Irrigation Leader

Volume 6 Issue 6 June 2015

Developing Low-Head Hydro in the High Desert: An Interview With Mike Britton of North Unit Irrigation District

Hydropower That Pencils Out

By Kris Polly

This issue of *Irrigation Leader* is dedicated to hydropower generation, specifically, the development of smaller-scale or low-head projects and the variables that must be considered. Like all our issues of *Irrigation Leader*, our magazine is written about, and for, the advancement of irrigation and the many great people who make the food security of our country possible. Our magazine is also written to inform those who have never been involved in irrigation and to develop greater understanding and appreciation for this important and necessary industry.

Many years ago, Mr. Shannon McDaniel, former general manager of the South Columbia Basin Irrigation District, told me, "The first rule about moving water through a canal is not to slow it down." He went on to explain that irrigation canals are specifically designed to move water in certain volumes and at certain speeds. Too fast and the canal can wash out; too slow and the canal will overtop from water piling up. To provide some context, this conversation took place during one of my many district tours with Shannon, while we were discussing developing hydropower in irrigation districts. His point about irrigation canals is that the energy of a canal is specific to its function. It is difficult to plug hydropower generation in a canal that was not originally designed to generate power, and as Shannon explained, it is the drops that must be considered for development.

The drops that Shannon was referring to are changes in elevation from one point of a canal system to another. Every surface water irrigation district has drops. Falling water has energy, but what is the minimum drop and flow of water that can be developed for hydropower? Ms. Gia Schneider of Natel Energy tells us in her interview that "the most cost-effective projects are those that have flow of a couple hundred cubic feet per second or higher with greater than 8 feet of drop." Other factors are important, such as proximity to power lines, local electricity markets, cost of the hydro turbine, etc. However, Gia has now provided every irrigation district general manager and board member a beginning point to think about, 200 cubic feet per second and 8 feet of drop.

Our cover interview with Mr. Mike Britton, general manager of the North Unit Irrigation District, located 40 miles north of Bend, Oregon, is a wonderful example of the long-term, conservative, and thoughtful way irrigation districts are managed. As Mike explains, everything a district does must "pencil out." His interview explains how and why his district decided to develop low-head hydropower for additional revenue.

This issue of *Irrigation Leader* magazine provides a variety of hydro generation– related articles with a few of the very best leaders. Congresswoman Cathy McMorris Rodgers, a longtime friend and advocate of irrigation and hydropower development, discusses her new legislation—Hydro 2 or the Hydropower Regulatory Modernization Act of 2015—which is designed to streamline hydro licensing. Ms. Megan Johnson and Ms. Rocio Uria-Martinez provide an excellent synopsis of the *2014 Hydropower Market Report* by the U.S. Department of Energy. Mr. Steve Boyd shares the experiences of Turlock Irritation District in its efforts to relicense Don Pedro Reservoir. Mr. Kerry McCalman, a true problem solver and Reclamation's senior advisor for hydropower and electric reliability compliance officer, discusses Reclamation's efforts to promote the development of small-scale hydro projects across the West. Finally, we have a great article from Mr. Brian Murtha of Voith Hydro about its StreamDiver technology.

We hope this issue is helpful to irrigation districts that are interested in developing hydro generation projects.

Kris Polly is editor-in-chief of Irrigation Leader *magazine and president of Water Strategies LLC, a government relations firm he began in February 2009 for the purpose of representing and guiding water, power, and agricultural entities in their dealings with Congress, the Bureau of Reclamation, and other federal government agencies. He may be contacted at Kris.Polly@waterstrategies.com.*

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Cover Photo: Mike Britton, general manager of North Unit Irrigation District standing next to trash screen made by International Water Screens.

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Developing Low-Head Hydro in the High Desert:

An Interview With Mike Britton of North Unit Irrigation District

North Unit Irrigation District (NUID) delivers water to nearly 60,000 acres in the high desert of Central Oregon, 40 miles north of the city of Bend near the town of Madras. The Deschutes and Crooked Rivers supply water to NUID's system. The district also operates and maintains the 200,000 acre-foot Wickiup Reservoir and the 6,000 acre-foot regulating Haystack Reservoir. NUID diverts, on average, close to 200,000 acre-feet and delivers, on average, 115,000 acre-feet. The district runs north 120 miles from Wickiup Reservoir—65 miles of main canal, 60 miles of river transportation, and 235 miles of ditches and laterals. NUID farmers irrigate from early April through mid-October and grow hay and forage crops, as well as carrot seed, grass seed, onion, and garlic.

July 1 marks Mike Britton's seventh year as general manager of NUID. Prior to his arrival at NUID, Mr. Britton managed a couple of irrigation districts in northern California—Westside Water District and Colusa County Water District, both of which are part of the Tehama–Colusa Canal Authority. Mr. Britton led the way at North Unit in developing alternative revenue sources for the district through small-scale hydropower projects. NUID is currently working with third-party developer, Natel Energy, on a low-head project at the Monroe Drop. Irrigation Leader*'s editor-in-chief, Kris Polly, spoke with Mr. Britton about the logistics of developing low-head projects and the overall value of hydropower for irrigation districts.*

Mike in the Monroe Drop Unit.

Kris Polly: How has the district addressed recent drought conditions?

Mike Britton: We have had several dry years now, and they seem to be increasing in severity. This year has been abnormally dry and warm.

We have undertaken efforts to conserve as much water as possible. The first 12 miles of our main canal are lined with shotcrete, and we've piped over 40 miles of laterals/ditches—after that, it is open ditch for the most part. Our first lining project in the late 1990s saved us about 23,000 acre-feet. Then, in 2010, we lined the last 5 miles of the canal banks to finish out the canal-lining project. That saved us almost 8,000 acre-feet.

Panoramic of Monroe Drop civil works.

However, lining is an expensive process and requires ongoing maintenance because of the freeze-thaw cycle we experience here in Central Oregon. We started a crack-sealing program about three years ago—we are using Aqualastic to fill cracks and holes. We have actually purchased all the equipment necessary, including an Aqualastic machine to prep and apply the product. So far, it's been a very good product—bulletproof. We have placed Aqualastic down in high-velocity areas where nothing else would work, and it has held up very well.

Kris Polly: What are the district's top issues?

Mike Britton: The drought obviously is one. And, like many other districts, we are struggling with Endangered Species Act issues. We have steelhead and bull trout swimming in our lakes and rivers. Recently, the Oregon spotted frog was listed as a threatened species, which creates another layer of uncertainty with regard to district operations. We are all working to try to find common ground where we can support wildlife and habitat while maintaining operations.

One other is the financial viability of the district. The cost of doing business continues to increase. There is a breaking point at which assessments on farmers exceed the revenues they generate. We have pursued several hydro projects in an attempt to ease that burden.

Kris Polly: How has NUID gone about developing hydropower?

Mike Britton: The district has a couple of dams that have been evaluated and are in one form or another of hydro development. Throughout our system, we have numerous drops of various sizes, flows, and velocities. The district actually looked at hydro development back in the 1980s—there were about a half-dozen feasible sites at the time. At that time, however, the district decided not to pursue any of the sites.

When I came on board, I saw [hydropower] as a good opportunity to generate revenue for the district. Right now, NUID's sole source of income is its patrons. With costs going up, we took a hard look at ways to generate more revenue and found that hydro was the best path to pursue.

One of the key elements of my job is trying to develop hydro projects. Fortunately, we have had a lot of people who have shown interest. This season, in addition to the Natel project, we commissioned a 3-megawatt facility on the main canal. Our Natel project is anticipated to come online within the next month. So we'll have two plants in place and are looking closely at other projects within the district.

The way the district has approached hydro development is through [third-party] developers. Those developers approach us and apply for preliminary permits. The district, as a quasi-municipal entity, has a development preference and can take a hydropower project back from a developer. We enter into an agreement with a developer in which it will construct, operate, and maintain the project for a certain number of years. During that time, the district shares in the revenue generated by the project. At the end of the agreement term, the project flips to district ownership. While we are only in the initial stages of these agreements, for the most part, the model has worked well so far.

Because it's a Bureau of Reclamation project, the district bears a heavy debt load for project construction. In addition, we incurred debt on some [Reclamation] Safety of Dams program work done a few years ago, as well as the $8 million canal-lining project I mentioned earlier. So we felt that we didn't want to take on more debt with respect to the hydro projects. While the projects would pay for themseleves, there is always that risk that something could go sideways or upside down. So we have pushed that risk on to the developers.

Central Oregon Irrigation District and Swalley Irrigation District have had projects online for a few years. We witnessed their trials and tribulations developing these projects, dealing with agencies and power companies, and

decided that was not for us. In 20 years, the projects will be ours and all the associated issues with initial hydro development will be behind us.

Being a public entity, we typically can't pick and choose the partners we work with. Natel filed an application on the Monroe site, and NUID agreed to let it develop the site under a hydro development agreement. It is a different mode than if you post [requests for proposals], which we would typically do. The sequence in which things happen is different. Luckily, there are not a lot of companies like Natel out there. It has been a good developer. And actually, back in 2010, we traveled down to Buckeye, Arizona, and looked at Natel's first installation when we were researching hydro development.

The Natel project is a low-head hydro facility. The net head for the project is about 15 feet with an average flow of 380 [cubic feet per second]. That will generate about 300 kilowatts. It won't make anyone rich any time soon, but the district's thinking is that the installation of multiple units will have significant positive financial effect over time.

