Hydro Leader

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MAY 2023

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Revisiting the Columbia River Treaty

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Hydro Leader

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Looking Toward the Future

By Kris Polly

The hydropower industry deals with large facilities, long-term agreements, years-long modernization projects, incremental technological progress, and generation-spanning workforce issues. That being the case, a long-range view toward the future is imperative for hydropower professionals. This month, we bring you the stories of numerous professionals who are working to forge the industry's future.

The Columbia River Treaty, which has governed flood control and hydropower production on the Columbia River since its signing by the United States and Canada in 1961, will expire in 2024. In our cover story this month, we speak with Scott Simms, the CEO and executive director of the Public Power Council and the chairman of the Columbia River Treaty Power Group, about ongoing work to modernize the agreement as it is renegotiated.

Next, we speak with Baha Abulnaga, the founder of engineering company Mazdak International. Responding to challenge competitions set up by the Bureau of Reclamation, the U.S. Army Corps of Engineers, and others, Mazdak adapted technologies from the mining sector for the purpose of dredging sediment from reservoirs. We discuss two impressive solutions: Mazdak's slurry pulsejet engine and its capsule pipeline technology.

Oregon-based Farmers Irrigation District uses the revenue from its two low-impact-certified hydropower plants to fund piping and system modernization. We speak with General Manager Les Perkins and Hydropower Operator Zach DeHart about the recent upgrades to the hydropower plants and their potential for making the local power grid more resilient.

We also speak with Ted Sorenson, the owner and head engineer of Sorenson Engineering. We hear about his trade of buying, rehabbing, and operating small hydroelectric plants and about what makes a small hydro facility an attractive candidate for purchase.

Linda Ciocci's accomplishments include 30 years as the CEO of the National Hydropower Association, and today she serves the industry as the executive director of the Hydropower Foundation. In our interview, she tells us about the foundation's work promoting research and developing the hydropower workforce.

A recent report from the Association of State Dam Safety Officials (ASDSO) puts the cost of rehabilitating all nonfederal dams nationwide at $157.5 billion—greater than estimates in years past. We speak with Sharon Tapia, California's state representative to the ASDSO, about the new methodology and updated cost data used to calculate that number and about how those funding needs could be met.

This month's stories help us look into our industry's future—to see what is needed, and to appreciate the ways in which colleagues near and far are already seeking to step up and meet those needs. I hope you enjoy reading about it.

Kris Polly is the editor-in-chief of Hydro Leader *magazine and the president and CEO 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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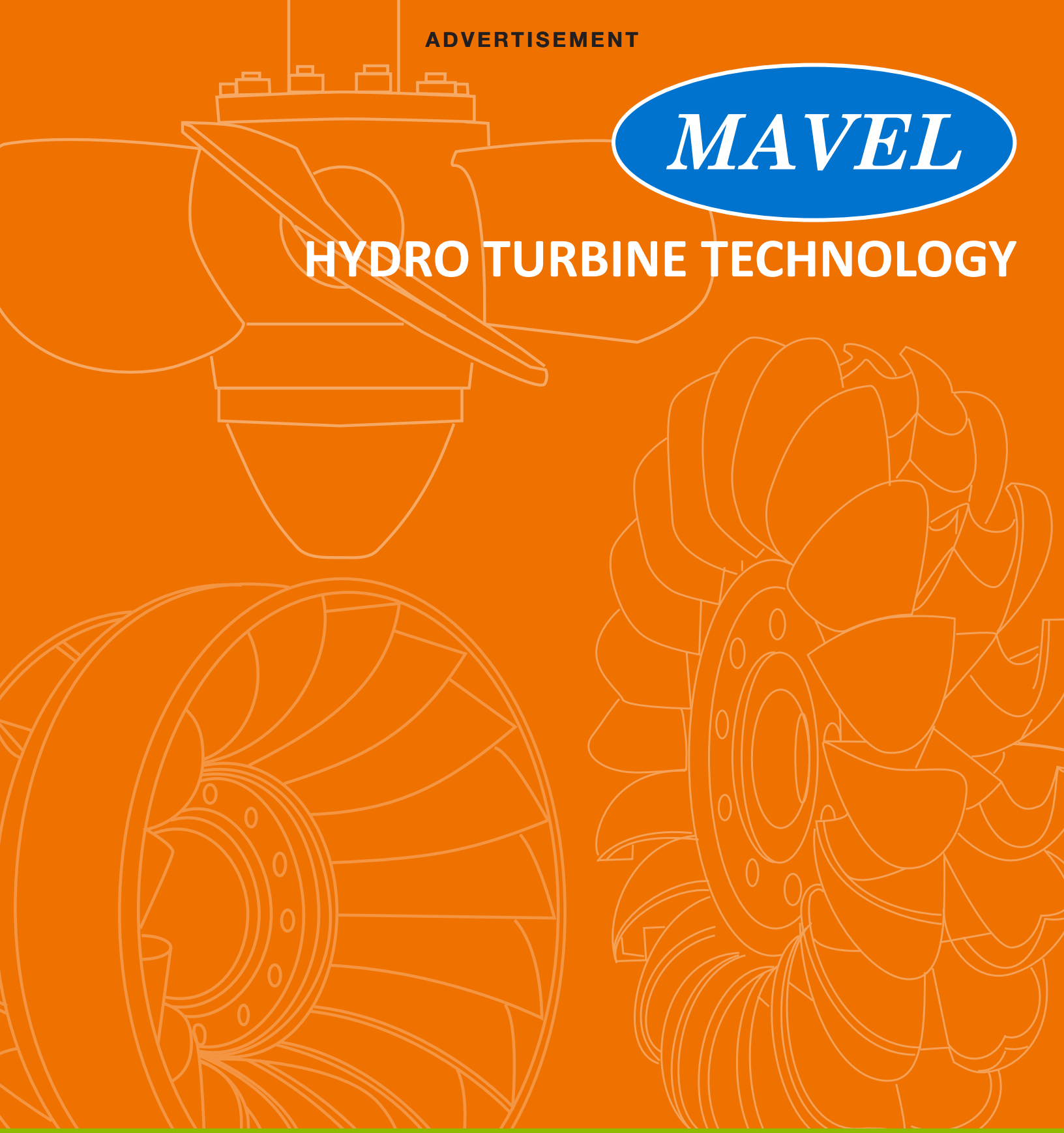

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Revisiting the Columbia River Treaty

The construction of Keenleyside Dam, located on the Columbia River in British Columbia, was made possibly by the Columbia River Treaty.

In 1961, the United States and Canada agreed to jointly develop and operate dams on the Columbia River for flood control and electrical power generation. Their agreement, the Columbia River Treaty, expires in 2024. In this interview, Hydro Leader *talks with Scott Simms, the CEO and executive director of the Public Power Council (PPC) and the chairman of the Columbia River Treaty Power Group, about the current negotiations to modernize the agreement as the deadline looms.*

Hydro Leader: Please tell us about your background and how you came to be in your current position.

Scott Simms: I'm a fourth-generation Pacific Northwest native. I was born, raised, and educated in the state of Washington. Growing up, I traveled around the state with my parents, riding horseback to wilderness area camping spots. That experience gave me an appreciation of the vast resource of our natural surroundings, including the Columbia River. I went to Washington State University and then moved to Portland in 1994. There, I worked with public affairs firms on issues management, state initiative campaigns, and corporate communications. The Nuclear Energy Institute and Portland General Electric were among my energy clients. After that, I worked on staff at Portland General Electric for 6 years and then for the Bonneville Power Administration (BPA) for 13 years. At BPA, I worked first in public affairs, then in corporate strategy, conducting scenario planning. I then served as the secretary of the U.S. Entity on the Columbia River Treaty. My role was to handle treaty liaison work between the two countries. After that, I worked as a manager of long-term power planning and later became director of communications for BPA. In 2019, I was hired as the CEO and executive director of PPC.

Hydro Leader: Please introduce PPC.

Scott Simms: PPC is a trade group in the Pacific Northwest that focuses on enhancing and preserving the value of the Federal Columbia River Power System (FCRPS). Our members—the nonprofit consumer-owned utilities—get all or part of their power supply from BPA. We serve the interests of more than 100 public utilities in Idaho, western Montana, Oregon, Washington, and parts of Wyoming and Nevada. Our goal is to work toward policies and initiatives that are

PHOTOS COURTESY OF PPC.

The construction of Libby Dam, located in northwestern Montana, was made possible by the Columbia River Treaty.

supported by as many of these utilities as possible and that produce tangible results for our members. We're currently working on rate cases, transmission issues, federal legislation, policy streamlining, fish and wildlife mitigation issues—the whole gamut. We're a small but mighty team, with seven of us in our Portland offices and two in Washington, DC. We continue the mission that PPC set out when it was formed in December 1966: to bring demonstrable value to our members in the form of cost savings and revenue enhancements. Over time, we have achieved rate savings on the order of multiple hundreds of millions of dollars for our members. In terms of how we interact with BPA, we're like a shareholder: here to support the agency's mission and also to hold it accountable in delivering on that mission.

Hydro Leader: Would you introduce the Columbia River Treaty?

