BEST PRACTICES
IN RAPID TRANSIT SYSTEM DESIGN

A Rapid Transit System design guide for residents, advocates, and policymakers in Montgomery County, MD

Cleveland HealthLine. Image by Dan Malouff.

CONTENTS

Introduction and executive summary 2

Dedicated lanes 8

Frequent, reliable service..... 14

Stations 18

Vehicles 24

Accommodations for people walking and biking 28

Branding 34

Finance 36

Conclusion 38

Notes 39

RAPID TRANSIT FOR MONTGOMERY COUNTY

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INTRODUCTION AND EXECUTIVE SUMMARY

A Las Vegas SDX station. Image by K. Hercwad on Flickr.

MONTGOMERY COUNTY, MARYLAND'S planned Rapid Transit System (RTS) offers an incredible opportunity to improve access to transportation options for residents, attract companies and maintain economic competitiveness, and to remake the county's aging commercial corridors into walkable, sustainable places.

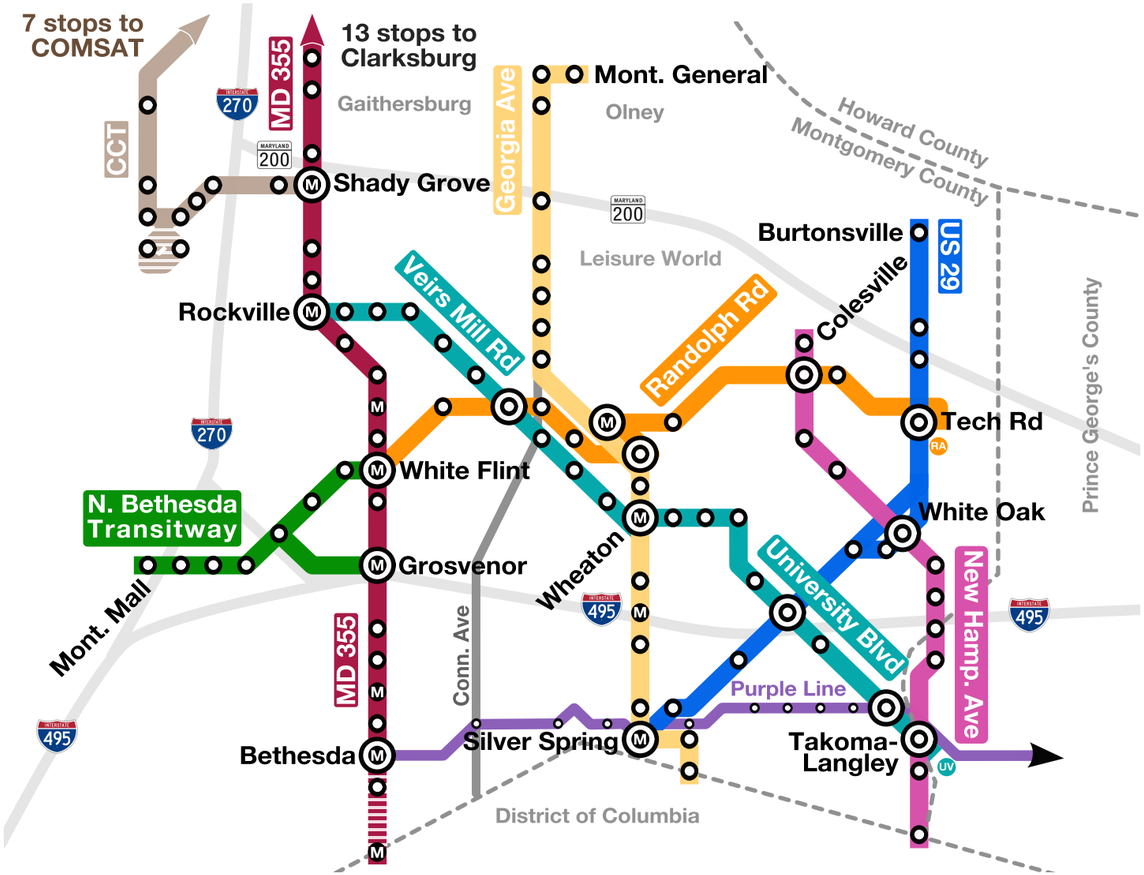
A rapid transit system (also referred to as bus rapid transit) is a mode of mass transit that applies many features of rail transit onto surface streets to deliver high quality, frequent transit service at a far lower cost than rail. Many have referred to it as "Metro on rubber tires." The primary features of RTS include dedicated lanes for vehicles to bypass traffic, frequent and reliable service, stops spaced farther apart than local buses, comfortable stations, and features to speed boarding times, such as off-board payment systems and level boarding.

As of 2015, there are more than 30 bus rapid transit systems in operation across the US and Canada and more than 25 others in planning. Many have been running since the early 2000s and have greatly exceeded expectations for ridership and service. Many have also expanded into full RTS networks with multiple lines, just as Montgomery County hopes to do.

Other rapid transit systems around the country

City	Name	Length	# of Lines	Weekday Ridership	Corridor Ridership Change	% Riders Who Previously Drove	Replaced Existing Bus Route?	Increase in Service (Compared to Local Bus)
Eugene, OR	EmX	11.8 mi	2	10,000 (2012)[1]	First year: +100%[2]	First year: 16%[3]	Yes	27% faster[4]
Los Angeles	Orange Line	18 mi	1	29,845 (2015)[5]	First year: +51%[6]	First four years: 25%[7]	No	Up to 100% faster[8]
Seattle	RapidRide	64 mi	6	53,500 (2014)[9]	First four years: 39%[10]	-	Yes	up to 69% faster[11]
Cleveland	HealthLine	10.9 mi	2	15,800 (2013)[12]	First two years: +60%[13]	First four years: 18%[14]	Yes	34% faster[15]

Routes approved in Montgomery's 2013 Countywide Transit Corridors Functional Master Plan[16]



Route name	Start	End	Route length (miles)	Forecast 2040 daily ridership[17]	In planning (2015)
355 North	Rockville Metro	Redgrave Pl (Clarksburg)	15.3	21,550	Yes
355 South	Bethesda Metro	Rockville Metro	7.8	43,900	Yes
Veirs Mill Road	Rockville Metro	Wheaton Metro	6.2	18,200*	Yes
US 29	Eastern Avenue	Burtonsville Park & Ride	12.3	15,850	Yes
Corridor Cities Transitway	Shady Grove Metro	Frederick County Line	20.1	35,900 (2035)[18]	Yes
Georgia Avenue North	Wheaton Metro	Montgomery General Hospital (Olney)	9.6	12,300	No
Georgia Avenue South	Eastern Avenue	Wheaton Metro	3.9	12,300	No
New Hampshire Ave	Eastern Avenue	Colesville Park & Ride	8.5	9,900	No
North Bethesda Transitway	Montgomery Mall	Grosvenor or White Flint	2.7	10,150	No
Randolph Road	White Flint Metro	Tech Rd (at US 29)	10.1	11,000	No
University Boulevard	Wheaton Metro	Takoma/Langley	5.5	18,200*	No

**University Boulevard was modeled with Veirs Mill Road, but studies have not yet begun for that part of the corridor.*

In 2013, the Montgomery County Council unanimously approved an 81-mile Rapid Transit System, otherwise known as its Countywide Transit Corridors Functional Master Plan, in what may be the most ambitious RTS plan for any suburban jurisdiction in the United States. The approved corridors will connect the county's major neighborhoods, employment centers, and commercial corridors. It will make high-quality transit accessible and convenient to a far greater population than ever before.