Kris Polly: Beyond your existing projects, are there any other opportunities for development within the system?

Mike Britton: We have a handful of other drops in the system, but many of them are in remote areas. The area between Madras and Bend is high desert rangeland, and our canal runs through that. There are no power transmission facilities out there to easily tap into. Most of those sites would require miles and miles of power lines to reach some of these sites.

In Central Oregon, power prices are not that great at the moment. A location that doesn't take a lot of shovel work, does not incur a lot of permitting costs, and is close to an interconnection will be that much more attractive. But if you are only getting 3 or 4 cents per kilowatt-hour, it doesn't really pencil out. As power rates increase, I'm sure we'll see the interest in low-head hydro increase for our sites.

Kris Polly: What is your advice to other irrigation districts considering developing hydropower in their system with a third-party developer?

Mike Britton: Every district is different, and levels of risk aversion are different, but if you have the financial capacity, expertise, and wherewithal to undertake these projects yourself [without the help of a developer], it is well worth the initial investigation to see if a project will pencil out. But if you are a small district with a limited staff and budget, the method by which we approached hydro development may work best. You won't get a lot of revenue right off the bat, but if you have multiple small-scale units, they will add up.

Mike next to the Natel SLH-100 hydroEngine™.

Streamlining Licensing to Harness Western Hydro

By Congresswoman Cathy McMorris Rodgers

In 1915, 100 years ago this year, Washington Water Power broke world records when it dedicated the tallest dam in the world, with the largest turbines in the world. Generations later, the Long Lake Dam—located on the Spokane River—continues to provide electricity, irrigation, and recreation for people in Spokane and the surrounding communities.

For more than 100 years, the development of the West and Pacific Northwest has been linked to hydropower. Initial settlements succeeded in places where they could use water to power mills that processed lumber and grain. Low-cost electricity from hydropower brought manufacturing jobs to our region. Dams on the Columbia and Snake Rivers transformed dry, barren land into some of the most productive agricultural regions in the world.

As Eastern Washington's representative in Congress, I'm proud to tell the story of hydropower and its positive impact. I am determined to share this story in our nation's capital and ensure that the future for hydropower is as bright as the past.

Here in Eastern Washington, hydropower plays a pivotal role—whether it's conventional, small, or conduit hydro, it provides 70 percent of electricity to the Pacific Northwest and represents a unique opportunity for job creation and energy production.

In the United States, hydropower produces approximately 100,000 megawatts of electric capacity each year—enough to power 75 to 100 million homes. This makes it the largest source of renewable electricity in the United States, providing nearly 50 percent of all renewable electricity in our nation.

Despite the inherent benefits of hydropower, federal policies and regulations discourage continued expansion. The outdated authorization processes and overlapping and duplicative requirements have disadvantaged hydropower as a cost-competitive resource.

Currently, hydropower provides just over 6 percent of all power generated in the United States, and there is great opportunity to expand. It came as a surprise to me to learn that only 3 percent of dams in the United States currently produce electricity. According to a study published by the National Hydropower Association, we could double hydropower production without building a new dam.

In 2013, I introduced the Hydropower Regulatory Efficiency Act—or, as I like to call it, Hydro 1.

Hydro 1 addresses the potential that exists for new hydropower growth. It facilitates the development of small hydropower and conduit projects, using emerging

technologies that improve the capture of energy along irrigation canals, municipal water supply conduits, and other infrastructure.

In a time of political gridlock, hydropower proved to be an issue that can bring people together. Hydro 1 passed Congress with unanimous support, and it was one of only 72 bills signed into law by President Obama that year.

Of course, there is more work to be done, and I'm working on a sequel to my original legislation, Hydro 2 or the Hydropower Regulatory Modernization Act of 2015.

As co-chair of the bipartisan Northwest Energy Caucus, I want to address federal laws that too often get in the way of using this renewable energy resource, to streamline the hydropower licensing and relicensing process to make it more efficient and transparent, and to encourage early environmental protection.

While the Federal Power Act and the Energy Policy Act of 2005 have tried to require better decisionmaking and promote efficiency in the Federal Energy Regulatory Commission's licensing process, unfortunately, too often the process remains burdensome and costly.

The discussion draft I released earlier this year seeks to start a conversation on how best to improve the process and expand an energy source for the Pacific Northwest and the rest of the country that will not only lower energy costs, but create thousands of jobs.

As hydropower is the largest source of renewable energy in the United States, we need to modernize the way we license projects that use hydropower, our cleanest, most affordable and reliable energy resource.

I am excited to help unleash American ingenuity to increase hydropower, lower energy costs for middle-class families, and expand domestic energy production.

I believe that 100 years from now, we'll be glad we did.

Cathy McMorris Rodgers is the U.S. Representative for Washington's 5th Congressional District. She is the Chairman of the House Republican Conference and a member of the House Energy and Commerce Committee.

Seeking Certainty in Central Valley Food and Power Production:

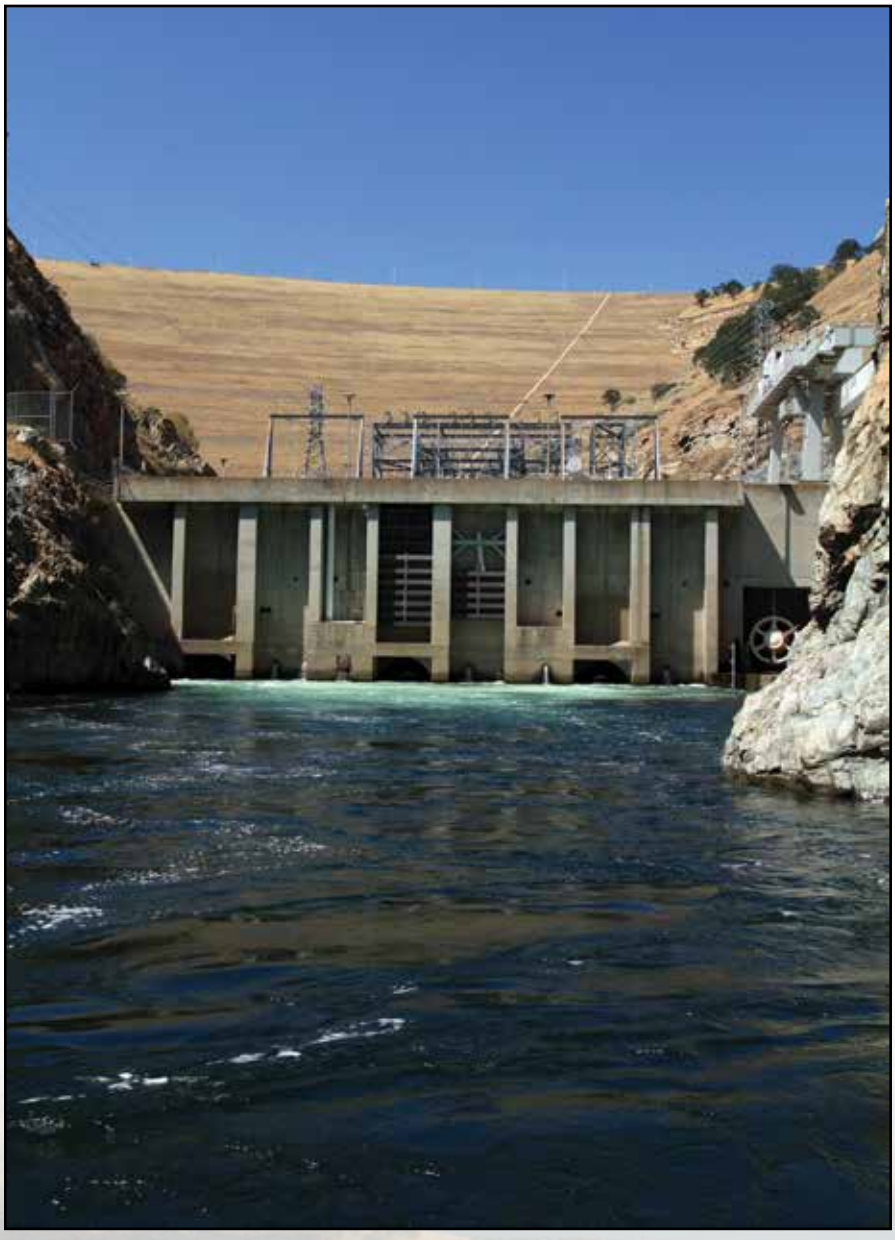
RELICENSING DON PEDRO RESERVOIR

By Steve Boyd

Founded in 1887, Turlock Irrigation District (TID) and Modesto Irrigation District (MID) were the first irrigation districts in California. Immediately after forming, the districts began gathering water rights on the Tuolumne River—and now hold some of the most senior water rights in California. We are also two of four irrigation districts within the state that provide retail electricity.

Together, TID and MID provide irrigation water to approximately 200,000 acres of prime farmland in California's Central Valley. The districts' customers are typically multigenerational growers living on or near their farm. Farms in the TID and MID territory average 27 acres in size and are the epitome of sustainable agriculture.

The focal point of the districts' operations is Don Pedro Dam and Reservoir, which provides water for irrigation and hydroelectricity. The reservoir is licensed by the Federal Energy Regulatory Commission (FERC), and this license is jointly held by TID and MID. The current license will expire in 2016, so in 2009, the districts began preparing to undergo the relicensing process. Due to the ongoing studies, we do not believe that we will have a new license by 2016, so the districts will be working on annual licenses going forward.