Scott Simms: The Columbia River Treaty is an international agreement between the United States and Canada that was ratified in 1964. Several disastrous flooding events led to the development of the treaty. The biggest was the Vanport flood of 1948, which wiped out the community of Vanport on the edge of Portland and left 18,000 people homeless. The two countries agreed to jointly develop and operate dams on the Columbia River for flood control and electrical power generation. Over the years, the treaty operations have been successful in the sense that the two sides—the U.S. Entity, which comprises BPA and the U.S. Army Corps of Engineers, and the Canadian Entity, which comprises BC Hydro and the Province of British Columbia—have overseen the treaty to ensure both countries benefited from this landmark water management agreement.

The Columbia River Treaty was, at its inception, a compact setup for the long game. It featured a 60-year agreement with flood control protection guaranteed through 2024. Also critically important to the treaty were power provisions to share the downstream power benefits. Both countries wanted certainty for the decades-long treaty, which provided benefits to and presented risks for both parties. The treaty allowed Canada to be assured of payments offsetting the large capital investments it would make in new dams to support flood control. For power, the negotiators agreed to a formula that ensured that Canada would receive half the additional power produced downstream at U.S. dams from the construction of storage facilities in Canada. This transfer of hydroelectric energy and capacity is known as the *Canadian Entitlement*.

At the same time, the negotiators recognized that the factors affecting the value of the agreement would change over time. Flood control was only paid for through 2024. Specific treaty provisions reduce the flood control protection

Canadian Prime Minister John Diefenbaker and President Dwight Eisenhower sign the Columbia River Treaty in January 1961.

Canada will provide while leaving open the question of how much the United States will pay for this protection. Starting in 2014, either party could have given 10-year notice to terminate the power provisions. This unilateral right for both countries was designed by the treaty framers to allow a renegotiation based on the realization of actual benefits—an off ramp of sorts that would allow either country to exit the treaty if it chose to.

Today, the perspective of U.S. electric utility interests is that the treaty calculations exceed the actual benefits of coordinated operations by 90 percent. Without a rebalancing of the power provisions of the treaty, Canada will continue to receive an outsized benefit from the transfers of electric power from the U.S. side of the border. The value being lost by the United States is approximately $300 million a year, depending on the value of carbon-free power in the western market.

The treaty has been heralded as one of the most successful international bilateral agreements in the world. I think that is because it was simple and was designed to be mutually beneficial, with a 50/50 split of the flood control and power benefits resulting from coordinated river reservoir operations. The treaty did exactly what it was supposed to do, which was to help control flooding on the unpredictable Columbia River, which would sometimes send a surge of water toward the Pacific Ocean, particularly in spring months when warm weather triggered heavy mountain runoff. (The Columbia is the fourth-largest river in the United States by volume and has the greatest flow of any North American river entering the Pacific.) In the 1960s, when the treaty was negotiated, the United States and Canada were rapidly developing. The treaty enabled four additional dams to be built: three in Canada and one in the United States. The treaty dams in Canada are Duncan Dam on the Duncan River and Keenleyside and Mica Dams, both on the Columbia. Libby Dam was built in the United States on the Kootenai River, at the headwaters of the Columbia, and was an important addition to the U.S. federal hydro projects that were steadily constructed beginning in the mid-1930s.

Hydro Leader: Please introduce the Columbia River Treaty Power Group.

Scott Simms: Many of our PPC members are also members of a coalition known as the Columbia River Treaty Power Group. It also includes a diverse group of investor-owned utilities, such as Puget Sound Energy in Washington and Portland General Electric in Oregon, and other Northwest trade groups and interests. The power group was formed to represent the interests of the treaty within the Pacific Northwest electric utility sector. When the U.S. Entity issued a regional recommendation on the future of the treaty in 2013, it became the foundation of the power group's advocacy for modernizing the treaty, including the rebalancing of the Canadian Entitlement.

Hydro Leader: In what ways would the power group like to see the Columbia River Treaty be rebalanced?

Scott Simms: Under the existing treaty, BPA must send hydropower energy and capacity to Canada every month. The Canadians can take the hydropower for their own use or sell it back to the United States. The treaty also gives Canada tremendous flexibility to decide when the United States must send power benefits north, which it does to its economic advantage, taking returns when power prices are high. This is an annual obligation of about 450 average megawatts of energy and 1,300 megawatts of capacity, relying on a methodology rooted in the original treaty.

The original methodology is also outdated, as there is no way the treaty framers could have anticipated how the energy market would evolve and ultimately affect the assignment of treaty benefits to the two countries. For example, U.S. hydropower generation hasn't grown as much as expected when the treaty was first negotiated because of the rise in wind and thermal power generation and operational changes to the region's hydro fleet that have been required for fish mitigation. As a result, we believe the situation has become inequitable. Since we raised that point a few years ago, the inequity has grown to about $300 million. This is because the markets continue to evolve, and we know through market prices in the West that carbon-free power is now an even more valuable commodity. We are seeing higher market prices for carbon-free hydropower and for the capacity value that comes from these hydropower facilities. We must modernize the treaty to get back to the original goal of balancing the benefits of coordinated river operations 50/50. We hear from the U.S. Department of State that this is a primary consideration in the current negotiations.

Hydro Leader: Who is the power group's audience, and how does it convey its message?

PHOTOS COURTESY OF PPC.

Scott Simms: A large group of stakeholders—utility companies and power interests and navigation, tribal, and fishing interests—are closely tracking the Columbia River Treaty. We've been spending a fair amount of time talking to the Northwest's congressional delegation. We have tremendous bipartisan support from the Democrats and the Republicans in both chambers of Congress regarding the importance of the Columbia River Treaty and our efforts to modernize it and rebalance these inequities. In fact, I was on Capitol Hill in early March to talk to our members of Congress about this and other issues that PPC is facing, and they remain highly engaged. Among the matters they want to hear more about is how flood control operations will change in 2024 and how that will affect their constituencies. You don't always see such strong bipartisan support for an issue in Congress these days, so this has been one of the more enjoyable aspects of the congressional relations aspect of my job.

The Columbia River gorge, with Washington State on the left and Oregon on the right.

Hydro Leader: What is the timeline for the renewal of the treaty, and what is the status of the negotiations?

Scott Simms: Canada and the United States just finished their 16th round of negotiations. They're planning more negotiations in the coming months. It is helpful to hear that the frequency of their meetings is increasing. Deputy Secretary of State Brian Nichols posted on Twitter a few months ago that the department was hopeful for an agreement in principle to be issued this summer, but we want to make sure that we understand the key elements of that modernization agreement in principle before the ink has dried. We're continuing to work closely through our congressional offices to understand where the opportunity might be for us to get more directly involved in the negotiations. We are offering our resources and hydrologic experts to the U.S. government as it conducts these negotiations. These technical resources can also provide perspective about the evolving aspects of the market within which the treaty is functioning—from the increasing consumer demand on electricity as an essential service, including increases in electricity needs caused by changing weather patterns, to new consumer preferences and policy changes that are ushering in fleet electrification and electric service demands.

Hydro Leader: What are your plans should negotiations stall and portions of the treaty expire in 2024?

Scott Simms: The 2024 deadline is looming. With every day that passes, the level of concern increases. This basin needs to know what the effects of a new flood control operation on reservoirs and flood control will be and whether the flood elements will affect power production. The power planners at BPA and the region's utilities need to know. We visited the Army Corps' offices in early March and shared our concerns that the Army Corps doesn't yet have a plan for flood control on the street that would define how it would go about handling the post-2024 flood control changes to reservoirs. I think the agency is hearing us and will release at least a draft plan for flood control operations in the next few months. If it doesn't produce something by the end of 2023, I think we're going to have to intensify our efforts and outreach, not only to Congress but even more so to the Biden administration.

Hydro Leader: Is there anything you would like to add?

Scott Simms: We want to be helpful in modernizing the treaty. The power group coalition was formed to be a supportive agent and partner, not a stakeholder that would stymie progress or create more complexity. The members of the power group are responsible to the rate payers of this region, who want to make sure that they have reliable electricity and a plan for flood control. We also want assurances that any agreement between the United States and Canada reflects the original intent of mutually and equitably sharing benefits between the two nations. Our goal is obviously to get this settled as quickly as we can. We're hoping that in all the modernization discussions that are happening between the United States and Canada, they're working to keep the treaty as simple and as close to the original intent as possible. The more that is added to the treaty, the more difficult it will be to manage it in the years to come. The treaty framers were incredibly wise to keep it simple and focused on mutual collaboration for the mutual benefit of the citizens of both countries. H

Scott Simms is the CEO and executive director of the Public Power Council and the chairman of the Columbia River Treaty Power Group. For more about the Columbia River Treaty Power Group, visit www.crtpowergroup.org.

