

ENVIRONMENTAL POLICY ASSESSMENT

The Napanee Limestone Plain: Implications for High-Speed Rail Route Choice

Technical Assessment for the Alto HSR Public Consultation

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PRINCIPAL FINDING

The southern corridor traverses one of the most ecologically sensitive and legally constrained landscapes in eastern Ontario. The Napanee Plain contains the highest concentration of alvar ecosystems in the province, overlying active karst geology that presents significant structural and hydrological hazards for major linear infrastructure. The corridor also encompasses critical habitat for multiple federally listed Species at Risk, including the Eastern Loggerhead Shrike — a species whose entire remaining Canadian breeding population is concentrated in the Napanee Plain and the Carden Plain. Six interlocking categories of concern are identified: karst geology and construction risk; alvar ecosystem destruction; the Salmon River Alvar as a site of exceptional conservation significance; Species at Risk conflicts and federal legal obligations; hydrological disruption; and invasive species corridor risk. Each of these concerns, individually, would represent a significant obstacle to project approval. Together, they constitute a formidable barrier to environmentally responsible route construction through the southern corridor.

ALTO's CEO confirms: species-at-risk and ecological surveys were just beginning as the consultation closed

On CBC Ottawa Morning on March 25, 2026 — one day before the consultation closed — ALTO's CEO Martin Imbleau stated publicly: "We intend to file the initiation of the [environmental assessment] process later this year. So we need to look at and to have some sampling in dangerous species. Are there any concerns on the wildlife that we're not aware of?" He confirmed environmental field surveys were commencing "this week."

The Napanee Plain is precisely the landscape where this admission carries the most weight. The Eastern Loggerhead Shrike, whose entire remaining Canadian breeding population is concentrated here, requires population survey data, habitat mapping, and SARA s. 73 authorisation assessment before any infrastructure decision can be made. Alvar ecosystem mapping, karst groundwater characterisation, and SARA-listed species distribution surveys were all still being initiated during the consultation the CEO publicly confirmed. Communities on the Napanee Plain were asked to evaluate a corridor without access to the ecological data that determines whether that corridor is legally viable.

Source: CBC Ottawa Morning, March 25, 2026. cbc.ca/listen/live-radio/1-100-ottawa-morning/clip/16205093

Section 1 — Karst Geology and Construction Hazard

1.1 Nature of Karst Terrain

Karst is a landscape formed through the dissolution of soluble rocks, primarily limestone and dolostone, by acidic groundwater over geological timescales. In the Napanee Plain, massive limestones were formed well before the Mesozoic era, often interbedded with shales. Karstic weathering has produced underground rivers and lakes, and in some systems stalactites and stalagmites indicate considerable antiquity. Surface expressions include potholes, subsidence features, and seasonally flooded pavements with fast-moving surface flow.

Several named karst features are documented within the Napanee Plain. The Roblin Hell Holes, located approximately 1.5 km east of Roblin along the east slope of the Salmon River valley, contains a limestone escarpment with sinkholes, talus boulders, flowerpots, and caves. The Moira Karst contains a major solution cave functioning as a hibernaculum for five species of bats — evidence of the region's extensive and mature subsurface karst development. Both sites are identified as Areas of Natural and Scientific Interest (ANSIs).

ENGINEERING RISK — LENNOX & ADDINGTON STEWARDSHIP COUNCIL (2022)

'The underground drainage, flooding and potential collapse of underground rock masses make karst dangerous to build on.' The document explicitly identifies transport and utility corridor construction as a regional threat to alvar ecosystems overlying this geology.

