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Stopping runaway wells in permafrost: the cryogenic freezeback method

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Abstract Artesian wells are often encountered in permafrost valleys where aquifer pressures beneath confining sub-permafrost vary between 135 and 1035 kPa (20 to 150 psi). These wells must be heated to prevent freeze-up. However, there are no standards for well heating in North America, and overheating can thaw the permafrost around the casing and lead to loss of control of the well. Further, Arctic warming may be playing a role in the increased frequency of occurrence of uncontrolled wells. With runaway wells, impacts to property and infrastructure can be catastrophic, and the costs to regain control of the well and mitigate damages high. Methods to regain control of artesian wells in permafrost are not well developed and are risky. A new method, cryogenic freezeback with liquid nitrogen, was successfully used to mitigate a runaway artesian well in a permafrost valley north of Fairbanks, Alaska. The well was stopped and infrastructure saved and restored to pre-icing conditions for approximately 63% of the insured property value. Three years of heat exchange and thermal monitoring indicate permafrost restoration and permanent freezeback. The event is documented from massive icing, emergency action to save the residence, well mitigation, to damage assessment and foundation restoration. The cryogenic freezeback method is presented complete with seepage and thermal analyses, well conversion, and thermal monitoring data. Remediation costs and lessons learned are summarized.

Key words permafrost hydrology; artesian wells; cryogenic freezeback; climate change