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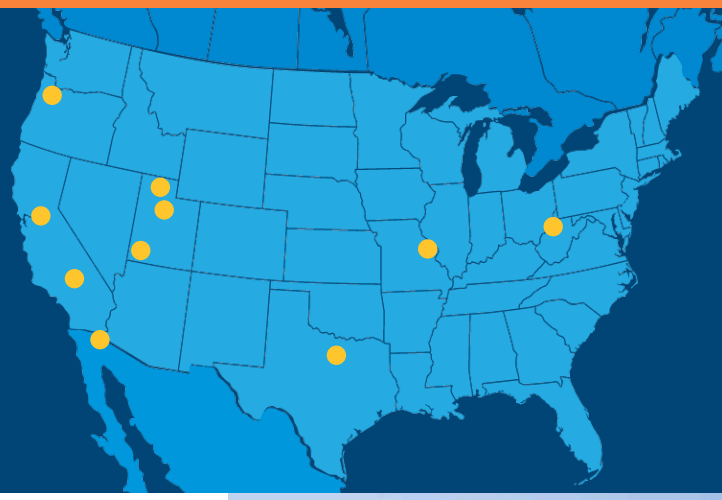

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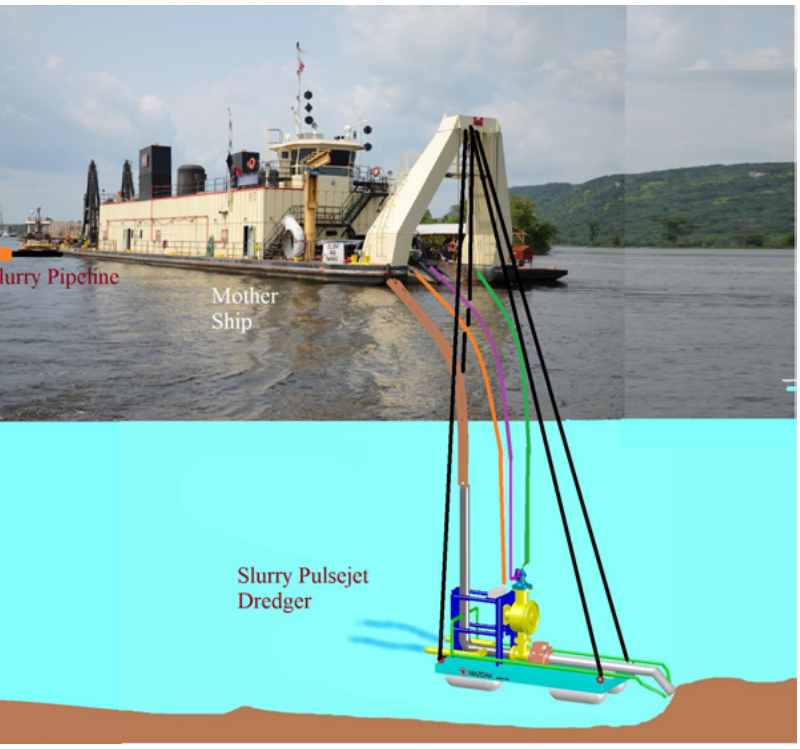
Mazdak International: New Inventions to Solve the Scourge of Sedimentation



A concept illustration of the pulsejet engine dredging at the bottom of a reservoir.

The pulsejet engine being tested at the bottom of a 14-foot-deep tank in Mazdak's lab.

America's 92,000 reservoirs are accumulating sediment at a rapid rate, and too often dam and reservoir owners ignore the issue because there are few good solutions. But sedimentation can dramatically reduce a reservoir's storage capacity, a river's habitat, and eventually a dam's ability to produce hydropower, says Baha Abulnaga, the founder of engineering company Mazdak International. In this interview, he shares with Hydro Leader *his company's solutions for deep reservoir dredging, which adapt slurry and hydraulic capsule pipeline technology he gained working in the mining industry.*

Hydro Leader: Please tell us about your background and how you came to be in your current position.

Baha Abulnaga: I am a professional engineer who has been working in the mining sector in different countries since the late 1980s. I became a specialist in slurry pipelines. I've published a lot of papers, and I wrote a book called *Slurry Systems Handbook* that was published by McGraw Hill. I was always fascinated by the possibility of cleaning sediments from reservoirs using slurry pipelines. I come from Egypt, which built one of the largest dams in the world, the Aswan High Dam. Since 1965, sediment has been accumulating at the rate of 135 million cubic meters per year in the reservoir called Lake Nubia-Nasser, starting some 500 kilometers (310 miles) upstream of the dam, forming a new delta and gradually moving closer to the dam over time. When sediments accumulate in a reservoir, they deprive downstream land of topsoil, nutrients, erosion protection, and other environmental benefits. So, I started to develop appropriate technologies to solve that problem.

Hydro Leader: Tell us about your company, Mazdak International.

Baha Abulnaga: Mazdak International is a licensed professional engineering company in the state of Washington. I founded the company in 1995 and initially focused on consulting for the mining and oil and gas sectors. We have five employees and are currently mainly a research operation. But we are expanding. We are building our own foundry to cast 9,000 tons of iron a year to build our products.

Hydro Leader: How is slurry involved in mining?

Baha Abulnaga: Since the 1940s, mining has shifted from dry to wet processing procedures. In the old days, you would grind the mineral ore, which generated a lot of dust. Then, people started adding water to the grinding process, forming a slurry. The slurry is processed to separate the valuable concentrate from rejects, known as *tailings*. Today, this is

PHOTOS COURTESY OF MAZDAK INTERNATIONAL.

the main way that many metals, including copper, gold, and silver, are processed.

Hydro Leader: What is the scale of the reservoir sedimentation problem in the United States?

Baha Abulnaga: The United States has 92,000 reservoirs, the largest number of any country in the world. About 950 of those, including some of the largest ones, such as Lake Mead, behind Hoover Dam, are run by the federal government. The rest are owned by cities, municipalities, states, and the private sector. The State of California, for example, owns a lot of large reservoirs. Here in the state of Washington, we have some reservoirs on the Columbia River, and we were the first producer of hydroelectricity in the nation. Since the 1950s, many other countries have also built big reservoirs.

Sedimentation is a growing problem in many parts of the world. It is expected that by 2050, 25 percent of the volume of the world's reservoirs will be filled with sediment. Every spring, when the snow melts, rivers rush, and they transport a lot of silt, sand, and gravel. In some countries, it happens after the monsoon period or after rainy seasons. When water enters a reservoir, its velocity slows down and it is no longer able to keep the sediments in suspension. First, the bigger sediments, such as gravel and coarse sand, separate. These coarse sediments form what is called *topset,* while the smaller sediments—fine sand, silt, and clays—deposit further along the reservoir and form *bottomset* accumulations. Over time, the topset sediments at the entry of the reservoir form a new delta.

Hydro Leader: To what extent are reservoir owners and operators already removing this sediment?

Baha Abulnaga: In reality, they have not been removing them. At the beginning of the 20th century, the attitude was, "We'll build a reservoir and consider 15–20 percent of its capacity dead storage, where sediment can accumulate. After 50–60 years, we'll abandon the reservoir and build a new one downstream." That idea is now obsolete. In 2015, the United States Society on Dams published a document called *Modeling Sediment Movement in Reservoirs* that stated that the old approach starves the river. It defined a new approach to sediment management based on sediment yield changes, sediment routing, mechanical removal, and combination strategies.

Because that reevaluation is relatively new, it's only now that people are looking seriously at solving the problem. For example, about 5 years ago in Kansas, the state government raised bonds to remove 3 million cubic yards of sediment from the John Redmond Reservoir and used the dredged material for farmland. Although the project cost $20 million, the local farmers supported the project because they wanted those sediments. The project also improved the quality of the water used to cool reactors at a nearby nuclear power plant.

In the 2000s, Denver Water dredged a reservoir after wildfires and a massive flood pushed a lot of gravel into the reservoir. The contractor ran into some problems, so the removal ended up costing $70 per cubic yard. After a full season, the contractor had only removed one-third of the volume the utility wanted to remove, so Denver Water canceled the contract.

The discharge of a mixture of water and sediments pumped by the slurry pulsejet engine.

Louisiana has done a good job of moving sediment to slow the loss of its wetlands. Because the state's coast has been eroded by rising sea levels and hurricanes like Katrina, the state adopted a policy called Coast 2050. It has been dredging inland reservoirs and lakes and pumping the slurry to build new shorelines. The last I heard, it is costing the state almost $1 billion a year, although the scarcity of dredgers could make the project even more expensive.

Hydro Leader: Let's move on to your product, the slurry pulsejet engine. How does it work?

Baha Abulnaga: In 2018, the U.S. Army Corps of Engineers and the Bureau of Reclamation organized an international competition. Mazdak won the first and second prizes by developing our hydraulic capsule pipeline, a new concept for transporting sediments. A year later, the two agencies joined with NASA to organize the Guardians of the Reservoir challenge competition. One of the new criteria was to remove sediments at depths greater than 50 feet. We proposed a concept that we call the *slurry pulsejet pump engine*. It's similar to a car engine, but instead of solid pistons, it has liquid pistons. Those pistons consist of water and dredged sediments, so they are slurry pistons. We adapted a concept that was initially developed some 130 years ago called the *Humphrey pump engine*, a liquid-piston pump engine that was used in the Thames River in England and at a couple of sites in the United States. We changed it so it could operate on slurry and added modern electronics and computers to control the pulse electronically. It can be built in different sizes, from 36 to 84 inches in diameter. You drop this engine down into the reservoir and apply a gaseous fuel such as natural gas or methane and air.

Mazdak's capsule pump launcher being loaded with capsules from a conveyor.

Once the internal combustion is started, it keeps pumping a slurry of water and sediments to the surface. It should be noted that many reservoirs produce their own methane through the fermentation of organic material trapped in sediments. Our pulsejet engine can use that biomethane.

Let me explain the advantages of this concept. Lake Mead is 660 feet deep. It's difficult to use mechanical means to dredge sediments at that depth. If you try to use a clamshell dredger, you spend half the time lowering an empty bucket, then you have to grab the sediments, raise them to the surface, swivel the crane, and empty them into a side barge. Some people have tried air-lift pumps. They create an artificial low-pressure zone formed of air and water in a pipe and let the sediments rush in, driven by the hydrostatic pressure of water at great depth. We decided to use a more efficient approach. We use much less air than an air-lift pump. Our discharge pipe is usually full of slurry made of water and sediments. We compensate for the difference between the high hydrostatic pressure of the water at the pumping depth and the slurry discharge pressure by creating a pulse of pressure from the ignition of a mixture of air and fuel on top of the slurry piston in our cylinders.

Hydro Leader: How quickly can your device remove sediment from the bottom of a reservoir?

Baha Abulnaga: The speed is based on the size of the cylinder. The pumps send pulses about every 10 or 12 seconds. The volume of the pulse is basically equivalent to the volume of the slurry of sediments. The slurry is usually 30–40 percent sediment by weight; the rest is water. We have designed the slurry pulsejet engine in different sizes to remove 1–4 million cubic yards a year. Larger volumes will require multiple pulsejet engines with dedicated pipelines. Some smaller reservoirs receive only 20,000 cubic yards of sediments a year; some of the biggest ones, such as the Lewis and Clark Lake Reservoir on the Missouri River in South Dakota, receive about 4 million cubic yards a year. Reservoirs that receive less than 1 million cubic yards a year would only need an engine in the 36- to 42-inch range. Sediments can only be dredged in certain seasons of the year: It is not feasible during floods or when reservoirs ice up.

Hydro Leader: When the sediment is brought up to the surface, is it just sent to the shore? Does it need to be treated in any way?

Baha Abulnaga: What you do with the sediment depends on where the reservoir is. The general concept that Reclamation prefers is what it calls *rerouting* the sediment from the reservoir past the dam to the river downstream via a bypass pipeline. Once the sediment is dredged and brought to the surface, more pressure is needed to move it further, so a slurry booster pump is used. The size of the booster pump station is based on the length of the bypass pipeline around the dam. The bypass pipeline may be only 2–3 miles long, but Tuttle Creek Lake in Kansas would require a bypass pipeline 15 miles long. The ideal solution is to reroute the sediment around the dam with a booster pump and release it gently to avoid disturbing the fish too much.

In other cases, you could use the sediment as topsoil. In deserts and arid areas, you could use the sediment to establish new farmland. Even on the Colorado basin, you could use it as topsoil. Otherwise, you reintroduce it into the river. Denver Water considered separating the sand from the gravel and selling them to the construction industry, because the project was close to a big city that needed a lot of gravel and sand for making concrete and building skyscrapers.

In some places, there are a lot of regulations about releasing sediment. In California, it is suspected that during the gold rush, miners used arsenic and mercury to wash off gold, and there may be heavy metals at the bottom of the reservoirs that were transported with sediments 100 years ago. California regulations strictly require that sediments removed from rivers and reservoirs be treated for heavy metals.

Hydro Leader: Let's move on to your other invention, the capsule pipeline technology. What problem was it designed to solve?

Baha Abulnaga: The second problem with reservoir dredging, one that slows the process and increases its cost, is that the abrasive gravel and coarse sand in many topset accumulations, especially in deltas, eats up the pumps and

PHOTOS COURTESY OF MAZDAK INTERNATIONAL.

pipes. The contractor must throw away the pumps and pipes at the end of the dredging season, which raises costs. One way to reduce abrasion after dredging sediment to the top of the water level is to transfer it to capsules and then move the capsules through a pipeline filled with water. Think of the pneumatic capsules that are sometimes used in drive-in banking or in hospitals. The hydraulic capsule is a similar concept. Once the capsules reach a certain speed, they develop what is called *lift force* and do not have any contact with the pipe wall. At the endpoint, there is a machine that opens the capsules, removes the sediment, and returns the empty capsules to the starting point.

This system has several advantages. The water in the pipeline doesn't get contaminated, because the sediments have no contact with the water. The system uses less water and less power. But the main advantage is that because abrasion is eliminated, the same pipes and pumps can be used over and over, from one dredging season to another. This is critical, because the length of slurry lines has continued to increase over time. For instance, at Lake Livingston, near Houston, engineers have proposed dredging the reservoir and transporting the sediment 20 miles to the coast. The capsule pump launcher could potentially save such a project 40 percent of its operational expenses.

Hydro Leader: So, the capsules are loaded and unloaded mechanically?

Baha Abulnaga: Yes. In 2021, we got money from the National Science Foundation to build a new capsule pump launcher, which takes the capsule from a conveyor and sends it into a water pipeline. The old technology, which was developed in the 1950s, used a complex technology like that used to transport ships through a lock. We use a completely different approach that is much simpler. Our patent has been approved to be issued in the next few weeks.

Hydro Leader: Have either of these two technologies, the pulsejet engine and the capsule pipeline technology, had commercial pilots yet?

Baha Abulnaga: No. We built prototypes in our lab and have done testing, but we haven't yet had a commercial application because of permitting issues. We've been trying to work with the Army Corps to find a location to introduce this technology as part of an annual reservoir maintenance process. We need a way to bypass the difficult environmental permits to do this type of work, such as by finding a contractor that has already a permit to do maintenance on a reservoir. We have also tried to work with nonprofit organizations such as the Missouri Sedimentation Action Coalition. We may have to offer this technology to the mining industry, because mining operations are often privately owned, and there are fewer restrictions on permits. Introducing new technology into a river reservoir is a lengthy process.

Hydro Leader: Do you plan to eventually manufacture the devices and sell them directly to customers?

Baha Abulnaga: We could sell them to contractors and engineering companies. If some reservoir managers want to own the products and use them for yearly maintenance, that would be the optimum solution. At the moment, a lot of reservoirs only dredge once every 10 years, so they may not be keen on owning the equipment themselves. They dredge once every 10 years because they think that it's easier to do a massive dredging project once in a while. A lot of reservoirs are also recreational sites where people go swimming and fishing, and when you want to do a major cleanup, you have to close the area, which upsets the public. But if you could dredge on a yearly basis without disturbing fishing or recreational activities too much, then it would make more sense to keep smaller equipment on site.

I'm hopeful that this technology will be adopted. We lose about 0.5–1 percent of our ability to produce hydropower every year due to sediment accumulation. Over 10 years, a hydroelectric facility may be losing 5–10 percent of its ability to produce power. Hopefully, the next generation of engineers will accept the idea of yearly maintenance, and then we can offer the equipment on that basis.

Hydro Leader: What is your vision for the future?

Baha Abulnaga: We need more people to focus on the sedimentation problem instead of kicking the can down the road. There are some reservoirs that are fully sedimented. The traditional 20th-century approach to managing sediments was to leave a dead storage volume in the reservoir. This approach can lead to the death of a reservoir. The Çubuk Dam, built in Turkey in 1935, had become totally idle by 1994 because of full siltation. It is predicted that because of climate change, by 2100, many coastal areas around the world may be underwater, up to 20 or 30 miles inland. Redirecting sediment from reservoirs to the coast, as is being done now in Louisiana with sediment from the Mississippi, is the only feasible way to protect our shores. I think Louisiana is doing a fantastic job, with support from Congress, on projects like Coast 2050. But many other states, including California, Florida, Georgia, Oregon, Texas, Washington, some of the eastern states, and probably even Alaska, will need to use sediment to fight rising sea levels. H

Baha Abulnaga is the founder of Mazdak International. He can be contacted at baha@mazdak.international.

Hydropower at Farmers Irrigation District: Building on the Past, Looking to the Future

Water from FID's Powerhouse 2 returning to the Hood River, with a view of orchards in the background.

A new Turgo runner is installed at Powerhouse 2 in 2015.

Farmers Irrigation District's (FID) glacial and spring-fed irrigation system, some of which was converted in the 1920s from old logging infrastructure, irrigates pear orchards and other fruit crops on some of the highest-value farmland in Oregon. The district's two low-impact-certified hydropower plants have generated enough income to do piping and other much-needed upgrades to the 100-year-old irrigation system and to spend $6 million to modernize the two powerhouses. In this interview, FID General Manager Les Perkins and Hydropower Operator Zach DeHart talk with Hydro Leader *about the rehab work and the potential for using the district's hydro plants to make the local power grid more resilient.*

Hydro Leader: Please describe your background and how you came to be in your current position.

Les Perkins: I'm actually a biologist. For a decade, I worked as a microbiologist in the brewing industry. Then, I helped cofound Farmers Conservation Alliance, a nonprofit that works in irrigation modernization, fish screening, passage, and barrier removal. Nearly 20 years ago, the district I work for now, FID, designed and patented a fish screen. I worked on the market transfer of the technology, and we built a company around fish screening in the Pacific Northwest. Farmers Conservation Alliance is still operating, but now it is largely doing irrigation modernization work in the western United States. Eight years ago, the board approached me and asked if I would be interested in managing the district. I am now the general manager of FID.

Hydro Leader: Please tell us about FID.

Les Perkins: FID serves about 2,000 customers on 6,000 acres of high-value farmland in Hood River County, Oregon. The main crop in the district is pears, although farmers also grow apples, blueberries, and cherries. We have some of the highest-value-by-acre farmland in the state. The district has been around since 1874. In our current form, we're made up of a couple of irrigating districts that merged in the 1970s. Our primary role is to deliver irrigation water; producing hydropower is secondary. Some of our infrastructure was originally built for logging. In the 1920s, the district acquired infrastructure from a lumber company and converted it into part of our current irrigation system. Our highest diversion is at 4,000 feet and was part of that original logging infrastructure. It was basically a series of flumes that delivered water to a mill pond on the spot that is now our reservoir.

