BRINGING RESPONSIBLE RAIL TO NORTH AMERICA

Integrated Travel Research & Development presentation to Rio Grande Rail Conference

January, 2026

ABOUT INTEGRATED TRAVEL (ITRD)

- ITRD is a binational non-profit (Canada & USA) focused on developing responsible regional passenger and freight rail corridors.
- Offices: Calgary, Alberta & Irvine, Texas.
- Vision: Rail as a cornerstone of mobility, improving access to healthcare, housing, and employment.
- Mission: Build a reliable, efficient, environmentally sustainable regional rail system.

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KEY MILESTONES TO DATE

2013

Alberta Council of Technologies

A group of railway professionals research and offer the benefits of regional inter-city passenger rail service in Alberta.

2019

Engineering Costing Estimate completed

Alberta Regional Rail completes the Edmonton to Calgary costing estimates based on current Alberta engineering studies and constructions estimates.

2021

Triangle Rail Group

begin work with Triangle Rail Group of TX to complete initial ridership and revenue forecast - to couple with Engineering cost estimates

2022

Release of Gravity Analysis

following the release of the 2021 census, a group of international economists provided guidance and peer review of the initial ridership forecast for the provision an integrated approach to inter-city mobility within the Calgary to Edmonton corridor

2023

ITRD – Canada Incorporation

The founders of Alberta Regional Rail establish ITRD as a non-profit to access university research programs in Canada

2024

ITRD – USA Incorporation

the founders of ITRD – Canada establish ITRD – USA as a non-profit to access university research programs in the USA

2025

Release of Economic Studies

Dozens of studies commissioned by ITRD in partnership with 40 leading international research institutions are released

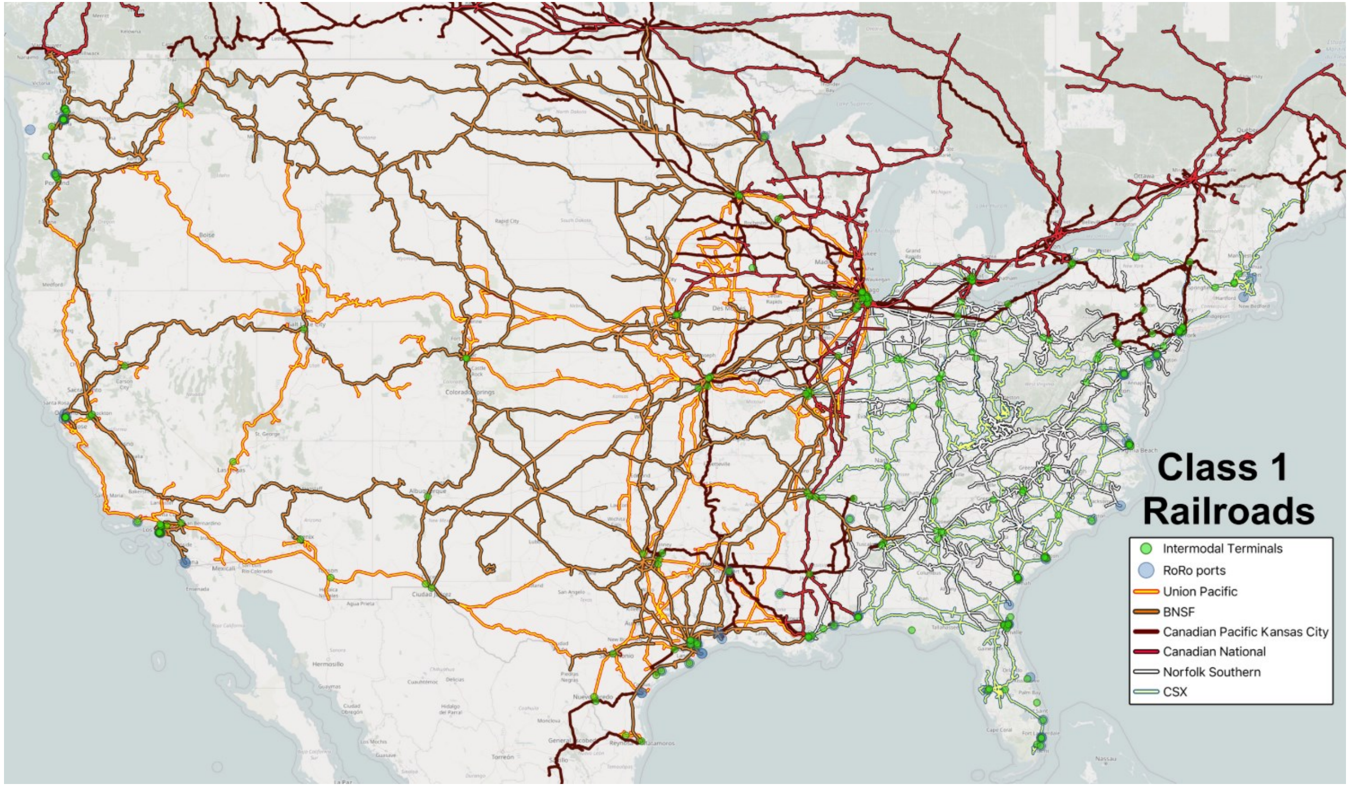
CONTINENTAL STRATEGY

ITRD recognises the need to implement a continental strategy to ensure that United States, Canada and Mexico remain competitive on the world stage.

ITRD's studies focus on the benefits of responsible rail investment.

ITRD researches opportunities for investment increase access, decrease service times and improve safety along the rail network.

ITRD advocates for investment to improve Freight and Passenger rail compatibility



PROJECT RESEARCH BACKGROUND

- Work began in 2019, building partnerships with railways, governments, airlines, transit agencies, and Indigenous communities.

- Research includes engineering specifications, rolling stock requirements, and gravity/demand forecasting.

- ITRD has commissioned dozens of studies with 40+ international research institutions since 2024.

- ITRD continues to forge alliances and relationships with Researchers, Class 1 Railways, Passenger Rail Operators, Airlines, Transit Authorities, Indigenous leaders and all levels of Government to ensure that our research is practical and compatible with our mandate to offer rural and urban municipalities improved access to employment, healthcare, entertainment, etc.

RESPONSIBLE RAIL (RR) CONCEPT

The presentation outlines Integrated Travel Research & Development's (ITRD) vision to introduce ***Responsible Rail***—a practical, sustainable, and economically beneficial regional rail system—connecting communities along the **CANAMEX / Ports-to-Plains** corridor.

It highlights the organization's background, research progress, demographic trends, and the strategic case for regional rail as a solution to the future challenges facing the Ports-to-Plains corridor.

The "Responsible Rail" framework is really effective positioning regional rail services not just as "transportation," but as a holistic solution for healthcare access (Wenatchee), social equity (Bronx), and reconciliation (Vancouver Island). Our findings for these regions are addressed within this presentation.

RR EMPHASIZES:

- **Safety:** Redundant signaling, automatic train control, collision avoidance.
- **Sustainability:** Hydrogen or electric propulsion, energy-efficient infrastructure.
- **Practicality:** Use of existing rail corridors and FRA-compliant rolling stock.
- **Accessibility:** Inclusive design for all users.
- **Equity:** Collaboration with Indigenous communities.

iTRD INTEGRATED TRAVEL RESEARCH & DEVELOPMENT

REGIONAL RAIL & HIGH-SPEED RAIL ECONOMICS

- RR may use hydrogen technology, avoiding costly electrification.

- RR can operate on existing tracks; HSR requires new dedicated infrastructure.

- North America’s long distances and lower population density make HSR less feasible for many community pairs in the USA and Canada. In Canada HSR is being built in the Toronto – Montreal Corridor while Brightline West is being constructed linking Southern California to Las Vegas

- HSR travel in excess of 250 kph where RR is often limited to 140 kph.

HOW REGIONAL RAIL ADDRESSES THESE FORCES

- Supports **economic diversification** through hydrogen rail technology.
- Reduces emissions by shifting travel from cars and planes.
- Supports **rural revitalization** and **affordable housing** access.
- Provides mobility for aging populations and newcomers.
- Manufacturing , Maintenance and export employment potential for rolling stock, IT and other Rail specific industries

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TRANSPORTATION CHALLENGES IN NORTH AMERICA

- Congestion in major cities.
- Limited rural transit options.
- Harsh winters impacting road reliability in Canada and Northern USA.
- High cost of vehicle ownership.
- High cost to expand the road network due to limited green field development options along utility corridors in urban centers

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DEMOGRAPHIC & ECONOMIC TRENDS

- **Population Growth (** substantial increases, potentially up to 25%, with strong regional shifts towards urban centers by 2046.)

- **Social & Cultural Shifts** (North America's population is aging, with lower fertility rates and increasing proportions of seniors, although immigrants offset some of this.)

ITRD INTEGRATED TRAVEL RESEARCH & DEVELOPMENT

COST OF INERTIA

- Lost environmental gains.
- Missed economic development.
- Reduced social connectivity.
- Lower public health benefits.
- Limited educational mobility.
- Fewer cultural exchanges.
- Continued infrastructure strain

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ITRD 2025 Research Summaries :

1. North Central Washington
2. South East British Columbia
3. Vancouver Island E&N Feasibility Study
4. Penn Station Access Project
5. Cascadia Rail Development
6. West Coast Express SW BC Station Placement
7. South Texas – Rio Grande Valley CBA
8. DART Silver Line Property Analysis
9. Southern Alberta Triangle Rail Feasibility Study
10. Hydrogen Fuel Cell Locomotive Retrofit Review
11. Calgary to Edmonton Regional Rail Studies
12. Alberta to Montana Tourism Train Study

RESTORING PASSENGER RAIL SERVICE : WENATCHEE – OROVILLE WASHINGTON CORRIDOR CBA

The study evaluates the feasibility of introducing passenger rail service along the Cascade & Columbia River (CSCD) corridor in North Central Washington. The proposed service would improve healthcare access, reduce preventable hospitalizations, and support regional economic development—especially in underserved communities like Okanogan County. Passenger rail is positioned not just as a transportation solution, but as public-health infrastructure and a seasonal tourism asset.

Core Goals

- Improve access to Wenatchee's full-service hospital for rural residents
- Reduce travel barriers for older adults, zero-vehicle households, and medically fragile patients
- Support tourism and small business growth in Chelan and Omak
- Align with Washington State Rail Plan and health-equity goals

Bottom Line

- Passenger rail along the CSCD corridor offers a dual benefit:
- Year-round healthcare access for vulnerable populations
- Seasonal tourism revenue to support operations
- It's a feasible, cost-effective, and equity-driven solution for North Central Washington.