A Rapid Transit System's success stems from the combination of several features that together provide a high-quality service for riders, and the resulting flexibility to adapt RTS to the particular needs of the communities along the routes. While there is no one size fits all solution, successful systems around the country frequently combine many of the following best practices for each RTS feature:

Dedicated lanes

- Dedicated lanes should be utilized along as much of the corridor as possible. Dual median lanes are considered preferable to a single median lane or curb lanes, though all improve transit service significantly.
- Lane widths for dedicated lanes should be between 11'-13', and as little as 10' in station areas. General travel lanes should be 10' for improved safety, and to allow space for improved access for people bicycling or walking.
- To keep dedicated lanes free from traffic, rapid transit systems can physically separate them with flexposts, low curbs, or colored paint (often red) to distinguish the lanes from general traffic.
- An enforcement plan is essential to maintain traffic-free dedicated lanes.

Frequent, reliable service

- At peak hours, vehicles should arrive every 5-10 minutes. At other times, there should be a maximum of 10-12 minutes between vehicles.
- Service spanning 18-20 hours/day best serves a diversity of riders and trips.
- Implementing Transit Signal Priority (TSP) at major intersections has proven essential to reducing delay for rapid transit systems around the country.
- The schedules, transfers, payment, and routes should be well thought out and integrated with other routes and transit modes to enable seamless transfers.

Stations

- Stop spacing can vary between 0.2 miles in the most dense locations to over one mile, but to speed service, should generally be further apart than local bus stops.
- Stations should be sized differently depending on their location and expected ridership. They should be no less than 10' wide (12' preferable) and 60' long to accommodate one articulated bus, and 140' to accommodate two.
- Stations can best speed and ease boarding for passengers with disabilities, strollers, and bicycles by having 14-15" curbs to enable level boarding. Bridge plates, which fold or extend out when the doors open, can help bridge the gap between the platform and the bus floor.
- Stations should have machines for passengers to purchase fares before they board to speed boarding.

- Other station features that improve passengers' experience include real-time arrival information, adequate lighting, safe access for people walking and biking to the station, clear route maps, seating, bike parking, and weather protection for colder climates.

Vehicles

- Vehicles should ideally be articulated, 60' long, have three or more doors, and have doors on both sides to be able to access curb or median stations.
- Vehicles should have interior bicycle racks and Wi-Fi for passenger convenience.
- Vehicles should utilize the greenest technology possible, especially as electric buses become more affordable and available.

Accommodations for people walking and biking

- People walking should have a continuous network of safe, accessible pathways on both sides of the street to enable safe, direct access to stations.
- Sidewalks should be a minimum of 6' wide, and have some sort of buffer – trees or landscaping, bike facilities, or parked cars – between the sidewalk and traffic.
- Intersections should be made safe and comfortable for people walking by providing 6' median refuges, high visibility crosswalks, and by narrowing crossing distances where possible using curb extensions. In some cases where no traffic signal exists, a pedestrian-activated signal should be considered.
- People biking should have access to a continuous network of low-stress facilities to connect to stations, and to cross RTS corridors.
- Protected bike lanes are now widely seen as a best practice, especially on high speed streets with multiple travel lanes such as RTS corridors. A shared use path could also be appropriate in some locations.
- Traditional bike lanes and sharrows should be used only on lower speed neighborhood streets.

Branding

- Branding distinct from other services and unified between signage, vehicles, and stations has been very successful in marketing RTS to new riders in other cities.
- Transit agencies should invest in a marketing plan, especially for new systems, to spread awareness and build ridership.

Finance

- Most rapid transit systems utilize a combination of state, local, and federal funding sources. Many depend on a dedicated funding source such as a sales or property tax increment.

This reports further examines the best practices for each RTS feature, based on examples from successful systems around the United States and Canada. It aims to educate and assist policy makers, community leaders, transit riders, and all residents in advocating for the best possible system for Montgomery County, Maryland.

Cleveland HealthLine. Image by Dan Malouff.

DEDICATED LANES

Metroway in Alexandria, VA. Image by Dan Malouff.

DEDICATED TRANSIT LANES, which enable vehicles to bypass traffic on busy roads, are one of the most important features of a successful rapid transit system (RTS). People driving benefit too, since they won't get stuck behind transit vehicles stopping for riders, and the higher transit speeds will encourage many drivers to shift to the RTS.

If designed well, dedicated lanes can be successful on roads of all shapes and sizes, from divided highways to downtown streets.

TREATMENTS

Dual median lanes: Dual median lanes are considered the highest quality treatment for RTS because they minimize conflicts with turning vehicles, and therefore can deliver the most "rapid" service.

Curb lanes: Where there is not enough space in the roadway to have two lanes and a station in the median, curb lanes can be used. Some cities, including Seattle and Houston, have implemented what they refer to as Business Access & Transit (BAT) lanes, which are curb lanes that allow vehicles to share the lane for one block only if they need to turn right or access a local business.

Single median lane: A single median lane may be used where space is very limited. The single lane can be bidirectional, where vehicles going in both directions can share one lane and use queue jumps to pass each other -- the Eugene, Oregon, EmX system includes such a treatment. The lane can also be reversible, as is currently the case for traffic lanes on Georgia Avenue and Colesville Road in downtown Silver Spring. With

Dual median lanes on Metroway in Alexandria, VA. Image by Kelly Blynn.

Los Angeles Orange Line's curb lanes. Image by Matt Johnson.

reversible lanes, transit vehicles in the peak direction will use the dedicated lane, while transit vehicles in the off-peak direction will ride in mixed traffic.

Mixed traffic: While segments in mixed traffic should be minimized to avoid delay, vehicles can travel in mixed traffic where major bottlenecks exist or where there is very low ridership. In cases where no lanes can be dedicated to transit, queue jumps can be built at certain intersections, which will allow RTS vehicles to move to the right of all traffic and pull in front of traffic as the light turns green.

