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From Surface to Aquifer: Road Salt Transport Through Urban Infiltration-Based Green Infrastructure

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Infiltration-based green infrastructure (IGI) is widely promoted as a sustainable solution for urban water management, yet it may also act as a pathway for contaminant transport to groundwater. While the urban hydrological benefits of IGI are well established, its subsurface impacts remain poorly understood. This knowledge gap is especially relevant in cold-climate urban regions, where road salt application annually introduces large quantities of Na^+ and Cl^- ions to the urban environment, and where the extent to which IGI facilitates their transport to groundwater remains poorly documented.

To address this, we instrumented three IGI sites in the greater Montréal region. At each site, a network of five piezometers equipped with pressure, temperature, and electrical conductivity probes provides continuous monitoring, complemented by geochemical sampling campaigns targeting stable water isotopes (δ^2H, $\delta^{18}O$), major ions, and alkalinity. Lysimeters were additionally installed to characterize transfer processes within the vadose zone.

The results suggest that the three study sites and their surrounding urban catchment function as active recharge zones, exhibiting rapid hydraulic head responses to precipitation events and springtime isotopic signatures dominated by snowmelt water. Chloride concentrations are elevated during this period across all piezometers, exceeding 600 mg/L, and correspondingly high electrical conductivity values are consistent with road salt inputs reaching the water table in late winter and early spring. Sodium concentrations remain elevated throughout summer and fall, long after chloride has returned to baseline levels. Na/Cl molar ratios exceeding 3 in summer, well above values expected from road salt dissolution alone, suggest that sodium cycling differs fundamentally from that of chloride. We hypothesize that cation exchange processes along flowpaths contribute to this delayed sodium release. However, the mechanisms driving this seasonal decoupling remain to be fully characterized.

Together, these findings suggest that IGI may act as preferential pathways for road salt transfer to urban groundwater, with direct implications for aquifer management and the sustainable design of infiltration-based green infrastructure in cold climates.