WENATCHEE–OROVILLE WASHINGTON CORRIDOR PASSENGER RAIL SERVICE CBA

- Restoring passenger rail service along the 131-mile Wenatchee–Oroville corridor would require a capital investment of $100–$120 million and ongoing operating subsidies. While quantifiable benefits fall short of costs (Benefit–Cost Ratio: 0.3–0.8), the project offers significant qualitative value in rural mobility, tourism, safety, and environmental impact.
- The current rail in the Okanagan Valley is Class 1 or 2, limiting speeds to between 15 and 30 mph. Right of Way investment will greatly improve efficient access to inland and export ports.
- Annual O&M: $3.2–$4.0M
- Annual revenue: $0.8M–$1.65M (40,000 to 82,500 riders)

    - Tourism and student travel are key demand drivers
    - Supports tourism and economic development in Okanogan Valley
    - Requires federal/state funding and long-term operating support
    - Should be evaluated alongside equity, connectivity, and environmental justice goals

Strategic Recommendation: Pilot a rail + shuttle system to create a complete health-access corridor

Pursue funding via:

- Federal rural mobility grants
- State health-access programs & Hospital system partnerships

Key Findings:

1. Healthcare Access

- Okanogan County residents face 60–120 minute travel times to Wenatchee
- High rates of diabetes, asthma, heart disease, and suicide mortality
- ***1,300–1,600 preventable hospital stays per 100k Medicare enrollees***
- Rail could reduce missed appointments and improve chronic-care access
- Estimated cost savings: hundreds of thousands annually from reduced hospitalizations

2. Economic & Tourism Potential

- Summer congestion in Chelan and SR-150/US-97 creates demand for rail alternatives
- Mode-shift rates of 5–15% yield 30K–89K summer riders, generating $0.5M–$2.2M revenue
- Scenic rail service could provide high-margin discretionary income

3. Gravity Model Results

- Chelan scores highest: short travel time + strong tourism
- Omak & Okanogan: high healthcare need + moderate distance
- Tonasket & Oroville: high need but long travel time reduces score
- Tourism demand layers on top of year-round healthcare demand, strengthening ridership forecasts

CRANBROOK TO GOLDEN BC CORRIDOR

The study concludes that traditional weekday commuter rail is not viable in the Cranbrook–Golden corridor. Instead, tourism-driven, seasonal, and weekend-focused mobility represents the real opportunity. Census commuting flows are extremely low, but tourism volumes are high, seasonal, and concentrated around weekends and holidays. The corridor's geography, economy, and travel patterns point toward targeted, flexible, pilot-ready services, not daily fixed-route rail.

Corridor Context - Connects Cranbrook, Kimberley, Invermere, Radium Hot Springs, and Golden

- High tourism demand (ski season, summer recreation)
- Highway 93/95 is the current backbone but suffers from winter hazards and congestion
- Existing rail right-of-way enhances feasibility

Commuter Rail Will Not Work

- Census journey to work data show very few daily commuters between Cranbrook and Golden.
- Communities are too far apart (~250 km, 3+ hours) for daily commuting.
- Labour markets are mostly local, not inter municipal.

Conclusion: A Monday–Friday commuter rail model is structurally misaligned with corridor realities.

Station Metrics (2025)

Station	Population	Ridership	CO_2 Savings (t/yr)	Econ Benefit ($M/yr)	Accessibility
Cranbrook	24,000	73,000	520	3.1	9.2
Kimberley	8,000	40,000	300	1.5	8.9
Invermere	13,000	55,000	420	2.2	9.0
Radium Hot Springs	5,000	25,000	190	1.0	8.5
Golden	9,000	41,000	310	1.8	8.7

Strategic Insights

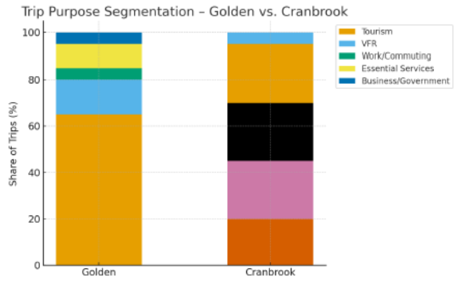
- Scenic segments (Radium–Golden) offer highest experiential value
- Fare elasticity shows tourists are more sensitive to price than commuters
- Clustering analysis identifies station roles:

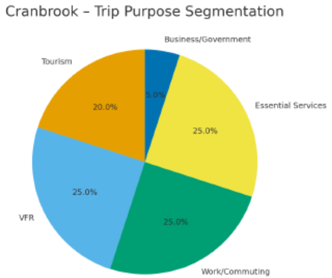
  - Regional Hubs (Cranbrook, Invermere)
  - Tourism Anchors (Golden, Radium)
  - Community Connectors (Kimberley, Canal Flats)

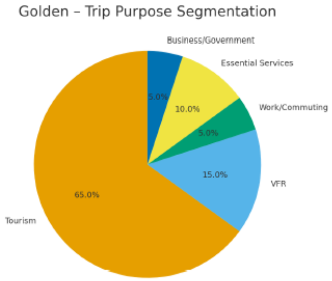
CRANBROOK–GOLDEN BC CORRIDOR REGIONAL PASSENGER RAIL RIDERSHIP PROJECTIONS

Ridership & Growth Projections

- **2025 base ridership:** 230,000 passengers
- **2040 projections:**
    - Conservative: 290,000
    - Base: 350,000
    - Optimistic: 400,000
- Ridership elasticity with emissions: ~0.97 (nearly 1:1 correlation)







TOURISM IS THE PRIMARY MARKET - CRANBROOK-GOLDEN BC CORRIDOR

Tourism Golden and Destination BC data sets show:

Strong seasonal peaks

- Winter: Ski tourism at Kicking Horse (Dec–Mar)
- Summer: Hiking, rafting, biking, national parks (Jun–Sep)

Weekend-heavy travel

- Visitors typically arrive Friday evening and depart Sunday afternoon.
- Accommodation occupancy spikes on weekends and holidays.

Visitor economy scale

- Golden's visitor economy: $169.4M in direct spending, 2,386 jobs (2023).

Conclusion: Rail or shuttle services must be seasonal, weekend-oriented, and tourism-led.

HOUSING & LABOUR CONSTRAINTS - CRANBROOK–GOLDEN BC CORRIDOR

Golden faces:
- Severe housing shortages for workers
- High seasonal labour demand
- Limited affordable commuting options

Cranbrook has:
- More available housing
- Regional airport (YXC)
- Year-round services

Implication: Mobility solutions must support seasonal workers, not daily commuters.

PROPOSED SERVICE CONCEPTS - CRANBROOK–GOLDEN BC CORRIDOR

1. Cranbrook–Kimberley Weekday Commuter Pilot

- Shorter distance
- Stronger labour-market ties
- Realistic for daily travel
- Low-cost, bus or rail-shuttle model

2. Summer Connector (June–September)

- Serves peak recreation season
- Targets visitors without cars
- Aligns with rafting, hiking, biking demand
- Could integrate with YXC airport arrivals

3. Winter Weekend Express (December–March)

- Timed to ski tourism patterns
- Friday PM northbound / Sunday PM southbound
- Supports both visitors and seasonal workers
- High reliability advantage over winter roads

All three concepts are designed for pilot testing, not immediate full rail deployment.

KEY INSIGHTS FOR POLICYMAKERS

1. Demand is real — but not commuter demand

- Tourism and seasonal travel dominate corridor mobility.

2. Rail must be phased

- Start with **bus or shuttle pilots**, then scale to rail if demand proves strong.

3. Weekend and seasonal windows are the sweet spot

- Not Monday–Friday commuter peaks.

4. Housing and labour shortages amplify the need for mobility

- But not in the form of daily long-distance commuting.

5. Funding must blend tourism, regional development, and transportation

- Traditional transit funding models won't fit.

CP Windermere Subdivision

The CP Windermere subdivision runs from Fort Steele to Golden, BC.

Mile	Station	Siding
0	FORT STEELE Junction with CP Cranbrook subdivision	Yard
6	DOYLE	–
8.5	Hotbox Detector	–
12.1	WASA	8517
17	TEEPEE	–
22.4	SKOOKUMCHUCK	–
25.2	Hotbox Detector	–
28.1	TORRENT	8775
34	COPPER CREEK	–
39.5	CANAL FLATS	9364
44.9	COLUMBIA LAKE	–
50.4	ENVIRON	–
50.4	Hotbox Detector	–
53.7	FAIRMONT	9481
60	RUSHMERE	–
64.4	GOLDIE CREEK	–
68.8	WINDERMERE	7928
73	FIRLANDS	–
77.6	RADIUM	–
83	EDGEWATER	2160
74.7	Hotbox Detector	–
88.3	LUXOR	8374
94.1	BRISCO	–
97.2	Hotbox Detector	–
102.2	SPILLIMACHEEN	8250
109.1	HARROGATE	–
114	CASTLEDALE	–
117.7	SEENEY	8532
123.3	Hotbox Detector	–
127.4	McMURDO	–
134	HORSE CREEK	8375
140	PURCELL	–
143	GOLDEN YARD	Yard
144.8	KC JUNCTION Junction with CP Mountain Subdivision	–

Bottom Line

- The Cranbrook–Golden corridor **can** support passenger mobility improvements — but **not** through conventional commuter rail. The viable path forward is **tourism-led, seasonal, weekend-focused service**, tested through **staged pilots** and aligned with regional economic realities.

VANCOUVER ISLAND RAIL PROJECT

A DATA-DRIVEN RIDERSHIP & FINANCIAL ANALYSIS OF THE E&H RAIL CORRIDOR

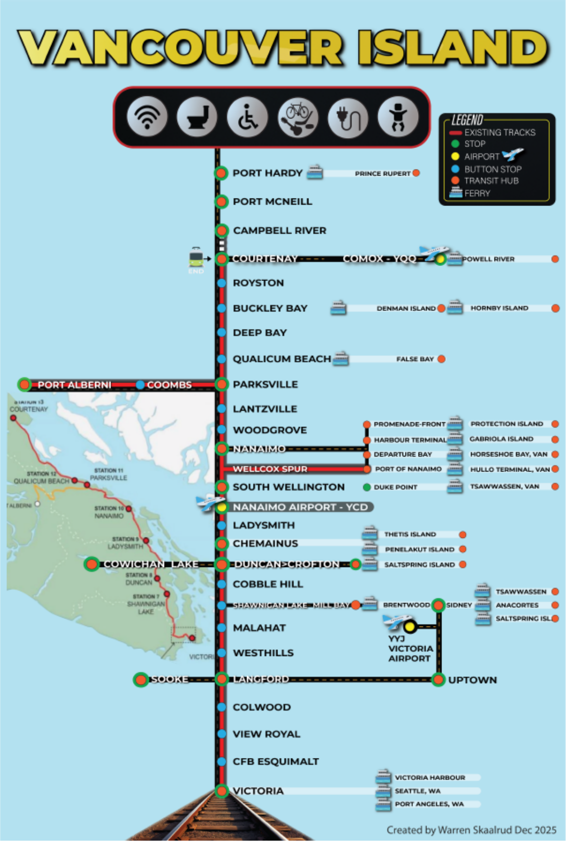
Shivani Chauhan & Dharmil Rajesh Gada (Integrated Travel, Arizona State University)
January 22, 2026

Abstract Key Points:

- Examines restoring passenger rail on Vancouver Island's E&N Corridor (Victoria to Courtenay, 234 km).
- Historical context: Built 1883 for industry; passenger service ended 2011 due to track issues; now owned by Island Corridor Foundation (ICF) amid First Nations land disputes.
- Case for revitalization: Addresses population growth, highway congestion (e.g., Malahat), environmental benefits (lower GHG emissions), and potential freight reduction (10,000–25,570 trucks/year).
- Objectives: Forecast ridership using Gravity Model, Direct Demand Model, and Mode Choice; evaluate financial feasibility.

Socio-Economic Profile:

- Key cities: Victoria, Langford, Duncan, Nanaimo, Courtenay (rapid growth in Langford +83.9%, 2011–2023).
- Population: 2011–2023 growth 11–84%; median income up 33–49%.
- Transportation: Relies on highways and BC Ferries; ferry traffic correlates with population/economic growth.



METHODOLOGY AND RIDERSHIP FORECASTING

Phased Modeling Approach and Key Findings

Phase 1: Gravity Model

- Estimates trip distribution based on population "mass" and distance.
- Calibrated using BC Ferries data as proxy (correl. >0.85 with island GDP/population).
- Parameters: α=1.0 (origin pop.), β=1.0 (dest. pop.), γ=2.0 (distance decay).

Findings:

- ***High demand in close pairs (e.g., Victoria-Langford)***
- ***Limitations: Ignores income/tourism.***

Phase 2: Direct Demand Model

- Log-log regression on panel data (2011–2023); adj. R^2=0.943.
- Variables: Pop (elastic >1), Income (negative for origin: -0.4%), Distance (-3.59%), Tourism (+18.9%).
- Key drivers: Population strongest; rail seen as "inferior good" for higher incomes; distance highly deterrent.