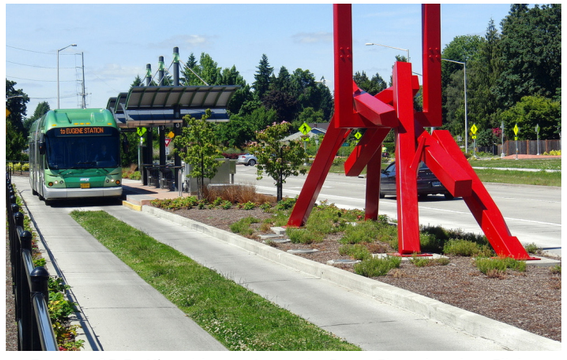
LANE WIDTHS

Transit lanes: Depending on space, dedicated transit lanes should range between 11' and 13' wide, and can be as narrow as 10' around stations, where vehicles are traveling slowly.[19]

Mixed traffic lanes: While 12' lanes are fairly typical on Montgomery's arterial corridors today, 10' lanes are now widely considered to be a best practice for traffic lanes. Numerous studies have demonstrated that narrower lanes reduce fatal crashes, encourage people

Eugene, OR EmX's reversible median lane. Image by rob_wrenn on Flickr.

Queue jump. Image by Dylan Passmore on Flickr.



Eugene, OR EmX's guideway. Image by Bruce Fingerhood on Flickr.

Bus lanes painted red on Ontario's York Viva system. Image by Sean_Marshall on Flickr.

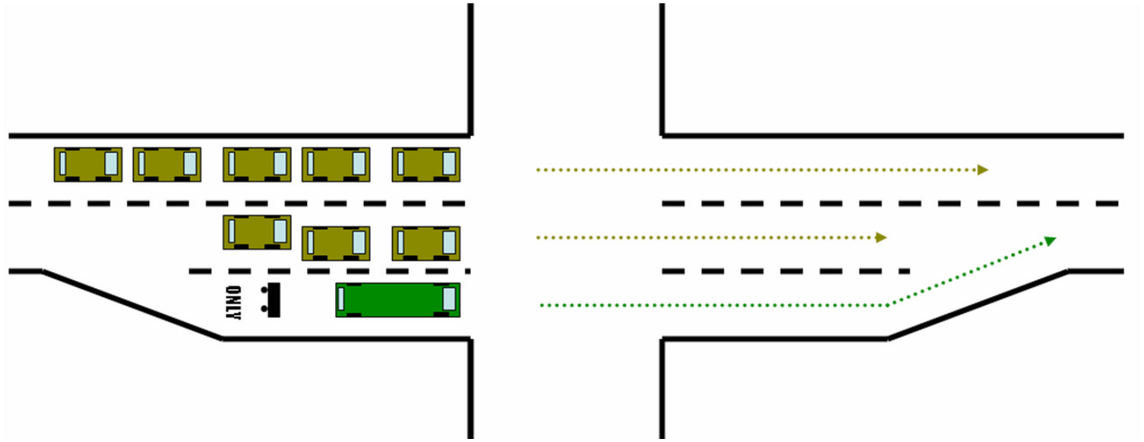


Diagram of a queue jump. Image by Andrew Bossi on Flickr .

to drive more carefully, and create safer and shorter crossings for people walking, while not reducing the capacity for cars.[20]

Physical separation: While not essential, many systems use some form of barrier to physically separate dedicated lanes from general traffic to help keep unauthorized vehicles out. Low curbs, parking stops, or flexposts are preferred to enable emergency vehicles to access the lanes or for a disabled vehicle to exit. Systems in Eugene, Oregon, and internationally have constructed guideways with an unpaved center, which is helpful for stormwater management, but is more expensive.[21]

Color: Many systems have used paint (often red) to visually separate dedicated transit lanes from mixed traffic lanes in a way that is visually appealing. Without physical separation, color is a good way to send a continuous message to drivers not to enter the space.

Enforcement: Enforcement mechanisms, such as cameras or fare inspectors, are critical to keep dedicated lanes free of traffic. Without physical separation, clearly posted fines for entering the dedicated lanes and enforcement cameras on the front of the transit vehicles can help ensure that people driving won't enter the transit lanes.

SHARING STREET SPACE EQUITABLY

Street space in our publicly owned rights of way is a precious commodity that should be shared equitably to best provide affordable and convenient transportation options for everyone. Los Angeles, Seattle, and New York City have all repurposed lanes on their busiest transit corridors and subsequently have seen transit ridership grow, with minimal impact to traffic.[22] The Countywide Transit Corridors Functional Master Plan has recommended that where the RTS is forecast to carry more people than the capacity of a general traffic lane, that lane should be dedicated to transit.

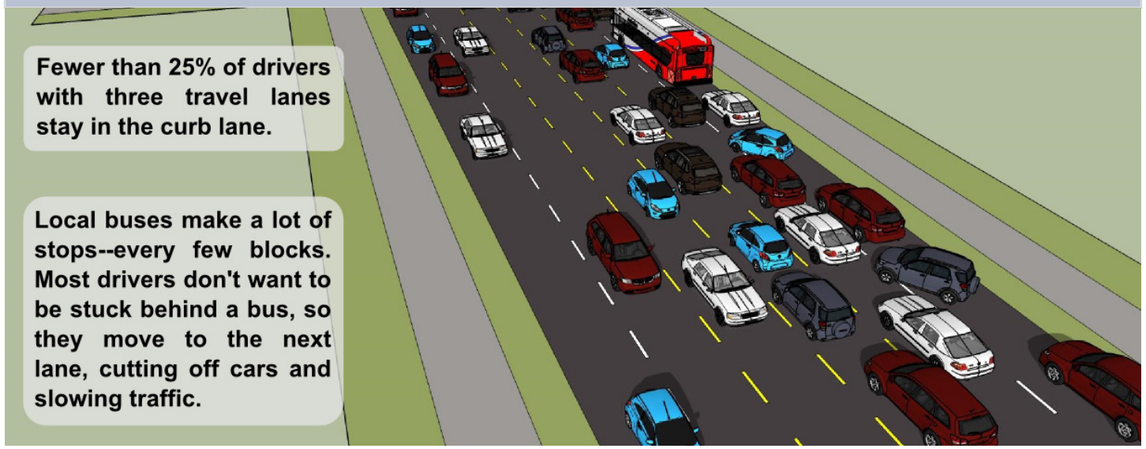
Moving people: A single travel lane can carry approximately 1,200 vehicles per hour, while Rapid Transit Systems carry 3,700 people per hour in Pittsburgh, 9,000 in Brisbane, Australia, and over 30,000 in Latin American cities.[23] In many segments the 2040 forecast RTS ridership surpasses, and in some cases far surpasses, the number of people in cars that a single travel lane can carry. If studies determine an existing traffic lane should be dedicated instead to transit, an analysis will be performed for both the corridor and the surrounding area to manage traffic demand.[24]

Taking cars off the road: In modeling conducted for the Montgomery County Planning Department, over half of all RTS trips would be new trips to transit.[25] Other rapid transit systems have succeeded in attracting many new riders as well:

- In Los Angeles, 25% of Orange Line riders previously drove; another 28% of riders previously did not make the trip at all.[26]
- In Cleveland, 30% of ridership on the HealthLine is due to new trips to transit.[27]
- In Boston, two years after opening, more than 30% of riders on Phase I of the Silver Line were new to transit.[28]

Separation can improve flow: Often when people driving are stuck behind a bus in the curb lane, they'll try to merge into the adjacent lane and pass on the left, causing delays or "friction." On busy transit routes with many buses in traffic, the curb lane where buses travel often doesn't operate at full capacity because of these merges. Because transit and cars move at different paces, separate facilities can help improve flow.

