Vélo Tunnel Québec

FINANCIAL ANALYSIS — CONSTRUCTION (REVISED)

Construction costs

A full bottom-up recalculation: drainage and geothermal broken out, the detailed nature simulation folded in, and five scenarios — from the most optimistic to the case where the boring machines never get cheaper.

From $6.8B to $15.7B — realistic ≈ $9.5B

Five scenarios for 150 km, in constant dollars. That is **$45M to $104M per kilometre**, versus $940M/km for the third road link — even in the worst case.

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Vélo Tunnel Québec · June 2026
Constant dollars — excluding inflation and interest
For information only

1. What changes versus the published $8.9B

The earlier estimate folded every piece of equipment into a single line — “Technical systems: $2,800M” — which concealed eight sub-items. Reopening each with the detailed analyses produced since, three gaps stand out. None is an error: these are items that were under-counted or simply absent.

ITEM	BEFORE	AFTER (DETAILED)	CHANGE
Nature simulation (immersive fit-out) + lighting	$180M (placeholder)	$500M fit-out + $8M phosphorescence	+ 328
Geothermal for the 150 stations (CAPEX)	0 — never budgeted	≈ $50M	+ 50
Catch-all “path + drainage + charging + electrical”	$450M (bundled)	$500M (split: 80+200+60+160)	+ 50
Net effect on technical systems	**$2,800M**	**≈ $3,230M**	**+ 430**

This +$430M of hard cost flows through engineering (10%), management (5%) and contingency (20%), for a total effect of about **+$0.6B** on the realistic scenario — moving it from $8.9B to ≈ $9.5B. Almost all of it comes from a single owned-up line: **the immersive fit-out costed properly**.

2. The two items broken out: drainage and geothermal

Drainage was in the budget, but buried in a catch-all with no figure of its own. Geothermal was genuinely absent from CAPEX: only its operating savings ($0.7–0.9M/yr) had been documented. Here are both items stated explicitly.

DRAINAGE AND PUMPING

≈ $200M

Channels and collection over 150 km (~$1,000/m ≈ $150M) + ~40 redundant pumping stations with discharge to surface (~$1.2M each ≈ $48M).

GEOTHERMAL FOR STATIONS

≈ $50M

150 stations × ~$330,000: heat pump (COP 3.5), loops, glycol distribution and redundancy. Drilling stays marginal — the tunnel is the borehole.

Drainage cross-check: pumping draws 9,000 MWh/yr running 24/7, because the tunnel passes below the water table in places. That corresponds to 1–3 MW of installed pumps, consistent with about forty pumping stations at the low points. The waterproofing membrane is already paid for in the “tunnels” line, so it is not counted again here.

Why geothermal stays small: since we are already drilling 150 stations down to 10 m, the loops cost a fraction of a stand-alone installation. What remains is the heat pumps, distribution and redundancy — hence a modest CAPEX (≈ $50M) for $0.7–0.9M/yr in savings. The item pays for itself, but it exists: it must appear in the budget, which it did not.

> **Honest range.** Drainage: $150–280M depending on the number of low points and the severity of infiltration. Geothermal: $35–110M depending on the share of premium stations and the level of redundancy. These ranges feed the scenarios in section 4.

3. Technical systems, rebuilt line by line

The $2,800M block opened into thirteen lines, each backed by an analysis. The two new lines are marked; the immersive fit-out replaces the old “lighting + nature projection” placeholder.

TECHNICAL-SYSTEMS SUB-ITEM	$M	SOURCE
Ventilation and air filtration	600	Ventilation analysis
Acoustics (textured concrete + panels)	450	Acoustics analysis
Nature simulation (immersive fit-out, 150 km)	500	Nature-simulation analysis
Security (1,500 cameras, 1,500 SOS posts, AI, drones, 24/7 centre)	550	Security file
Fire suppression + emergency exits + refuge niches	350	Fire file
Electrical distribution (MV/LV, substations, transformers, cabling)	160	Split from catch-all
Drainage and pumping — broken out	200	New (cross-checked)
Generators + backup power (UPS)	120	Energy file
Telecommunications (5G, WiFi, fibre, radios)	100	Telecom file
Cycle path (asphalt 150 km, base, markings)	80	Split from catch-all
E-bike charging points (150 stations)	60	Split from catch-all
Geothermal for stations — new line	50	New (CAPEX)
Phosphorescent emergency lighting	8	Phosphorescence analysis
Total — technical systems (realistic)	**3,228**	**vs 2,800 before**

Avoiding double-counting: functional lighting has no separate line — it is included in the LED “luminous sky” of the fit-out (the layer that lights the tunnel and creates the sense of openness). Only the phosphorescent emergency marking, a distinct safety device, remains a line of its own.

4. Five scenarios, from minimum to maximum

The dominant lever remains the **tunnel boring rate in rock**; then come the station mix, the scope of the fit-out, and the choice to buy or lease the sites.