Don Pedro Dam and Powerhouse as seen from the Tuolumne River.

HISTORY

In the late 1890s, the districts constructed LaGrange Dam, a run-of-the-river dam on the Tuolumne River. Its sole purpose is to raise the river level high enough to divert water for irrigation into the districts' gravity-fed canal systems. In the 1920s, the districts built the original Don Pedro Reservoir, which held about 289,000 acre-feet.

Typically, there was enough water to get through an irrigation season, but not enough to weather a drought. The ability to provide irrigation water for seven months of the year brought prosperity to the region. Our forefathers saw this value and immediately began exploring the potential for a bigger reservoir, which ultimately would become new Don Pedro Reservoir. After entering the retail electric business in the mid-1920s, TID added a powerhouse off its main canal just downstream of LaGrange Dam, whereby we release the river requirements into the canal through the powerhouse and down into the river.

The 1906 San Francisco earthquake and subsequent fire impressed on San Francisco city officials the importance of having a reliable water supply. They began searching up and down the state and found a source above the districts on the Tuolumne River.

Development above our site made the districts uncomfortable, as we had senior water rights. The resulting tussle led to congressional intervention and the passage of the Raker Act, which protected the districts' water rights and enabled the City and County of San Francisco (CCSF) to develop above us. Today, CCSF's drinking water system provides water to 1 million people in the Bay Area.

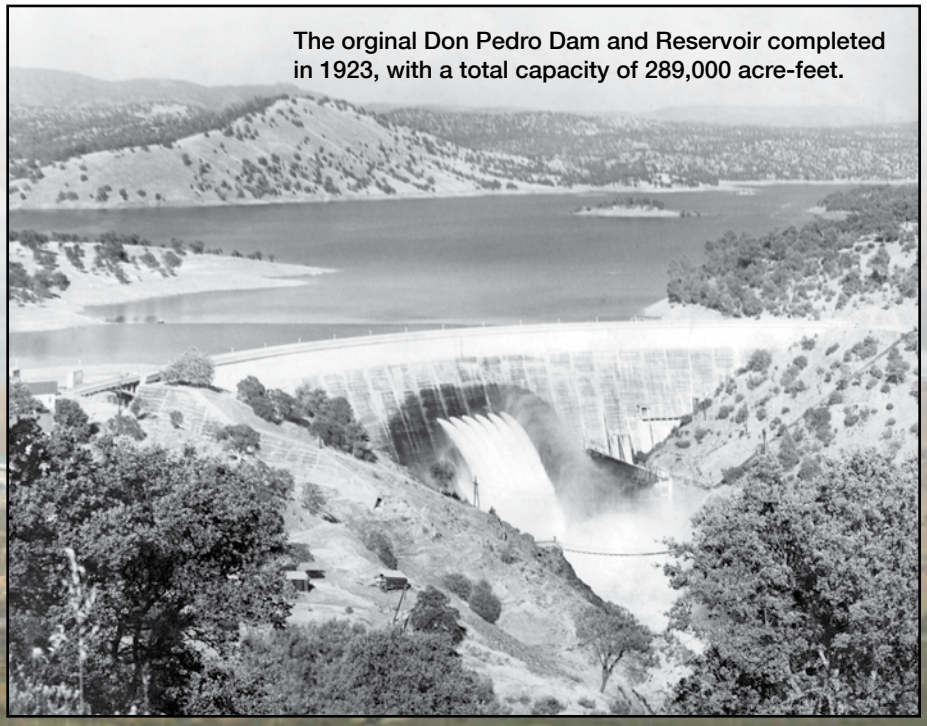
Originally, there were two plans for new Don Pedro—one for a 1-million-acre-foot reservoir and another for a 2-million-acre-foot reservoir. The 2-million-acre-foot reservoir was more appealing but financially challenging for the two districts. CCSF approached the districts with an offer to pay half the construction costs for new Don Pedro in exchange for water banking rights. Those banking rights gave San Francisco the ability to prerelease water into Don Pedro, and then, at later times, hold back water that would have otherwise been the districts'.

This arrangement gave San Francisco operational flexibility and the districts a bigger reservoir. It has been beneficial for TID and MID customers and CCSF residents. This initial arrangement grew into the strong partnership that we have with San Francisco today.

OF FISH AND FERC

FERC issued the initial license to the districts in 1967 to construct and operate new Don Pedro Reservoir and its 2.03 million acre-feet of storage. Its main purpose was water storage, not the generation of electricity. On Don Pedro, as elsewhere in the districts, hydroelectric generation is a byproduct of irrigation. Today, the district's irrigation operations support a $1 billion agricultural industry.

Thus far in the relicensing process, we have completed more than 30 studies at a total cost of $25 million that address operations, economics, and the environment. The districts and the CCSF conducted robust socio-economic studies showing the effects of water costs to the region. The districts have developed a suite of models that we can use to evaluate a variety of operation schemes, including



The orginal Don Pedro Dam and Reservoir completed in 1923, with a total capacity of 289,000 acre-feet.

how releases from Don Pedro will affect storage, reservoir, and river water temperatures. We have also undertaken population studies for fall-run Chinook salmon as well as steelhead rainbow trout, both of which are species of interest on the Tuolumne River downstream of Don Pedro.

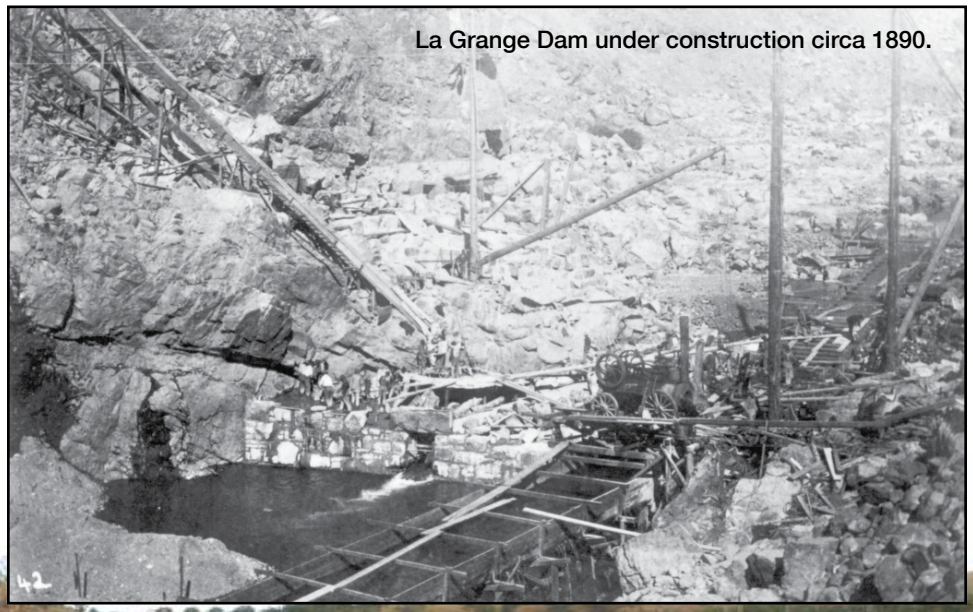
There is currently no fish passage at Don Pedro. In the studies for Don Pedro, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service requested studies for fish passage through Don Pedro. FERC initially ruled that LaGrange, a nonlicensed facility, prevents fish from going downstream and therefore renders a study of fish passage at Don Pedro unnecessary.

In response, the National Marine Fisheries Service and the U.S. Fish and Wildlife Service filed a petition with FERC to consider LaGrange under FERC's jurisdiction. About a year ago, FERC reviewed the petition and agreed it should be considered a project under FERC's jurisdiction. The districts appealed FERC's decision in the D.C. Court of Appeals and lost.

Don Pedro is an earth-filled dam, almost 600 feet tall and a half-mile thick at the base. Any fish passage project around a structure the size of Don Pedro Dam would be an incredibly large and complex undertaking. Some ideas proposed by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service include lifts, elevators, and large collection structures requiring massive infrastructure and large attraction flows in order to operate.

Right now there is talk of trapping and hauling fish downstream of LaGrange and placing them in Don Pedro with some type of out-migrating collection facility at the head of the reservoir. Given that typical reservoir level fluctuations span a couple of hundred feet a year, capturing out-migrating smolts, putting them into a truck, and moving them downriver will create a lot of challenges and incur incredible costs.

Interestingly, one of the Don Pedro relicensing



La Grange Dam under construction circa 1890.

La Grange Dam and Powerhouse.

studies, which cost $1 million to conduct, indicated that 90 percent of out-migrating salmon born in the Tuolumne River are consumed by nonnative predatory fish species before they make it to the river's mouth. So while the National Marine Fisheries Service and the U.S. Fish and Wildlife Service focus on the need for flow to improve the fishery, the districts believe that flow is only a component of a healthy fishery and that predation is the real problem. The districts believe that our studies show that a host of nonflow in-stream measures would make a significant improvement in the river.

ONE STEP AT A TIME

The National Marine Fisheries Service and the U.S. Fish and Wildlife Service also argue that LaGrange would be "used and useful" for Don Pedro Reservoir and therefore should be considered a complete unit of development and become a part of the Don Pedro license. FERC did not rule on that claim, basing its jurisdiction over LaGrange on other issues and reiterating the need for the districts to pursue a license for LaGrange separate from Don Pedro.

Every decision we make about LaGrange is actually about what is best for Don Pedro, so we are proceeding with a license for LaGrange.

