ENVIRONMENTAL IMPACT ASSESSMENT

Potential Effects of High-Speed Rail on the Napanee River Watershed

Alto HSR Southern Corridor — Environmental Impact Assessment

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KEY FINDING

The Napanee River watershed sits directly over active karst systems with known sinkholes, losing streams, and active shoreline spring complexes. HSR infrastructure on this terrain creates irreversible contamination and subsidence risks that cannot be fully mitigated by standard engineering measures. This assessment concludes that a route chosen through the southern corridor crossing the Napanee watershed presents risks that are disproportionate to the project's connectivity benefits.

Executive Summary

The Napanee River watershed is a provincially and ecologically significant waterway draining the Frontenac Arch Biosphere Reserve across Lennox & Addington and Hastings counties. A route chosen through the Alto High-Speed Rail (HSR) southern corridor would cross the Napanee River and its watershed multiple times, introducing construction and operational risks of exceptional severity due to the underlying karst limestone geology, the extraordinary species-at-risk profile of the watershed, and the sensitivity of the aquifer systems that feed the river's baseflow.

This assessment identifies eight primary impact categories: (1) karst aquifer contamination and subsidence; (2) alteration of surface hydrology and baseflow; (3) impacts on Species at Risk, including grey ratsnake, Blanding's turtles, and multiple fish species; (4) de-icing chemical and stormwater loading; (5) construction vibration and blasting effects; (6) loss and fragmentation of riparian habitat; (7) impediments to fish passage; and (8) introduction of invasive terrestrial and aquatic species through construction equipment, ballast material, and train transfer. Each category carries legally significant implications under the Species at Risk Act (SARA), the Fisheries Act, and the Impact Assessment Act.

Section 1 — Watershed Overview and Ecological Context

1.1 The Napanee River System

The Napanee River originates in the lakes and wetlands of the Frontenac Uplands and flows southwestward approximately 72 kilometres before discharging into the Bay of Quinte at Napanee, Ontario. The watershed encompasses approximately 2,800 km² and includes tributaries such as Beaver Creek, the Salmon and Napanee Rivers, the Wilton Creek sub-watershed, and the Depot

Creek system. In its upper reaches, the river flows across the Frontenac Axis — ancient Precambrian Canadian Shield granite and meta-sedimentary rock. In its lower reaches below Camden East, the river transitions onto the Paleozoic limestone platform, where Ordovician and Silurian formations underlie a thin and discontinuous glacial till mantle. This transition zone is of critical importance to any infrastructure assessment.

1.2 Karst Geology and Hydrogeology

The lower Napanee watershed sits atop active carbonate karst terrain. Karst landscapes form through the dissolution of soluble rock by slightly acidic groundwater, producing sinkholes, cave systems, losing streams, and spring complexes. The Napanee lowlands contain documented sinkholes, losing stream reaches, and discharge springs that deliver cold, high-quality groundwater to the main stem river. Groundwater in karst systems moves rapidly through conduits and fractures — unlike porous media aquifers where pollutants are filtered and attenuated — meaning that surface contamination events can translate into spring and river contamination within hours to days. The Napanee River's baseflow is substantially sustained by karst spring discharge, making the river's ecology directly dependent on the integrity and stability of the aquifer.

GEOLOGICAL RISK

Karst terrain is rated internationally as among the highest-risk environments for linear infrastructure due to sinkhole subsidence, groundwater contamination pathways, and unpredictable void geometry at depth. Standard geotechnical investigation methods routinely miss karst features at the scales relevant to railway embankments and bridge foundations.

1.3 The Frontenac Arch Biosphere Reserve

The Napanee River watershed lies within the UNESCO-designated Frontenac Arch Biosphere Reserve, approximately 2,700 km² (approximately 667,000 acres) recognised for its exceptional biodiversity. The Frontenac Arch serves as a biological corridor connecting the Adirondack Highlands with the Canadian Shield, and the river system is integral to the movement and survival of terrestrial and aquatic species that depend on this connectivity. In 2025, the Thousand Islands National Park and surrounding lands, including portions of the Napanee watershed, received formal recognition as a Key Biodiversity Area (KBA) under the international KBA Standard.

