




## AN EVALUATION OF RAPID TRANSIT OPTIONS FOR THE REGION OF WATERLOO

Last Updated: 2011-03-10	TECHNOLOGY OPTIONS	Bus Rapid Transit (BRT)	Light Rail Transit (LRT)	Aerobus / Aerorail	NOTES:
					Note: Of the ten (10) options analysed by the Region, only three (3) are presented here. The others were eliminated due to cost prohibitiveness.
Criteria from Terms of Reference	All criteria are scored on a scale of ★ (poor) to ★★★★★ (excellent)	Dedicated bus lanes	On-grade rail infrastructure	Above-grade suspension rail	
Reurbanization (Regional Growth Management Strategy)	System Flexibility	★★★★	★★★★	★★★★★★	All assessed technologies are generally flexible in their ability to integrate with other infrastructure, but on-grade solutions inherently require more re-construction of urban routes. Aerorail can dock at grade, above grade, or below grade, and is the most flexible.
	Environmental Impact of Construction	★	★	★★★★	Both BRT and LRT will require extensive reworking of roads, bridges, rail crossings, and buildings. Aerorail avoids nearly all re-construction of existing infrastructure.
	Environmental Impact of Operation	★★	★★★★	★★★★	Hybrid busses are available, but electric trains are preferred. LRT will run less efficiently than Aerorail because of coordination with other on-grade traffic.
	Land use Compatibility	★	★	★★★★★★	BRT and LRT require extensive roadwork. Aerorail requires minimal footprint from support pilons, and can span up to 600m (2000 ft) between pilons.
	Operating Constraints	★★★★	★★★★	★★★★★★	BRT and LRT offer simple station designs on grade that are largely compatible with existing and planned urban environments, excepting noteworthy challenges around pedestrian and cyclist safety. Aerorail offers increased flexibility, stations that may be on/at/above grade, thus separating the transit infrastructure from automobile traffic, but maintaining flexible accessibility.



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	Urban Design Objectives	★★★★	★★★★	★★★★★	All solutions are fully compatible with Regional growth and urban revitalization strategies. Aerorail, being above grade, leaves more at-grade space available for commerce, and enables the transit system to operate at higher speeds without complications to at-grade activities.
Safety	Pedestrians	★★★	★★★	★★★★★	BRT and LRT are hazardous to pedestrians and cyclists, especially in winter weather. Major transit systems have annual fatalities. Because of the required number of route crossings with existing infrastructure in our Region, the only fully safe solution is above-grade. Lightning protection for all three systems is readily available, standardized, and in common use.
	Cyclists	★★★	★★★	★★★★★	
	Other Road Vehicles	★★★	★★★	★★★★★	
	Lightning protection	★★★★★	★★★★★	★★★★★	
	Winter Weather Sensitivity	★★★	★★★	★★★★★	
Service Quality	System Compatibility	★★★★	★★	★★★★★	BRT can leverage existing infrastructure, but needs new dedicated lanes. LRT can use existing rail beds, but needs extensive infrastructure built. Aerorail integrates readily with existing buildings and road grid.
	System Accessibility	★★★★	★★★★	★★★★★	Stations for any transit system can be made usable, but Aerorail stations are the easiest to locate in ideally accessible locations. BRT and LRT are more tied to following existing grid patterns, while Aerorail can simply fly over, then lower down to an accessible station.
	Service Frequency	★★★★	★★★★	★★★★★	BRT and LRT are limited by all other at-grade traffic.
	User Experience	★★★	★★★	★★★★★	LRT can be exciting, but is amazingly frustrating when stuck in traffic and unable to reach speed. BRT is limited by traffic. Aerorail is liberating, and offers a scenic view of the City.