OUR STATUS

Currently, the districts are finalizing the last couple of FERC-ordered studies. Under FERC's integrated licensing process, the districts are adhering to a relatively rigid timeline for the process. As a result of some of our big studies in 2012, additional studies were ordered the following year. Going forward, the districts will use that information to amend the final license application that is currently before FERC.

The National Marine Fisheries Service and the U.S. Fish and Wildlife Service have requested, and we have agreed to, additional predation studies that would look at the predation issue from a more segmented perspective. We were told by the permitting agencies that because of the drought, the California Department of Fish and Wildlife could not issue the permit for us to conduct the electrofishing needed to mark and recapture the predators in the river. For the second year in a row, FERC has issued a one-year extension, so we are standing by on the follow-up predation study for the Don Pedro project, while moving ahead with the LaGrange licensing.

LESSONS LEARNED

Start early in the relicensing process. There are a lot of varied interests in relicensing, ranging from concerned homeowners who live near the dam to tribal and fishery interests. Try to build relationships with everyone involved and put a solid, diverse team together to work through the issues.

TID and MID, and the customers we serve, want certainty in the supply of water and energy. That certainty is the real value in this process. Our grower-customers are small family farms, and they are making million-dollar decisions based on what they think the water supply will be in the coming years. The whole farming economy is placed at risk without that certainty.

Don Pedro supports a billion-dollar agricultural industry here in the valley. Our job is to protect the water supply, to put it to maximum benefit, and at the same time, to do what is right for the Tuolumne River.

Steve Boyd is the director of water resources and regulatory affairs for the Turlock Irrigation District. He is TID's project manager for the relicensing effort. You can reach Steve at (209) 883-8364 or seboyd@tid.org.

La Grange Dam in the foreground, Don Pedro Dam and Reservoir in the distance.

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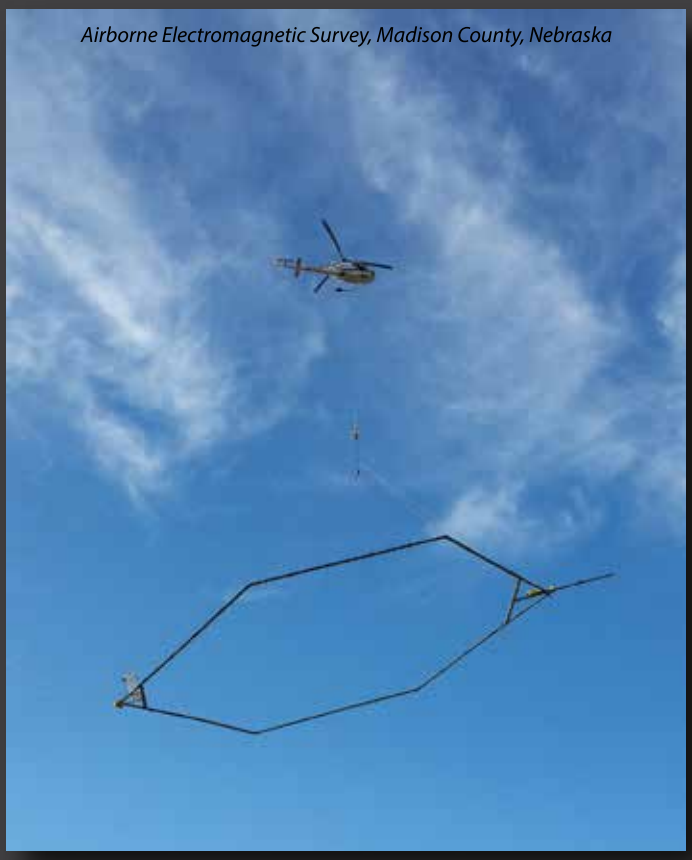

Airborne Electromagnetic Survey, Madison County, Nebraska

Ground-based Geophysical Survey, Ontario, Canada

AEM Flight Operations near Bismarck, North Dakota

Photo Courtesy of BJ Crocker, Native American Helicopters

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Assessing Hydropower in the West

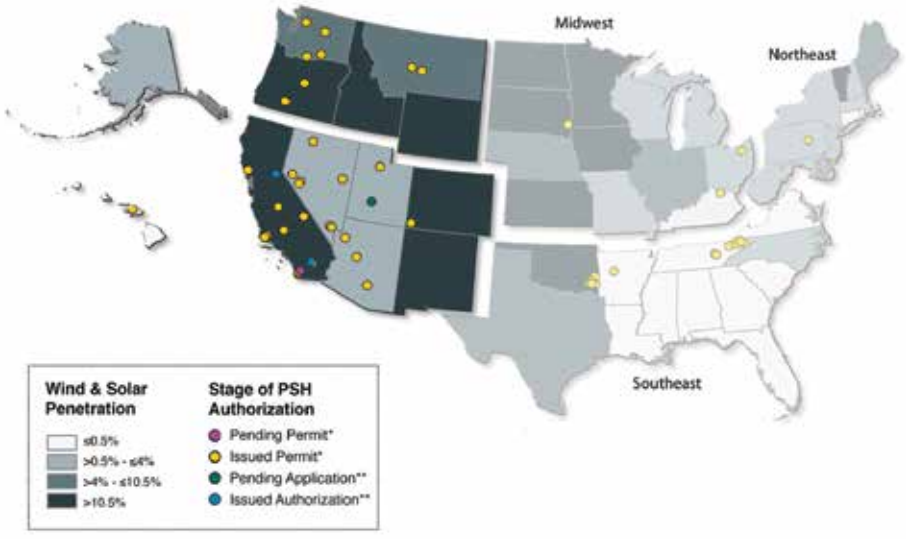
By Megan Johnson and Rocio Uria-Martinez

On April 27, the U.S. Department of Energy (DOE) released the *2014 Hydropower Market Report*, which provides a quantitative baseline on the distribution, capabilities, and status of hydropower in the United States. Although the report shows many interesting trends and figures, this article focuses on those related to the western region.

Of the 2,198 active U.S. hydropower plants with a total capacity of 79.6 gigawatts (GW) (approximately 7 percent of all U.S. generating capacity), half the installed capacity is located in three western states—Washington, California, and Oregon. Hydropower projects support more than just the power system, though. Many projects, particularly the larger ones, are connected to reservoirs that also provide recreation, flood control, irrigation, navigation, or water supply. The Northwest and Southwest (together referred to here as the West) contain 89 percent of all irrigation multipurpose projects, accounting for 20.6 GW of total installed capacity.

The United States experienced a net hydropower capacity increase of 1.4 GW from 2005 to 2013 from three types of projects: (1) adding electrical generation to existing nonpowered dams or conduits, (2) new stream-reach developments, and (3) capacity upgrades/additions at existing hydropower facilities. Approximately half the total net capacity increase (707 megawatts (MW)) took place in the West. Most of the capacity increases in the West—and elsewhere—resulted from unit upgrades or additions at existing projects.

Considering the West's arid climate and heavy reliance on irrigation for agriculture, it is not surprising that a large proportion of existing and proposed hydropower associated with irrigation infrastructure would be in that region. The vast majority (97 percent) of hydropower in conduit facilities installed in the United States from 2005 to 2013 is located in the West. Similarly, 86 percent of the 50 applications for qualifying conduit status submitted to the Federal Energy Regulatory Commission (FERC) from August 2013 to the end of 2014 came from the West. When qualifying conduit status is granted, the project owner does not need to apply for FERC authorization—either license or exemption—to proceed with hydropower installation (up to 5 MW) at existing conduits. This has the potential to significantly reduce the time and cost of these projects.



Note: This map displays the location and development status of proposed new pumped storage hydropower (PSH) projects in the United States in relation to the fraction of total generating capacity that is either wind or solar in each state. The point locations of PSH projects were derived by computing county centroids. Please note: some points overlap due to county level aggregation.

*Projects on the *Pending Permit* and *Issued Permit* stages have high attrition rates.

