Logjam

By

J. L. Gordon.

George woke to the ringing of his cell phone. The automated voice notified him that the water level at the Eagle Canyon dam had dropped below the low alarm level. This was puzzling, since the spring snowmelt runoff had commenced, and if anything, the water should be at flood level. He dressed and jumped into his 4X4 for the hour drive to the dam. Half way there, his cell phone rang again, and this time the voice advised that the water level had now exceeded the high flood level. Thoroughly alarmed, he raced to the dam, arriving at dawn, to see water flowing over the crest. The automated spillway gate had failed to open, being prevented from doing so by a massive log jam lodged against the gate and dam.

George could see that a dam washout at the left abutment was possible, so he called the owner of a camp facility below the dam to evacuate all campers, and notified the local police. Fortunately, the volume of water contained in the headpond was small, so no major downstream flooding was expected from a washout. He then turned his attention to seeing what he could do to minimize the developing damage. The trashrack cleaning machine, a converted backhoe, was parked upstream of the dam on a now inundated alluvial terrace, and if the washout proceeded as he expected, the terrace would be would be washed out through the breach and the backhoe lost in the canyon below the dam. He managed to get a steel rope from the Hyster winch on a D6 bulldozer attached to the backhoe, and haul it out to higher ground. He could not do anything else. The sluice gate was thoroughly jammed closed by logs resting on top of the gate and threatening to dislodge the sluice hoist mechanism.

With water flowing over the dam, erosion was transporting sand and gravel into the intake, and this was now passing through the units and likely damaging the turbines, confirmed by excessively high guide bearing temperatures. George decided to keep the units running, since reducing flow through the turbines would only increase flow over the dam.

Within hours, water was overtopping the dam by about 1m, but fortunately the dam remained intact. However, erosion was seriously undermining a retaining wall at the right abutment, so a watch was maintained until the flood receded and a mobile crane could be used to open the spillway gate and dewater the forebay.

What had happened? The small 15MW run-of-river power facility was built in a steep sided canyon, with a concrete dam containing an overflow weir, one radial sluice gate and the power intake built into the left bank. About a year previously, George’s company had purchased the facility. The damsite was in a rain forest with very large trees, with logging in some areas of the watershed. Prior to the event, the radial sluice gate was fully open, passing the spring flood, and the powerplant was operating at about 40% capacity. Apparently, a massive log jam had formed somewhere upstream in the canyon, and blocked the flow, causing the water

level to drop, which in turn, caused the automated radial sluice gate to close. Eventually, the force of water building up against the log jam, must have caused it to release, and a large flood wave of water and log debris rushed down the canyon onto the dam, with the logs becoming lodged on the dam, preventing the sluice gate from opening.

A month later, the flood flow had receded sufficiently to allow an inspection of the damage. A temporary cofferdam was installed, allowing generation to commence a few days later. Some 14 months were needed to assess repair options, rebuild the dam, and increase spill capacity by the addition of another gate and stoplog sluice.

Lessons learned.

There are several lessons here. (1) The new owners of the facility had not undertaken a thorough review of their facility to ascertain that the design met their standards. The hydro plant was originally owned by a family, with a micro-hydro unit of only 500kw capacity. It had been sold to an entrepreneur, who upgraded the facility and increased capacity to 15MW, but had left the original spillway intact, with a capacity only capable of passing the 1/10 flood. After the failure, the spill capacity was more than doubled, increased to the 1/1000 flood flow. (2) With a small dam in a steep canyon, subjected to a large volume of debris during floods, it is wise to maintain a constant surveillance at site during the flood season. (3) In a rain forest, there is the constant danger of large logs damaging small hydro structures, particularly during floods. Logs tend to lodge on stream banks in jams, and these grow in volume if there are no large floods to carry the debris downstream. When a large flood eventually occurs, the resulting morass of debris can easily overwhelm spillways, as occurred during the 1996 Saguenay 1/5000 flood in Quebec. To quantify this problem, a large utility in Canada, recently undertook a helicopter survey of rivers in the watershed upstream of a major dam, and discovered an estimated 24,000m^3 of log jams in about 30km of river bed. The jams appeared stable under a normal flood, but would be transported downstream during a major flood event.