1.2 Implications for High-Speed Rail Infrastructure

High-speed rail demands exceptional precision in track alignment, grade, and sub-base stability. Karst terrain is inherently incompatible with these requirements:

- Subsidence risk: The dissolution of limestone and potential collapse of subsurface caverns creates unpredictable and ongoing settlement hazards beneath any founded structure
- Irregular flooding: Seasonal and episodic inundation of karstic pavements, with fast surface flows, exposes embankments and cuttings to hydraulic stress that conventional drainage engineering cannot fully mitigate
- Foundation variability: The interbedding of limestone with shales creates highly variable bearing capacity across short distances, making uniform foundation design impractical
- Sinkhole formation: Ongoing karstic dissolution can create new sinkholes at unpredictable locations and timescales, presenting long-term operational safety and maintenance risks
- Drainage interference: Cut-and-fill operations and drainage infrastructure could modify subsurface flow paths, potentially triggering new subsidence events beyond the right-of-way

1.3 Construction Mitigation Strategies and Cost Implications

Constructing high-speed rail through karst limestone terrain requires engineering responses that are fundamentally different and substantially more costly than those used on geologically stable alignments. Before any construction could begin, a karst corridor would require an intensive pre-construction ground investigation program including closely-spaced boreholes, geophysical surveys, and systematic karst cavity mapping.

Where direct embankment construction over karst is not feasible, as would commonly be the case across the Napanee Plain, engineers have three primary options: cavity grouting (pressure injection of cement grout to fill subsurface voids and fissures); deep micropile foundations (small-diameter steel-reinforced piles drilled through unstable overburden and karst voids to reach competent bedrock); or elevated viaduct structures that transfer all loads to deep foundations, bypassing the

unstable karst surface entirely. Each option carries substantially higher capital cost than standard at-grade embankment construction.

The precision requirements of high-speed rail are particularly significant here. Ballastless slab track, the standard for modern HSR operations, permits post-construction subgrade settlement of no more than 15 mm, with heave limited to approximately 5 mm. Karst terrain, characterised by irregular, unpredictable, and ongoing dissolution processes, is fundamentally incompatible with these tolerances.

A directly comparable scenario arose during HS2 Phase 2b, where the proposed alignment crossed the Cheshire salt-dissolution district. An independent engineering assessment of that 20.2 km section concluded that the piling, ground stabilisation, and viaduct works required would add approximately £750 million to construction costs, equivalent to approximately £37 million per kilometre, near-doubling expected per-kilometre costs. Scaled to the Napanee Plain context, the implied cost premium for karst segments of the southern corridor would represent a very substantial addition to the project's overall budget.

Section 2 – Alvar Ecosystems: Significance and Vulnerability

2.1 Global Rarity

Alvar is defined as a naturally flat and open vegetation pattern occurring on limestone or dolostone bedrock, characterised by thin, restricted, or absent soil cover. These landscapes experience alternating seasonal flooding, intense summer drought, and deep winter frost heave, supporting a highly specialised assemblage of plants and animals, many of which are rare or absent elsewhere.

Globally, alvar is restricted to two regions: the Great Lakes Basin of North America and the Baltic region of Europe. Within North America, 85 percent of alvar communities are found in Ontario. Despite more than 120 identified sites in the Great Lakes region, alvars collectively comprise only 0.2 percent of the land area.

GLOBAL CONSERVATION CONTEXT

Alvars are globally imperilled. Almost all alvar types found in the Great Lakes region are considered globally imperilled and under stress. They provide habitat for globally and provincially rare plants, contain large numbers of rare, threatened, endangered, and disjunct species, and are irreplaceable repositories of biodiversity adapted to the specific conditions of limestone bedrock environments. (MNRF, 2007; Napanee Plain Joint Initiative, 2017)

2.2 The Napanee Plain Concentration

Approximately 50 alvar sites have been identified in the Napanee Plain and Prince Edward County alone. The Napanee Limestone Plain Important Bird and Biodiversity Area (IBA) supports many rare bird, insect, and plant species across a mosaic of shallow-soil habitats, savanna grasslands, small woodlots, and exposed pavement, interspersed with cattle grazing and mixed farming uses.