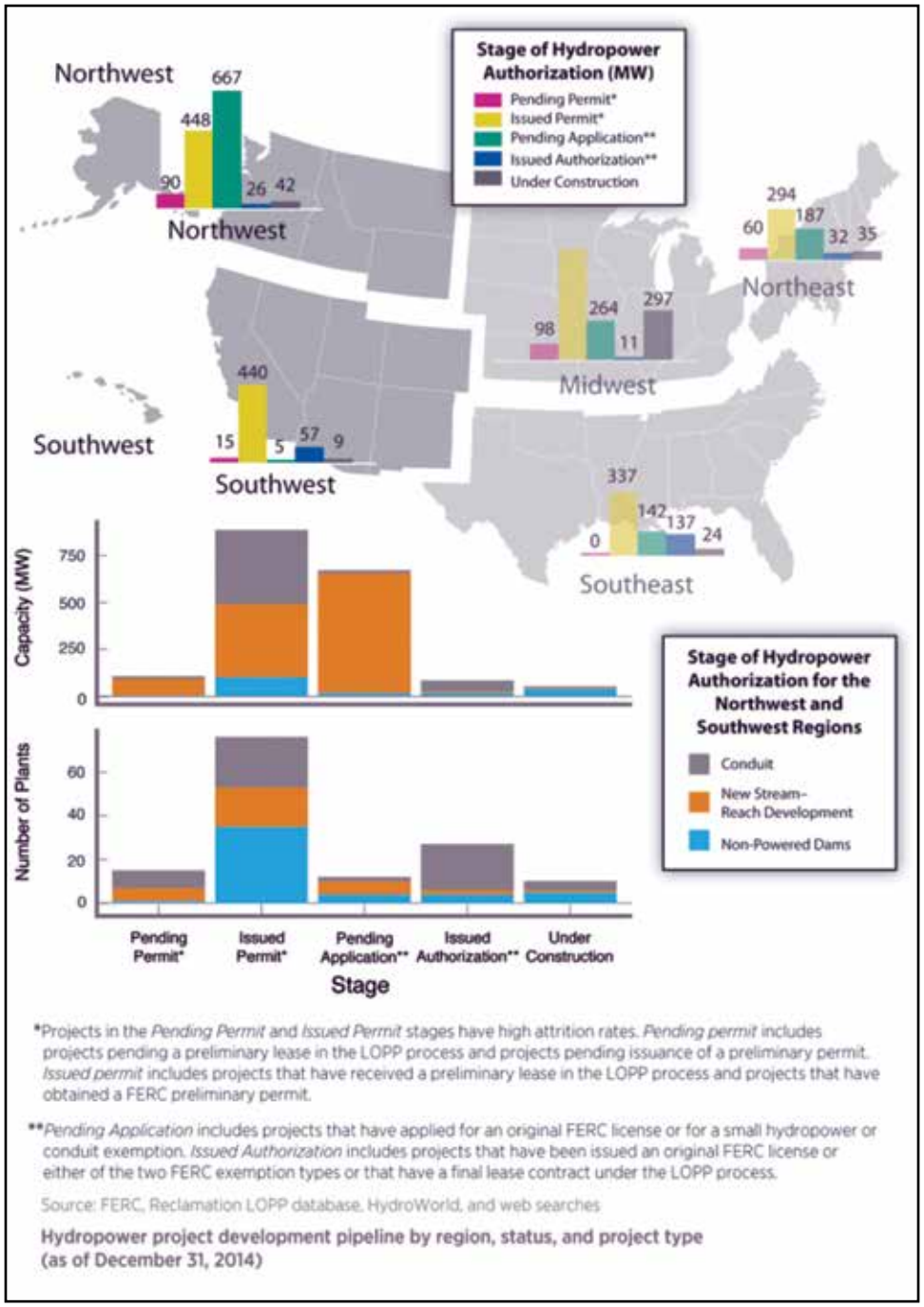
***Pending Application* includes projects that have applied for an original FERC license. *Issued Authorization* includes projects that have been issued an original FERC license.

Source: FERC

Pumped storage hydropower project development pipeline by region and status in relation to state-level penetration of variable renewables (as of December 31, 2014)

The time it takes to acquire a FERC license or exemption to build a hydropower facility varies widely based on size, resource type and ownership, environmental impacts, and other project-specific factors. There are 140 western hydropower projects currently in the FERC or the lease of power privilege development pipeline, of 331 (or 4.4 GW) in the whole country. The majority will need FERC authorization, but seven are proposing installations at nonpowered dams or conduits owned by the Bureau of Reclamation and follow a different permitting pathway. Instead of a FERC license or exemption, those projects require a lease of power privilege from the Bureau of Reclamation. In the West, 50.6 MW are currently under construction, and an additional 82.6 MW have already received a FERC license, a FERC exemption, or a lease of power privilege.

Additionally, many new pumped storage hydropower (PSH) projects are under consideration and could lead to a significant expansion of the existing fleet. PSH projects cycle water between an upper and a lower reservoir, taking advantage of electricity price differentials. PSH releases water from the upper reservoir to generate electricity at peak demand periods, and pumps water from the lower reservoir to the upper reservoir when electricity prices are low. The U.S. fleet currently comprises 42 plants—17 in the West—with a total capacity of 21.6 GW. There are 51 PSH projects (or 39 GW) in the FERC development pipeline, with 33 PSH projects (or 25 GW) located in the western region. Only 3 of those sites had pursued a license application as of the end of 2014, and all 3 are located in the Southwest. Two of those 3 projects—both in California—received FERC authorization in 2014. Eagle Mountain was the first original license for a PSH facility in more than 15 years, and Iowa Hill, a second PSH facility, was authorized as part of the relicensing of an existing hydropower project—the Upper American River Project. The remaining projects in the pipeline have been issued (or have pending) preliminary permits to conduct feasibility studies.



*Projects in the *Pending Permit* and *Issued Permit* stages have high attrition rates. *Pending permit* includes projects pending a preliminary lease in the LOPP process and projects pending issuance of a preliminary permit. *Issued permit* includes projects that have received a preliminary lease in the LOPP process and projects that have obtained a FERC preliminary permit.

**Pending Application includes projects that have applied for an original FERC license or for a small hydropower or conduit exemption. *Issued Authorization* includes projects that have been issued an original FERC license or either of the two FERC exemption types or that have a final lease contract under the LOPP process.

Source: FERC, Reclamation LOPP database, HydroWorld, and web searches

Hydropower project development pipeline by region, status, and project type (as of December 31, 2014)

Unlike the existing PSH fleet, which was built primarily to complement base load nuclear or thermal plants, new PSH facilities are often geared toward integrating variable renewables, such as wind and solar. To explore the extent to which increasing levels of variable renewables are helping fuel interesting in PSH development, individual states are shaded by the fraction of their total installed generating capacity provided by wind or solar.

The seasonal pattern in hydropower generation in the West differs from that of the rest of the country. In the West, most of the runoff comes from melting snowpack. For that reason, peak generation is observed during late spring. At least 62 percent of the hydropower capacity installed in the West falls into the high-flexibility portion of the operational mode spectrum, meaning that it has

some amount of reservoir storage and the project operator can schedule water releases to generate electricity when it is most valuable (to the extent allowed by environmental constraints and reservoir elevation rules).

The U.S. hydropower fleet has a long history—some projects have been active for more than 100 years. The fleet's important contributions to the power grid and to the broader economy will continue into the future through investment in upgrades and rehabilitation of the existing plants as well as through additional development. The fleet supports and is supported by a vibrant industry, which is directly responsible for up to 60,000 direct jobs nationally. The report identifies 172 companies in the United States that manufacture one or more of six main hydropower plant components. Those companies are an important part of the clean manufacturing sector of the economy, which innovates, creates jobs, and contributes toward broad energy security and climate policy objectives. For more information, please download the *2014 Hydropower Market Report* at http://nhaap.ornl.gov/HMR/2014.

Top 20 States by Installed Hydropower Capacity and Hydropower Percentage of In-State Generation

Hydropower Capacity (MW)	
Cumulative (end of 2014)	
WA	21,303
CA	10,334
OR	8,335
NY	4,673
AL	3,109
MT	2,638
ID	2,568
TN	2,499
GA	2,241
NV	2,096
NC	1,904
AZ	1,679
SD	1,600
SC	1,371
AR	1,321
PA	882
OK	807
KY	805
VA	786
ME	723
Rest of United States	7,963
TOTAL	79,637

Hydropower Percentage of In-State Generation (%)	
Average (2011–2013)	
WA	74.89
ID	68.98
OR	63.60
SD	48.32
MT	39.10
ME	25.69
AK	21.45
NY	18.94
VT	18.89
CA	15.49
TN	12.70
NH	7.30
NV	7.05
AZ	6.62
ND	6.48
AL	6.36
MD	5.10
AR	4.20
NC	3.99
NE	3.73
Rest of United States	1.01
TOTAL	7.06

Megan M. Johnson is currently a post-master research associate in the Environmental Science Division at Oak Ridge National Laboratory. She is a data scientist (M.S. University of Tennessee, Knoxville, 2013) whose focus is statistical analysis for data visualization and communication for energy systems and markets.

Rocío Uría-Martínez, is a research staff member in the Environmental Sciences Division at Oak Ridge National Laboratory. She is an agricultural and resource economist whose focus is modeling energy systems and markets with emphasis in the interaction among engineering, economic and regulatory aspects.

Kerry McCalman

The Bureau of Reclamation is the second-largest producer of hydroelectric power in the United States. Its 53 power plants produce enough electricity to serve 3.5 million homes. Reclamation's point man for all things hydropower is Kerry McCalman, senior advisor for hydropower and electric reliability compliance officer.

As senior advisor, Mr. McCalman serves as the liaison on intergovernmental initiatives associated with hydropower development and delivery and is responsible for Reclamation's overall compliance with Federal Energy Regulatory Commission (FERC) Mandatory Bulk Electric System Reliability Standards. He also coordinates implementation of corporate partnership efforts involving Reclamation's power functions and activities in collaboration with the U.S. Department of Energy, the U.S. Army Corps of Engineers, the Bonneville Power Administration, the Western Area Power Administration, and the Tennessee Valley Authority.

Mr. McCalman has worked for Reclamation for 15 years in power, operations, and maintenance management positions in Idaho, Colorado, Montana, and Utah. Prior to his tenure with Reclamation, he served as a hydropower manager for the U.S. Army Corps of Engineers in Oklahoma.

Irrigation Leader*'s editor-in-chief, Kris Polly, spoke with Mr. McCalman about Reclamation's latest efforts to promote hydropower, the differences between FERC licensing and a lease of power privilege, and the potential for small hydro development across the West.*

Kris Polly: Please tell us about the hydropower projects that Reclamation is working on in the West.