It doesn't take much to improve traffic flow – a study by the Metropolitan Washington Council of Governments found that when vehicle-miles-traveled on area roadways dropped by just 0.6% in the summer months, travel time delay dropped by 18%.[29]



Reduced flow when buses are in mixed traffic. Diagram by Geri Rosenberg.

Specialized bus signal for Metroway in Alexandria, VA. Image by Kelly Blynn.

FREQUENT RELIABLE SERVICE

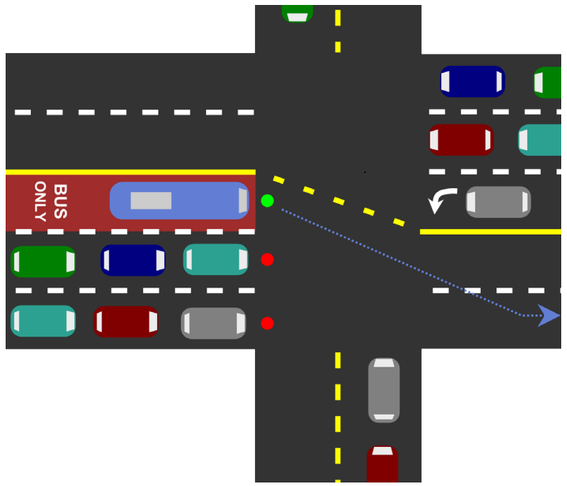
King County (Seattle region) RapidRide schedule. Image by Oran Viriyincy on Flickr.

TRANSIT RIDERS OFTEN RANK the frequency and reliability of transit service as its most important features. When people know they can show up and board a vehicle within five to ten minutes, there's no need to look at schedules. There are a few important elements to consider in ensuring frequent and reliable service.

Headways: Vehicles should run regularly at all hours, and even more frequently during peak hours. The Federal Transit Administration recommends that headways, or the time between transit vehicles, should be 10-12 minutes at maximum.[30] At peak hour, headways should 5-10 minutes or less.[31] Los Angeles' Orange Line, Boston's Silver Line, and Pittsburgh's East Busway all operate at 4 minute headways during peak hours.[32]

Service span: The rapid transit system (RTS) should still be convenient late at night and on weekends to be most useful for residents working a variety of jobs. The American Public Transit Association (APTA) recommends aiming for 18-20 hours/day service and coordinating with the schedules of local universities and major employers.[33]

Transit signal priority (TSP): Transit signal priority allows transit vehicles to communicate with the traffic signals along their routes to slightly alter signal timing to keep transit vehicles on schedule. In New York City, off-board payment and TSP combined have yielded over 20% reduction in end-to-end route travel times. In



Example of transit signal priority (TSP). Diagram by Geri Rosenberg.

Los Angeles, 30% of the travel time reduction achieved by MetroRapid service is attributed to TSP, which has caused less than one second of delay per light cycle to other vehicles.[34] TSP works by either shortening the red light or lengthening the green light by just a few seconds. The RTS can also have its own signal, which will often look quite different from a typical traffic light.

Where dedicated lanes switch from a median lane to a curb lane and vice versa, the RTS signal can turn green a few seconds earlier than the other signals so that the RTS vehicle can safely and efficiently move over to its new lane. Turning vehicles should also have separate signal phases to increase safety.

Integrated network: RTS corridors should integrate seamlessly where they intersect with other RTS corridors or other transit modes:

- Transfer stations: Stations where routes intersect should be designed and located in a way to ensure that transfers between routes are convenient, safe, and have clear signs to guide passengers. Schedules should be planned to lower wait times for those needing to transfer.
- Connecting with other modes: The signage, payment, fares, scheduling, and infrastructure of the RTS network should be integrated with other county and regional transit such as Metro, the Purple Line, and MARC to provide a smooth, high-quality experience for riders.
- Leveraging local bus service: Reorganizing local bus routes to connect to a higher capacity RTS has been highly successful in other systems. The RTS provides an opportunity to reorganize some Ride On routes to connect more neighborhoods to high quality transit. Ontario's Viva network is overlaid onto the existing system of local bus routes, some of which were rerouted to act as feeders for Viva, and its Blue Line acts as a backbone for the entire network.[35]
- Parking: Because a primary goal of the Rapid Transit System is to reduce reliance on cars in order to reduce traffic and improve the environment, parking should be added only in limited situations such as end of the line stations. WMATA researchers have found that a significant number of those parking and riding at Metro stations come from 1-2 miles away. Priority should be placed on making those short trips safe and convenient to walk or bike.

Rendering of Corridor Cities Transitway connecting with the MARC Brunswick line by Maryland MTA.

York Viva signage in Ontario, Canada. Image by wyliepoon on Flickr.

STATIONS

End-of-line station for Snohomish (Seattle region) Swift. Image by SounderBruce on Flickr.

STATIONS SHOULD BE SAFE and accessible to all, designed to reflect the needs of the communities they serve, and have the capacity to handle projected ridership.

STOP SPACING

Stops should be farther apart than local bus service to decrease travel times. In North American systems, stop spacing ranges from an average of 0.2 miles on Cleveland's HealthLine to 1.1 miles on Los Angeles' Orange Line.[36] Stations should be closer together in more urban areas and farther apart in less dense areas.

ONE SIZE DOESN'T FIT ALL

While ideally all stations should share branding, stations can be sized appropriately to the destinations surrounding each location. Station types to consider for each corridor include:

Neighborhood station: A neighborhood station would be a small station serving a primarily residential area or an area with a constrained right-of-way.

Destination station: A destination station would be a slightly larger station to support greater ridership generated by nearby employment centers, commercial areas, or other major institutions such as federal agencies or colleges.

Transit center: A transit center is built in such a way to ease transfers to other modes of transit, such as Metro or MARC.

Smaller Grand Rapids, MI Silver Line station. Image by John Eisenschenk on Flickr.

Larger Grand Rapids, MI Silver Line station. Image by John Eisenschenk on Flickr.