2.3 Alvar Community Types and Their Dependencies

Alvar communities are classified by the amount of soil overburden overlying the limestone bedrock, producing a gradient from bare pavement to woodland: Alvar Pavement (less than 10% tree cover, with spring ponds supporting rare small plants including Dwarf Skullcap, which shows 71–85% of its Great Lakes occurrences on alvars); Alvar Grassland (the most widespread type, with up to 20 grass species and 12 sedge species, supporting a diverse grassland bird community); Alvar Savanna and

Shrubland (dominated by Eastern Red Cedar); and Alvar Woodland (partial canopy of 25–60% cover). The alternation of seasonal flooding and summer drought is ecologically essential to maintaining the distinctive plant diversity of alvar grasslands. Disturbance to either the hydrological cycle or the soil integrity eliminates this diversity irreversibly.

Section 3 – The Salmon River Alvar: A Site of Exceptional Conservation Value

3.1 Site Description and Status

The Salmon River Alvar, located approximately 2 km southwest of Lonsdale, Ontario, is a 847-hectare site within the Napanee Plain physiographic region. It holds ANSI designation and meets all five ANSI criteria. It is described in provincial assessments as one of the richest alvars in Ontario. The site supports a full range of alvar community types, including alvar pavement and grassland, alvar woodland with Red Cedar, Red Cedar savanna, dry woodlands on limestone bedrock, and riverine and riparian communities. No other alvar community in the Napanee Plain region shows this range of community types.

3.2 Species Richness and Rarity

The Salmon River Alvar has the second-highest native species richness recorded in any Ontario alvar. It supports many rare alvar species, and field assessments conducted in the 1980s and 1990s documented a level of ecological diversity unmatched elsewhere in the Napanee Plain.

INTERNATIONALLY RARE SPECIES — SOLE CANADIAN POPULATION

The Salmon River Alvar woodland is home to an internationally rare plant, the Juniper Sedge (*Carex juniperorum*), the only such population in Canada. Destruction of this habitat through corridor construction would result in national extirpation of the species. (Lennox & Addington Stewardship Council, 2022)

3.3 Existing Fragmentation and the Role of the 401

The Salmon River Alvar's wildlife corridor has already been structurally interrupted by the Highway 401 and its associated concrete barriers. This severance has been identified in site assessments as an ongoing ecological threat. The introduction of a second major linear infrastructure corridor — an HSR right-of-way, fencing, noise barriers, and associated access roads — would compound this fragmentation severely.

The total maintained infrastructure corridor, including track, fencing, access roads, cleared safety margins, and maintenance strips, is approximately 60 metres wide. The fenced track right-of-way itself is approximately 30 metres. For fragmentation and species impact assessments, the operative maintained corridor width is 60 metres.

Section 4 – Species at Risk: Legal and Ecological Implications

4.1 Federal and Provincial Legal Framework

The Species at Risk Act (SARA, 2002) places legally binding obligations on federal proponents and those seeking federal permits in relation to listed species and their critical habitat. SARA Schedule 1 listed species receive protection from destruction of critical habitat and from killing, harming, harassing, pursuing, capturing, or taking individuals. An environmental assessment of a project of this scale involving federal approvals would trigger formal assessment of SARA obligations.

Ontario's Species Conservation Act (enacted June 2025, not yet proclaimed) replaces the Endangered Species Act, 2007 and will provide parallel provincial protections. Under the SCA, species protections for SARA-listed aquatic species and migratory birds will be removed to eliminate duplication with federal regulation — making SARA the operative protection for several species present in this corridor, including the Loggerhead Shrike, Bobolink, and Eastern Meadowlark.

Species	ON Status	COSEWIC	SARA Status	Habitat Dependency	Note
Eastern Loggerhead Shrike	S2-B	Endangered	Schedule 1 — Endangered	Alvar grassland, shallow limestone soils. Total wild Canadian population ~40 individuals (WPC 2023); 22 breeding pairs in Ontario (2022) — below the federal Recovery Strategy's short-term Ontario target of 35 pairs.	Critical habitat designated on Napanee Plain
Bobolink	S4-B	Threatened	Schedule 1 — Threatened	Meadow and grassland habitat	Provincially downlisted to Special Concern (COSSARO 2021); federal SARA Threatened status is operative protection under the Species Conservation Act, 2025
Eastern Meadowlark	S4-B	Threatened	Schedule 1 — Threatened	Open grassland and alvar	
Grasshopper Sparrow	S4-B	Special Concern	Schedule 1 — Special Concern	Alvar grassland specialist	
Short-eared Owl	S2-N	Special Concern	Schedule 1 — Special Concern	Open grassland, ground nesting	
Upland Sandpiper	S4-B	Special Concern	Schedule 1 — Special Concern	Open alvar grassland, ground nesting	
Juniper Sedge	S1	Endangered	Federal assessment required	Salmon River Alvar woodland — sole Canadian population. Destruction would constitute national extirpation.	
Henslow's Sparrow	S1 (historical)	Endangered	Schedule 1 — Endangered	Tall-grass alvar meadow; historically present in IBA, suitable habitat remains	Source: ECCC Recovery Strategy (2014)

Table 1. Species at risk in the Napanee Plain alvar system directly affected by southern corridor construction.

4.2 The Eastern Loggerhead Shrike — A Critical Case

The Eastern Loggerhead Shrike (*Lanius ludovicianus migrans*) is the most acutely endangered species in this landscape. The Eastern subspecies once ranged across northeastern North America from New Brunswick to eastern Manitoba, but its numbers have collapsed over the past fifty years. The total wild Canadian population is now estimated at approximately 40 individuals (Wildlife Preservation Canada, 2023 Field Report), with only 22 breeding pairs confirmed in Ontario in 2022, below the federal Recovery Strategy's short-term target of 35 pairs across all Ontario core areas combined.

Throughout the 1990s, the Napanee Limestone Plain IBA alone supported at least 30 percent of Canada's entire Loggerhead Shrike population; as recently as 2003, approximately 35 percent of the national total, representing 50 percent of Ontario's breeding birds, were found on this site. The Napanee area remains one of only two surviving breeding locations in Canada.

POPULATION CONTEXT — EASTERN LOGGERHEAD SHRIKE

Loggerhead Shrike numbers are declining faster than any other grassland bird in North America. The Napanee Plain once held at least 30% of Canada's entire Eastern Loggerhead Shrike population (1990s); as recently as 2003, 35% of the national total bred here. Today, the total wild Canadian population is estimated at approximately 40 individuals (Wildlife Preservation Canada, 2023 Field Report), with only 22 breeding pairs in all of Ontario confirmed in 2022, below the federal Recovery Strategy's short-term provincial target of 35 pairs. The Napanee limestone alvar area remains one of only two regular breeding locations in Canada.

The shrike's ecological requirements create multiple conflict points with HSR construction:

- Open grassland habitat loss: Construction of a right-of-way through alvar grassland directly eliminates breeding and foraging territory
- Perch disruption: Shrikes depend on dead branches, fence posts, and telephone wires in open areas for territory defence and prey spotting
- Prey base reduction: The shrike's prey (grasshoppers, crickets, dragonflies, small rodents, frogs, and small snakes) is entirely dependent on intact alvar grassland
- Nesting disturbance: Construction noise and vibration during the April–June nesting season would directly disturb breeding attempts; the species is sensitive to disturbance within 400 m of active nest sites
- Barrier effects: Fencing, noise barriers, and elevated structures create movement barriers across the open landscape on which shrikes depend

4.3 Additional Grassland Bird Species

The Bobolink (Threatened under federal SARA; downlisted to Special Concern provincially following the 2021 COSSARO re-assessment, federal SARA is the operative protection) and Eastern Meadowlark (Threatened federally) are both grassland-obligate species whose primary threats are identified as loss of meadows and hay fields. Both species nest in the cultural grasslands and alvar grassland communities of the Napanee Plain.

Population surveys documented in the 2004 IBA Conservation Plan recorded 150–200 pairs of Upland Sandpiper breeding annually in the IBA, approximately 2 percent of the entire Canadian population, along with 150–200 pairs of Grasshopper Sparrow, 150–200 pairs of Vesper Sparrow, and 200–400 pairs of Eastern Meadowlark. The Henslow's Sparrow, though present in the IBA in low numbers during the 1990s, has not been recently recorded. Its former presence confirms the Napanee Plain as historically capable of supporting this species; suitable habitat persists in the IBA and any further habitat loss through corridor construction would foreclose potential recolonisation.