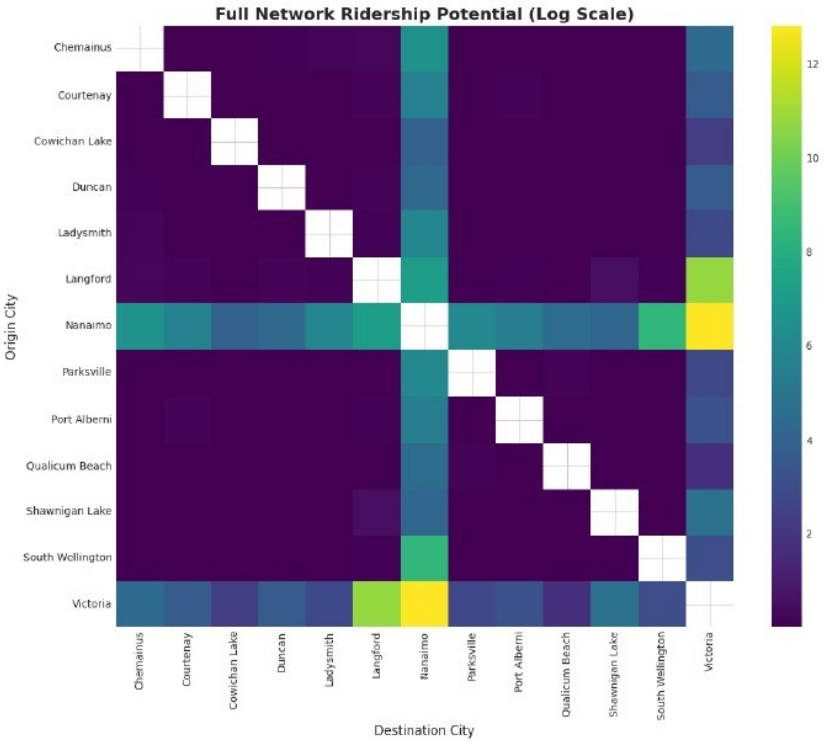


Fig. 3. Ridership Heatmap

Phase 3: Mode Choice and Forecast

- Compares rail vs. car "Generalized Cost" (time × VOT $27.36/hr + cost + frequency penalty).
- High-demand segments: Commuter core (Victoria-Langford-Nanaimo); lower in north.
- Conservative 2040 forecast: 1.55 million annual trips (realized demand, assuming hourly service, $3–$21 fares).

Financial Analysis, Challenges, and Proposed Solutions

Key Financial Projections:

- Operating recovery ratio: ~39% (farebox covers 39% of costs).
- Upfront capital: High for track modernization and First Nations reconciliation (viewed as generational infrastructure like highways/hospitals).

Challenges:

- Operational gap; historical grievances with 14 First Nations; competition from cars/highways.
- Sensitivity to shocks (e.g., COVID dip in travel).

Proposed Framework:

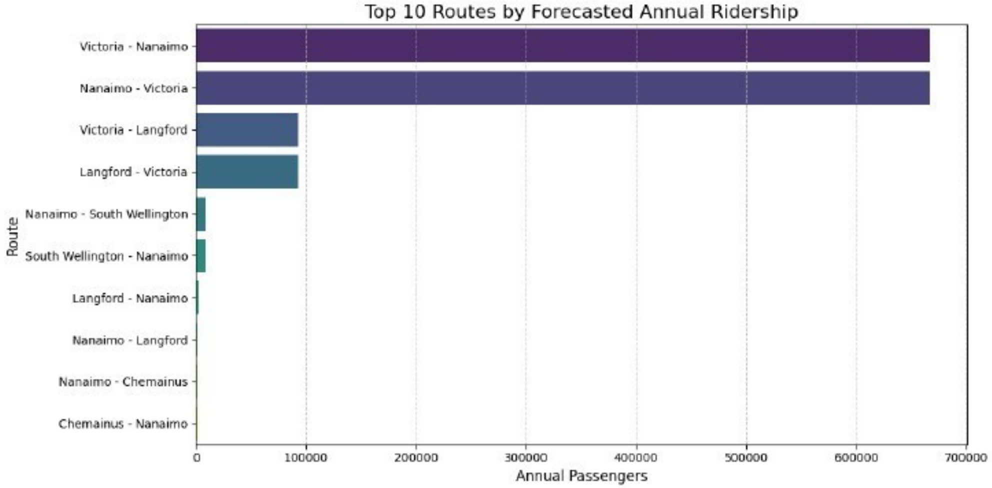
- Government incentives: Land Value Capture (LVC) districts to fund via real estate uplift.
- Indigenous Equity Trusts: Convert costs to equity dividends for First Nations.
- Broader benefits: Resilient transport, sustainability, economic competitiveness.

Conclusion:

Rail is viable as community asset; 1.55M trips by 2040 driven by commuting needs; prudent investment with reconciliation focus.

TABLE I
HISTORICAL SOCIO-ECONOMIC PROFILE OF KEY CORRIDOR MUNICIPALITIES (2011-2023)

	Population		Pop. Growth	Median Income ($CAD)		Income Growth	Distance from
City	**2011**	**2023**	**(2011-23)**	**2011**	**2021**	**(2011-21)**	**Victoria (km)**
Victoria	82,464	100,539	22.0%	45,827	67,500	47.3%	0.0
Langford	30,183	55,525	83.9%	69,820	93,000	33.2%	9.9
Duncan	5,002	5,556	11.1%	35,703	53,200	49.0%	46.3
Ladysmith	8,019	9,622	20.0%	54,413	81,000	48.9%	71.5
Nanaimo	85,582	108,340	26.6%	52,744	75,500	43.1%	92.3
Parksville	12,044	14,677	21.9%	50,261	66,500	32.3%	120.6
Courtenay	24,662	31,193	26.5%	50,168	72,000	43.5%	182.6



Despite the operational profit, the massive upfront capital cost creates a significant challenge for standard economic valuation over a 30-year lifecycle Table IV (4% discount rate).

TABLE IV
30-YEAR COST-BENEFIT ANALYSIS

Metric	**Value**	**Description**
PV of Benefits	$744 Million	Revenue + GHG Savings ($0.75/trip) + Congestion Relief ($12/trip)
PV of Costs	$2.55 Billion	Capital ($2.21B) + 30 Years of Operations
Net Present Value (NPV)	-$1.81 Billion	Negative economic return
Benefit-Cost Ratio (BCR)	0.29	For every $1 invested, only $0.29 of direct benefit is generated

Note on CBA Methodology: While the 'Strategic Fare Structure' lowers direct Fare Revenue, it does not negatively impact the Total Benefit calculation. In Social Cost-Benefit Analysis, a reduction in fares effectively transfers value from the 'Operator' (Revenue) to the 'Passenger' (Consumer Surplus/Pocket Savings). Therefore, the PV of Benefits remains stable at $744 Million, driven by the societal value of affordable mobility.

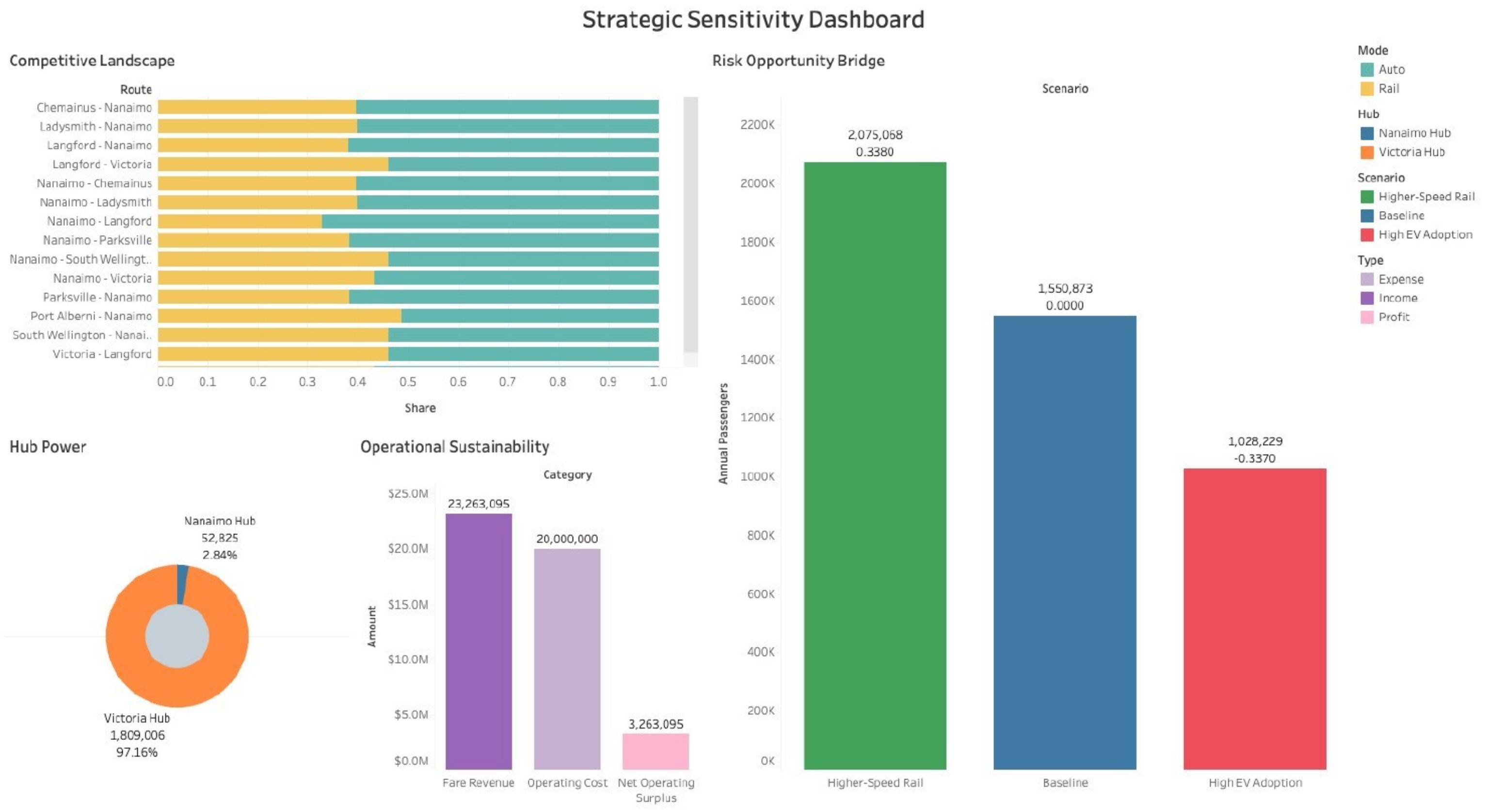


Fig. 5. Comprehensive Dashboard Analysis showing Ridership Trends

The Vancouver Island Rail Corridor has the potential to evolve into a modern, resilient, and sustainable multimodal transportation system. This study presents an integrated modernization framework built on five key pillars: intermodal connectivity, solar energy integration, predictive maintenance, advanced composite track materials, and station electrical modernization.

The proposed approach delivers meaningful environmental benefits through emissions reduction, renewable energy adoption, waste diversion, and forest conservation, while improving operational reliability, safety, and passenger experience. Smart monitoring, durable materials, and modern electrical systems collectively enhance long-term performance and resilience.

Together, these initiatives position the corridor as a future-ready transportation asset that supports clean mobility, regional connectivity, and long-term sustainability, offering a scalable model for modern rail infrastructure renewal.