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	Emergency Evacuation	★★★★★	★★★★★	★★★★	Emergency situations obviously vary: at grade is relatively simple, and evac of Aerorail is consistent with other monorail and above-grade systems in common use (eg: at the Toronto Airport).
Threshold Capacity	Ridership/Capacity	5,000 - 12,000/hr	9,000 - 20,000/hr	5,000 - 20,000/hr	BRT/Aerorail are best suited to today; LRT/Aerorail are best suited to long-term. Aerorail has best flexibility to start modestly today and grow with ridership.
	Speed	★★★	★★	★★★★★	BRT would be faster than LRT through the urban cores, but both are severely limited by the need to coordinate with on-grade traffic: studies done by the Region have already shown BRT and LRT to be less rapid than existing GRT in the urban cores. All technologies have similar max speeds, but Aerorail will have room to reach speed.
	Expandability of Carrying Capacity	★★★★	★★★★	★★★★★	BRT can add buses. LRT can add trains. Aerorail can extend cars and/or add trains.
Integration / Expansion	Effectiveness of Coverage	★★★★★	★★★★★	★★★★★	All three solutions would be designed on arterial corridors that would integrate GRT feeder routes, and can adequately access the Region's centres.
	Compatibility with Existing Road/Rail Infrastructure	★★★	★★★	★★★★★	BRT and LRT are substantially incompatible with Waterloo Uptown, Kitchener Downtown, Eagle St, and the Grand River, either creating significant new traffic congestion (reducing existing road space) or significant new transit infrastructure costs. Aerorail simply flies over, and can span up to 600m (2000 ft) between support pilons.
	Inclusiveness of Cambridge	★★★★	★	★★★★★	BRT integrates Cambridge; LRT is cost prohibitive to Cambridge; Aerorail will offer a high-speed artery.
	Potential to integrate with VIA, GO Transit, GRT	★★★★★	★★★★★	★★★★★	All proposed technologies integrate readily with other forms of transit.
	Ability to Start Small	★★★★★	★	★★★★★	BRT and Aerorail can start with a modest ridership. LRT is not well suited to our current population.



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	Suitability in 2030	★	★★★★★★	★★★★★★	BRT is a short-term fix that will not work in 2030.
	Expandability of Network to Include Additional Routes	★★★★	★★★	★★★★★★	BRT can add routes - rapid routes require dedicated infrastructure; LRT requires substantial infrastructure; Aerorail requires modest infrastructure.
	Opportunity to add routes for nearby towns: Elmira, Breslau, Baden, New Hamburg...	★★★★★★	★	★★★	BRT is the simplest opportunity by which to integrate adjacent communities.
	Opportunities to add routes for less proximate centres: Stratford, Guelph, Brantford...	★★★★★★	★	★★★	BRT is the simplest opportunity by which to integrate adjacent communities.
Job Creation	Job Creation Potential	★★★	★★★	★★★★★★	BRT/LRT will create infrastructure construction jobs; Aerorail has potential to create manufacturing jobs too.
	Ownership Potential	-	-	★★★★★★	Aerorail is looking for a flagship City to call home, and is willing to sell part-ownership to local partners.
	Academic Research Potential (i.e.: UW / WLU / CC jobs)	★	★	★★★★★★	Simply put, BRT and LRT have been done; Aerorail, though built from established subsystems and proven technologies, is yet new and fresh.
Cost & Financial Risk	Construction cost	\$20M/km	\$35M/km	\$10-15M/km	Note that BRT and LRT typically include extensive externalities in the budget, such as complimentary infrastructure improvements, which have historically driven budgets up to nearly double the prices shown. Aerorail avoids the threat of these extra costs by being above grade.
	Construction Time	★★★	★★★	★★★★★★	Aerorail could be operational within 6-9 months from approvals; BRT-LRT will require 2-3 yrs. Construction minimum. Time for approvals is in addition to either.



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Disruptiveness of Construction	★ ★ ★	★ ★	★ ★ ★ ★ ★	BRT and LRT infrastructure construction will require extended road closures that will affect businesses adversely. Aerorail is much less disruptive and will not require road closures.
Ability to Build Small Pilot Projects and Phase Growth	★ ★ ★ ★ ★	★ ★	★ ★ ★ ★ ★	iXpress is a BRT pilot. A pilot-scale Aerorail project could be built in Waterloo from WLU to UW to RTPark for ~\$50M and commissioned in ~6-12 mos, showcasing stops at grade, above grade, and in a building, all for the same cost as the current roadwork project at Weber & the VIA/CN rail crossing. An LRT pilot project would be difficult to define with a meaningful ridership.
Local Manufacturability	★ ★ ★	★ ★ ★	★ ★ ★ ★ ★	BRT/LRT infrastructure can be constructed with local trades, but components will all be purchased from elsewhere. Aerorail body shell is the only component that cannot be fabricated locally within SW Ontario.
Established Technology	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★	Aerorail is designed from well-proven subsystems, but is an otherwise new technology. Aerorails are under construction in China and Malaysia, but none are yet operational. BRT and LRT are well proven.
Proprietary Technology and ability to bid competitively	★ ★	★ ★	★ ★ ★ ★ ★	BRT and LRT are fully proprietary, and tie us to one vendor (eg: Bombardier): only infrastructure work can be bid. Aerorail body shell is proprietary, but all other components are based on common industry supply and can be bid competitively.
Operations & Maintenance Cost	★ ★ ★ ★	★ ★ ★	★ ★ ★ ★ ★	All major transit solutions in the world run at an operating loss (Toronto is one of the world's most profitable at only 20% loss) and are tax subsidized. Aerorail has potential to actually break even.