ITEM ($M)	A · OPTIM.	B · REALISTIC	C · PRUDENT	D · PLATEAU	E · FULL FREEZE
Effective tunnel rate (rock, US$/mi)	8	15	21.5	32	40
Tunnels (150 km)	1,030	1,930	2,770	4,120	5,150
Stations	800	1,240	1,240	1,700	1,700
Technical systems	2,913	3,228	3,258	3,378	3,418
of which immersive fit-out	250	500	500	550	550
of which drainage	150	200	220	260	280
of which geothermal	35	50	60	90	110
Bike fleet (76,000)	177	177	177	177	177
Québec–Lévis link (shuttles)	90	90	90	90	90
Land acquisition	0	125	125	250	250
Hard subtotal	**5,010**	**6,790**	**7,660**	**9,715**	**10,785**
Engineering and design (10%)	501	679	766	972	1,079
Project management (5%)	251	340	383	486	539
Environmental review, geotech, permits	120	120	120	120	120
Subtotal	**5,882**	**7,929**	**8,929**	**11,293**	**12,523**
Technical contingency	15%	20%	20%	25%	25%
TOTAL	**≈ 6.8**	**≈ 9.5**	**≈ 10.7**	**≈ 14.1**	**≈ $15.7B**
Cost per kilometre	**45**	**63**	**71**	**94**	**$104M**

The “low” scenarios

A — Optimistic: machines hit their long-term target, easier rock, economy stations, lean fit-out, leased land, 15% contingency.

B — Realistic: 2030 target ($10M/mi soft ground + 50% rock), balanced mix, full fit-out, partial land purchase.

C — Prudent: anchored on Nashville (~$21.5M/mi effective), everything else as realistic.

“The machines never get cheaper”

D — Plateau: boring improves a little but plateaus far from target (~$32M/mi), premium stations, land bought, 25% contingency.

E — Full freeze: today’s rate stays frozen (Prufrock-4, ~$27M/mi soft ground) + hard rock = $40M/mi. The worst credible case.

> **The dominant lever is the tunnel.** On its own it moves the total from $6.8B to $15.7B. Everything else combined moves it far less. So the real question is not "how much does drainage cost" but "will the boring machines reach in rock the costs they target in soft ground." Nashville (2026–2029) is the full-scale test.

5. And if Elon Musk's boring machines never get cheaper?

This is the heart of scenarios D and E. The soft-ground rate has fallen steadily — ~$50M/mi in 2018, ~$30M in 2021, ~$27M today (Prufrock-4) — and the 2030 target is $8–10M/mi. But nothing guarantees that fall in hard rock. Here is the full ladder, from most optimistic to full freeze.

BORING-MACHINE ASSUMPTION	SOFT GROUND (US$/MI)	ROCK PREMIUM	EFFECTIVE (US$/MI)	TUNNELS 150 KM
A — Long-term target reached	~5–6	×1.4	8	1,030
B — 2030 target (realistic)	10	×1.5	15	1,930
C — Nashville anchor	~14	×1.5	21.5	2,770
D — Plateau (stalls early)	~21	×1.5	32	4,120
E — Full freeze (today's rate frozen)	~27	×1.5	40	5,150

Calculation: effective rate (US$/mi) × 1.38 (CAD rate) × 93.2 mi (= 150 km) = tunnel cost in CA$M. Even in the full freeze at $5.15B of tunnels — triple the realistic figure — the complete project reaches $15.7B, still well below the other regional megaprojects on a per-kilometre basis.

> **The nuance that protects the project.** The debate over the rock premium (+40% vs +60%) is second-order: it moves the tunnels by only about $0.25B. It is the base rate — the Prufrock trajectory — that drives the whole spread. And Québec's geology (the Lévis Formation, low-abrasion shales) belongs to the same Ordovician sedimentary family as Nashville's limestone: it is the best real-world anchor we have.

6. The revised realistic scenario, in detail

The full budget for scenario B, line by line — the recommended reference base.

ITEM	AMOUNT ($M)
Tunnels (150 km in Québec rock, $15M/mi effective)	1,930
Stations (150, balanced mix)	1,240

ITEM	AMOUNT ($M)
Technical systems (13 sub-items, see section 3)	3,228
Bike fleet (76,000 vehicles)	177
Québec–Lévis link (trucks, boats, terminals)	90
Land acquisition (partial)	125
Hard subtotal	**6,790**
Engineering and detailed design (10%)	679
Project management (5%)	340
Environmental review, geotech, permits, consultation	120
Subtotal	**7,929**
Technical contingency (20%, excl. inflation)	1,586
TOTAL — revised realistic 2030	**≈ 9,515**

7. Comparison with other megaprojects

The point that does not move, even after revision: the per-kilometre cost stays in a class of its own. The revised realistic figure ($63M/km), and even the full freeze ($104M/km), remain far below the region's other large projects.

PROJECT	LENGTH	COST / KM	STATUS
Vélo Tunnel Québec (revised realistic)	150 km	**≈ $63M/km**	Proposed
Vélo Tunnel Québec (full freeze, worst case)	150 km	≈ $104M/km	Scenario E
Montréal REM	67 km	$254M/km	Partly in service
Québec tramway	19 km	$305M/km	In planning
Third road link Québec–Lévis	8.3 km	$940M/km	Estimates $5.3–9.3B

The gap rests on three unchanged factors: a far smaller tunnel diameter (3.6 m versus 12–15 m), stations with no platforms or carriages, and the absence of heavy rolling stock. The cycle network stays four to fifteen times cheaper per kilometre, even in its most pessimistic scenario.

Methodological honesty. This recalculation raises the realistic figure from $8.9B to $9.5B — not because the project "grew," but because the nature simulation, drainage and geothermal are now counted at their true value rather than under-counted or absent. Presenting the most complete figure, even a slightly higher one, makes the case stronger: there is no hidden item left to unearth. The amounts remain planning-level estimates; a specialized engineering study, and above all the completion of Nashville, will sharpen the tunnel range — the one item that truly moves the total.

Vélo Tunnel Québec — a citizen project for a 150 km underground cycle network in the greater Québec City region, using The Boring Company's tunnel-boring technology. Document prepared by Philippe Leblond · June 2026 · revised version · for information only. Constant dollars, excluding inflation and interest.