Kerry McCalman: One of the big things we are working on is encouraging the development of hydropower on existing Reclamation dams and canals. Working through the MOU [memorandum of understanding] we just renewed with DOE [U.S. Department of Energy] and the Army Corps [U.S. Army Corps of Engineers], we are trying to encourage new development with new technologies that show a promise of reducing the costs and time frames for developing hydropower. We are also continuing to improve efficiencies and optimize the operations of our existing hydropower fleet.

We are actively promoting new technologies for small hydropower development. In conjunction with DOE, we are doing two projects on canals in Oregon and one in Colorado to develop new technologies that will make small-

Roza Canal inline hydropower unit.

Carter Lake lease of power privilege in Colorado.

scale hydropower development less expensive. We are also working on the Roza Canal in Washington, testing out hydrokinetic technologies. We're hoping it will be a benefit to irrigation districts, power customers, and hydro developers as they are making decisions on hydropower development.

Kris Polly: Last year, you released your revised directives and standards. Have you seen an uptick in interest in hydropower projects?

Kerry McCalman: We have. Prior to that time, the development of hydropower on Reclamation facilities was somewhat sporadic. We have seen a recent surge in activity—we currently have 26 projects in some stage of development under the FERC licensing process on Reclamation dams and canals. We have 18 in various stages of development under the lease of power privilege process on Reclamation dams and canals.

Most of those projects are fairly small—from a few hundred kilowatts to a few megawatts. What we are finding is that most of the larger projects have already been developed. A lot of what seems to be left out there right now is fairly small, but it does add up. We currently have around 500 megawatts of installed capacity through FERC license plants or Reclamation lease of power privilege plants. Overall, that capacity provides a great deal of benefit to the people of the West.

Kris Polly: Walk us through a typical development scenario if an irrigation district is developing hydro either through FERC or lease of power privilege.

Kerry McCalman: Our first step is to get with FERC to determine who has jurisdiction for project. If FERC has jurisdiction, then we direct the developer to them. Jurisdiction is determined by who was given the authority to develop hydropower on the project originally. In some cases, it is clear in the authorizing legislation. There are a few projects for which it is not so clear, so sometimes we have to go through congressional documentation and determine intent when the project was initially proposed.

If Reclamation has jurisdiction under its lease of power privilege authority, we start working on that process. We look at what types of studies need to be done, like NEPA [National Environmental Policy Act]. From there, we develop a lease of power privilege contract that outlines how the development will be done. Reclamation requires that we review all the design specifications to ensure continued project operations and public safety. The lease of power privilege developments have moved along fairly

well. In some cases, we have been able to get a plant online in less than two years.

Kris Polly: What is the significant difference between development under FERC and development under Reclamation's lease of power privilege?

Kerry McCalman: Under the FERC licensing process, the entity can file for a preliminary permit and receive one relatively easily. In the Reclamation lease process, we ask for proposals up front and choose the proposal most suited to developing power at that site. So our review process happens more on the front end compared to FERC. After the FERC permit is granted or the lease is received, the process is quite similar going through design and construction. Also, with the new public law, irrigation districts, power customers, and other project operators are given a higher preference for development.

Kris Polly: In general, how long does the process take?

Kerry McCalman: What our directives and standards shoot for on a lease of power privilege contract is an 18-month period on canals and a 24-month process on dams. Those goals are in there to keep projects moving and to see timely execution of the lease contract. In all these small projects, time is money. The faster we get the permitting and regulatory side done, the more viable these projects seem to be.

Shavano Falls is a lease of power privilege in western Colorado with the Uncompahgre Valley Water Users Association.

Kris Polly: What is the term on a lease of power privilege project?

Kerry McCalman: The Reclamation Act of 1939 sets a lease of power privilege term at 40 years. With that, Reclamation has the right to periodically inspect the facilities constructed on Reclamation infrastructure. For the most part, we have had a really good relationship with developers and operators.

Kris Polly: What is your message to irrigation districts considering a hydropower project?

Kerry McCalman: Go out and look at the resources assessments that we have done and our revised lease of power privilege standards. Reclamation had not focused on private development of hydropower resources on its facilities prior to 2010. That year, we started revising our lease of power privilege process to clarify our treatment of private developments. We also undertook resource assessments of our canals and dams. They are online and can lead one to some of the more viable projects out there.

Keep in mind, they are not feasibility studies by any means, so the next step would be to do a feasibility study to see whether the project is worth pursuing. Then, look at DOE development grants. Some of the states also have development grants and low-interest loans. Also take a look at the work we have done with DOE on new small hydropower technologies. Some of them might help get the cost down to help the projects be more viable.

And finally, contact your regional Reclamation hydropower coordinator or my office.

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Gia Schneider

An era of small-scale hydropower development is upon us. With the advent of new technologies and designs that make small projects economically feasible; the increased desire for clean, carbon-free power; and the relatively recent passage of legislation streamlining regulatory impediments for development, low-head hydropower projects are becoming a valuable tool for power and revenue generation for irrigation districts and water providers in the United States and abroad.

At the forefront of this movement is Natel Energy and its founder, chairman, and chief executive officer, Gia Schneider. Natel has developed a hydropower product that enables the cost-effective production of energy from existing low dams, irrigation canals, and other low-head hydropower resources. Since founding Natel in 2009, Ms. Schneider has directed the company's overall strategy and business from the ground up.

Ms. Schneider has 15 years of experience in the energy industry. Prior to holding her current position with Natel, she provided strategic and tactical solutions to energy companies as a consultant for Accenture and then as an energy marketer at Credit Suisse. She holds a bachelor of science in chemical engineering from MIT.

Irrigation Leader*'s editor-in-chief, Kris Polly, spoke with Ms. Schneider about her company and about what irrigation should evaluate when considering the development of a low-head hydropower project.*

Kris Polly: Please provide our readers with some background on Natel Energy.

Gia Schneider: Natel was founded in 2009 with the goal of commercializing technology for low-head hydropower—sites where you have anywhere from 6 to 60 feet of draw with a particular focus between 10 and 30 feet of draw. The goal was to take this technology aimed at low-head projects and make it cost effective to develop at scale.

Our company involves a bit of family history. My father invented the original technology during the first energy crisis [in the late 1970s]. My father, along with my brother and I, started the company in 2009. My brother and I are both MIT-educated engineers. My brother is a mechanical engineer and I am a chemical engineer by training. Now, I work on the finance side of the operation, while my brother works on the product development and engineering track as the company's chief technology officer.

We spent the first few years working to take the technology to the market. We put our first hydro project online with an irrigation district in Arizona in 2010.

Our core business model is to sell a hydropower equipment package with a 20-year monitoring and maintenance contract. We provide a modest level of engineering support and manage the installation of the equipment at the project site. In addition, depending on the situation, we can do full private development build out—siting, permitting, interconnect, power purchase agreement, and construction management.

Kris Polly: What is the company currently currently working on?

Gia Schneider: All our work has come to a head in the last two years with the development of Natel's SLH-100 turbine and the commissioning of the first of our commercial projects.

We are an early commercialization stage company. Our first trial project was connected in April 2010. Natel's first commercial project—the retrofit of the Monroe Drop for the North Unit Irrigation District in Oregon—is being installed right now and will be commissioned in June. We also have two projects in construction right now: One is in Maine and the other is about to break ground in Chile.

Kris Polly: How is your technology different from traditional turbines?

Gia Schneider: The technology is called the hydroEngine™. It is a fully flooded, two-stage impulse turbine. Each of those terms is important in understanding how it works. Fully flooded means that our turbine, like a Kaplan or a Francis turbine, is housed in a casing that is filled with water via a penstock and exits through a draft tube.

There are two types of turbines in the hydro industry: impulse and reaction. Impulse turbines work by the water

pushing the foil surface, while reaction turbines work by water lifting the foil surface. Impulse turbines have a simpler design and therefore are cheaper to manufacture.

Thus, the unique aspect of the hydroEngine™ comes in its packaging. All other impulse turbines on the market do not operate fully flooded. Full flooding enables the turbine to efficiently and effectively utilize the energy of the water.

Kris Polly: For an irrigation district that has drops, what are some factors that the district should consider to determine whether a low-head project is viable?

Gia Schneider: There are specific criteria we look for when talking with an irrigation district. First, we look at flow and head. The amount of power you can generate is pressure multiplied by flow, so understanding flow and head helps us assess the baseline power potential for that site.

Then we consider what the flow profile would look like over the first three years of operations. For example, a wasteway that may have substantial flows for a few days of the year generally is not an ideal site. Understanding how much of the year you have flow is very important.

Then we have to evaluate the physical site—the proximity of roads and points of interconnection. Our rule of thumb is to be situated between a half-mile and mile from those points. We also do a quick assessment of the land ownership and potential issues with regard to permitting the project site itself.

All those factors help to determine both feasibility and priority.

Kris Polly: Is there a minimum amount of flow required?

Gia Schneider: We have found that the most cost-effective projects are those that have flow of a couple hundred cubic feet per second or higher with greater than 8 feet of drop. Each individual hydro project requires a certain amount of water at a given head, so if you have three times that particular quantity of water, you can put in three hydroEngines™.

We are currently working on a smaller product that would require less flow.

Kris Polly: Since your company was founded, have you seen an increase in the interest in low-head projects?

Gia Schneider: Yes, definitely. Over the last few years, we have seen an increase in interest and awareness from irrigation districts, the broader hydro industry, and the U.S. Department of Energy. That has happened for a couple of reasons: New technology has made those projects more cost effective to develop, and there has been an increase in the desire to diversify our energy supplies, particularly using hydropower to balance out wind and solar.

