professors who understand the technologies and who are preparing engineers and scientists to solve this and other problems. Another great source of information is the non-profit associations such as the American Membrane Technology Association (the old American Desalting Association). Please consider contacting the AMTA Executive Director, Dr. Harold Fravel, hfravel@amtaorg.com, 772-463-0820.

Technology in advanced treatment of water continues to improve through research. Reducing energy, operating, and capital costs are priorities for federal, state, and non-profit advanced water treatment research funding. Oklahoma presents a special case for brackish desalination, since there is no opportunity to use an ocean outfall to dispose of the salt concentrate. The Bureau of Reclamation as well as well as many states, especially California, continue to support research

funding for inland concentrate disposal with the expectation of reducing treatment costs for those communities that are finding traditional sources of water inadequate.

Senator INHOFE. Thank you, all three, very much.

Let me just restate that in Oklahoma the legislative goal for chloride control is to reduce the naturally occurring chlorides in the Red River. Now, multiple studies dating back many, many years and designs have been completed, many of them by the Corps of Engineers—we are talking over 40 years ago, in 1978 was one of them. Yet a single project has not been constructed in Area 6, that is Southwestern Oklahoma, despite the Corps spending $3.1 million in Area 6 over the past 10 years.

Now, my question would be to you, Mr. Dalton. If all of these studies and designs, at full Federal expense, have been completed over the past four decades, then why is the Corps asking for yet another study of the project to determine feasibility of building projects to reduce the chlorides in the Red River?

Mr. DALTON. Mr. Chairman, that study we are looking at now for Area 6 started out, as you mentioned in your opening remarks, looking at now a re-evaluation of what had been previously completed for that particular study. I think it was maybe around 2005 or so that we looked at it and we started revising the study or updating the study. At that time, we ran out of money to do that.

Since that time we have been looking and talking with the State and county for, looking for a non-Federal partner to cost share in that.

Senator INHOFE. But there have actually been studies. They completed studies we are talking over a period of 40 years. I am looking at my situation. How do I go back to Oklahomans and ask them to spend money for a new feasibility study when we have gone through all of this? We have spent millions of dollars. Not a shovel has been in the ground yet.

Did you listen to Mr. Price's testimony? Do you think there are some technologies—is this something, Mr. Price, where technology is moving in desalination right now, and there are areas like perhaps the area I referred to in Southwest Oklahoma that might be able to benefit from some of these?

Mr. PRICE. Yes, chlorides can be removed by desalination.

Senator INHOFE. Yes, but if it is as simple as that, then is it a matter of cost?

Mr. PRICE. Generally, it is a matter of cost.

Senator INHOFE. So your technology has not really had a dramatic improvement in terms of reducing the costs?

Mr. PRICE. In the past 30 years it has had a dramatic improvement. Several orders of magnitude.

Senator INHOFE. Is anything going on right now that we may be overlooking in Oklahoma?

Mr. PRICE. I could discuss it with the Corps of Engineers. I am not aware that they would have kept up with the technology.

Senator INHOFE. Have you kept up with all the technology, Mr. Dalton?

Mr. DALTON. I am not familiar with exactly what the chloride removal we are looking at for this particular project. It is something we looked at as part of some of our other projects, I believe. I do not have specifics on that.

What I would like to respond to, Mr. Chairman, is that we don't know how much is required to complete the study, how much more

work is required. As far as talking with the non-Federal sponsor or citizens about why they should cost share, we plan on taking advantage of the work that has already been done. There's has been a number of parts of that study that have been completed.

What we need to do now is to take a look at what has been done and determine what needs to be done so that we can provide you with the work that we think is remaining and the cost and schedule to do that.

Senator INHOFE. Yes, that would be helpful. I remind you and everyone else who is here that next week Senator Boxer and I plan to go ahead and start the markup of the WRDA bill.

Senator BOXER. Yes.

Senator INHOFE. So we need this stuff now. I want to make sure that anything that can be done, and these projects are the kinds of projects we are dealing with in this bill. We want to stay on top of this thing, and yes, I would like to have—to be sure and I am sure as Mr. Price said, that the Corps has a lot of research and all that. But just make sure there is not something looming out there that would help us resolve this problem. Because right now, we are getting into the WRDA bill and that is what this is all about. Our intention is not to let these things slide. We should be doing the WRDA bill every 2 years, and I think we are on schedule to do that. This is the type of thing that we are wanting to do.

Senator Boxer.

Senator BOXER. Thank you. That is music to my ears, and I hope we can avoid on either side any kind of poison pill amendments that do not belong there. I think we have shown that we can do that.

So Mr. Bilodeau, do you view desal as a potential component of a comprehensive water supply system? I have a few questions on this, I will ask them all and then give you the time. Do you think it should be a component—is cost a concern as you explore the addition of desal to your water supply system? Could Federal water infrastructure loan programs help address some of these cost issues?

Mr. BILODEAU. Senator Boxer, the answer is yes to all those questions. Definitely desalination, we are looking very closely at having that part of our portfolio of sources. Of course, we have the Santa Ana River which is sort of our free source of water, and we have the groundwater replenishment system as we discussed. Desalination would be sort of the third leg to the stool.