Section 5 – Hydrological Disruption of Karst Systems

5.1 Karst Hydrology and Alvar Dependence

The ecological integrity of Napanee Plain alvars is fundamentally dependent on the karst hydrological system beneath them. Alvar communities require the seasonal alternation of flooding and drought that karst drainage creates: spring flooding maintains pavement pond species assemblages, while summer drought is essential to suppressing the competitive exclusion of specialised alvar plants by more aggressive species. This hydrological cycle operates through subsurface drainage networks, underground streams, solution channels, and caverns, that are interconnected across the landscape. Disruption at one point in the system can have cascading effects on alvar communities at significant distances from the construction footprint.

5.2 HSR Construction as a Hydrological Threat

The MNRF Alvar Fact Sheet (2007) lists change in the flow or amount of water as one of ten major regional threats to alvar ecosystems. HSR construction would introduce multiple hydrological disruptions:

- Cut-and-fill earthworks sever or redirect subsurface drainage pathways
- Drainage infrastructure (culverts, ditches, interceptor drains) modifies the timing and volume of water reaching alvar communities
- Impermeable surfaces in the right-of-way alter surface run-off patterns that feed seasonal ponds
- Grouting of karst voids for foundation stabilisation can block underground flow systems, affecting spring emergence and wetland communities
- Long-term compaction of soils in adjacent areas alters infiltration rates, modifying groundwater recharge patterns that sustain karst systems

Section 6 – Invasive Species Corridor Risk

6.1 Alvar Vulnerability to Invasion

The introduction of weeds and non-native species is identified as one of the top ten regional threats to alvar ecosystems (MNRF Fact Sheet, 2007). Alvar communities are particularly vulnerable because disturbance events that expose bare soil or create new edge habitat provide immediate establishment opportunities for invasive plants. Invasive species particularly phragmites, common buckthorn, dog-strangling vine, and garlic mustard, can override the drought mechanism that maintains alvar biodiversity by establishing dense monocultures that exclude native alvar flora regardless of hydrological conditions.

6.2 HSR as an Invasive Species Vector

Linear infrastructure is among the most effective vectors for invasive species dispersal in Ontario's landscape. HSR construction would create a continuous disturbance corridor through the Napanee Plain alvar complex that would function as a persistent invasive species introduction pathway:

- Construction equipment transporting invasive plant propagules in soil, gravel fill, and tire treads across multiple alvar sites
- Disturbed fill material providing ideal bare-soil establishment conditions for invasive annuals
- Permanent right-of-way edge creating a maintained grass strip that favours weedy species over alvar specialists
- Drainage ditches and disturbed verges providing dispersal corridors linking previously isolated invasive populations

- Increased maintenance vehicle access introducing new propagules repeatedly over the operational life of the line

Section 7 – Adequacy of Existing Protections

A recurring theme in the source documents reviewed for this assessment is the inadequacy of existing regulatory designations to protect alvar ecosystems from development pressure. The Lennox & Addington Stewardship Council (2022) states explicitly that an Area of Natural and Scientific Importance (ANSI) designation 'no longer defends that area from development.' The Salmon River Alvar ANSI meets all five designation criteria yet remains predominantly privately owned and subject to incremental threat from residential subdivision, recreational vehicle traffic, and agricultural intensification.

In the context of ALTO HSR, this framing has specific implications. A federal environmental assessment triggered by SARA obligations would require ALTO to demonstrate that critical habitat for listed species would not be destroyed or adversely affected. Given the concentration of SARA-listed species in the Napanee Plain, and the alignment of the southern corridor through their documented habitat, the burden of proof on the proponent would be substantial. The inadequacy of existing protections does not reduce this burden — rather, it places additional responsibility on the assessment process to fill the gap.