TYPICAL STATION DIMENSIONS

- **Station length:** All stations should be able to accommodate at least one articulated bus (typically 60’ long, compared to the typical 40’ local bus), and more popular stations may need to be able to accommodate two articulated buses, or one articulated bus and one local bus.[37]
- **Station width:** Curb stations shouldn’t be less than 10’ wide, while median stations should be at least 12’ wide or even wider, if space is available.[38]

End of line station: An end of line station may include other features such as parking, a drop-off area, and transfers to other transit modes. Snohomish County, Washington, co-located non-profits and government agencies with their end-of-line transit center for the Swift system.

STATION PLACEMENT

Center median: With median lanes, a center median station can be built that serves the transit line in both directions. The benefit is that only one station is needed, saving space and funds. The downside is that only vehicles with doors on the left can access it, so local buses may not be able to access those stations.

Side median: With median lanes, stations can also be placed on the right-hand side of the approaching RTS vehicle. The downside is that you then need two stations, but the benefit is that local buses can also access them without needing doors on the left side.

Center median station on the Cleveland HealthLine. Image by Dan Malouff.

Side median platform on the Metroway in Alexandria, VA. Image by Kelly Blynn.

Standard curbs on the Snohomish (Seattle region) Swift. Image by Atomic Taco on Flickr.

Curb: With curb lanes, stations can be placed on the side of the road and incorporated into the sidewalk. Local buses can use these stations as well.

LEVEL BOARDING

Stations should ideally be level with vehicle floors to speed boarding times and ease access for those in wheelchairs, with strollers, or with bicycles.

Level or “near-level” boarding: Given that the floor height of most buses today is approximately 15”, curb heights should be 14-15” to achieve level boarding. The HealthLine in Cleveland and the EmX in Eugene, Oregon, both utilize level boarding.[39]

Raised platform: A raised platform is in between a standard curb and level boarding, typically 8-10” to enable a single small step. This improves accessibility while minimizing potential damage to vehicles caused by scraping higher curbs.[40]

Standard curb: Standard curb height is 6” on county roads and 8” on state roads, which would require one or two steps up to access the vehicle. Some rapid transit systems, including the Los Angeles Metro Rapid and York Viva, use standard curbs.

Bridge plates: Vehicles can also have bridge plates, which extend or fold out of open doors, to cover any gap that may exist between the vehicle and the station platform.

OFF-BOARD FARE COLLECTION

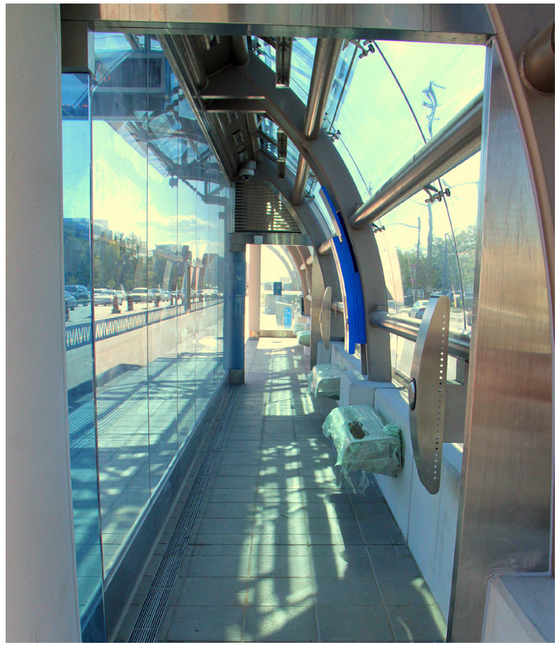
Boarding time (also known as “dwell time”) often represents up to 20% of local bus travel time, especially on busy routes. Stations should have machines to collect fares prior to boarding to speed boarding time. In New York City, off-board fare collection is responsible for 30% of the time savings seen on their Select Bus Service routes.[41] Flat fares (not distance-based like Metro) are currently used on all North American rapid transit systems.

A bridge plate on the Eugene, OR EmX. Image by streetcar.press on Flickr.

Payment machines on the Cleveland HealthLine. Image by Dan Malouff.

Protected median station in the Eugene, OR EmX system. Image by Rob_wrenn on Flickr.

Bicycle parking at a Los Angeles Orange Line station. Image by Matt Johnson on Flickr.



A York, Ontario VIVA weather-protected station. Image by Wyliepoon on Flickr.

Machines: Fare machines can vary from system to system, and are evolving rapidly to take payments not just from cards, but phones as well. Seattle's RapidRide simply has a place to tap their equivalent of SmarTrip in the shelter. In Snohomish County, WA, the Swift service uses retrofitted parking machines to provide off-board fare collection for a much lower capital cost than traditional transit fare machines.

Multiple door boarding: With off-board fare collection, passengers can board through all doors instead of just the front. In London, England, prepayment and all-door boarding has reduced dwell time by 75%.[42]

Enforcement: To protect against fare evasion, agencies set high fines and employ inspectors to do routine and/or random checks. In New York City, there are actually fewer incidents of fare evasion on Select Bus Service routes than on regular local bus service.[43]

REAL-TIME ARRIVAL INFORMATION

To support those waiting, stations should have visible real-time arrival information. This is the most common request by passengers concerning information at bus stops,[44] and it already exists at some of the most popular bus stops in Washington DC and Montgomery County.

SAFETY AND ACCESSIBILITY

Stations should be well lit, ADA-accessible, and provide a safe and comfortable way for people walking and people with disabilities to access them. Approaching stations, sidewalks should be a minimum of 8' wide.[45] On high-speed streets like those in Montgomery County, bollards can be used around median refuges to provide greater safety.

OTHER STATION FEATURES

RTS stations should include other amenities as well, such as clear route maps, signs, schedules, seating, trash receptacles, and bike racks. Given the cold winters in Montgomery County, stations should provide a refuge from the wind for waiting riders.

A median refuge on the Metroway, in Alexandria, VA. Image by Kelly Blynn.

VEHICLES

Fort Collins, Colorado MAX vehicle. Image by Timothy Wilder, City of Fort Collins.

RTS VEHICLES CAN LOOK AND FEEL MORE like a light rail train than an ordinary bus. Vehicles with a more modern style and amenities to increase passenger comfort, including wide aisles, comfortable seats, and large windows, have been shown to attract more riders.

Vehicle capacity: RTS vehicles should be 60' long and articulated to allow greater capacity for passengers. Depending on layout, articulated RTS vehicles can have a capacity of 90-120 passengers, both seated and standing. Fewer seats can allow a higher capacity, with more room for standing passengers, but enough seats should be provided for the comfort of passengers, especially those traveling longer distances.

Doors: Vehicles should have at least three doors to speed boarding and disembarking time. Vehicles ideally will have doors on both sides so that vehicles can approach center median or side stations, though this can increase costs and reduce seating.

Interior bicycle racks: Bicycle racks can be placed inside RTS vehicles, just as the EmX in Eugene, Oregon, and Swift in Snohomish County, WA, do to make stops quicker and rides more convenient for people biking. Montgomery County is interested in utilizing vertical hanging interior bicycle racks to maximize space for passengers.