We're a municipal corporation (much like other government entities and special districts) with eight employees. Zach, our hydro operator, is focused on hydropower. Everyone on the crew helps operate our two hydropower plants, and everyone is involved on the irrigation side of things. Over the last 30 years, we've converted open ditches to pipe, which not only saves water but also eliminates a whole lot of maintenance and liability and, therefore, costs. At one time we had 14 employees, but we've gotten to the point at which we can run the district with 8 people.

PHOTOS COURTESY OF FID.

Hydro Leader: Tell us about your hydropower projects.

Zach DeHart: We have two powerhouses with a combined capacity of 4.4 megawatts. Each houses one hydro turbine. One is a 1.8-megawatt Pelton wheel facility. It's a Chinese turbine and generator set. It's been wonderfully reliable but is due for maintenance in the next couple of years. Our other power facility was completely repowered. In 2015, we tore out our older two Francis units and put in a new Turgo unit. It now runs almost year round with few interruptions. When a thunderstorm rolls through, we can expect to get kicked offline because of issues with the overall grid, but otherwise, it is highly efficient and reliable.

Hydro Leader: Would you tell us about your upcoming projects?

Les Perkins: One of the reasons we did a repower in 2015 is that we have aggressive water. Our system is glacially fed, so we had two units that were just getting torn up. Basically, we could watch the efficiency drop through the year, which resulted in expensive annual rebuilds. The Turgo project was a way to address that. It decreased the overall capacity of the plant, but it increased the annual output, because the Turgos have a nice efficiency curve with our flow range and maintain efficiency well even with aggressive water.

Hydro Leader: Would you discuss the funding of your hydro projects? How have they affected your district fiscally?

Les Perkins: For our district, hydro was a savior. In the 1980s, we were inefficient at delivering water. We had about 70 miles of open ditches. The infrastructure had been built nearly 100 years before and hadn't been upgraded. Late in the summer, we had a hard time getting water to all our growers. The district had started looking at putting in hydro in the 1970s, and it installed the plants in the mid-1980s. Once the plants were up and running, they started generating revenue. Some of that revenue was used to enclose open ditches and put pipe in the ground. As that happened, less water was lost to seepage and more water was available to go to the plants, and that increased our revenue, which again was used to do more piping. Today, we are almost entirely piped. We have 2½ miles of main canal left to go, and we hope to have that closed in by 2026.

Hydro has been a huge source of funds for upgrading our system. We've also taken on a lot of debt to make system improvements. We take loans for projects and pay them off over time using our hydro revenue. As we pay off a loan, we take on another loan to do another project. Our power purchase agreements have changed over time, which has caused us some consternation. We're in the process of renegotiating our power purchase agreement right now. In less than 3 years, our existing purchase agreement will expire, and rates look significantly lower than what we've had over our last 15-year contract. We are looking at losing as much as 50 percent of our revenue in the first few years of our upcoming power purchase agreement, so we're having to recalibrate. Fortunately, our major projects are mostly completed.

Hydro Leader: Can you provide a preview of the energy projects to come?

Zach DeHart at the factory acceptance testing for the new digital controls for Powerhouse 3.

Zach DeHart: We have put a ton of money into both of our powerhouses over the last 10 years. The most recent upgrades have primarily been related to unit control. Over the last couple of years, we started replacing our antiquated, 1980s-era analog systems with fully digital controls and did efficiency upgrades. The newer technology has lower power usage, greater power outputs, and so on. The upgrades will allow us to cut down on spare parts and maintenance time. If the system has an outage due to a controls malfunction, we can do a plug-and-play replacement instead of a total rewire.

Our next big project is a generator rewind for the older Chinese unit, which hasn't seen a major overhaul since it was installed almost 40 years ago. That's the next big, and hopefully final, electrical maintenance item in upgrading this 40-year-old unit to a modernized system. The most recent complication is the lead time for the parts. Since the COVID-19 pandemic, everything takes longer to get. After this project is done, we hope we can run for another 40 years without having to do this again.

Les Perkins: Since 2015, we have invested about $6 million to upgrade these powerhouses. Both have matching digital controls and high-pressure units. We put in new main-unit

breakers in both facilities, new exciters, and a new transformer in the switchyard. Now, our SCADA system is pretty robust, so remote monitoring and controls are greatly improved over what we had in the past. It's allowed Zach to work with our electrical engineer to fine-tune our set points so that we don't get bumped offline as frequently. The line maintenance work PacifiCorp has done over the last 2 years—more aggressive tree trimming, reconductoring, and putting in additional switches—has also kept us online more reliably.

Zach DeHart: We used to get bumped offline fairly frequently; you could bet on it twice a month. Now, we've only had one shutdown in the last 6 months. It's made my job much easier.

Hydro Leader: Is there anything you'd like to add?

Les Perkins: We've researched how our powerhouses could provide grid resilience in the face of emergencies, such as extreme weather events and rolling blackouts. We did a feasibility analysis for doing a solar-plus-battery microgrid installation that would enable us to island our plants, black-start them, and then route power directly to critical infrastructure, including 911 switches, the hospital, water and sewer systems, gas pumps, and refrigeration. We know what equipment it would take and how it could be incorporated into our current infrastructure; we just don't have a legal mechanism to do it. We would need to cooperate with Pacific Power to be able to route power effectively using its infrastructure. We also looked at laying redundant lines to critical infrastructure ourselves, but that's unrealistic and exorbitantly expensive. We're waiting to have policy and legislation enacted that allows us to do this work. Because we are a qualified facility, meaning we sell our power under the Public Utility Regulatory Policy Act of 1978, the ways we can sell our power are limited. Nowhere in the enabling legislation or rules is there language that allows us to have the battery storage or multiple types of generation we would need to do these things. There is interest from the state, the county, and Pacific Power to get this work done, but it's going to take some change in legislation and policy action for the contractual and financial pieces to be worked out. Currently, there's no mechanism or rate structure for paying us for grid services. It is an expensive project, but there is currently a lot of infrastructure funding out there, so we're hoping we can take advantage of this rare opportunity.

We've also looked at a community solar project. Oregon has a community solar program that is pretty attractive, so we're currently conducting a feasibility analysis for a district-owned project. It would be separate from our existing facilities, but the district would basically own a half-megawatt solar project in the community, with 50 percent of that serving low-income households.

Hydro Leader: What is your vision for the future?

Les Perkins: There's still a lot of opportunity to use existing infrastructure to generate hydroelectric power from irrigation systems, wastewater systems, and drinking water systems. There are opportunities for systems that serve communities to provide resilience to the power grid. As more intermittent renewables come into the system, the consistent baseload nature of hydro should be attractive. FID is certified by the Low Impact Hydro Institute (LIHI), so we are viewed the same way as solar and wind. We generate renewable energy certificates just like any other renewable. When we go through the LIHI recertification, we will work with the Oregon Department of Environmental Quality and the Oregon Department of Fish and Wildlife to identify and address any issues. The recertification process holds us to standards that we must maintain.

Zach DeHart: On the topic of utilizing the existing infrastructure to generate power, I would highly recommend that your readers look at the City of Hood River's upcoming project to put a microturbine on its drinking water system. The ground hasn't been broken, but the project has been greenlit. It would be wonderful to see thousands of projects like that all over the state and the nation. The funding for that type of project is practically nonexistent, though, which makes it hard to pencil out.

Les Perkins: Because drinking water systems are located where people are—unlike a lot of our irrigation infrastructure, which is out in the woods and not close to load—many of those projects could be behind the meter. There are opportunities for cities and districts to put in small microturbines that can offset load. That way, they don't have to go through a power purchase agreement; they can just have a behind-the-meter project that is offsetting load adjacent to the facilities. H

Les Perkins is the general manager of Farmers Irrigation District. He can be contacted at les@fidhr.org.

Zach DeHart is the hydropower operator at Farmers Irrigation District. He can be contacted at zach@fidhr.org.

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Thinking Small: Sorenson Engineering Specializes in Small-Scale Hydroelectric

Sorenson Engineering Hydro Facility.

Sorenson Engineering designs, develops, builds, buys, rehabs, and operates small hydroelectric plants. Since 1980, the company has specialized in both rehabilitating existing small plants and tapping the potential of existing water diversions to accommodate hydropower for the first time. In this interview, owner and head engineer Ted Sorenson talks with Hydro Leader *about 40 years of going with the flow.*

Hydro Leader: Please tell us about your background and your experience in hydropower.

Ted Sorenson: I went to school at the University of Idaho, where I trained to be a civil engineer and got my degree in sanitary engineering. In 1980, I started Sorenson Engineering. We develop, permit, design, construct, own, and operate projects worldwide. Over the last 40 years, we've added hydropower to gravity irrigation systems where the water was already diverted—whether it was by a gravity sprinkler, a canal drop, or an existing reservoir or dam. In the last 10 years, we've started to bid to purchase small hydroelectric plants from utilities. When it is not economical for them to operate, we rehabilitate them and put them in working order. I've designed some 50 new hydroelectric power plants that range in size from 200 kilowatts (kw) to 40 megawatts (mw). We own and operate some 26 small hydropower plants, most of them on existing diversions that never had a hydro power plant before. We have also rehabilitated eight small power plants, some that haven't seen upgrades in 100 years of operation.