Of course desalination is the most expensive, though, of those sources. But as you mentioned, Federal loan programs could certainly help with the cost of that.

We are fortunate in that there are innovations taking place, though, in that arena with membrane technology, and we are looking forward to breakthroughs.

Senator BOXER. Would you explain that to us in short what that means, membrane technology?

Mr. BILODEAU. Well, in terms of reverse osmosis, of course, you are pulling the water molecules across a membrane. The private sector actually, I believe Lockheed Martin is developing a membrane called graphene. We have offered to pilot test their technologies in our plant, to look at the effect of it. Because we are very

excited about these innovations, and we want to push those forward, because they are going to have worldwide implications and hopefully drive down the cost of that water.

To put it in perspective, the water that we produce in our groundwater replenishment system the non-subsidized cost is about $850 an acre-foot whereas the cost of desalinated water is about $1,200 an acre-foot. So it is about 50 percent more expensive.

Senator BOXER. I would just note, and I think my colleague agrees, everybody needs clean water. So when you are faced with a situation where maybe you have a water emergency, the cost diminishes because we need it. It is the staff of life in so many ways.

So what we are trying to do is work with my colleague to get a lot of my Water–21 legislation in this. I think so far it has been great. We are looking at reauthorization of the Desalination Act. Mr. Chairman, if we can put that in the bill, reauthorize an act we already have, which would include desal pilot projects, also required development of drought resilient guidelines to help communities deal with drought, that would be helpful. I hope we could support new grants to support development of innovative technology and change or modify the SRF loan program to better support innovative technologies because we kind of haven't updated it in a while.

Those four things, would you agree, would be a good start for us?

Mr. BILODEAU. Absolutely. One of the bigger challenges we have is actually the distribution of the water because this will be a new plant that we are looking at in Huntington Beach. And the distribution system alone is over $100 million, just to move the water around to where we need it. So a loan program would be a tremendous help to us.

Senator BOXER. How about the WIFIA program? The Chairman and I worked together to get that done. It is based on TIFIA which would allow you to leverage funds and get pretty much interest-free loans. Would that be helpful as well?

Mr. BILODEAU. Interest-free, yes, we certainly could use that.

Senator BOXER. Well, it is extremely low interest, because basically the interest rate is set based on the chance that you might default. It is very low, especially, I would say Orange County has proven it can get out of some trouble. You did in the worst situation after the market crash. How well I remember that and how hard that was.

So let me turn to Mr. Price. Do you think the U.S. should have a greater role in water supply technology development? You discuss in your written testimony the historic role of the U.S. Government in developing desalination and other treatment technologies. But you say the investment has declined, and we are not participating in the new research as much as we were. Is that a correct reading of what you said?

Mr. PRICE. That is correct. One of the ways that I investigated that was talking to one of the professional journal editors to get a feel as to how the number of scientific publications have changed over probably the last 30 or 40 years. Basically the U.S. was a leader in the science of desalination 30 years ago. It has now dropped to maybe, it is an order of 10, 10 times less in terms of

publication than it was in the past. I think that is probably due to the Federal funding more than anything else.

Senator BOXER. Well, thank you. I don't have any other questions for the panel.

I just want to say again to my Chairman, this is an area where I just think the work of this committee could really spark an entire new effort to rekindle the new technologies. We hear of defense companies that are looking at the ways to deal with desal. I think it is right there, and I just think a little spark from this committee could drive change and alleviate one of the biggest problems that we face as a Nation.

And we always have had these issues. I know Oklahoma, my God, when you think back in history the problems that Oklahoma has had and California over the years with drought. This is like buying a really good insurance policy, and while we are doing it become a leader in the world in these technologies. So I am excited to work with you, Mr. Chairman, and I think this committee can really light a fire under this desal and recycling, the kind of things we like to see happen.

Senator INHOFE. I think that will happen, and the timing could not be better. I know there is a simple answer to this.

Mr. Price, when you are talking about researching it, you have Barbara and me, and you have the big ocean out there and we have the little Red River. Is your research into technology and all that, will that equally apply to both? Or do you concentrate in one area that is more advanced looming technology in one area than the other? Or is it the same?

Mr. PRICE. The technologies remain the same, but for brackish water like the Red River, it is a lot less expensive. It takes less energy to remove the dissolved salts because there are fewer salts.

Senator INHOFE. Well, Mr. Dalton, we will submit a question for the record to get new details on how to make chloride control construction a reality in our Area 6 that we are so concerned about.

Anyway, the timing is right, we are getting into our WRDA bill. That is what this is all about, and it has been a problem in my State for a long time, and it is one that—it would kind of be fun to solve a problem instead of just delay it. We are anticipating doing that.

So I think any other comments any member of the panel would like to share with us on this committee, while we only have the two of us here, we have staff from all the rest of the committee, and they are very interested in this issue. Any other comments you want to make?

All right, in that case we are adjourned. Thank you very much for coming.

Senator BOXER. Thank you so much, everybody.

[Whereupon, at 10:57 a.m., the committee was adjourned.]

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