VANCOUVER ISLAND RAIL CORRIDOR MODERNIZATION STUDY

This study looks at the corridor from a **systems perspective**, focusing on key modernization strategies that are already well-researched in the attached paper, plus one emerging area:

1. **Intermodal Connectivity**

Better connections between rail and other modes of transport such as airports and ferry terminals.

2. **Solar Energy Integration in Rail Infrastructure**

Using solar technologies (especially canopies) to generate clean power and protect track infrastructure.

3. **Smart Maintenance and Sensor-Based Monitoring Systems**

Modern sensing and data systems that move the corridor from reactive maintenance to predictive, condition-based maintenance.

4. **Advanced Composite Track Materials**

Replacing traditional wooden ties with long-life composite materials to reduce maintenance, improve durability, and support circular economy goals.

5. **(Ongoing / Proposed) Station Electrical Infrastructure Modernization**

A research focusing on station-side electrical systems: energy-efficient lighting, EV charging, power for lifts and safety systems, and robust electrical safety and backup pow

1. Why Intermodal Connectivity Matters

Integrating the rail corridor with airports and ferry terminals creates:

- **Better passenger experience**: Travelers can move easily between air, ferry, and rail without needing a car for every leg
- of their journey.
- **Higher ridership and revenue:** Convenient connections encourage more people to use trains, increasing ticket revenue and supporting nearby hotels, businesses, and tourism.
- **Reduced road congestion and emissions:** Shifting trips from road to rail helps decrease highway traffic and associated green house gas emissions.
- **Stronger regional accessibility:** Communities along the corridor gain improved access to the airport, ferry terminals, and regional economic hubs.

Research shows that cities with good airport–rail integration see measurable gains in hotel revenue and regional economic activity, and that intermodal hubs are a common feature of successful modern rail systems.

Nanaimo Airport Connection:

The existing rail corridor passes very close to Nanaimo Airport (YCD):

- The track is approximately 260 meters from the airport entrance.
- This creates an opportunity for a new platform station near the airport, rather than relying on the historic Cassidy station.

A practical concept includes:

- **Airport-adjacent platform station:** A simple platform located at the nearest rail–road intersection to the airport.
- **Short pedestrian link:** A direct, well-lit walking route from the platform to the terminal (approximately a 5-minute walk).
- **Coordinated schedules:** Train times aligned with peak flight times to minimize passenger waiting.
- **Future option: very short rail spur:** Given the short distance, a dedicated spur could be evaluated as a future upgrade if demand justifies it.

This approach delivers most benefits of a direct airport rail link at a fraction of the cost of traditional long airport rail extensions.

VANCOUVER ISLAND RAIL CORRIDOR PORT CONNECTIVITY

Ferry and Duke Point Connections: the corridor can also be integrated with ferry operations:

- Downtown Nanaimo Station to Departure Bay / Hullo ferries
  - Approximately 3 km between the station and ferry terminals.
  - Can be served by a short, frequent shuttle bus (5–7 minutes).
  - Provides a simple rail–ferry connection for passengers traveling to or from Vancouver.

Duke Point (freight and passenger potential)

- Duke Point hosts key port and short-sea shipping facilities.
- A future rail extension (15–20 km) could:
  - Support ferry passengers using Duke Point.
  - Enable container and goods movement by rail rather than by truck.
  - Reduce highway truck traffic and support regional logistics.

This positions the corridor as a true multimodal passenger and freight corridor.

VANCOUVER ISLAND RAIL CORRIDOR PORT CONNECTIVITY

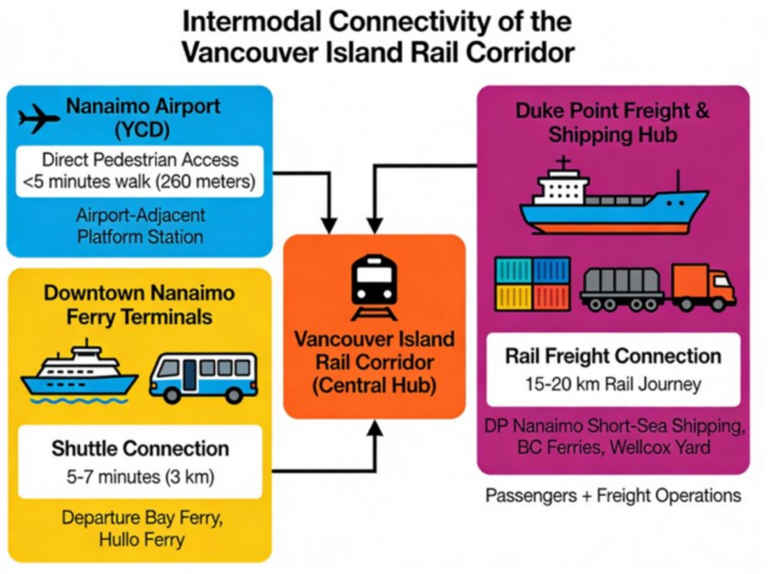


Fig 1. Intermodal connectivity flowchart

Several international transportation systems support this intermodal approach:

- **Baltimore–Washington (BWI)** – Free shuttle between terminal and rail station.
- **Boston Logan** – Shuttle buses connecting terminals to the MBTA rail system.
- **Vancouver Canada Line** – Direct rail link from airport to downtown.

These examples demonstrate that even short shuttle-based connections can be highly effective when they are frequent, reliable, and well-integrated with rail schedules.

Solar Energy Integration in Rail Infrastructure Concept: Solar energy can be systematically integrated into the rail corridor infrastructure, with the primary implementation approach.

Solar canopy structures spanning track sections are physical structures installed above or alongside the railway carrying photovoltaic panels, similar to the proven Belgian solar rail tunnel model that combines energy generation with infrastructure protection benefits.

This approach converts the entire rail corridor into a linear distributed energy generation system, simultaneously addressing power supply needs for rail operations while providing secondary benefits related to track protection, maintenance reduction.

Potential applications for the Island Corridor include:

- Integration with station canopy structures – Passenger shelters and platform canopies incorporate solar panels, providing weather protection while generating electricity and maximizing co-located infrastructure benefits.
- Direct linkage with station electrical modernization – Canopy-mounted solar supplies power for station lighting, digital signage, EV charging, backup systems, and other electrical equipment, enabling an integrated clean-energy station ecosystem.
- Phased expansion based on performance and funding – Successful pilots scale to 30–50% corridor coverage over time, increasing renewable energy penetration and climate resilience while distributing capital investment across funding cycles.

Parameter	Solar Canopy
Cost per km	$4-5 million
Energy Output	1-3 MW/mile
Track Protection	High
Visual Impact	Moderate-High
Implementation Complexity	High
Proven Technology	Established

Fig 2. Solar canopy parameter table

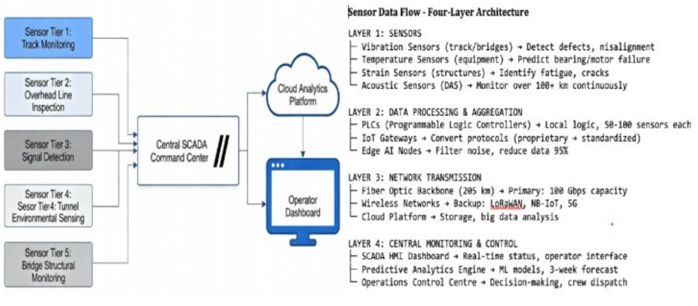


Fig 5. System Architecture and Integration

S&C Approach: Leverage modern AI and Predictive Maintenance via:

- **Distributed sensor networks** measure track geometry, structural strain, vibration, and temperature in real time to assess asset health.
- **Data Driven** Optimized maintenance scheduling
- **Distributed Acoustic Sensing (DAS**) – Fiber-optic cables function as continuous sensors over 100+ km, enabling track geometry monitoring, train detection, landslide alerts, and intrusion detection.
- **MEMS vibration accelerometers** – Deployed at high-stress locations (curves, switches, bridges), detecting early vibration signatures linked to wheel, bearing, and geometry defects.
- **Thermal imaging systems** – Infrared monitoring identifies overheating in electrical equipment, mechanical components, and wheel–rail interfaces before failure occurs.
- **Acoustic emission sensors** – Ultrasonic detection of microcracking and stress events in bridges, welds, and fasteners provides 2–6 weeks of early warning.
- **AI-powered vision systems** – High-speed cameras with machine learning detect 20+ defect types at operational speeds with 98.5% accuracy and <0.5% false positives.

Sensor Type	Deployment Density	Primary Function	Quantified Impact
MEMS Accelerometers	Every 150–200 m	Vibration anomaly detection	30% fault detection improvement
Thermal Cameras	Every 25 km	Electrical/mechan ical overheating	25% electrical fault reduction
Fiber-Optic DAS	Continuous across corridors	Track geometry, structural strain	20% real-time alert reduction
Acoustic Emission	At critical bridges/tunnels	Structural health monitoring	40% crack detection acceleration
AI-Vision	At 12 major stations	Automated visual inspection	60% labor reduction

Fig 3. Sensor technology table

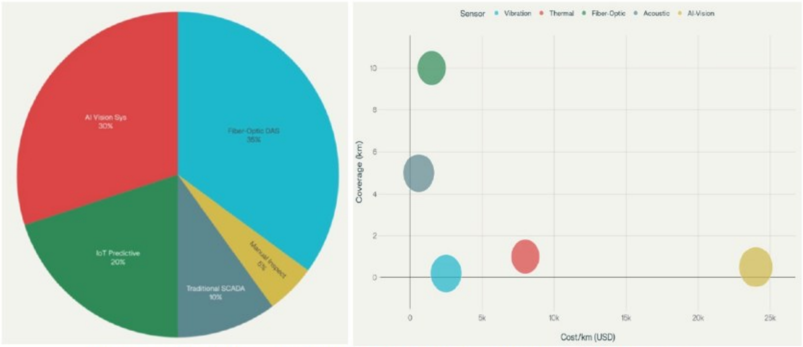


Fig 4. Maintenance cost reduction by technology & Sensor Cost effectiveness

Composite Ties: A Long-Life Alternative:

Advanced composite railroad ties offer a fundamentally improved alternative:

- **Engineered composition** – Manufactured from recycled plastics and reinforcements (≈45% HDPE, 30% PET, 15% glass fiber, 10% natural additives), composites are tailored for mechanical strength and environmental resistance.
- **Extended service life** – Composite ties are field-validated for 50+ years, more than tripling the lifespan of wooden ties and significantly reducing replacement frequency.
- **Moisture immunity** – Composites do not absorb water, eliminating swelling, rot, and moisture-driven degradation.
- **Freeze–thaw durability** – Proven resistance to 500+ freeze–thaw cycles ensures long term performance under seasonal temperature variation.