Natel's hydroEngine™ generates power at drops between 6 and 60 feet in height.

This is all happening with the knowledge that we will not build large hydro projects in the way that we have in the past due to permitting and environmental issues. So the focus is shifting to low-head projects that utilize existing water infrastructure.

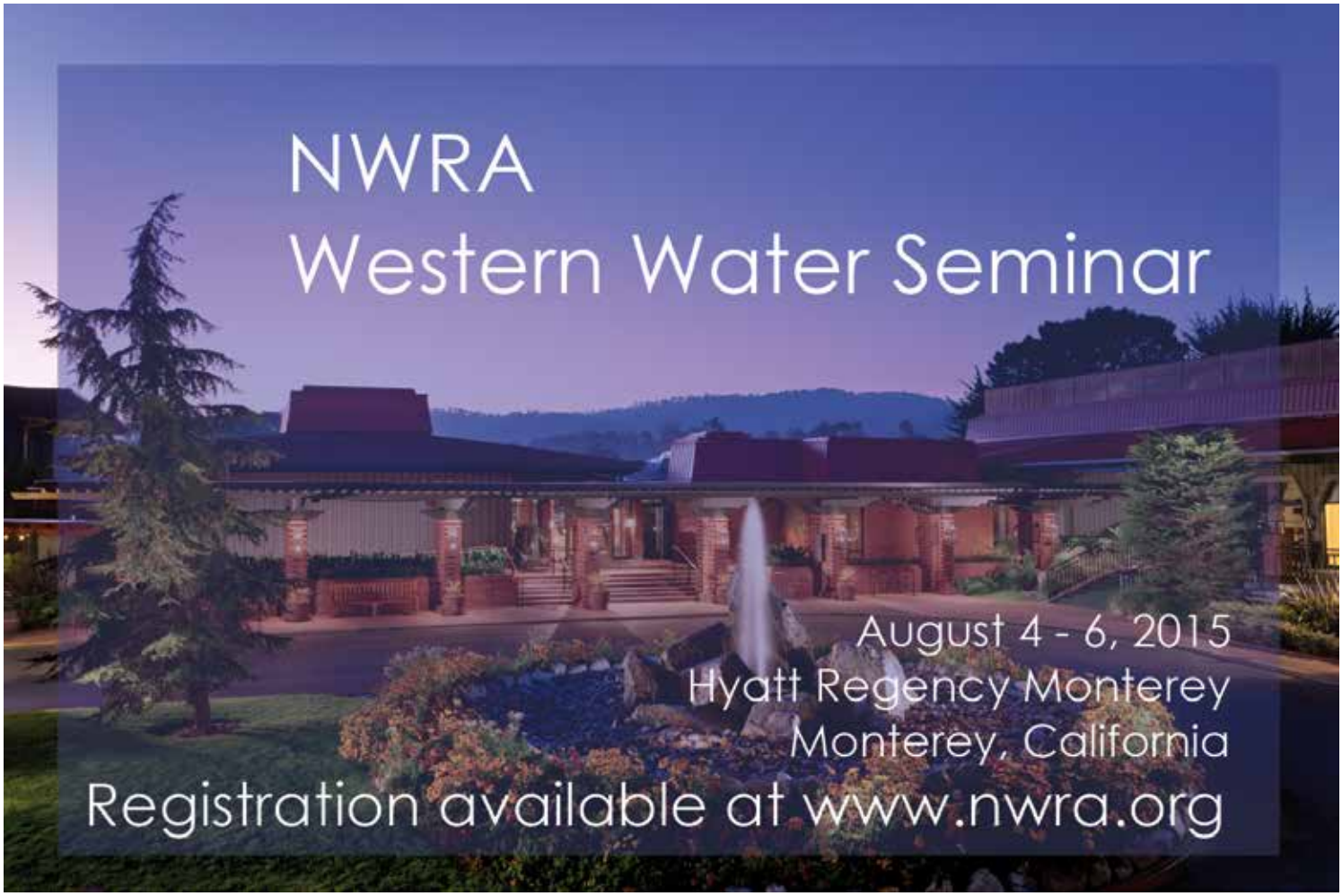
Kris Polly: What should irrigation districts think about when considering low-head hydro as an additional source of revenue?

Gia Schneider: The quantity of additional revenue depends on where the district is located, which determines the power price. Development approach is also important—some districts want to develop a project entirely on their own in order to see the full revenue from the electricity bills, while others follow the wind energy model and lease the site to a developer and receive revenue from that.

Kris Polly: What is your advice for irrigation district managers or their boards of directors who are considering low-head hydro development?

Gia Schneider: A simple listing of drops and flows within the irrigation system is relatively easy to obtain and is very useful in determining how much potential is available for the district. Then you have to think about interconnection points, the relevant utility, and the pricing. The district must also decide whether it wants to undertake a program of developing the project directly or in partnership with a developer.

For more information about Natel, you can reach Gia at gia@natelenergy.com.



Fair Water
USERS COALITION

The Fair Water Users Coalition represents entities that rely on water supply contained in federally owned lakes and reservoirs operated by the U.S. Army Corps of Engineers. The primary mission of the coalition is to ensure that water supply costs from federal facilities are fair, affordable, and predictable.

The coalition was able to include language in the Water Resources Reform and Development Act (section 1046(b)) that requires the U.S. Army Corps of Engineers to provide operation and maintenance projects plans and cost estimates to contracting entities for a five-year period. This new law will greatly enhance the ability of water supply users to budget for this expense.

CURRENT PRIORITIES

- WRRDA implementation
- U.S. Government Accountability Office study on water supply and congressional outreach
- Uniformity of projects considered as "joint use"
- Credit for beneficial projects/practices
- Calculating water supply costs

It is our goal to continue to grow and have members in all 25 states that have U.S. Army Corps of Engineers lakes and reservoirs with water supply storage.

Please feel free to contact Paul Kalchbrenner, the executive director of The Fair Water Users Coalition, to discuss your specific issues and answer any questions you have about the coalition. Mr. Kalchbrenner can be reached at (202) 6641102 or pkalchbrenner@engage-dc.com.

StreamDiver gets lowered into the intake shaft of the plant.

Voith Hydro's StreamDiver:
Small Hydro Solutions to Meet 21st Century Demand

By Brian Murtha

For many *Irrigation Leader* readers, hydropower is synonymous with the massive dams dotting the western landscape. These iconic landmarks were key factors in the economic and social development of the West and still contribute massive amounts of energy to the nation's electric grid.

Though these structures elicit a sense of pride, they are only one part of the 21st century hydropower equation. Consider that there are over 80,000 existing dams in the country, and only 3 percent produce hydroelectric power. These dams have the capacity to generate an additional 65,000 megawatts of renewable energy, giving homeowners and businesses the electricity needed to power their future.

Much of this capacity will come from tapping into existing water infrastructure to provide energy previously thought impossible for commercial deployment, often at small-scale facilities. These structures may be less visible than their 20th century cousins, but they will be just as reliable, and most importantly, they will still make key contributions to our electric grid.

Recognizing the future, in 2013 Congress passed legislation designed to encourage small hydropower development through a more efficient licensing process. Of interest to irrigation districts is the licensing exemption for small conduit projects under 5 megawatts, which is included in the Hydropower Regulatory Efficiency Act.

The Federal Energy Regulatory Commission (FERC) created a streamlined process for determining whether a nonfederal tunnel, canal, pipeline, aqueduct, flume, or ditch can be exempt from the traditional licensing process. It involves a five-page notice of intent form for developers to provide some basic information about the proposed project.

In less than two years, FERC has exempted 39 of 57 applications, with another 5 pending as of late April 2015. Many of these projects are being proposed by irrigation districts in the western United States. Most applications were approved within two months of receipt of the notice of intent. As someone accustomed to a many-years-long licensing process—a process that often discourages investors who balk at the uncertain payback schedule—the expedited nature of these projects is a positive development.

Even with many regulatory issues mitigated, irrigation district managers must still grapple with the question of whether hydropower makes economic sense. For many, Voith Hydro's StreamDiver could be an option.

Voith Hydro is an almost 150-year-old company, founded in Germany, with its U.S. headquarters in York, Pennsylvania. Voith Hydro is the worldwide leader in the development and manufacturing of hydropower equipment, including turbines,

generators, and automation systems. Voith is noted for its environmentally friendly technology, powering our world more cleanly and efficiently. The StreamDiver—the "plug-and-play" turbine, as *Irrigation Leader* said in March—is the latest in a long line of such technological innovations.

The StreamDiver is a modular, scalable, and self-contained turbine designed for run-of-river power stations or canals with low heads (typically, 6 to 30 feet)—just like many of the conduits now opened up for expedited hydropower development. The StreamDiver's design is a simplified version of a conventional bulb turbine. The largest StreamDiver model is capable of producing up to nearly 1 megawatt of power, or enough energy to power almost 1,000 households.

The StreamDiver is an oil-free machine, eliminating the chance for oil leakage into the waterway. The bearings are river water lubricated, and the generator itself is river water filled. The streamlined design also minimizes operation and maintenance costs compared to traditional turbine concepts, and installation is comparatively simple—it can be placed directly into an existing weir or dam system potentially with only small modifications to existing structures, often invisible to the untrained eye. These innovations support the economic feasibility of a new hydropower project.