Hydro Leader: When did you begin buying existing facilities to refurbish them and operate them?

Ted Sorenson: That started about 15 years ago. I sold power to some of the utilities and began talking to the operators, and some of them came and toured our small

PHOTOS COURTESY OF SORENSON ENGINEERING.

hydroelectric plants. They apparently liked what they saw, so they gave me the opportunity to bid on some the plants they had that were broken down. Rather than decommissioning them, I would rebuild them. That's how I got started with older facilities.

Hydro Leader: What are the criteria that determine whether you can make an existing unit profitable?

Ted Sorenson: There are three considerations that determine whether a hydro power plant is feasible or profitable. First, you need to look at the hydrology to see if there is good flow. Second, you need to find out if you can get the necessary permits to build or upgrading the plant. Third is your ability to get a power sales agreement. If you don't have all three of those, you don't have a site.

Hydro Leader: Who do you sell power to?

Ted Sorenson: In California, we sell power to the CAISO grid, which is an independent service operator. In other states, we often sell it back to the utility according to the published rates. These rates are on file with the states' public utilities commissions.

Hydro Leader: How do you determine the price at which you can sell power? How do you make it profitable?

Ted Sorenson: Well, it's kind of a chicken-and-egg situation. We must calculate what it is going to cost for the facility repairs, understand the hydrology, and estimate what the power plant will produce. You look at the power sales rate to see if there is a decent rate of return. We have been operating power plants for many years, so we have a pretty good idea of what it takes.

Hydro Leader: What do you think are the biggest misconceptions about the value of hydropower?

Ted Sorenson: The biggest misconception is utilities' belief that hydro is an intermittent resource. The generation at small hydro facilities is contingent on the water available, but hydropower is steady. It follows the hydrological cycles, so it's fairly predictable, more predictable than wind or solar.

Hydro Leader: What is your vision for the future?

Ted Sorenson: My vision for the future is to do more of the same. I enjoy working in hydro. It is a clean, renewable resource. I think of it as the original renewable power resource. Now I have four kids in the business—three engineers and a lawyer. They want to continue to make our vision a reality, so we plan to continue as long as there are markets for the power. H

Upper Turnbull Hydro Project in Fairfield, Montana.

Ted Sorenson and Colleague with a turbine at a Sorenson Engineering Project.

Ted S. Sorenson, P.E. is the Founder and Principal of Sorenson Engineering. He can be contacted at ted@tsorenson.net.

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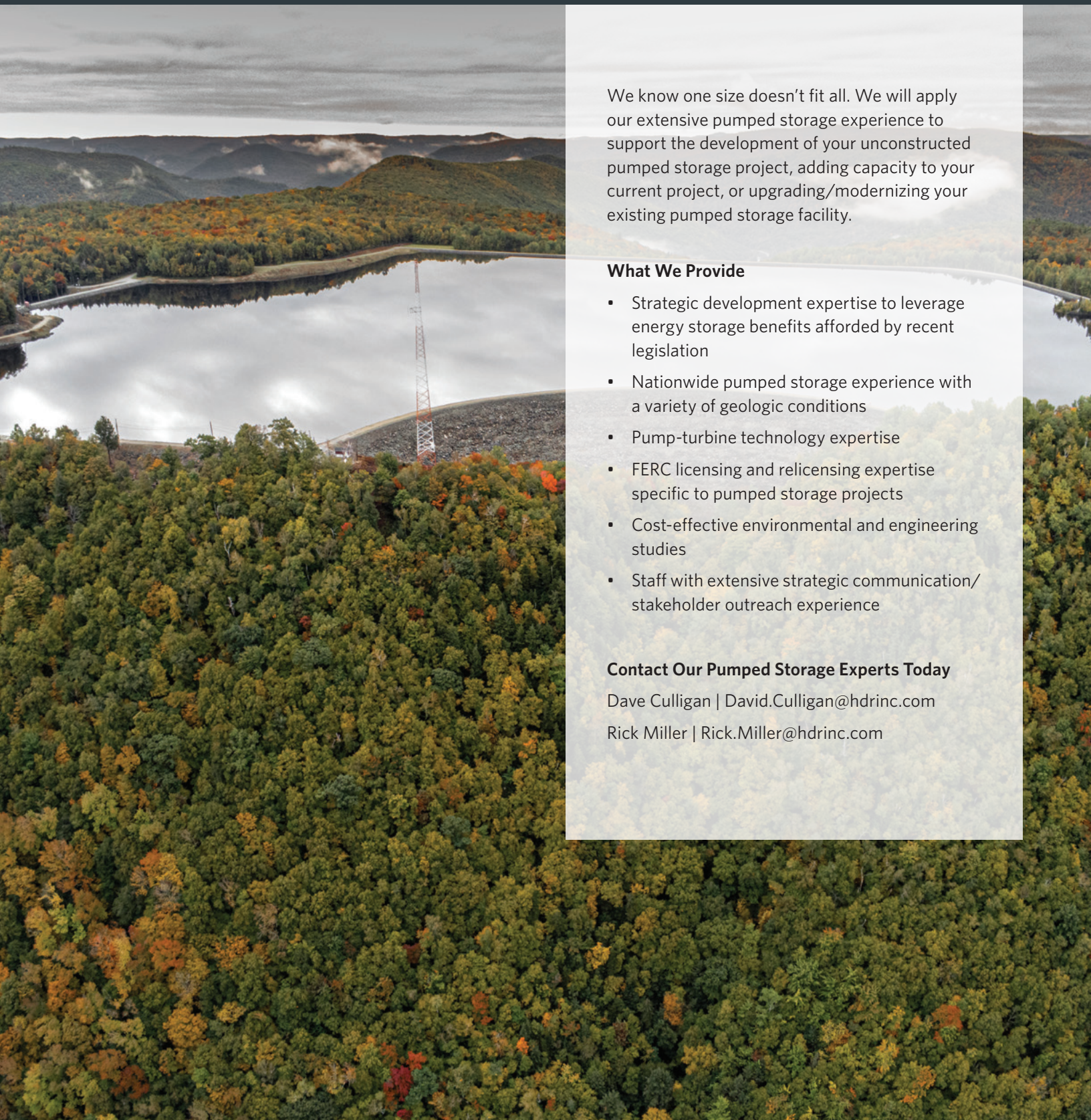

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NHA
National Hydropower Association

Linda Ciocci: 30 Years as a Hydro Industry Leader

Participants in a 2019 Hydro Think Tank event.

After 30 years as CEO of the National Hydropower Association (NHA), Linda Ciocci became executive director of the Hydropower Foundation. She is also a founding member of the American Council on Renewable Energy and served three terms on the U.S. Department of Commerce's Federal Advisory Committee on Renewable Energy. In this interview with Hydro Leader*, Ms. Ciocci talks about the foundation's work, from designing fish-friendly turbines to creating a pipeline of young talent to work in hydro. She also reflects on how hydro has changed over her long tenure and about the industry's promising future.*

Hydro Leader: Please tell us about your background and your career in hydropower.

Linda Ciocci: I started in hydropower as a legislative representative with the American Public Power Association. While I was there, I had the opportunity to interact with NHA. Around 1990, NHA was looking for a CEO and offered me the position. When I started, NHA was a small organization that didn't represent the breadth of the industry. We had about 25–30 members total: mostly independent power producers, a few investor-owned utilities, and one public utility—not many entities on the service side of the industry. During my 30-year tenure, we expanded our membership to more than 200 members, became more inclusive, and became the major public face of the industry. We expanded our staff and program areas to include technical services and marine energy and improved some of the regulatory policies for our industry. In 2019, I took over the Hydropower Foundation as its part-time executive director.

Hydro Leader: What major changes did you see over your decades in the industry?

Linda Ciocci: When I started in hydro, we were the largest renewable energy and the strongest. We had a far larger share of the market. When you look at where wind and solar are today, the evolution of their technologies is significant. They have now toppled hydropower.

The biggest change has been a recognition of the need for hydropower. When wind and solar were a small portion

PHOTOS COURTESY OF THE HYDROPOWER FOUNDATION.

of the market, they pushed for greater expansion without the understanding that hydro is essential to secure the grid. There is much more synergy today. Hydropower is an essential pathway to more renewables and a clean energy future.

Wind and solar got where they are today for two reasons: incentive policies and research and development. They spent a lot of time with the U.S. Department of Energy (DOE), building research programs that would address the challenges they faced in expanding their industries. For hydropower, the main challenge was fish passage, yet the DOE had proposed eliminating its hydro research program in 1993.

The other major reason for the eclipse, as I mentioned, was tax incentives. We worked with the other renewable organizations and nongovernmental organizations to get hydropower recognized in those programs. It was not easy, and our progress was mostly incremental, but today, hydropower is recognized in tax policy on an equal standing with the other renewables.