Cost Category	Wood Ties (30-yr)	Composite Ties (30-yr)
Initial Investment	$41.8M	$58.0M
Replacement Cycles	$62.6M	$0
Maintenance Labor (30% reduction)	Baseline	–$8.5M
Service Disruptions	$18.2M	$2.1M
Total 30-Year Cost	**$122.6M**	**$51.6M**

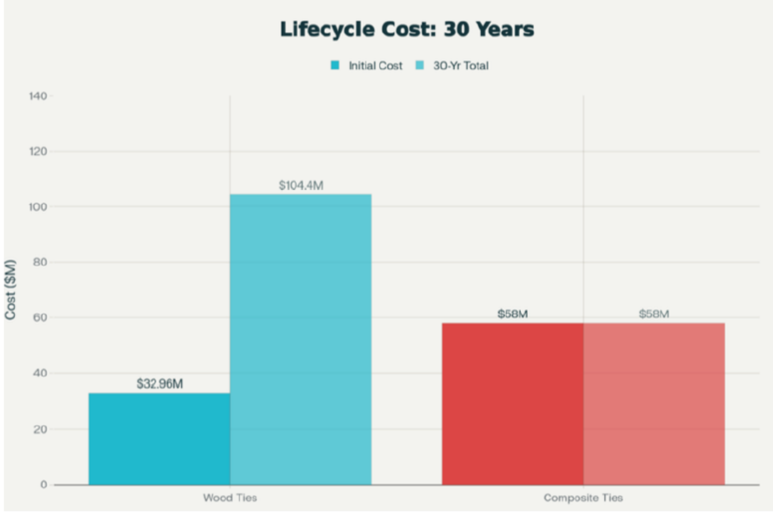


Fig 6. Lifecycle cost comparison chart

VANCOUVER ISLAND RAIL CORRIDOR SEGMENT-LEVEL TRACK COSTS

Upgrading Victoria–Courtenay to Class 2 standards totals **is estimated to be $901M**, including:

- Track & structures
- Rolling stock
- Signals
- Stations
- Yard upgrades

Environmental Remediation - For 72 km of CVRD corridor:

- Physical remediation: $126M–$216M
- Risk assessment: $68M–$122M
- Reserve lands: $8.75M–$15M + additional risk assessment

Total remediation can exceed $200M, significantly affecting BCR and NPV.

VANCOUVER ISLAND RAIL CORRIDOR OPERATING COSTS & REVENUE

- Annual operating cost: ~$32M
- Projected fare revenue: ~$26M
- Operating shortfall: ~$6M/year (requires subsidy)
- Trail maintenance: ~$0.3M/year

Rolling Stock & Fleet

- Required fleet: 13–22 DMUs for high frequency service
- Fleet cost: $264M–$432M
- Maintenance facility: $75.5M
- Station upgrades (Victoria–Langford): $27.2M

VANCOUVER ISLAND RAIL CORRIDOR BENEFITS & EXTERNALITIES

Economic

- Direct + indirect impact: ~$95M (select scenarios)
- Tourism uplift, job creation, and regional economic resilience

Social

- Improved access for remote and Indigenous communities
- Emergency routing and redundancy
- Mode shift from cars → rail

Environmental

- GHG reductions (monetized using BC carbon pricing)
- Habitat preservation
- Reduced road congestion and emissions

User Benefits

- Time savings of 21–40 minutes
- Consumer surplus from lower travel cost
- Reliability improvements vs. winter road conditions

CASE STUDY OF THE PENN STATION ACCESS PROJECT

CASE STUDY OF THE PENN STATION ACCESS PROJECT

The Penn Station Access (PSA) Project will extend Metro-North's New Haven Line to Penn Station via the Amtrak Hell Gate Line, adding **four new stations** in the East Bronx: **Co-op City, Morris Park, Parkchester/Van Nest, and Hunts Point.**

The study evaluates PSA using demographic analysis, GIS accessibility modeling, and a multi-criteria decision analysis (MCDA). Findings show PSA will **dramatically reduce commute times**, expand access to jobs and education, and deliver major **equity, environmental, and economic benefits** to historically underserved neighborhoods.

Bronx residents currently face:

- 60–90 minutes commuting time to Midtown Manhattan
- Limited access to regional rail
- High dependence on slow bus–subway combinations
- Significant inequities in job access and mobility

CASE STUDY OF THE PENN STATION ACCESS PROJECT

OBJECTIVE

The study:

- Compares PSA to global rail expansions
- Recommends best practices for station placement

Freight Line Context: PSA operates on the Amtrak-owned Hell Gate Line, which also carries freight from:

- CSX
- Norfolk Southern (via Conrail Shared Assets)
- New York & Atlantic Railway
- Amtrak maintenance and freight

Freight considerations require:

- Signal upgrades
- Four track segments
- Bridge rehabilitation
- Careful scheduling and dispatch coordination to ensure PSA does not disrupt freight operations while improving passenger reliability.

DATA ANALYTICS FRAMEWORK

The study integrates:

- ACS Census data
- MTA/NYC DOT transit layers
- GIS accessibility modeling
- Economic Opportunity Index
- MCDA scoring across five weighted criteria

MCDA Weights:

- Accessibility (30%)
- Economic Opportunity (25%)
- Demographics & Density (20%)
- Land Use/TOD Readiness (15%)
- Environmental/Equity (10%)

CASE STUDY OF THE PENN STATION ACCESS PROJECT

KEY FINDINGS

Overall Station Ranking (MCDA) **

1. **Morris Park – 89**
2. Hunts Point – 82
3. Parkchester/Van Nest – 78
4. Co op City – 73

1. Morris Park

- Major employment hub (medical + institutional)
- Largest commute time reduction (40–45 min)
- Strong TOD potential

2. Hunts Point

- High need, high equity community
- Significant commute savings (35–40 min)
- Environmental justice benefits

3. Parkchester/Van Nest

- Extremely dense residential area
- High ridership potential
- Strong TOD opportunities

4. Co op City

- Largest population catchment
- Moderate commute savings
- TOD constrained by cooperative ownership

** All four stations show strong transit mode share (62–71%), indicating high adoption potential.

COMPARATIVE INTERNATIONAL COMMUTER RAIL PROJECTS

PSA mirrors global patterns seen in:

- Calgary Green Line – TOD-driven station placement
- London Crossrail (Elizabeth Line) – major accessibility-driven economic uplift
- Tokyo suburban rail – integrated land use + rail planning

These examples reinforce the importance of:

- TOD readiness
- Multimodal integration
- Predictive modeling for corridor constraints

RECOMMENDATIONS FOR EFFECTIVE PSA STATION PLACEMENT

- Use Multi-Criteria Decision Analysis (MCDA) tools to balance accessibility, equity, TOD, and feasibility.
- Prioritize through-running to reduce bottlenecks.
- Strengthen multimodal connections (bus, cycling, pedestrian).
- Target areas with redevelopment potential (e.g., Morris Park, Parkchester).
- Use predictive modeling for freight–passenger interactions.
- Align station planning with long-term economic goals.
- Integrate value-capture tools (joint development, zoning incentives).

PSA is a transformative regional mobility investment that:

- Cuts commute times
- Expands economic opportunity
- Improves transit equity
- Strengthens regional resilience
- Supports TOD and environmental goals

The project demonstrates how data analytics, GIS modeling, and MCDA can guide equitable, high impact transportation planning — and provides a replicable framework for other North American rail corridors.

ANALYSIS OF PASSENGER RAIL STATION LOCATIONS IN CASCADIA

ANALYSIS OF PASSENGER RAIL STATION LOCATIONS IN CASCADIA

The study evaluates three interconnected passenger rail opportunities in British Columbia and the Cascadia region.

The analysis uses 2025 demographic data, economic projections, environmental metrics, and GIS based reasoning to determine optimal station locations and long-term regional benefits for:

1. Whistler Passenger Rail Development (via the Sea to Sky Corridor)
2. Cascadia High Speed Rail (Vancouver–Seattle–Portland)
3. Surrey Passenger Rail Station (as a Lower Mainland hub)

Accessibility - Measured by multimodal integration.

- Surrey (90/100): SkyTrain, RapidBus, major highways, future Surrey–Langley extension.
- Whistler (65/100): Dependent on the vulnerable Sea to Sky Highway; rail would significantly improve reliability.
- Cascadia Corridor: High speed rail could connect 9 million people across the megaregion.

KEY FACTORS INFLUENCING STATION LOCATION IN CASCADIA

Population Density is the strongest predictor of ridership.

City	Density (people/km²)	Implication
Vancouver	6,100	Mature, high-capacity market
Surrey	2,200	Strong growth, ideal for major station
Burnaby	2,740	Strong but less growth potential
Abbotsford	440	Too low for a major anchor station
Whistler	67	Seasonal demand only

Economic Impacts

Surrey

- 10,000+ jobs
- 3% GDP uplift
- 18% property value increase
- Strong TOD potential around Surrey Central

Whistler

- **2,000+ jobs**
- **2.5% GDP uplift**
- Seasonal tourism (3M annual visitors) drives viability
- Requires subsidies due to low permanent population

Cascadia Corridor

- **$355B economic growth**
- **200,000+ jobs**
- **25% property value uplift**
- Major cross-border trade and mobility benefits

Conclusion: Surrey offers the strongest ROI; Cascadia offers the largest regional transformation.

ENVIRONMENTAL CONSIDERATIONS FOR RAIL DEVELOPMENT IN CASCADIA

Passenger rail is dramatically cleaner than cars or planes:

- Rail: 41 g CO_2/passenger km
- Car: 171 g
- Airplane: 255 g

Additional insights:

- Rail reduces congestion and fossil fuel use.
- Sea to Sky reuse minimizes new land disturbance.
- Climate resilience (flood/landslide mitigation) is essential.

Conclusion: Rail is a cornerstone of BC’s climate strategy.

LOCATION SPECIFIC FINDINGS IN CASCADIA

Whistler Rail

- Once in a generation opportunity due to CN's 2026 exit.
- High tourism demand supports viability.
- High capital costs and environmental sensitivity require careful planning.

Cascadia High Speed Rail

- Operations expected 2040–2045.
- Requires cross border coordination on technology, ticketing, and operations.
- Reduces short haul flights and strengthens regional economic integration.

Surrey Station

- Best combination of density, accessibility, and growth.
- TOD around Surrey Central could reshape the Lower Mainland.
- Requires equity measures to prevent displacement.