Wi-Fi: Many systems, including Aspen, CO's VelociRTFA, Fort Collins, CO's MAX, and San Antonio, TX's VIA Primo, offer free Wi-Fi on their vehicles to enable transit riders to work, study, or read on their way to their destination. In surveys conducted on all three campuses of Montgomery College,[46] this was a top priority for

A Las Vegas Gold Line vehicle. Image by Erik Weber on Flickr.

Interior bicycle racks on the Snohomish (Seattle region) Swift. Image by Atomic Taco on Flickr.

students and staff alike. Vehicles can also provide USB and electrical outlets.

Fuel: Typical gas-powered transit vehicles are becoming less common in favor of more sustainable technologies, like biodiesel, diesel hybrid, and electric. Amsterdam has recently announced their entire bus fleet will be electric by 2025.[47] The DC Circulator is considering a pilot program to eventually replace its fleet with fully electric vehicles.

While electric can be the "greenest" technology, assuming the electric grid continues to shift to renewable energy, capital and operating costs can be significantly higher than other options. Electric transit manufacturers in the United States are working now to standardize their technology and charging mechanisms to make all-electric fleets an easier investment. While the cost of electric vehicles is likely to decrease with technology improvements, biodiesel and hybrid vehicles currently offer an effective and affordable green option.

Los Angeles Orange Line interior. Image by EMBARQ Brasil on Flickr.

Left side doors on a Cleveland HealthLine vehicle. Image by wyliespoon on Flickr.

ACCOMMODATIONS FOR PEOPLE WALKING & BIKING

Median refuge island on Monroe Street at the Art Institute of Chicago. Image by Stephen Vance on Flickr.

MOST RTS RIDERS will access stations on foot or by bicycle, so making it safe and comfortable to reach stations on foot or by bicycle is essential. Currently, many of the planned RTS routes are proposed for wide, high-speed arterial streets with narrow sidewalks squeezed against the sides, no dedicated bike lanes, and long crossing distances. There is much work to be done, but planning the Rapid Transit System provides an excellent opportunity to improve the safety for people walking and bicycling in the corridors, whether to transit or other daily activities.

High-speed right turns like this one on 355 in Germantown are considered a "worst practice" in pedestrian design. Image from Google Maps.

The Countywide Transit Corridors Functional Master Plan designated over two dozen new Bicycle-Pedestrian Priority Areas around proposed RTS stations. Bicycle-Pedestrian Priority Areas are a state program designed to direct funding and focus on improving access for people walking and biking in key areas.

ACCOMMODATIONS FOR PEOPLE WALKING

The primary objective in designing a pedestrian-friendly corridor should be to provide a continuous system of safe, accessible pathways for people walking on both sides of all streets, with crossings at regular intervals to better connect neighborhoods. At intersections, people walking should have a direct, safe crossing that is as short as possible. High-speed right turns that create more lanes of fast-moving traffic to cross should be avoided. Some of the best practices in design for people walking include:

Sidewalks: Boston's Complete Streets Guide recommends a minimum sidewalk width in neighborhood residential areas of 5', and a width of 10-12' in downtown areas, which allows for two people abreast to pass each other in either direction.[48] The Countywide Transit Corridors Functional Master Plan recommends a minimum sidewalk width of 6'.

Buffers: A buffer between the sidewalk and roadway is essential for providing comfort and protection for people walking, and is an important component of managing stormwater. 2.5' is considered the bare minimum width necessary to accommodate street trees, 4-6' is considered ideal, and a 10' buffer on boulevards can be an attractive way to include benches and other street furniture where space allows. When

space is limited, street parking or bike lanes can serve as a buffer, as well.[49]

Crosswalks: Wide, high-visibility crosswalks are considered a best practice and are preferable to the two parallel lines often used.[50]

Median refuges: Median refuge islands are protected spaces placed in the center of the street to make crossing wide streets safer for people biking or walking. They should be at least 6' wide to fit a bike, stroller, or wheelchair, and can have bollards or other elements to provide additional protection.[51] Given the high speed and wide nature of the rapid transit corridors, median refuges should be provided that extend through the crosswalk to provide people walking and biking with a safe way to cross.

Pedestrian signals: Because people will be walking to stations frequently, the pedestrian signal phase should be activated without needing to press a button, and people walking should be given a few seconds head start before turning vehicles--also known as a leading pedestrian interval, or LPI.

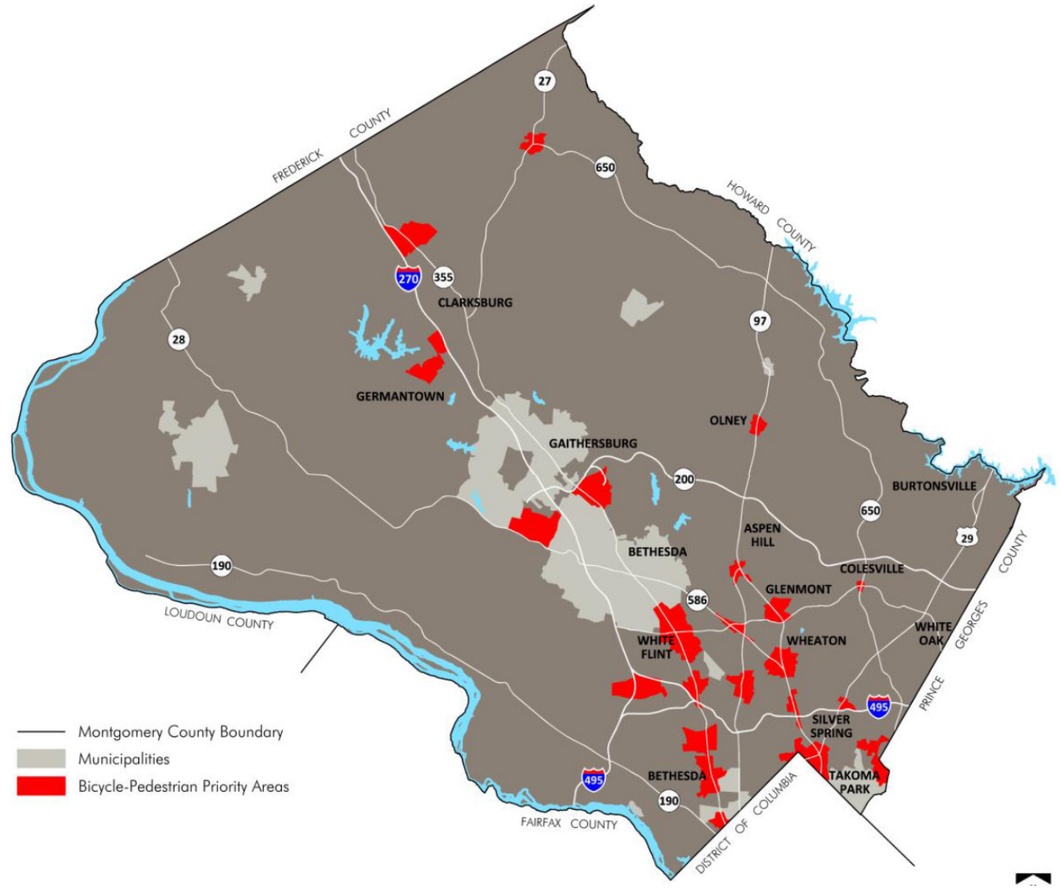
Siddewalk with buffer at 1st & M Street NE DC. Image by Dan Reed.