Section 2 — Proposed Corridor and Crossing Locations

Alto has not yet published finalised HSR route alignment details. Based on publicly available corridor mapping and geographic constraints, the following crossing zones are assessed as likely or probable. Each is treated as a distinct impact locus while recognising that alignment refinement may shift individual crossings. The total maintained infrastructure corridor — track, fencing, access roads, cleared safety margins, and maintenance strips — is approximately 60 metres wide. Habitat impact assessments in this document reference the 60 m total maintained corridor as the operative footprint for ecological and hydrological assessment.

Crossing Zone	Waterbody / Feature	Karst Risk	SAR Significance
Zone A — Upper Napanee	Napanee River main stem (above Camden East)	**Moderate**	High — grey ratsnake, Blanding's turtle
Zone B — Beaver Creek	Beaver Creek / Depot Creek confluence area	**High**	High — Brook Floater mussel, American eel
Zone C — Limestone Plain	Multiple losing stream reaches	**Very High**	Very High — karst spring habitats
Zone D — Lower Napanee	Napanee River near Napanee township	**High**	High — riparian wetlands, fish habitat

Table 1. Assessed crossing zones with karst risk level and SAR significance. Karst risk reflects probability of encountering active dissolution features based on Ontario Geological Survey bedrock mapping.

Section 3 — Species at Risk: Napanee River Watershed

3.1 Regulatory Framework

Under the Species at Risk Act (SARA, S.C. 2002, c. 29), the federal government has a legal obligation to protect listed species and their critical habitat from destruction. Any federal undertaking, including infrastructure approvals under the Impact Assessment Act, is required to assess effects on SARA-listed species and their critical habitat. Under Ontario's Species Conservation Act, 2025 (enacted June 2025, replacing the Endangered Species Act, 2007), provincial protections for SARA-listed aquatic species and migratory birds will be removed, making SARA the operative protection for several species in this corridor. The Napanee River watershed supports an unusually high density of listed species, several of which are directly river-dependent.

3.2 Key Species: Herpetofauna

Grey Ratsnake (Pantherophis spiloides)

Listed as Threatened under SARA. The Frontenac Arch population represents the most northerly significant concentration of the species in Canada. Grey ratsnakes depend on rocky outcrops and forest edges for thermoregulation and den sites, and frequently traverse riparian zones to access foraging habitat. Critical habitat for grey ratsnake has been designated under SARA and mapped in the Napanee watershed; destruction of critical habitat without authorisation is a federal offence under SARA s. 58. The Ontario habitat regulation additionally protects a 1,000 m radius around every known occurrence site under the Species Conservation Act, 2025. The proposed HSR corridor would fragment critical movement corridors, increase mortality during operation, and permanently alter thermal microhabitats.

Blanding's Turtle (Emydoidea blandingii)

Listed as Threatened under SARA. Blanding's turtles depend on wetland complexes connected by upland travel corridors for nesting and overwintering. The Napanee River floodplain and adjacent wetlands provide key habitat. Females undertake long-distance terrestrial movements (up to several kilometres) to reach nesting sites, making them highly vulnerable to linear infrastructure mortality. HSR fencing without adequate underpasses would functionally sever access between wetland and nesting habitat.

Wood Turtle (Glyptemys insculpta)

Listed as Endangered under SARA. Wood turtles are closely associated with cool, clear river systems with sandy banks — precisely the habitat type maintained by karst spring discharge into the Napanee River. Population viability studies have demonstrated that even low levels of additional adult mortality (as few as 2–3 individuals per year) can push local populations toward extirpation due to the species' low reproductive rate.

3.3 Key Species: Fish

Species	SARA Status	Napanee Watershed	Primary Threat from HSR
American Eel (Anguilla rostrata)	Threatened	Confirmed present (as far upstream as Simcoe Falls in Yarker)	Passage barriers at bridge crossings; sediment loading
Eastern Sand Darter (Ammocrypta pellucida)	Threatened	Lower reaches	Sedimentation of sandy substrate; dewatering
Lake Sturgeon (Acipenser fulvescens)	Endangered (GL–Upper St. Lawrence pop.)	Napanee R. / Bay of Quinte	In-water construction; substrate disruption
Brook Floater (Alasmidonta varicosa)	Endangered	Tributaries	Host fish disruption; sediment smothering
Redside Dace (Clinostomus elongatus)	Endangered	Cold headwater tributaries	Thermal loading; de-icing chemicals

Table 2. Fish species at risk in the Napanee River watershed with primary threats from HSR construction and operation.