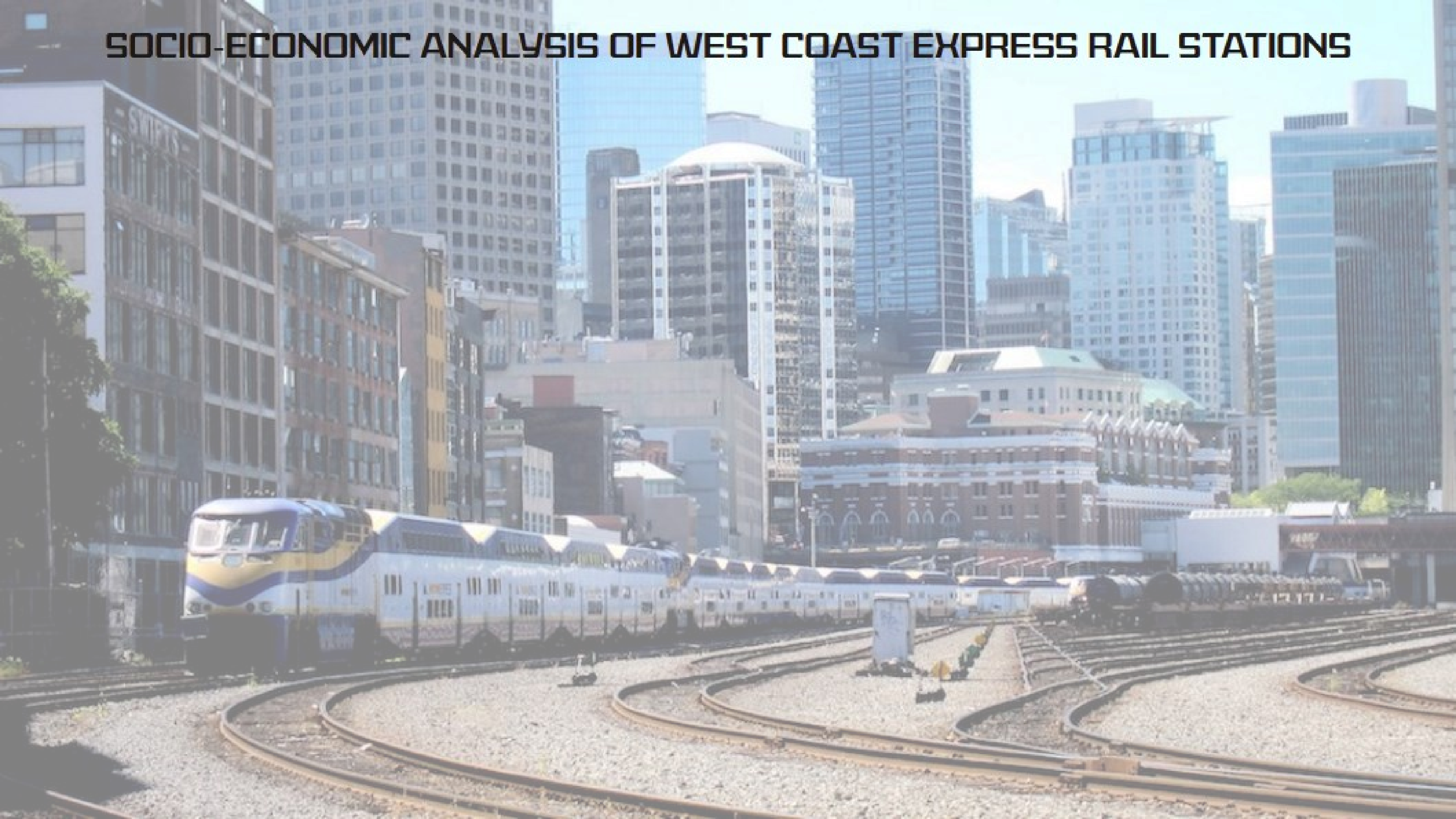
RECOMMENDATIONS FOR THE FUTURE EXPANSION OF PASSENGER RAIL IN CASCADIA

1. Acquire the Sea to Sky Corridor for Whistler passenger rail before CN's exit.
2. Prioritize Surrey Central as the primary Lower Mainland station using GIS based site selection.
3. Integrate early with Cascadia planning for interoperability and cross border benefits.
4. Embed equity safeguards (affordable housing, community benefit agreements).
5. Design for sustainability (electrification, wildlife crossings, climate resilient infrastructure).

Conclusion

Surrey is the most strategic and transformative location for a new passenger rail station in BC. Whistler rail is viable with subsidies and corridor acquisition, while Cascadia high speed rail offers unprecedented regional economic and environmental benefits. Together, these initiatives could create a sustainable, equitable, and economically dynamic rail network for the next generation

SOCIO-ECONOMIC ANALYSIS OF WEST COAST EXPRESS RAIL STATIONS



This study evaluates how land use, accessibility, economic activity, environmental benefits, and rider perceptions shape the performance of five key West Coast Express (WCE) stations in Metro Vancouver: Waterfront, Port Coquitlam, Maple Meadows, Pitt Meadows, and Mission City.

Using GIS buffer analysis, statistical regression, and survey data, the research identifies the strongest predictors of ridership and outlines how station characteristics influence regional mobility and development.

The analysis investigates:

- What socio-economic factors drive ridership at WCE stations
- How station location, land use, and accessibility shape performance
- How WCE contributes to economic development and environmental sustainability
- What improvements can enhance ridership and regional equity

KEY FINDINGS – IMPACTS OF WCE STATION LOCATION

1. Employment Density is the strongest predictor of ridership:

- Stations near major job clusters (e.g., Waterfront) have the highest ridership.
- Residential population alone is not a strong predictor.
- This aligns with transit research showing that job access drives commuter rail demand.

2. Suburban stations depend heavily on Park and Ride:

- Port Coquitlam: ~600 stalls
- Maple Meadows: ~467 stalls
- Mission City: ~500+ stalls
- Pitt Meadows: ~140 stalls

These stations serve long distance commuters who rely on car access to reach the train.

3. Accessibility and multimodal integration matter

- Waterfront excels due to SkyTrain, SeaBus, and bus connections.
- Suburban stations with strong bus loops perform better.
- Weak pedestrian and cycling access limits ridership potential.

4. Rail stations generate local economic benefits

- Waterfront: highest business activity, tourism, and commercial value uplift
- Port Coquitlam & Maple Meadows: retail and service growth near stations
- Stations act as anchors for transit-oriented development (TOD)

5. Environmental benefits vary by station

- WCE reduces vehicle kilometers traveled (VKT) and CO_2 emissions.
- Mission City provides the largest per rider environmental benefit by replacing long car commutes.
- Waterfront contributes the highest total CO_2 reduction due to ridership volume.

WEST COAST EXPRESS RIDER SATISFACTION IS HIGH

- Overall satisfaction: 9.0/10
- 94% rate travel time as good/excellent
- 57% choose WCE because it is faster than driving
- Cleanliness, comfort, and safety drive loyalty

Study Methodology

The study integrates:

- GIS 1 km catchment mapping for population, employment, and land use
- Regression modeling with ridership as the dependent variable
- Accessibility index (bus, walk, bike, parking)
- Economic spillover analysis (business counts, commercial value)
- CO_2 reduction modeling using VKT displacement
- Rider perception surveys

Limitations include weekday only ridership focus, fixed catchment radius, and survey self selection bias

CONCLUSION ON WEST COAST EXPRESS SERVICE IN BC

The West Coast Express plays a vital role in:

- Connecting suburban communities to Vancouver's job core
- Reducing congestion and emissions
- Supporting local economic development
- Providing high quality, reliable commuter service
- Socio economic factors—especially employment density, accessibility, and park and ride capacity—are central to station performance. Enhancing multimodal integration and TOD can strengthen WCE's contribution to sustainable regional mobility.

Recommendation:

- Extend service hours beyond peak-only operations
- Leverage data-driven planning tools (AI forecasting, GIS analytics)

MAP
AND GENERAL INFORMATION OF
LOWER RIO GRANDE VALLEY OF TEXAS

No. on Map	Name of District	Local Name	Post Office Address	Acres in Brush	Acres Cultivated	Acres Irrigable	Canals, Rail Roads, Towns etc.	Gross Area in Acres
	ACTIVE DISTRICTS							
1	Cameron County W.I. Dist. No. 1	Harlingen District	Harlingen, Texas	4,227	34,633	38,900	3,066	42,571
2	Cameron County W.I. Dist. No. 2	San Benito District	San Benito, Texas	9,425	48,160	53,515	14,305	68,380
3	La Feria Irrigation Dist. C.C. No. 3	La Feria District	La Feria, Texas		28,300	28,300	4,253	30,553
4	Santa Maria Irrigation Dist. C.C. No. 4	Santa Maria District	Santa Maria, Texas	1,780	2,750	4,500	153	4,653
5	Cameron County W.C. & I. Dist. No. 5	El Jardin District	Brownsville, Texas	3,362	15,102	19,000	4,016	23,500
6	Cameron County W.C. & I. Dist. No. 6	Los Fresnos District	Los Fresnos, Texas	583	15,300	14,183	3,200	17,651
7	Cameron County W.C. & I. Dist. No. 7	West Brownsville Dist.	Brownsville, Texas	805	1,484	7,293	490	8,778
8	Cameron County W.C. & I. Dist. No. 8	Barreda Tract	Brownsville, Texas	6,300	3,486	11,786	977	11,786
9	Hidalgo & Cameron Co. W.C. & I. Dist. No. 9	Mercedes District	Mercedes, Texas	2,000	33,000	64,000	17,760	81,760
10	Cameron County W.I. Dist. No. 10	Rutherford Harding	Los Fresnos, Texas	2,762	976	3,734	1,245	4,979
11	Cameron County W.I. Dist. No. 11	Bayview Citrus Groves	Port Isabel, Texas	10,674	4,000	10,674	460	11,134
12	Cameron County W.I. Dist. No. 12	Kempner Tract	Los Fresnos, Texas	485	550	1,035	115	1,150
13	Cameron County W.I. Dist. No. 13	Arroyo Gardens	Brownsville, Texas	2,413	450	2,873	413	3,286
15	Cameron County W.I. Dist. No. 15	McLeod-Hood Tract	Harlingen, Texas	387	1,090	1,477	151	1,628
16	Cameron County W.I. Dist. No. 16	Rice Tract	San Benito, Texas	1,073	710	1,783	224	2,007
17	Cameron County W.I. Dist. No. 17	Dennis-Foster Tract	Olmito, Texas	1,151	290	1,441	209	1,650
18	Cameron County W.C. & I. Dist. No. 18	Adams Gardens	Harlingen, Texas	4,231	3,592	7,823	1,497	9,320
20	Donna Irrigation Dist. H.C. No. 1	Donna District	Donna, Texas	8,050	27,570	35,520	6,956	42,476
21	Hidalgo County W.C. & I. Dist. No. 1	Edinburg District	Edinburg, Texas	3,200	27,050	30,250	2,108	32,358
21a	Contracts to Water by H.C.W.C.& I.D. No. 1			12,252	3,120	15,372		15,372
22	Hidalgo County W.C. & I. Dist. No. 2	Pharr-San Juan Dist.	San Juan, Texas	6,640	44,900	51,526	13,152	64,900
23	Hidalgo County W.C. & I. Dist. No. 3	McAllen District	McAllen, Texas	427	6,331	6,763	929	7,737
24	Hidalgo County W.C. & I. Dist. No. 5	Progreso-Mercedes	Progreso, Texas	700	7,400	8,100	534	8,634
25	Hidalgo County W.I. Dist. No. 6	Engelman Gardens	Edinburg, Texas	1,555	7,500	9,055	1,579	10,634
26	Hidalgo County W.C. & I. Dist. No. 6	Goodwin Tract	Mission, Texas	12,000	9,000	21,000	2,103	23,103
27	Hidalgo County W.C. & I. Dist. No. 7	North Mission District	Mission, Texas	10,551	16,700	27,091	6,773	33,864
28	Hidalgo County W.C. & I. Dist. No. 11	Bentsen Tract	McAllen, Texas	177	774	951	136	1,087
29	United Irrigation Company	Mission System	Mission, Texas	3,420	14,500	17,960	2,631	20,600
	16 Small Independent Systems	in Cameron County		5,670	14,506	20,176	8,424	28,600
	14 Small Independent Systems	in Hidalgo County		1,473	4,800	6,213	2,605	8,720
			Total Active Districts	125,385	401,817	525,310	106,034	636,445
	INACTIVE DISTRICTS							
14	Cameron County W.I. Dist. No. 14			no record	no record	no record	no record	15,600
19	Cameron County W.I. Dist. No. 19	Monte Grande	Olmito, Texas	8,230	1,170	9,380	520	9,980
30	Rio Bravo Canal Company	Rio Bravo Tract		1,000	2,000	no record	no record	3,000
31	La Gloria Canal Company	La Gloria Tract		2,500	500	no record	no record	3,000
32	Hidalgo County W.C. & I. Dist. No. 12	Franklin Tract	Linn, Texas	no record	no record	no record	no record	30,000
33	Willacy County W.C. & I. Dist. No. 1	Willacy District	Raymondville, Texas	88,000	40,000	no record	no record	120,000
34	Starr County W.C. & I. Dist. No. 1	Starr County Dist.	Rio Grande City, Tex.	19,000	2,300	no record	no record	20,300
	Total Inactive Districts							225,160
	Total Active and Inactive Districts							861,605

Note. Inactive Districts are Districts not in operation.

CARS OF FRUIT & VEGETABLES SHIPPED BY SEASON 1927–1938

	1926–1927	1927–1928	1928–1929	1929–1930	1930–1931	1931–1932	1932–1933	1933–1934	1934–1935	1935–1936	1936–1937	1937–1938
Fruit	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Canned Fruit	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Vegetables	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total Cars	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Note— Shipment of fruit by other means than Rail Road, estimated Rail Road car loads. Shipment of vegetables by truck not shown, (no information available.)