Pedestrian-activated signals: Where many people are walking or biking but no traffic signal exists, Rapid Flash Beacons and High-Intensity Activated Crosswalk (HAWK), signals that people walking and biking can activate to cross a street where there are many people walking or biking, may be a good option. They are currently found in several places in Montgomery County, including University Boulevard, New Hampshire Avenue, Gude Drive, as well as in Washington DC.

Curb extension. Rendering by NACTO on Flickr.

Level sidewalk across a driveway in Champaign, IL. Image by Pam Broviak on Flickr.

Bicycle-Pedestrian Priority Areas designated as part of the Countywide Transit Corridors Functional Master Plan



Curb extensions: Also known as bump-outs or bulb-outs, curb extensions widen the sidewalk, usually at corners, to slow down turning traffic and reduce crossing distances for people walking. Typically, curb extensions are about 6', or the width of a parked car.[52]

Safe driveways: Many of Montgomery County's rapid transit corridors feature frequent driveways for businesses and residences that pose a danger to people walking. Sidewalks should stay level, continuous, and well marked across driveways in order to minimize difficulty for people with disabilities and to alert drivers to the presence of people walking.[53]

BICYCLE ACCOMMODATIONS

Bicycling experts have found that “low stress” streets and facilities, such as separated bike lanes, are essential in encouraging more than just the most confident people to bicycle. In a study by Portland State University, researchers found that the vast majority of people who wish to bike are “interested but concerned” and that, on a four-lane (or wider) street with 30-35 miles per hour traffic or higher (currently true for all of the RTS corridors), most people would only feel safe biking in separated, protected facilities.[54]

Connectivity is also very important for good bicycle accommodations in the RTS corridors. Many of the RTS corridors currently present major barriers to people walking and biking, due to high levels of speeding traffic and long crossing distances. Facilitating connections across these corridors, such as continuing bike lanes through intersections or narrowing crossing distances to reach stations and better connect neighborhoods, will be critical to encouraging people to bike, walk, and take transit.[55]

Suburban buffered bike lane in Grove City, OH. Image by Dan Malouff.

Protected bike lanes: Physically separated from traffic by flexposts, curbs, or other elements, protected bike lanes offer the calm experience of a separated path on a high-speed street. They can be designed to accommodate people biking in one or two directions, and are typically between 8’ and 12’ wide. Protected bike lanes are now widely considered a best practice for encouraging more people to ride bicycles, especially on high-speed streets with high traffic volumes such as the RTS routes.[56] Protected bike lanes can be found on Washington DC’s 15th Street NW and M Street NW. Montgomery County has one on Woodglen Avenue in White Flint.

Shared-use paths: In Montgomery County, shared-use paths are typically 10’ wide but can vary between 8’ and 14’. They are for use by people walking and biking and are separated from traffic by a curb, barrier, or landscaped area. They can either be on the side of a road or in their own right-of-way entirely, such as the North Bethesda Trail.[57]

Buffered bike lanes: Buffered bike lanes are like conventional bike lanes with a designated buffer space, usually at least 2’ wide, between the bike lane and traffic lanes.[58] In urban environments, a lane of parked cars is often used to provide greater protection and comfort for those riding bikes without requiring as much infrastructure as protected bike lanes.

Bike lanes: Conventional bike lanes should be at least 5.5’ wide and are best suited for streets that have fewer than 3000 vehicles per day and traffic speeds of less than 25 miles per hour.[59] These are likely best for side streets that residents use to access RTS stations. Like other bike accommodations, green paint is often used to continuously distinguish the bike lane from traffic, and can be continued through intersections to remind turning drivers to look for people biking. A study in Portland found painted lanes through intersections increased drivers yielding to people on bikes from 72% to 92%.[60]

Shared bus/bike lanes: While not ideal, in constrained sections it may be acceptable for bicycles and buses to share a lane, as is the case in parts of Philadelphia, New York, Minneapolis, and Ocean City, MD.[61]

Sharrows: Sharrows indicate a shared lane between people biking and people driving, and are best used when the difference between car and bicycle speeds is very small. Sharrows should not be used on streets with design speeds greater than 25 miles per hour for safety reasons.[62] In some cases, it may be best to accommodate people biking on parallel streets with low traffic levels, in which case sharrows may be an appropriate choice.

Bus stop on Vancouver, Canada’s Dunsmuir Separated Bike Lane with extended bike lane through intersection. Image by Paul Krueger on Flickr.


Los Angeles’ Orange Line Trail, a shared-use path. Image by Bob Blumenfield on Flickr.


Bike lane extended through an intersection in Chicago. Image by Steven Vance on Flickr.

7th Street shared bus/bike lane in DC. Image by Dan Malouff.

BRANDING

Branded Snohomish (Seattle region) Swift station. Image by Sounder Bruce on Flickr.

ATTRACTIVE, UNIQUE, CONSISTENT BRANDING will help identify the high-quality RTS service as something new and separate from existing transit service. The names of many systems around the US cleverly refer to their high-speed and reliability along with a reference to local geography or transit agencies, like the VelociRFTA (Aspen, CO), the Emerald Express/ EmX (Eugene, OR), and the new CTfastrak (Hartford, CT).

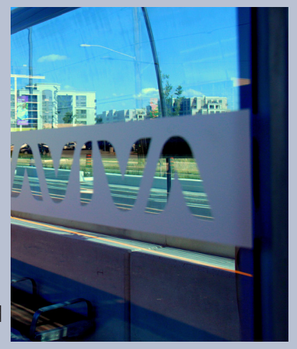
Distinctive from other transit: To separate RTS vehicles, stations, and service from other local transit, RTS branding should be unique.

Unified: Vehicles, route names, stations, signs, maps, and other elements of the system should share the same branding to help riders more easily identify the service. Ontario, Canada's York Viva does this particularly well, with the vehicles, seats, signs, maps, trash cans, recycling bins, and even the glass of the station shelter all decorated with the attractive Viva logo.

Inclusive naming process: While consultants or government officials can brainstorm initial ideas for system names, it's important to utilize the creative talent of the community to generate ideas and vote on a system name that the majority support.