3.4 Key Species: Flora and Other Taxa

The Napanee River's alvar and limestone plain habitats support several provincially and nationally rare plant communities. Alvars — globally rare ecosystems with 85% of the world's alvar habitat in Ontario — would be directly and irreparably fragmented by an east-west HSR corridor. Rare plant species including Lakeside Daisy (Hymenoxys herbacea) and Small White Lady's Slipper (Cypripedium candidum) are documented in this region. The Salmon River Alvar woodland is home to Juniper Sedge (Carex juniperorum) — the only population in Canada; corridor construction would constitute national extirpation.

Section 4 — Hydrological Impacts

4.1 Baseflow Alteration

The Napanee River's baseflow regime is critically dependent on groundwater discharge from the Ordovician limestone aquifer. This discharge sustains cool, well-oxygenated conditions in summer when surface temperatures would otherwise become lethal to cold-water fish species. Construction of HSR embankments across the limestone plain would alter local drainage patterns and inevitably intercept shallow groundwater flow paths. Embankment fill across losing stream reaches could significantly impact water that would otherwise recharge the karst aquifer, or conversely, intercept subsurface flow and redirect it away from existing spring discharge points.

4.2 Floodplain Hydraulics

HSR embankments across the Napanee River floodplain would function as partial flow barriers during flood events. The river's relatively flat lower gradient means that even modest impediments to lateral floodplain flow can significantly increase upstream flood stages and duration. Standard bridge sizing for HSR typically focuses on conveyance of the main channel flow but may be inadequate to pass flood flows across wide, flat floodplains without substantial embankment fill.

4.3 Karst Subsidence and Void Collapse

HSR embankments impose significant dynamic loading on the ground surface. On karst terrain, this loading can trigger progressive dissolution and collapse of subsurface voids that have developed over thousands of years, creating sinkhole formation beneath or adjacent to infrastructure. This represents both a catastrophic safety risk and a mechanism for rapid, uncontrolled discharge of contaminated surface water directly into the aquifer on which all of the region's rural landowners depend for high-quality drinking water.

SAFETY AND ENVIRONMENTAL RISK

A sinkhole collapse under or adjacent to an HSR embankment in a karst zone could simultaneously: (1) cause a derailment; (2) release diesel fuel, hydraulic fluids, or cargo into the karst aquifer; and (3) permanently alter the spring discharge system supplying baseflow to the Napanee River. There is no engineering solution that eliminates this risk on active karst — only route avoidance does so.

4.4 Stormwater and Runoff Quality

HSR corridors generate significant impervious surface — ballast track, access roads, maintenance facilities — that concentrates and redirects stormwater. On karst terrain, standard retention pond designs may be situated over dissolution features, and runoff that infiltrates through road-base gravel can bypass surface treatment entirely and enter subsurface conduits directly. The Napanee water treatment facility draws from the river, and the Wellington and Stone Mills wellfields draw from the carbonate aquifer. Contamination of karst groundwater poses a direct public health risk that cannot be remediated once the aquifer is affected.

Section 5 — De-Icing Chemical Impacts on Karst Systems

High-speed rail in Canadian climate conditions requires substantial winter maintenance using chloride-based products (sodium chloride, calcium chloride, magnesium chloride) and acetate-based products (potassium acetate, sodium acetate). Both chemical classes pose specific risks to the Napanee karst system.

5.1 Chloride Accumulation

Chloride ions are highly mobile in groundwater and do not attenuate through sorption or biodegradation. Once chloride enters the karst aquifer, it persists and accumulates. Studies of road-salt impacts on Ontario karst springs have documented progressive chloride increases over multi-decadal timescales, with documented impacts on freshwater invertebrate communities at concentrations well below provincial water quality objectives. The Napanee River's spring-fed tributaries currently maintain exceptionally low conductivity — a key habitat characteristic for Species at Risk including Brook Floater mussel and Redside Dace.