MONTHLY AND ANNUAL MEAN TEMPERATURES

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	AN'L	Temperature below freezing: No. of days	Lowest
1911–1937, MEAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MONTHLY AND ANNUAL PRECIPITATION

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	AN'L	Total average wind velocity
1911–1937, MEAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE— TEMPERATURES, RAINFALL AND VELOCITIES OF WINDS FROM RECORDS OF UNITED STATES WEATHER BUREAU AT BROWNSVILLE, TEXAS.

1920 and 1930 Government Census of principal towns and Counties, with elevations.

Names of Towns, Counties	1920	1930	Elev.
Brownsville	11,791	22,021	35.0
Harlingen	1,784	12,124	36.0
San Benito	5,070	10,753	35.0
McAllen	5,331	9,074	122.0
Mercedes	3,414	6,608	65.0
Mission	3,847	5,120	140.0
Weslaco		4,879	75.0
Edinburg	1,406	4,821	92.0
Donna	1,579	4,103	84.0
Pharr	1,863	3,225	118.0
Rio Grande City		2,283	150.0
Raymondville		2,050	38.0
San Juan	1,303	1,615	[illegible]
La Feria	736	1,594	[illegible]
Port Isabel		1,177	[illegible]
Alamo		1,018	[illegible]
Rio Hondo		518	[illegible]
Lyford		734	[illegible]
Cameron Co.	36,662	77,540	
Hidalgo Co.	38,110	77,004	
Starr Co.	11,089	11,409	
Willacy Co.		10,499	

Note:- Willacy County was part of Cameron and Hidalgo Counties in 1920.

HIGH-SPEED RAIL POTENTIAL IN SOUTH TEXAS

The study combines **QGIS geospatial analysis** + **Gravity Model** to estimate ridership. It evaluates the feasibility of a **high-speed rail (HSR)** corridor between:

- Rio Grande Valley (RGV)
- Laredo Metro Area

Regional Context:

- Rio Grande Valley population (2020): 948,877
- Laredo Metro Area population (2020): 262,646
- Distance between regions: 146 miles (McAllen ↔ Laredo)

Geospatial Analysis Highlights

- City boundaries mapped and georeferenced in QGIS
- 50-mile buffer zones created around both metro areas
- Cities within catchment areas identified using Texas City Boundaries shapefile
- Ensures accurate population and distance inputs for modeling

GRAVITY MODEL RESULTS IN SOUTH TEXAS

Metric	Value
Total annual intercity passengers	2,922,907
Estimated HSR capture rate (30%)	876,872 riders/year

Key takeaway: Nearly **900,000 annual riders** could shift to high-speed rail.

Implication - There is strong natural travel demand between the two major South Texas population centers

HSR will:

- Reduce travel times
- Improve reliability
- Support business mobility and tourism
- Strengthen regional economic integration

ECONOMIC & CONNECTIVITY BENEFITS OF RAIL SERVICE IN SOUTH TEXAS

- Enhanced access to Laredo's international trade hub
- Expanded labor markets and business opportunities
- Job creation during construction and operation
- Potential to attract new investment and development

Limitations:

- Gravity Model simplifies real-world travel behavior
- Capture rate is an assumption
- Analysis uses 2020 population data
- No cost-benefit or engineering feasibility included

Recommendations

- Full feasibility study (engineering, cost, environmental review)
- Market demand & mode-shift analysis
- Corridor alignment & station location planning
- Explore funding models (including public-private partnerships)
- Stakeholder and community engagement

STRATEGIC STATION PLACEMENT FOR SUSTAINABLE COMMUTER RAIL DEVELOPMENT

Context: Transportation Challenges in South Texas

- RGV cities have grown rapidly without proportional transit investment.
- Heavy reliance on **Highway 83** has created severe congestion.
- Public transit is fragmented across three agencies with no regional rail integration.
- Rail is positioned as a sustainable, equitable alternative to car dependency.

Key Literature Insights

- Population density + transit connectivity are the strongest predictors of rail success.
- GIS is essential for overlaying demographic, environmental, and facility data.
- NEPA and Texas environmental regulations require early compliance.
- Equity frameworks (USDOT tools) ensure underserved community's benefit.

Findings

- Income shows a **negative correlation**, indicating higher transit dependence in lower-income areas.

Estimated Ridership (sample):

- Brownsville: 15,790
- McAllen: 14,462
- Mission: 9,793
- Rio Grande: 3,241

GIS SUITABILITY MAPPING FOR STATION DEVELOPMENT IN SOUTH TEXAS

GIS Suitability Mapping -Environmental overlays ensure stations avoid flood zones and sensitive habitats. Three high-priority zones emerge:

McAllen Zone

- Dense residential + commercial clusters
- Strong bus connectivity
- Major medical and retail facilities

Brownsville Zone

- Port access
- Airport proximity
- Strong bus network

Mission Zone

- Key rural connector
- Near proposed high-speed terminal
- Environmental overlays ensure stations avoid flood zones and sensitive habitats.

COMPOSITE STATION RANKING FOR RAIL STATIONS IN SOUTH TEXAS

Using the weighted suitability formula, these sites balance ridership potential, infrastructure readiness, and environmental feasibility.

Top 3 Station Sites:

- McAllen Central Station — 0.87
- Brownsville Port Access Station — 0.85
- Mission Medical District Station — 0.79

To create a seamless multimodal system:

- Co-locate stations with bus hubs
- Align schedules across agencies
- Implement shared GTFS feeds
- Develop unified fare systems
- Add park-and-ride, bike lanes, micro transit links

CONCLUSIONS OF PASSENGER RAIL STATION ANALYSIS IN SOUTH TEXAS

The study confirms that **McAllen, Brownsville, and Mission** are the optimal initial station locations for a commuter rail system in the RGV. These cities offer the strongest combination of:

- Ridership potential
- Transit accessibility
- Facility proximity
- Infrastructure readiness
- Environmental feasibility

POLICY RECOMMENDATIONS FOR RAIL STATION DEVELOPMENT IN SOUTH TEXAS

- Phase implementation starting with the top three stations.
- Begin NEPA and permitting early to avoid delays.
- Strengthen multimodal integration with bus, bike, and micro transit.
- Pursue federal/state funding (FTA CIG, TxDOT Rail Division).
- Use PPPs for station-area development.
- Adopt equity-driven policies (tiered fares, subsidies).
- Embed climate resilience in design and construction.

DART SILVER LINE PROPERTY VALUE ANALYSIS

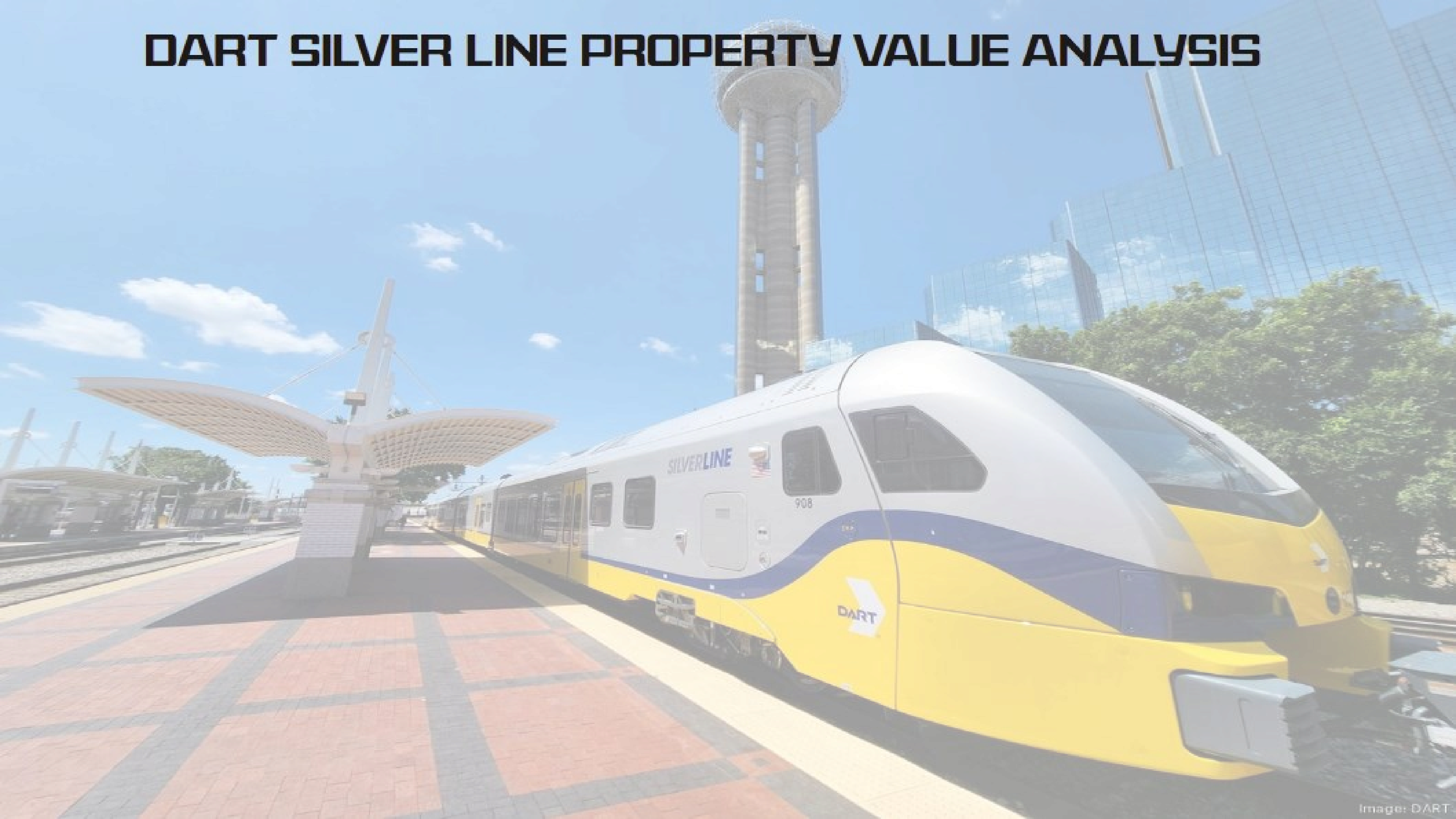


Image: DART

DART SILVER LINE PROPERTY VALUE ANALYSIS

Key Findings:

- Properties within 0.5-mile radius of stations show 2–3x higher appreciation than 1-mile radius
- Commercial properties near stations grow fastest (up to 8.1% annually)
- Growth phases in 5-year intervals:
    - Rapid / Maturation / Stabilization

- 1-mile properties: 88.7% growth
- Commercial properties most sensitive to transit proximity
- Land value outpaces improvement value
- TOD drives premium appreciation

The DART Silver Line is a transformative infrastructure investment with clear property value impacts. Strategic, diversified investment near transit hubs offers strong returns and long-term growth. Diversified investment across stations and property types is recommended

PASSENGER RAIL FEASIBILITY STUDY:

CALGARY – LETHBRIDGE – MEDICINE HAT

INTEGRATED TRAVEL
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FEASIBILITY STUDY: CALGARY – LETHBRIDGE – MEDICINE HAT PASSENGER RAIL

Assessment of a proposed regional passenger rail service connecting Calgary, Lethbridge, and Medicine Hat.

Recommended Upgrades:

- Track strengthening & realignment
- Modernized signalling
- Double tracking in high traffic segments
- Yard modernization
- CCTV, secure boarding, communication systems

Cost Ranges:

- Track upgrades: $2–5M/km
- Double tracking: $3–7M/km
- Yard modernization: $50–150M
- Electrification: $3–5M/km
- Bridge upgrades: $50–100M

TICKETING & SERVICE PLAN CALGARY – LETHBRIDGE – MEDICINE HAT PASSENGER RAIL

Estimated ticket prices: $34.79–$45.40 CAD

Proposed travel times:

- Calgary → Lethbridge: **1.5–2 hours**
- Lethbridge → Medicine Hat: **1–1.5 hours**
- Calgary → Medicine Hat: **2.5–3 hours**

Service frequency:

- Multiple daily departures
- Peak/off-peak schedules
- Weekend & holiday service

The Calgary–Lethbridge–Medicine Hat passenger rail corridor is not only feasible but offers economic, environmental and quality of life goals.