YORK VIVA MARKETING STRATEGY[64]

Ontario, Canada's York region developed a two-year (2002-2003) marketing and communications plan to develop and introduce the new Viva brand more than three years before the Viva system began operations. Since then, York's transit agency has retained marketing staff for the Viva service.



Branding in the York Viva system. Images by wyliespoon on Flickr.

Viva's initial campaign slogan, "uniquely great transit," emphasized the system's new features and benefits. An interactive website and an online newsletter were utilized to encourage ridership. An outreach program involving community "Viva Ambassadors" and high school and college students, called "Team Viva," raised community awareness at public venues and special events.

In 2005, the year Viva began operations, a market research summary found very high brand recognition, including 83% of non-riders interviewed. In the first full year of service, transit ridership in Viva corridors increased 56.57%.[65] A follow-up study in 2007 found that 100% of non-riders interviewed were aware of the Viva service.

FINANCE

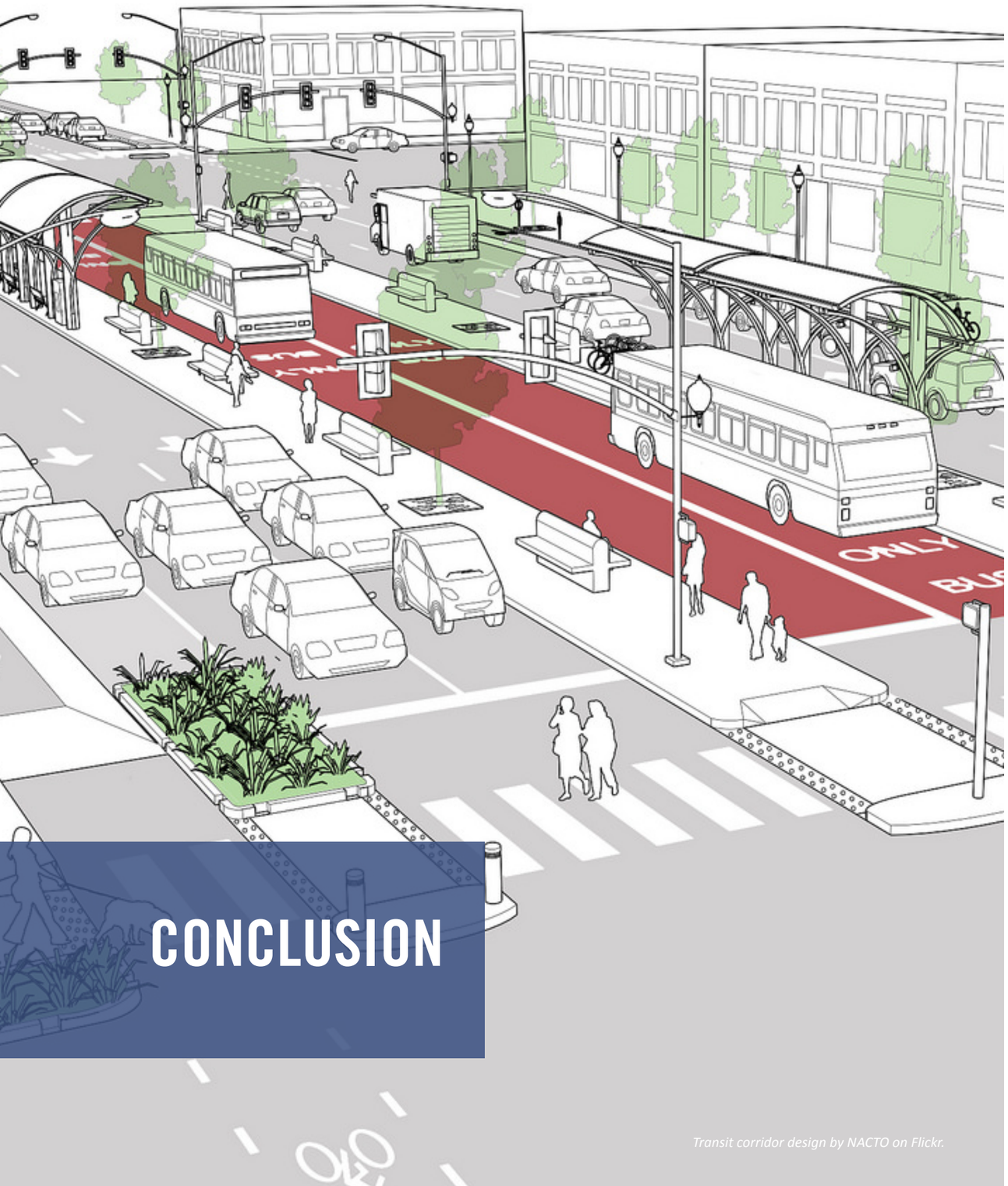
Eugene, OR EmX. Image by Rob Sounder on Flickr.

MOST RAPID TRANSIT SYSTEMS in the US and Canada have cost, on average, less than $25 million per mile to construct and have received funding from a mix of federal, state, and local sources.

A dedicated source of funding for transit, such as an increment of the sales or property tax, or a mechanism to capture increased value around transit stations, is considered a best practice for producing sustainable and predictable financing for transit systems.[66] Here is how a few of the most successful rapid transit systems in the United States have been financed.

Financing structures: Other rapid transit systems around the country

City	Name	Major Funding Sources (Non-Federal)	Major Funding Sources (Federal)	Cost/mile (Millions)
Eugene, OR[67]	EmX	20% Local Funds	80% Federal New Starts & Federal Small Starts	$5.25-$6.25
Los Angeles[68]	Orange Line	47.8% State Funds 41.8% Voter-Approved ½ Cent Sales Tax 1.3% City of Los Angeles	8.3% Federal New Starts & Other Federal Funds	$21
Seattle[69]	RapidRide	37% Voter-Approved 1/10 Cent Sales Tax Other Local Funds 1% State Funds	49% Federal Very Small Starts 13% Other Federal Funds	$2-$4
Cleveland[70]	HealthLine	29.7% State Funds 15.2% City of Cleveland 5.9% Other Local Funds	49.1% Federal Funds	$4.8[71]-$7.5[72]



CONCLUSION

Transit corridor design by NACTO on Flickr.

Montgomery County has a great opportunity to develop a first-class rapid transit network that will support present and future generations by drawing upon the lessons learned from other systems and the knowledge of residents who are daily users of the existing transportation system. When combined, the features of modern rapid transit systems frequently produce a 15-25% travel time savings over previous services, and a 5-25% increase in ridership or greater – Boston's Silver Line produced an 85% ridership increase.[73]

Just like the planners of our Metro system, Montgomery County leaders and residents now have the opportunity to make an essential investment for future generations.

With creative thinking and effective community engagement, Montgomery County can integrate this high-quality transit network into existing county roads and communities to reduce traffic, increase access to jobs and services, lower carbon emissions, and improve quality of life for all.

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Rendering: Rockville Pike with RTS. Source: White Flint Partnership