Over the past 30 years, there have been a lot of improvements in the way hydropower operates and a huge change in how hydropower is used. When I first started out, the industry was completing the last remaining pumped storage projects. That was the heyday of pumped storage plants, which were built alongside nuclear power plants to take their energy at night when the demand was low. They essentially served as giant batteries and stored energy during the night to release it during the day when demand was high. Today, pumped storage is being used in a totally different way, namely load following, mainly to ensure that the grid system is stable when wind and solar are not available. Essentially, though, it is still a large battery and the most widely used storage technology around the globe. There have been significant changes in how conventional hydropower projects operate as well. Some are baseload, while others load follow. And there is much more care for and consideration of the environment.

Hydro Leader: Please tell us more about the Hydropower Foundation.

Linda Ciocci: The Hydropower Foundation was created in 1993 by a group of NHA board members. In the early 1990s, a slew of hydropower plants were coming up for relicensing. One of the greatest challenges in those licenses was fish passage. Around the same time, members of the NHA board felt that there was a need for a larger research and development program for hydro. There was no program at the DOE at the time.

We raised a half million dollars from the industry and challenged the DOE to match the funds. That restarted the hydro program at $1 million. Our primary focus was fish passage. We thought it would be simple to develop a new turbine to pass fish successfully, but we discovered that there was little knowledge about fish behavior in the hydro system. It took us more than 10 years of continued funding to develop the advanced hydro turbine, otherwise known as the *fish-friendly turbine*. A lot of new turbine technology came out of that program. Much of our current knowledge about fish behavior was furthered by that program, and we have successfully deployed new-generation turbines with a much greater fish survival rate throughout the system.

The 2023 Hiring for Hydro event, hosted by the Hydro Foundation and the Northwest Hydroelectric Association.

We have always tried to be at the forefront of the challenges facing the industry. As time went on, the issue of workforce became more important, and we began to realize that there

The Hydropower Foundation's Hydro Think Tank program involves onsite work at a hydropower facility.

was an opportunity for the foundation to serve as a conduit to bring new people into the industry. We worked with the DOE to create a Research Awards Program that melded our science and research needs with workforce needs. The program brought together university students at the graduate and undergraduate levels to work on research that supported the industry. For example, students focused on water quality, fluid dynamics, or basin-wide approaches to ensure environmental protection. The program was broad and provided generous funding that covered tuition and research costs. When we started the program, we had hoped to attract students to hydropower. Some 85–95 percent of the students either continued their research or ended up working in the hydropower industry. But the program was limited by funding, and over the years, we weren't able to bring in as many students as the DOE would have liked, so funding was discontinued. The Grant Fellows Program followed that. It was smaller than the research awards program but still important.

Those programs launched the foundation's focus on workforce development and working with universities. Today, we have specific workforce programs like Hiring for Hydro and our Hydro Think Tank. Hiring for Hydro matches students with industry positions. Our most recent event was hosted with the Northwest Hydroelectric Association at the end of February. Twelve students attended that event, which started with a Hydro 101 session, gave them a good sense of working for the industry, and provided help with resumes. Then, we unleashed them at a career fair. Some of those students are negotiating right now to line up a position for when they graduate.

The Hydro Think Tank program brings students to work in a more concentrated way. Students are given a real-life problem provided by the industry. It can range from a dissolved oxygen issue to reshaping the energy output to match the needs of a solar field. We divide the students into competitive teams, and they work at a hydro facility for several days. They present their solutions, and the winning team gets a small award. The program gives students an opportunity to work on real-life problems, go to a facility, and interact with the industry in a professional way. A good portion of the students that go through the program end up being hired when they graduate. We think it's been a huge success. We're doing two think tanks this year: one in the Southeast, working with the Southern Company and Kleinschmidt Associates, and another in the Pacific Northwest, funded by a host of utilities from the area. Both programs have diversity and inclusion as a goal. We reach out to historically black colleges and universities as well as 4- and 2-year colleges and trade schools. It is not easy, but we have had tremendous success with both programs.

Hydro Leader: Would you talk about the incoming wave of expected retirements?

Linda Ciocci: Some 25–30 percent of industry employees will retire over the course of the next 5–10 years. Essentially, we are experiencing a grey tsunami. The average turbine in the United States is over 60 years old. We are an aging industry in terms of our projects and our workforce. A large number of the people who worked on these projects are now retiring. And with a system in need of modernization, the people who built and maintained these projects will take their hydro expertise with them when they retire. How are we going to transfer that knowledge base before they're gone? We're in a crisis state; we need to bring young people in and get ready for that turnover. The new workforce needs to be well trained and ready to take on the challenge. We need engineers, project managers, and environmental

PHOTOS COURTESY OF THE HYDROPOWER FOUNDATION.

scientists, to name a few. And it is not just modernizing an outdated system. We lack people across the board in the broad hydropower community.

The other big problem is that universities have given up their hydropower programs over the years because they didn't see opportunity. Many thought the industry was going to fade. They didn't recognize the impact and the value that hydro can bring as we move into the future. Now, there's an opportunity for the university systems to recreate those programs. Often, they're not even aware of the opportunities that exist in hydro. The Hydropower Foundation is working with universities to try to get them reengaged in hydro engineering. We are helping them redevelop their hydro curricula in electrical, mechanical, and civil engineering so that students are better prepared once they graduate. We share hiring opportunities and provide hydro professionals to speak before them about the vast career opportunities that exist in the industry.

One of the biggest issues facing the industry is trying to find mid-level employees. Right now, companies rob from each other because there is such a big demand for people with the necessary expertise and knowledge base. One of the things we've been trying to create is a veterans' program that would train mid-level career people coming out of military service for work in the hydropower industry. We haven't found funding for that initiative just yet, but it is certainly timely. We also look to other industries, such as the coal industry, for mid-level employees. If you are a mid-level employee within our industry, you can write your ticket almost anywhere in the country. We would like to change that!

Hydro Leader: What do you think are the most effective ways to get young people to think of hydropower as a promising career field?

Linda Ciocci: We're not very good as an industry in reaching out to the next generation. I think some of it is exposure. Students need to be exposed to hydro at the university level to see the opportunities. I think they've heard a lot about wind and solar and see them as growing industries, but they don't necessarily know much about hydro. But when we bring students into our Hydro Think Tank program, the industry sells itself. The students love it and want to join. Bringing them to conferences is also key. Their eyes pop out of their heads when they walk into a conference and see 500 exhibitors. It didn't occur to them that the hydro industry had this many career options. There is a breadth of opportunities in different fields, including law, environmental science, engineering, and project management, to name a few. And in many cases, you have the extra bonus of working on a hydro facility on a gorgeous reservoir.

Hydro Leader: Is there anything else that you'd like to discuss?

Linda Ciocci: The Hydropower Foundation has received a couple of grants from the DOE. We are working with the DOE's Water Power Technologies Office to update its *Hydropower Vision* report, which I was a part of when it was first issued in 2016, while I was at NHA. We are in the process of reimagining what hydro needs to look like in 2050 and how to get there.

The other grant involves working with the DOE on a science, technology, engineering, and mathematics, or STEM, project. Part of that effort is a collegiate competition in conventional hydropower that will be launched at the NHA conference in May. Teams from colleges around the country will be participating. That is exciting.

Hydro Leader: What is your vision for the future?

Linda Ciocci: I think the hydropower industry has never been in a better place. It's becoming more widely understood that hydro is needed for the security of our grid system. There has never been as much funding for the industry. Between the Bipartisan Infrastructure Law and the Inflation Reduction Act, there are currently incredible opportunities for funding hydropower improvements. I don't believe we've ever had a brighter future than we do today.

Today, the hydro industry faces three main challenges: licensing, workforce development, and water supply and management. Licensing continues to be a difficult process that slows down development. The Uncommon Dialogue and the NHA are working to improve it. I've discussed workforce development. The third challenge is that water patterns are changing, so we need to adapt. We hope to work on that challenge and are working to find a funding source.

Hydropower has an incredible future. It has challenges, as all energy sources do. The Hydropower Foundation is working to address them, particularly workforce issues, where the challenge is growing. We will continue to work in areas that are critically important to the industry. Our biggest challenge is funding. Our Hiring for Hydro and Hydro Think Tank programs are currently sponsored by industry members, but we would like to see them funded at higher levels. We'd also like to broaden some of our grant programs, and we're looking at new programs beyond workforce. We look forward to working with the DOE, other agencies, and foundations to create programs that meet the challenges we see. Despite the funding gap, the Hydropower Foundation is strong and ready to meet the future head on.

Linda Ciocci is the executive director of the Hydropower Foundation. She can be contacted at linda@hydrofoundation.org.

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Sharon Tapia on the Rising Price Tag of Dam Rehab

Over the course of the last several decades, the formerly agricultural land downstream of Perris Dam in California has been developed significantly, leading to an increase in safety concerns. In 2018, Perris Dam was rehabilitated for seismic stability concerns and improvements were made to the dam's spillway.

In its recently updated report, The Cost of Rehabilitating Dams in the United States, *the Association of State Dam Safety Officials (ASDSO) estimates the cost to rehabilitate all nonfederal dams nationwide at $157.5 billion, with $34.1 billion of that for high-hazard dams. In this interview,* Hydro Leader *talks with Sharon Tapia, California's state representative to the ASDSO, about why that number has risen significantly from previous years—and what ASDSO wants Congress to do about it.*

Hydro Leader: Please tell us about your background and how you came to be in your current position.