Challenges remain (funding, infrastructure upgrades, ridership optimization), but the long-term benefits strongly support advancing the project to detailed planning and stakeholder engagement.

HYDROGEN INTEGRATION FOR LOW-EMISSION LOCOMOTIVE SYSTEMS

GLOBAL HYDROGEN LOCOMOTIVE DEVELOPMENTS

H2 LOCOMOTIVE TEST PROJECTS

United States – Stadler FLIRT H2

- $127M California partnership
- 130 km/h top speed
- 1,742 miles on a single refuel
- In service on the Arrow Corridor

Canada – CPKC Hydrogen Program

- Hydrogen–battery hybrid locomotives (Units 1001, 1200)
- 1.2 MW traction power
- Hydrogen production + refuelling hubs in Calgary, Edmonton
- **First mainline hydrogen refuelling station in Golden, BC (2025)**

South Korea – Hyundai Rotem LH2

- Liquid hydrogen locomotive development
- Focus on high-energy-density storage

Overall Conclusions

- Hydrogen is a **viable, low-emission locomotive fuel**, offering:
- 30–50% NOx reduction
- Zero CO_2 and CO emissions when used in fuel cells
- Strong alignment with global decarbonization goals

However, successful deployment requires:

- High-pressure combustion validation
- Scalable hydrogen production and refuelling infrastructure
- Updated safety standards
- Continued advances in fuel cell and SOFC hybrid systems
- Hydrogen's role in rail is accelerating globally, and the technology is approaching operational maturity for regional passenger and freight applications.

This study evaluates hydrogen's potential as a low emission locomotive fuel, using NASA CEA combustion simulations and a review of global hydrogen rail technologies. It compares hydrogen with naphthalene (diesel proxy), ammonia, and acetylene, and examines fuel cell and SOFC hybrid systems. The findings confirm hydrogen's strong environmental advantages and highlight the engineering, safety, and infrastructure requirements for real world deployment.

Overall Observation

Hydrogen consistently:

- Lowers flame temperature
- Reduces carbon-based NOx pathways
- Improves combustion stability
- Cuts NOx by 30–50% depending on blend and pressure

HYDROGEN INTEGRATION FOR LOW-EMISSION LOCOMOTIVE SYSTEMS

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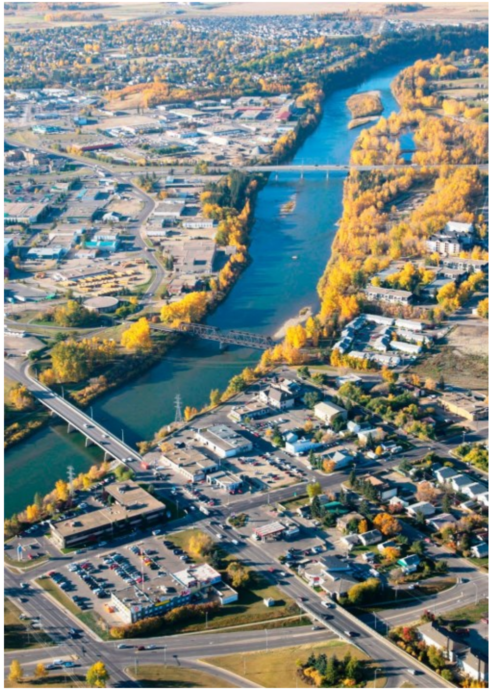
CALGARY TO EDMONTON REGIONAL RAIL FEASIBILITY STUDY

CALGARY–EDMONTON CORRIDOR

- The Calgary–Edmonton Corridor is the most urbanized area in Alberta and is one of Canada's four most urban regions.
- Measured from north to south, the region covers a distance of approximately 400 km (250 mi). It includes the metropolitan areas of Calgary and Edmonton and cities of Airdrie, Red Deer, Lacombe and Wetaskiwin.
- Population is expected to be 6.9 million in 2045



PHASING & SEQUENCING TO DEVELOP REGIONAL PASSENGER RAIL IN ALBERTA

The report develops a **phased, financially realistic, and politically feasible** plan to reinstate passenger rail service in the **Calgary–Edmonton corridor**, Alberta's economic backbone. Using cost benchmarking, demand modeling, and multi-criteria analysis, the study identifies a **CAD 3.4B capital requirement** and recommends a **three-phase rollout** that maximizes early ridership, minimizes risk, and supports long-term corridor development.

The strongest early-value strategy is to begin with **Calgary–Airdrie** and **Edmonton–Leduc**, capturing high demand with minimal infrastructure complexity.

PHASING & SEQUENCING TO DEVELOP REGIONAL PASSENGER RAIL IN ALBERTA

Corridor Context

- The Calgary–Edmonton corridor holds **80% of Alberta's population and GDP**.
- Current travel options rely almost entirely on **Highway 2/QEII**, which faces congestion up to **92,000 AADT**.
- Population expected to grow from **4.2M to 6.9M by 2051**.
- Passenger rail was discontinued in 1985; reinstatement addresses congestion, emissions, and mobility gaps.

SCQ (Situation–Complication–Question)

- Situation: High population and economic concentration but limited intercity mobility.
- Complication: Rising demand + congestion + CAD 3.4B capital requirement.
- Question: How to deliver a feasible, phased rail system that provides early value and reduces risk?

MCDA Criteria

- Capital cost
- Demand & revenue potential
- Social benefit
- Environmental impact

MAIN RAIL STATION DEVELOP BUDGET FOR REGIONAL PASSENGER RAIL IN ALBERTA

Station Typology & Cost Assumptions:

Main Stations (Calgary, Edmonton)

- High demand anchors
- Iconic architecture
- Cost: ~CAD 140M each

Secondary Stations (Airdrie, Red Deer, Leduc)

- Regional Hubs
- Cost: ~CAD 50M each

Tertiary Stations (Local stops)

- Low-cost infill
- Cost: ~CAD 20M each

COST BENCHMARKING REGIONAL PASSENGER RAIL IN ALBERTA

Using Brightline Florida as a benchmark:

- 105 km = CAD 1.075B (2025 value)
- 325 km Calgary–Edmonton ≈ CAD 3.4B (tracks + stations)

Rolling stock estimates:

- Siemens Ventura: CAD 30–50M per trainset
- 10 trainsets: CAD 300–500M
- Diesel alternatives: CAD 150–350M

Demand & Revenue Analysis

Based on Arduin & Fryer (2022):

- 5.2M annual riders projected
- Highest demand between Calgary–Airdrie and Edmonton–Leduc
- Full corridor fare benchmark: CAD 40
- Estimated revenue based on distance × demand × CAD 0.13/km

Note - Red Deer is the strongest mid corridor anchor.

BUILDOUT OF A REGIONAL PASSENGER RAIL SYSTEM IN ALBERTA

- Early rail service development phases should focus on shorter, high demand segments, connecting Downtown Calgary, Calgary International Airport, Airdrie, Leduc, Edmonton International Airport and Downtown Edmonton.
- Tertiary stations should be added only after core ridership stabilizes.
- A three-phase structure minimizes testing and certification delays.

  - Calgary–Airdrie + Edmonton–Leduc
  - Red Deer
  - All tertiary stations

The phased development plan will offer:

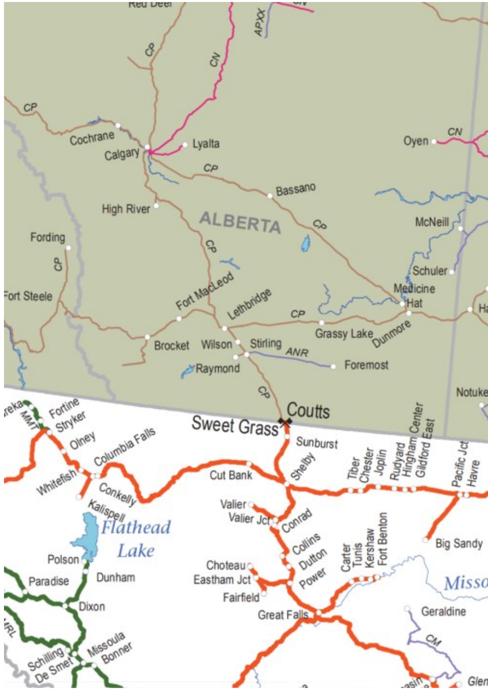
- Highest early ridership
- Lowest early capital requirement and minimized capital risk per rider
- Strong political feasibility
- Fastest early wins and enables scalable expansion along the corridor

ALBERTA TO MONTANA REGIONAL RAIL FEASIBILITY STUDY

REGIONAL RAIL BENEFITS TO ALBERTA – MONTANA CORRIDOR

We believe that a US-Canada “Responsible Rail” project like the one we are proposing has the potential to build prosperity for both countries.

- **Increased tourism:** by connecting Banff, Glacier, Yellowstone.
- **Enhanced economic connections**: by increased trade and economic activity between Montana and Alberta.
- **Enhance the quality of life:** through better mobility and positive environmental impacts.
- **International airport/destinations connections:** by linking Calgary International Airport add additional departure airport gateways for Montana communities.



ALBERTA TO MONTANA REGIONAL RAIL FEASIBILITY STUDY

- Environmental impacts caused by the number of tourists visiting national parks in Alberta and Montana by passenger vehicles will be mitigated via a bus shuttle last mile solution coupled with a frequent, affordable and reliable passenger rail service linking Banff, Waterton, Glacier and Yellowstone National Parks. Since 1950 , annual visitation to these parks continues to grow an average of 2 % annually.

- In 2024 Banff National Park attracted 4.3 million visitors. Glacier National Park in Montana attracted 3.2 million visitors, Waterton Lakes National Park welcomed 540,000 visitors and Yellowstone National Park attracted 4.7 million visitors.

- The majority of the visitors travel to only to one of the Parks.

- Given 12.74 million visitors traveled to the region's national parks in 2024, it is likely that many of the visitors would consider to travel via an experiential tourism train while vacationing in this area. The proposed daily service from Calgary would be attractive to nearly 27 million passengers who fly into Calgary (18.9 million passengers) and Edmonton (7.92 million passengers).

- A passenger rail service linking the national parks daily will mitigate vehicle congestion in the national parks and provide additional jobs within the tourism sector.

Next Steps:

A comprehensive assessment of the potential for responsible and sustainable transportation to the region via a tourism train is recommended. The study is expected to thoroughly examine the following:

- Positive and negative impacts of RR transportation system on the Alberta and Montana economies.
- Impacts on tourism, particularly the increased visitation to Banff, Glacier, Waterton and Yellowstone National Parks through the connectivity provided by the rail including environmental impacts.
- Economic benefits to both large and small communities in both countries, as well as the potential benefits to indigenous communities.
- Environmental benefits of rail travel compared to car and air transportation, including carbon reduction targets.
- Positive and negative safety of the rail system and rail over other forms.
- Cost of both start-up and operational capital costs will be analysed, as well as potential capital funding models and government support from both Canada and the United States.

FUNDING GOALS :
SPONSORSHIPS AND RESEARCH CONTRACTS

To Continue this Valuable Research ITRD seeks:

- **Funding to complete investment grade feasibility studies.**
- **Support the creation of regional rail transportation authorities to manage all aspects of the proposal process.**
- **Complete Capital expenditures (CapEx) and environmental impact plans for rail corridors**

Q&A

iTRD

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