Section 8 – Cumulative Impacts

The concerns documented in this assessment do not operate independently. They interact and compound in ways that make the cumulative impact of HSR construction through the southern corridor substantially greater than the sum of its parts:

- Karst construction hazards (Section 1) require drainage engineering that directly disrupts the hydrological regime on which alvar ecology depends (Section 5)
- Alvar habitat loss (Section 2) eliminates the prey base and nesting habitat of Species at Risk grassland birds (Section 4), while the construction disturbance corridor provides the vector for invasive species introduction that will degrade adjacent unaffected alvar (Section 6)
- The Salmon River Alvar (Section 3) is already fragmented by Highway 401. A second linear corridor would further isolate the remaining intact portions, eliminating corridor function for bobcat, grey ratsnake, and Blanding's Turtle
- The inadequacy of ANSI designation (Section 7) means that the alvar network has no regulatory backstop against infrastructure development, making the environmental assessment process the only mechanism for identifying and responding to these risks
- The Juniper Sedge's sole Canadian population sits within a site that is simultaneously one of Ontario's richest alvars, one of the two remaining Loggerhead Shrike breeding strongholds in Canada, and a site underlain by unstable karst geology, negative outcomes in any one category cascade into all others

Section 9 — Formal Requests

1	<p>Publish a full SARA species inventory and critical habitat mapping for the southern corridor</p> <p>ALTO has not yet publicly released a full inventory of SARA-listed species and identified critical habitat for the corridor under assessment. This information is a prerequisite for informed public consultation and for any credible claim that SARA obligations have been considered.</p>
2	<p>Commission and publish a full karst hydrogeological investigation before route selection</p> <p>Using dye tracing, borehole surveys, ground-penetrating radar, and electrical resistivity tomography to map subsurface conduit networks beneath the proposed alignment. The engineering risk associated with karst, including the HS2 Cheshire precedent of near-doubled per-kilometre costs, must be formally assessed and included in route cost comparisons.</p>
3	<p>Commission an independent assessment of the Salmon River Alvar and Napanee Plain alvar complex</p> <p>Including the Juniper Sedge's sole Canadian population, Eastern Loggerhead Shrike critical habitat, and cumulative fragmentation effects of a second linear barrier south of Highway 401. Assessment must address the SARA three-part test: all reasonable alternatives, all feasible mitigation, and no jeopardy to survival or recovery.</p>
4	<p>Assess invasive species corridor risk as a discrete component of the Environmental Assessment</p> <p>A management plan for invasive species introduction, establishment, and spread along the right-of-way must be developed before construction approval, with legally binding monitoring and adaptive management obligations over the operational life of the line.</p>
5	<p>Apply the corrected right-of-way width of 60 metres in all fragmentation and species impact assessments</p> <p>The total maintained infrastructure corridor (rack, fencing, access roads, cleared safety margins, and maintenance strips) is a minimum of 60 metres wide. Additional electrical infrastructure such as sub-stations will require additional land and should be accounted for. Impact assessments using narrower figures will underestimate habitat loss, edge effects, and barrier effects on species movement.</p>

Conclusions

The southern corridor alignment through the Napanee Limestone Plain presents a convergence of engineering hazard, ecological sensitivity, and federal legal constraint that is without parallel among the ALTO corridor options. The karst geology underlying the region is explicitly characterised as dangerous to build on. The alvar ecosystems overlying that geology are globally rare, legally recognised, and home to species whose national survival depends on the integrity of this precise landscape.

The Eastern Loggerhead Shrike's entire remaining Canadian breeding population is concentrated in the Napanee limestone alvar system and the Carden Plain. The only Canadian population of Juniper Sedge exists in the Salmon River Alvar. The Bobolink, Eastern Meadowlark, Grasshopper Sparrow, Short-eared Owl, Upland Sandpiper, and historically present Henslow's Sparrow are all documented in the Napanee Plain IBA with SARA-listed or COSEWIC-assessed conservation status. Any route assessment that does not account for these conditions in full will produce recommendations that are environmentally unsound and legally vulnerable.

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