5.2 Acetate Biochemical Oxygen Demand

Acetate-based de-icers impose significant biochemical oxygen demand (BOD) when they enter surface water or shallow groundwater. Decomposition of acetates by microorganisms consumes dissolved oxygen. In the cold, groundwater-fed reaches of the Napanee system, even moderate BOD loading from de-icing chemical runoff could depress dissolved oxygen to levels stressful or lethal to sensitive species during critical thermal windows.

5.3 International Precedent

The HS2 project in the United Kingdom encountered similar concerns regarding de-icing chemical impacts on chalk aquifer systems in the Chilterns Area of Outstanding Natural Beauty. Environmental regulators required extensive hydrogeological modelling and, in several cases, route modifications to protect sensitive groundwater-dependent habitats. The Napanee karst system presents equivalent or greater sensitivity given its species-at-risk profile.

Section 6 — Construction Phase Impacts

6.1 Blasting and Vibration

Where the HSR alignment crosses Precambrian bedrock outcrops at the karst-Shield transition zone, rock blasting will be required. Blasting and heavy construction vibration can propagate through interconnected karst conduit systems over unexpectedly large distances, causing: collapse of unsupported cave passages and sinkholes; disturbance and mortality of cavity-dwelling species; disruption of spring discharge geometry; and direct mortality of fish through pressure shock. Timing restrictions under the Fisheries Act cannot address the propagation of vibration and sediment pulses through karst conduits.

6.2 Sediment and Turbidity

River crossings and floodplain construction generate substantial sediment loads. In karst systems, fine sediment entering losing streams or sinkholes can permanently clog conduit systems that supply spring flow to the river — 'karst plugging' — an irreversible impact. Under the Fisheries Act (s. 35), deposit of deleterious substances in fish-frequented waters is prohibited without authorisation. Fine sediment from construction is a deleterious substance for the Brook Floater mussel, which is an obligate filter feeder dependent on low-turbidity conditions.

6.3 Aggregate and Quarry Operations

HSR construction requires substantial aggregate. The Napanee and Belleville region is an active limestone quarrying area. New or expanded quarrying to supply construction aggregate would impose additional hydrogeological risk. Quarry dewatering — pumping groundwater from quarry faces — can substantially alter regional groundwater gradients, reducing spring discharge and river baseflow over large areas.

6.4 Worker and Equipment Staging

Construction staging areas, concrete batch plants, and fuel storage facilities represent acute contamination risks. Concrete washout water is highly alkaline (pH 11–13) and lethal to aquatic organisms. On karst terrain, spills from staging areas can reach the aquifer rapidly through sinkholes and soil pipes. Standard containment measures designed for non-karst sites provide inadequate protection in this setting.

Section 7 — Cumulative and Indirect Effects

7.1 Induced Development Pressure

HSR stations at Belleville and/or Kingston would generate substantial induced development pressure in the agricultural and rural lands of the Napanee watershed. Secondary urbanisation — new residential subdivisions, commercial development, expanded road networks — would increase impervious cover, municipal sewage loading, and diffuse chloride inputs to the watershed beyond those directly attributable to the railway itself.

7.2 Barrier Effects on Wildlife Populations

The HSR corridor would add a new approximately 60-metre-wide infrastructure barrier to a landscape already crossed by Highway 401, Highway 7, and multiple provincial and county roads. For species already stressed by these existing barriers — particularly grey ratsnake and Blanding's turtle — the addition of a high-speed barrier represents a potentially threshold-level fragmentation impact. Population viability analysis for both species suggests that additional adult mortality of even a few individuals per year in key movement corridors could push local populations below viability thresholds.

7.3 Climate Change Interaction

Climate projections for Eastern Ontario indicate increasing drought frequency and severity, longer low-flow periods in summer, and more intense precipitation events. These trends increase the relative importance of groundwater-sustained baseflow to river ecology. Infrastructure that compromises karst aquifer integrity or recharge will have proportionally greater impact under future climate conditions. Quinte Conservation hydrologists have documented increasing frequency and severity of droughts across the southern corridor over recent years.