The benefits of the StreamDiver are not merely conceptual. For nearly three years, a StreamDiver pilot project has successfully operated for Austria's largest utility, Verbund, at its 5-megawatt Nussdorf plant, located near Vienna on a side canal of the Danube River alled the Donaukanal. The project was initially slated to last two years, but its success has extended its life for a third. With a maximum output of 450 kilowatts, the StreamDiver now has over 24,000 operating hours, and has exported more than 7 gigawatt-hours of electricity.

Why did Verbund initially opt for hydropower at Nussdorf? Put simply, existing infrastructure made it possible to develop low-impact hydropower on the Donaukanal. In the mid-1990s, a large run-of-river hydropower plant was built on the Danube, which in turn raised water levels at the Nussdorf site. Realizing that potential power generation was being lost, Verbund used existing flood gates and a natural drop in head to build a power plant at Nussdorf.

The initial Nussdorf StreamDiver results are encouraging. In addition to high ecological performance (the Donaukanal contains as many as 30 fish species, many of which are endangered), the StreamDiver has operated maintenance free for nearly three years—one of Verbund's top requirements. Initial data indicate that replacement of the river-water-lubricated bearing pads, along with routine maintenance, will be required only once every five years. Even then, maintenance would take the unit out of service for approximately one week. After one year, the Nussdorf StreamDiver was removed for a planned inspection and returned to the canal in just half a day.

The StreamDiver was able to adapt to difficult demands and integrate seamlessly into existing hydropower infrastructure at Nussdorf. So far, the StreamDiver has lived up to the high expectations that initially led Verbund to deploy the technology, and the lessons learned at Nussdorf will be applied to future applications for the StreamDiver.

Though domestic interest in the StreamDiver has recently has increased, Voith is still in search of its first U.S.-based project. We are encouraged by the StreamDiver's versatility and adaptability; developers for water systems of all sizes have expressed interest in the StreamDiver. Without question, the StreamDiver has the potential to transform how we think about using our existing water resources across a wide variety of applications.

These are exciting times for hydropower, even if current projects are not as visible or on the same physical scale as they were 80 years ago. With the StreamDiver and other advanced technology, Voith Hydro stands ready to redefine how we think about 21st century hydropower.

Brian Murtha is the sales manager for modernization and small hydro at Voith Hydro in York, Pennsylvania. Should you have any questions about the StreamDiver or other Voith technology and how it can be used, please do not hesitate to contact Brian at (717) 792-7191 or brian.murtha@voith.com.

Historic Nussdorf site near Vienna.

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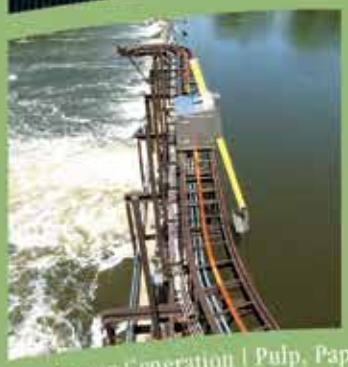

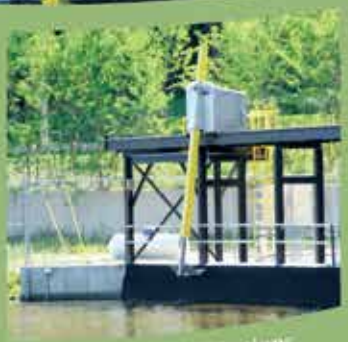

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Preparation of yearly budget and plan for the equitable distribution of water for each irrigation season; setting and collecting of yearly assessments of water right acreage; updating and maintaining of water right records and water usage records; supervision of one office manager, 4 part-time river riders and 7-10 ditch riders; overseeing of water ordering and delivery schedules; regulating system reservoirs in conjunction with reservoir owners; determining decree priorities to be served according to river flow; accessing and analyzing weather and flow data; assessing snowpack to determine expected runoff and water availability; working with local, state and federal agencies; assisting legal counsel in preparation of documents for on-going lawsuits; keeping board members and federal judge informed; mediating disputes between water rights owners; communicating with press regarding general operations and incidents; inspecting diversions to assure adherence to Decree; monitoring condition of river banks, tributaries and diversions structures and informing owners or responsible parties of needed repairs; maintain vehicles and other U.S. Board equipment; interacting and corresponding with members of the public regarding water rights.

Requirements:
Two to five years of experience and/or education in water management recommended but not required.

Candidate must possess the ability to:
Advance to the position of Chief Deputy Water Commissioner/ Water Master by November 1, 2015. Communicate clearly and effectively, both orally and in writing; operate a computer, including word processing, spreadsheet and internet functions; legally drive on highways and in adverse off-road conditions; maintain excellent working relationships with staff and other entities' personnel; hike various distances in difficult terrain; perform physical labor requiring moderate exertion; interpret and act upon board actions; understand and comply with California and Nevada water law; read and comprehend technical manuals and data.

Salary Range: Negotiable based on experience.

Benefits: Employer-paid health, dental and vision insurance for employee; family insurance available at employee's expense, paid annual and sick leave, employer contribution to retirement account, Vehicle provided for work-related travel.

Applications can be requested and resumes e-mailed to walkerusbwc@aim.com or by mail to: US Board of Water Commissioners 410 N Main Street, Yerington, NV 89447

ASSOCIATE OR SENIOR WATER RESOURCES/AGRICULTURAL ENGINEER

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PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

Provost & Pritchard Consulting Group is an employee owned company with seven offices covering California's Central Valley. We are adding to the engineering staff in most of our offices.

To be considered for the position, candidates must demonstrate they are willing and able to be part of a dedicated team of engineering professionals who specialize in serving agricultural entities and irrigation districts throughout California's Central Valley and beyond. Candidates must show an understanding of water resources engineering and be able to apply their knowledge in a practical manner.

We expect serious candidates to have a thorough understanding, interest and broad experience in areas such as:

Irrigation District Operations

- System Modernization
- Groundwater Management, Recharge and Banking
- Environmental Compliance Issues
- Water Transfers and Exchanges
- Developing Feasibility Studies
- Public Works Construction Contracts
- Project Funding
- Water Rights
- Project Planning and Design

This position will actively pursue and lead projects on ag/water related client issues and requests. Duties will involve project planning, engineering consulting and design, client contact and project management.

Requirements: Must hold an active CA PE license or licensed in another state and be willing to sit for CA license within 18 months of hire; 5+ years experience leading and directing work teams in studies, investigations, and designs bringing positive results. Demonstrated business development success and project management experience required. Experience with irrigation districts and knowledge of California water rights and water systems preferred. Occasional field work and overnight travel are required.

Visit our website at www.ppeng.com to learn more about us. If interested, please submit your resume to hr@ppeng.com.

Provost & Pritchard Consulting Group is an equal opportunity/affirmative action employer. We offer a comprehensive, competitive compensation package. Level and salary of position will be commensurate with experience of selected candidate.

Heart Mountain Irrigation District

MANAGER

Heart Mountain Irrigation District is seeking a full time Manager.

Responsibilities include, but are not limited to, day to day operations of the District, leadership of our small, but dedicated staff in delivery of water to landowners, maintenance and upkeep of the District. Knowledge of agriculture, irrigation, computer programs and basic construction are helpful. Candidates will have the ability to create and implement a yearly budget. Have a good working relationship with staff, commissioners, landowners, and local, state and federal employees.

Heart Mountain Irrigation District is a Bureau of Reclamation project located in the beautiful Big Horn Basin of Wyoming providing irrigation water to 31,000+ acres. HMID is an equal opportunity employer. Please send resumes/references to Heart Mountain Irrigation District, 1206 Road 18, Powell WY 82435. Questions can be directed to Gary Kellogg at 307-754-4685.

Irrigation Leader

2015 CALENDAR

June 3–4	North Dakota Missouri River Stakeholders, Spring Conference, Bismarck, ND
June 7–10	American Water Works Association, Annual Conference, Anaheim, CA
June 10–12	Groundwater Management Districts Association, Summer Session, Coeur d'Alene, ID
June 17–19	Texas Water Conservation Association, Mid-Year Conference, Galveston, TX
June 17–19	WESTCAS, Annual Conference, San Diego, CA
June 22–23	Idaho Water Users Association, Summer Water Law & Resource Issues Seminar, Sun Valley, ID
July 8–10	North Dakota Water Resource Districts Association, Annual Summer Meeting, Bismarck, ND
July 20–24	ESRI, User Conference, San Diego, CA
August 4–6	Kansas Water Congress, Summer Conference, Lawrence, KS
August 4–6	National Water Resources Association, Western Water Seminar, Hyatt Regency Monterey, Monterey, CA
August 19–20	Four States Irrigation Council, Summer Tour, Casper, WY
August 19–21	Colorado Water Congress, Summer Conference, Vail, CO
August 25–27	Texas Alliance of Groundwater Districts, Groundwater Summit, San Marcos, TX
October 14–16	Texas Water Conservation Association, Fall Meeting, San Antonio, TX
October 27	Columbia Basin Development League, Conference and Annual Meeting, Moses Lake, WA
October 28–30	WESTCAS, Fall Conference, Tucson, AZ

For more information on advertising in *Irrigation Leader* magazine, or if you would like a water event listed here, please phone (703) 517-3962 or e-mail Irrigation.Leader@waterstrategies.com. Submissions are due the first of each month preceding the next issue.

Past issues of* Irrigation Leader *are archived at

www.WaterAndPowerReport.com