Sharon Tapia: I am a registered civil engineer in California, and since 2017, I have been the manager of the Division of Safety of Dams, known as DSOD, under California's Department of Water Resources. I oversee the implementation of the statewide Dam Safety Program, which regulates nearly 1,240 nonfederally owned dams for dam safety. I have been with DSOD for over 30 years and have held technical, supervisory, and managerial positions. I am also the president-elect of ASDSO's board of directors and serve as the state representative for the U.S. Department of Homeland Security's Cybersecurity & Infrastructure Security Agency.

Hydro Leader: How long have you been involved with ASDSO?

Sharon Tapia: I have been a member of ASDSO since the early 1990s, and in 2017, I became more actively involved in the association as a state representative. Since 2019, I have been serving on its board of directors.

Hydro Leader: How did ASDSO decide that a new methodology was needed for its new report about spending on dam rehabilitation?

Sharon Tapia: In 2002, ASDSO released its initial report on the cost of rehabilitating dams. Periodic updates were made

PHOTO COURTESY OF THE CALIFORNIA DEPARTMENT OF WATER RESOURCES.

to the report to account for the increase in the number of dams and inflation, and minor adjustments were made to the assumptions used to estimate costs. When ASDSO's board of directors reviewed the 2022 report, it agreed that the methodology and the cost data for dam rehabilitation projects should be reviewed to ensure that they were still valid and accurate, considering that more dam-specific information is now readily available through the U.S. Army Corps of Engineers' National Inventory of Dams (NID) and that project costs, especially those related to construction, have escalated over the years.

Hydro Leader: What kind of work did that refresh require?

Sharon Tapia: A task force was formed, and it determined that both the methodology and the project cost data needed to be updated to better estimate dam rehabilitation costs. The task force reviewed all the available data in the NID and concluded that dam height, a parameter used in previous reports, remained a valid parameter. However, the categories of height needed to be refined to better capture costs for large and complex projects, such as dams over 100 feet tall. Dams' condition assessment rating and age were also considered when estimating the number of dams in need of rehabilitation and the level of work needed. Cost data were gathered from ASDSO members nationwide for over 500 dam projects. ranging from small repairs to full dam replacement projects. The cost data came from projects that had been completed over the last 10 years and included estimated costs for known upcoming projects.

Hydro Leader: What estimate did you come up with?

Sharon Tapia: The cost to rehabilitate all nonfederal dams nationwide is estimated at $157.5 billion. Of that amount, $34.1 billion is for dams considered to have high hazard potential. If these high-hazard dams were to fail, there would be the potential for loss of life in addition to property damage and environmental effects.

Hydro Leader: Does that estimate cover only the physical rehabilitation of the facilities, or does it also include things like needed reviews and inspections?

Sharon Tapia: The rehabilitation estimates are meant to represent average costs for the planning, design, and

PHOTO COURTESY OF THE SANTA CLARA VALLEY WATER DISTRICT.

Santa Clara Valley Water District's Anderson Dam Tunnel Project includes the construction of a new low-level outlet system consisting of a 1,700-foot tunnel up to 24 feet in diameter. The project is part of the larger upcoming Anderson Dam Seismic Rehabilitation Project, estimated at over $1 billion, which will include the seismic rehabilitation of the 235-foot-high dam, the construction of a new spillway, and the completion of the outlet system.

construction phases of a dam project. This would include costs for engineering, construction materials, and labor. Since environmental and other regulatory permitting requirements vary by state, the cost data collected for most projects did not include them, but when they were included, they were used in calculating average national project costs.

Hydro Leader: How do those estimated rehabilitation needs compare to the funding that is currently available?

Sharon Tapia: Today, we have a once-in-a-generation level of federal funding for dam rehabilitations thanks to the Infrastructure Investment and Jobs Act, commonly known as the Bipartisan Infrastructure Law (BIL). The total currently available funding resources are difficult to estimate, as a comprehensive study would be needed to gather data on all resources, including federal and state grant and loan programs and funding provided by dam owners.

Hydro Leader: What level of funding would you ideally like to see?

Sharon Tapia: In the past, annual funding levels have typically been less than 1 percent of what we currently have in the BIL. With the tens of thousands of dams in need of rehabilitation, funding levels need to remain high—ideally in the range of billions of dollars per year over the next two decades.

Hydro Leader: What are some of the factors that have contributed to the current needs? Are delayed repairs a factor?

Sharon Tapia: Costs continue to rise as maintenance, repair, and rehabilitation work is deferred. About two-thirds of dams are privately owned by entities such as businesses and companies, utilities, homeowner associations, and private citizens. These owners and the public agencies that own dams have varying levels of technical and financial resources. Projects may be delayed for a considerable length of time; their completion is generally dependent on a dam owner's ability to secure funding and acquire environmental and other required permits.

Hydro Leader: Was the estimate also increased by discoveries about previously unknown vulnerabilities of existing dams?

Sharon Tapia: As dam safety engineering advances, it is possible to identify areas of concern that were not recognized in the past. Often, this knowledge is gained through lessons learned from dam failures and emergencies and through advancements in research.

Hydro Leader: Can you summarize why the scale of need cited in this report has increased from previous years?

Sharon Tapia: Major factors contributing to the increased costs are the new methodology and updated cost data. The new methodology provides an improved estimate of the number of dams in need of rehabilitation and the level of work needed—from small repairs to major rehabilitations—based on the age and condition assessment rating of the dam. The updated costs that we collected ranged from $10,000 for small repairs to more than $500 million for the rehabilitation of large and complex dams.

Hydro Leader: Who is the main audience for the new report?

Sharon Tapia: The main audience remains the same as when the report was released in the early 2000s. It is intended to inform dam safety stakeholders, such as Congress, state governments, the Federal Emergency Management Agency (FEMA), and ASDSO members. Findings from the report can be used to inform national and state policies to increase the availability of funding sources for dam rehabilitations and state dam safety regulatory programs.

Hydro Leader: What results do you hope the report will have?

Sharon Tapia: The objective of the report is to highlight the continued need for a high level of funding for dam rehabilitations, especially the federal government's investment in both grants and loan programs. We ask Congress to continue to support and increase appropriations for all federal dam rehabilitation loan and grant programs, including FEMA's National Dam Safety Program. FEMA's High Hazard Potential Dam Grant Rehabilitation Program provides pass-through grants to states. A more effective and streamlined approach to implementing this program and future programs is needed to allow dam owners to fully take advantage of available funding. Appropriations to support the implementation of the Army Corps' Water Infrastructure Financing Program, a new program that will provide low-interest loans to dam owners for dam rehabilitation, are needed on a long-term basis. Lastly, and equally important, is the need to provide adequate resources to all federal agencies that own, regulate, or provide technical or research support for dams. Dams are a vital part of our nation's infrastructure, and continued investments are needed to improve their safety and reduce risks to the public and to economic assets. H

Sharon Tapia is California's state representative to the Association of State Dam Safety Officials. She can be contacted at sharon.tapia@water.ca.gov.

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United States Society on Dams job listings page at: https://www.ussdams.org/resource-center/job-postings/

Hydro Leader

Upcoming Events

May 1–3 Northwest Hydroelectric Association, Technical Workshop and Owners Forum, Spokane, WA
May 5–6 National Conference of State Legislatures, Spring Conference, Palm Springs, CA
May 8–10 American Public Power Association, Cybersecurity Summit, Denver, CO
May 8–10 National Hydropower Association, Water Power Week, Washington, DC
May 9–11 Association of California Water Agencies, Spring Conference, Monterey, CA
May 10 Nebraska Water Resources Association, Water Roundtable, Lincoln, NE
May 16–23 Edison Electric Institute, Business Diversity Conference, St. Louis, MO
June 11–13 Edison Electric Institute, EEI 2023, Austin, TX
June 11–13 Idaho Water Users Association, Water Law and Resource Issues Seminar, Sun Valley, ID
June 14–16 Texas Water Conservation Association, Summer Conference, The Woodlands, TX
June 16–21 American Public Power Association, National Conference, Seattle, WA
July 11–13 Hydrovision International, Charlotte, NC
July 19–21 North Dakota Water Resource Districts Association and North Dakota Water Education Foundation, Joint Summer Water Meeting and Executive Briefing, Dickinson, ND
July 25–26 National Hydropower Association, Northeast Regional Meeting, Springfield, MA
August 2–4 National Water Resources Association, Western Water Seminar, Medora, ND
August 14–16 National Conference of State Legislatures, Legislative Summit, Indianapolis, IN
August 22–24 Colorado Water Congress, Summer Conference, Steamboat, CO
August 24–25 National Hydropower Association, Alaska Regional Meeting, Valdez, AK
September 12–13 National Hydropower Association, Alaska Regional Meeting, Anchorage, AK
September 13–14 Nevada Water Resources Association, Fall Symposium, Reno, NV
September 15 Agribusiness and Water Council of Arizona, Annual Meeting and Water Conference, Phoenix, AZ
September 17–20 American Public Power Association, Business and Financial Conference, Phoenix, AZ
September 21–22 P3 Water + Energy Summit, San Diego, CA
September 25–27 National Rural Water Association, WaterPro Conference, Aurora, CO
October 3–5 Rio Grande River Water Users Association, Inaugural Meeting, Santa Fe, NM
October 8–14 *Municipal Water Leader* Ancient Water Systems of Rome and Pompeii Tour, Italy
January 23–25, 2024 *Irrigation Leader,* Irrigation Leaders Workshop, Phoenix/Chandler, AZ

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