Section 8 — Regulatory Assessment Gaps

Based on review of publicly available Alto HSR project documents and consultation materials, this assessment identifies the following substantive gaps in environmental baseline information — each of which represents information required for a lawful impact assessment under the Impact Assessment Act and for compliance with SARA, the Fisheries Act, and the Safe Drinking Water Act (Ontario). Approvals cannot legally proceed in the absence of this information.

- No karst hydrogeological mapping has been published for the proposed crossing zones. Site-specific dye-trace testing and speleological survey are required; standard desktop geotechnical assessments are insufficient.
- No spring inventory or baseflow contribution analysis has been published for the Napanee River under the proposed crossing alignment.
- SARA Critical Habitat mapping for grey ratsnake has not been incorporated into publicly available corridor assessment materials. This is a legal requirement before project approval.
- No cumulative effects assessment has been published addressing the interaction of HSR impacts with existing Highway 401 and Highway 7 barrier effects on herpetofauna viability.
- No climate-adjusted baseflow vulnerability analysis has been presented for the Napanee River watershed or its karst spring tributaries.
- No assessment of drinking water supply risks to the Stone Mills wellfields and Napanee municipal aquifers has been made publicly available.
- No analysis of acetate and chloride de-icing chemical loading on Napanee River water chemistry or Species at Risk critical habitat has been presented.

Section 9 — Formal Requests

1	**Commission independent karst hydrogeological mapping before any route decision** Dye-trace testing to establish subsurface flow connectivity between proposed construction sites and downstream springs must be completed before alignment selection. This investigation typically takes 2–3 years under varying hydrological conditions.
2	**Conduct a spring inventory and baseflow contribution analysis** Establishing pre-construction baseline conditions across the full hydrological range — both early spring (runoff) and late summer (August–September drought period) — at all proposed crossing zones in the Napanee watershed.
3	**Publish SARA Critical Habitat mapping with legal analysis** For grey ratsnake, Blanding's turtle, and wood turtle in relation to the proposed southern corridor, including formal legal analysis of SARA s. 58 implications and the three-part permit test for each species.
4	**Conduct population viability analysis for herpetofauna** For grey ratsnake and Blanding's turtle in the Frontenac Arch region, explicitly modelling the addition of HSR as a barrier and mortality source on top of existing Highway 401 effects.
5	**Assess risk to drinking water supplies** For the Napanee municipal water system, Stone Mills wellfields, and Wellington aquifer using quantitative fate-and-transport modelling under a karst contamination scenario, before any infrastructure approvals are issued.
6	**If a southern route is chosen: require bridge-only crossings** No embankment fill across any floodplain sections of the Napanee River and its tributaries. Continuous hydrogeological monitoring wells with real-time telemetry at all karst crossing zones for a minimum of two years prior to construction.
7	**Require full wildlife passage infrastructure** Ecopassages with associated drift fencing at all points where the corridor crosses documented grey ratsnake and Blanding's turtle movement corridors, with long-term effectiveness monitoring under SARA.
8	**Establish a Napanee River Karst Environmental Protection Fund** With mandatory capitalisation before construction begins, to compensate for groundwater and species impacts that cannot be avoided or mitigated. Prohibit chloride-based de-icers within the karst recharge area; require acetate alternatives with BOD monitoring at downstream springs.

Conclusion

The Napanee River watershed represents one of the most ecologically sensitive and hydrogeologically complex environments on the proposed Alto HSR southern corridor. The combination of active karst geology, extraordinary Species at Risk density, UNESCO Biosphere Reserve designation, Thousand Islands Key Biodiversity Area recognition, and dependency of municipal water supplies on karst aquifer integrity creates a risk profile that is exceptional even by the standards of environmentally challenging infrastructure projects.

The environmental assessment information currently available to the public is insufficient to support a lawful determination of likely significant effects under the Impact Assessment Act, or a conclusion of no likely jeopardy to Species at Risk under SARA. This is not a minor procedural gap — it is the absence of the core hydrogeological and ecological baseline without which impact prediction is scientifically impossible. A route decision of this consequence and irreversibility demands that baseline.

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