SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1
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Case Study: Water Temperature Conditioning Project Aims to Help Fish Thrive

Crews working at the mouth of the WTC tunnel in March 2018.

Water temperature is very important for fish. Every life stage—from egg to adult—has specific requirements and thermal tolerances that can have a drastic impact on the fish's growth, development and even whether it will survive or not.

Rivers that are too warm can be lethal for fish-rearing. High temperatures have an adverse effect on spawning populations, while too-cool temperatures can delay spawning, slow egg incubation and limit juvenile growth.

Because they disrupt the natural flow of a river, dams can impact water temperature. For example, during the early summer, water drawn from the bottom of Spada Lake Reservoir can be much cooler than water from a free-flowing stream and too cold for spawning to be effective in the upper reaches of the Sultan River.

"In general, you see a lot of concern around temperatures that are too hot," said District Manager of Natural Resources **Keith Binkley**. "Interesting thing about the Sultan River, specifically in Reach Three (near Culmback Dam), is that cold temperatures are the issue. Those conditions can lead to spawning that is delayed, egg incubation that is extended and then, when fish do hatch, their growth is further constrained and they struggle to survive and overwinter."

To fix the problem, over the past eight months, the District has undertaken what's been deemed the Water Temperature Conditioning (WTC) project. When finished, a pipe will divert warm water in the summer from the power tunnel to the upper reach of the Sultan River, giving fish better conditions in which to spawn and grow.

During the summer, water that enters the Sultan River below Culmback Dam is often too cold to create an environment that's particularly supportive of fish life.

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Fish Thrive...

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Unlike in other seasons, water drawn from the fixed inlet at the bottom of the Spada Lake Reservoir during summer months is drastically cooler – up to 18 degrees cooler – from water at the surface of the reservoir.

During the re-licensing effort of the District's Jackson Hydroelectric Project in 2011, concerns were raised about the potential temperature impacts on the Sultan River and resulting effect on salmonid (salmon and trout) populations. The District took a number of steps to expand fish habitat, including building side channels and modifying the Diversion Dam.

The passage improvements at the Diversion Dam made it possible for fish to once again spawn in the third reach of the Sultan. With salmon and steelhead species spawning further upstream and closer to the cold waters released at the outlet of Culmback Dam, the success of their spawning efforts was a concern. That made the WTC project necessary.

The WTC project aims to fix the cold water problem by building a bypass tunnel off of the original 1983 power tunnel to direct warmer water straight into the Sultan River immediately downstream from the dam. During the summer months when the reservoir is stratified, this will effectively raise the temperature of the third reach, making it hospitable for fish. The power tunnel can draft warmer water from the reservoir through selective withdrawal panels located in the intake structure. District biologists will be able to blend this newly available warmer water with traditional sources to optimize river flow temperatures for the needs of the fish inhabiting the reach.

Construction began in September 2017 to build the WTC tunnel. The first task was to blast a tunnel from the river through solid rock to a spot close to the power tunnel connection. Due to the sensitivity of the 14-foot diameter power tunnel, which carries millions of gallons of water from the Spada Lake Reservoir to the Jackson Powerhouse every day, the contractor was directed to install a "finder rod" that would aim the tunnel construction process and find 35 feet prior to breakthrough into the power tunnel.

After months of blasting in 8- to 10-foot increments, the tunneling contractor, RedPath, found the rod nearly dead center in December. A month later, a 15-foot long by 12-foot diameter concrete barrier was poured near the middle of the tunnel to act, more-or-less, like a giant plug in the middle of the newly excavated tunnel, waiting to hold back water coming from the power tunnel.

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The pouring of the concrete plug was one of the most delicate parts of the project. More than 90 cubic yards of concrete were pumped over 1,100 feet from high above the dam and down through the new tunnel. Giant wooden forms held the concrete in place as fans whirred to keep the curing temperature within tolerances and the concrete from cracking. It took a full day and some extra bracing, but the pouring of the plug was a big success.

"The plug pour was a meticulously planned and executed element of the project. The District and contractor worked through every conceivable failure mode and incorporated mitigation to prevent it. After several weeks of planning, the actual pour was completed in one 10-hour work day," said Project Manager **Eric Schneider**. "Definitely a sigh of relief after the pour and the temperature monitoring were complete."

With the plug in place and intersecting pipe and valve installed, it was time for the big shutdown. In early March, the power tunnel was de-watered and efforts began to connect the final 35 feet of the WTC tunnel to the power tunnel. Work was performed from both sides of the remaining rock as small detonations created a 4-foot diameter hole through the final 10 feet. Connection complete.

With a free-flowing connection established between the two tunnels, water pressure to the new concrete plug is now a permanent condition. When the power tunnel was initially watered back up, engineers waited anxiously on the dry side of the concrete plug to investigate for leakage. With roughly 2 million pounds of water force behind the plug, the resulting leakage is only about 3 gallons per minute. "This is definitely within the expected and acceptable limits," said Eric.

During the shutdown, the District was also able to get other important work done in the tunnel and at the Jackson Powerhouse. One of the biggest wins was the installation of 4 miles of fiber-optic cables through the power tunnel, connecting Jackson with Spada Lake and giving the District better communication tools for increased safety and security at the dam.

District crews also performed some much-needed maintenance on equipment like transformers and insulators at the Powerhouse, rebuilt the rock trap inside the power tunnel, and swapped out some key control computers (PLCs).

Construction of the rest of the WTC tunnel from the power tunnel and additional work in the tunnel and on the Jackson Powerhouse was completed in 12 days, two less than scheduled.

"I've been very impressed with the focus on safety and the collaboration between District staff and contractors to get all the elements of this complex and hazardous work completed to date," explained Generation Senior Manager **Brad Spangler**. "Everyone has kept their head in the game, and the safe, successful completion to date of all this interrelated work is a tribute to every individual involved." ■