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A numerical, laboratory, and field study of riverbed filtration

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Riverbed filtration is an appealing alternative to conventional riverbank and surface water intake systems, offering advantages of high flow rates, natural filtering, and undiminished performance under ice conditions. Its proper functioning requires careful study and monitoring of river flow dynamics, subsurface characteristics, and the interactions between these surface water and groundwater components. A research effort has been underway at INRS to develop principles and guidelines for the design, operation, and maintenance of riverbed filtration systems. A pilot system has just been completed in the Montmorency River near Quebec City (Canada). The installation consists of 4 horizontal wells (or drains), each of 20 m length and 30 cm diameter, placed 4 m apart, at a depth of 1.5 m within the riverbed sediments, and in a direction orthogonal to river flow. The housing trench for each drain is 2 m wide and 2.10 m deep and is composed of 90 cm of gravel topped with 70 cm of sifted alluvial sediments and a 50 cm protective layer of pebbles extracted from the sifted sediments. The average annual water level in the river is 1.2 m, while its mean head during low flow periods is 90 cm. The pilot installation is instrumented with multilevel pressure and temperature sensors and several flowmeters for continuous monitoring in both drainage and backwash modes. In gravity drainage (water intake) mode, the yield is expected to exceed the municipal demand criterion of 35 000 m3/d. Backwash operations, needed to unclog the trenches of fine sediments that can accumulate during water intake, are considered critical to maintaining the design performance targets for the system. Prior to construction of the pilot system, flow patterns, pressure responses, and turbidity behavior in both drainage and backwash modes were extensively studied in laboratory (sand column and sand box) and numerical (SEEP2D) experiments. These tests were fundamental to defining the design parameters and instrumentation features of the pilot system. More detailed lab and numerical simulation studies will be undertaken in tandem with the pilot system operation. The presentation will give an overview of the findings from the prior laboratory and numerical experiments and present initial results from the operation of the pilot system.