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Social Transformation	Comprehensiveness of Demographic Appeal	★ ★	★ ★ ★	★ ★ ★ ★ ★	While campaigning for the 2010 municipal election, several candidates asked residents about various transit options. CREW was advised by several candidates that above-grade transit seemed to be the most exciting, and the most likely to attract new users, especially among boomers and zoomers. BRT and LRT would service the core reasonably well, but would pose limited to no attraction to suburbians or others who typically drive.
	Role Leadership - reputation	★ ★	★ ★	★ ★ ★ ★ ★	Like the Blackberry, Aerorail is built from known technologies and proven subsystems, but it does something new and exciting.
	Impact on Other Municipalities	★ ★ ★	★ ★ ★	★ ★ ★ ★ ★	Other mid-size growing centres (eg: Guelph, London) are watching our transit project: we will either lead well or lead badly, and our reputation will either shine or tarnish. Especially if we bring local manufacturing to the Region (eg: Aerorail), we will have opportunity to promote and sell it to other growing regions.
	Community Growth	★ ★ ★ ★	★ ★ ★ ★	★ ★ ★ ★ ★	All three solutions will help service increasing population and thus facilitate community growth, but Aerorail is the most flexible, and can most easily start with a small ridership and grow with the population.
	Urban Redevelopment	★ ★ ★ ★	★ ★ ★ ★	★ ★ ★ ★ ★	All three solutions will attract development to the transit corridor, but Aerorail is the most exciting technology, and can be expected to attract more attention than other technologies.



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### Conclusions:

1. BRT and LRT are two common solutions implemented broadly in the transit industry: an industry where most systems operate at a loss and need to be forever tax subsidized. Aerorail, in contrast, represents an opportunity to achieve a transit system that pays for itself.
2. BRT and LRT will both present noteworthy challenges in infrastructure construction, imposing very expensive infrastructure rework projects that will significantly affect traffic, that will disrupt local business, and that will endure for an extended period of time, all along core arterial routes, in several cases leaving permanent impact (reduced lanes on several arterial routes). Further, history has shown that the degree of infrastructure rework required is rarely adequately budgetted in advance, and that we should expect the project budget to as much as double by the time all final costs are in. Aerorail is much simpler and less disruptive to install, will have minimal impact on traffic during construction, no adverse impact on local businesses, will leave no lasting encroachment on existing traffic arteries, and is much less sensitive to the typical causes for cost-overruns.
3. Both BRT and LRT will need to integrate with on-grade traffic and make frequent stops in the downtown cores: they will not be able to be rapid, and will in fact be slower than existing GRT service. Aerorail avoids this entirely, and would be a truly rapid transit solution.
4. Aerorail is the most cost effective solution, can be constructed largely from components supplied locally, and is not encumbered by the same patents and proprietary relationships as either BRT or LRT: it can be fully serviced in the aftermarket at reduced cost.
5. Aerorail is the only solution proposed which can start at a scale that is appropriate for our current population, and also grow as ridership grows to service our future expected population, while properly respecting and integrating Cambridge from day 1.
6. Aerorail can do everything that LRT can do and more, for less than the cost of BRT. Although Aerorail is new and cannot yet be visited elsewhere, it is built on well proven sub-systems, and can be constructed at a pilot scale for modest cost.
7. Aerorail is a form of LRT, and is fully compliant with the requirements of the funding offered by the Provincial and Federal governments. All three solutions will receive support funding from the upper tier governments in the same amount.
8. Aerorail offers tourism appeal, with increased potential for building ridership on evenings, weekends, holidays, and for recreational purposes.
9. Aerorail is innovative, is well suited to our region's reputation for being one of the smartest regions of the world, and can be built on pilot scale: all the benefits of Aerorail can be secured with minimal risk, and without committing to expanding it to the whole region.

### Recommendations:

1. The Region of Waterloo should commission a Pilot System of three (3) Aerorail stations to be installed from the Research & Technology Park campus (RTPark) to the University of Waterloo campus (UW) to Wilfrid Laurier University campus (WLU). This pilot installation could then be monitored through the winter, studied copiously by interested stakeholders, and proven. When successful, the system could readily be expanded as the basis of our Region's future transit solution. If unsuccessful, then Waterloo Region would have invested only \$50M (comparable to roadwork) in a world-leading technology that can still be easily integrated with any other transit solution we would desire. We will have captured all the benefits that Aerorail can offer us with minimal risk, and can move confidently forward with more traditional technologies of our choosing.



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### *CREW wishes to thank the following contributors to this report:*

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CREW gratefully acknowledges the financial contributions from the following locally based organizations which made this report possible:

