RED LINE

MODE SCREENING REPORT
JULY 2024

MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION

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EXECUTIVE SUMMARY

Since the Baltimore Red Line Project ("Project") was re-initiated in June 2023, Maryland Transit Administration (MTA) has evaluated six Preliminary Alternatives, presented to the public in November 2023, using 22 measures of effectiveness (Table 1). The results revealed that transit mode was the primary differentiator between the Preliminary Alternatives.

Based on the measures of effectiveness results and public input received, MTA has reconfirmed Light Rail Transit (LRT) as the Project mode. As shown in Table 1, the LRT Preliminary Alternatives showed higher projected ridership including new transit trips, better cost effectiveness, and much stronger public support than bus rapid transit (BRT). These reasons were also included in the rationale for selecting LRT as the mode for the Locally Preferred Alternative (LPA), which was announced in August 2009; they still hold true for the Preliminary Alternatives.

With LRT being reconfirmed as the mode for the Baltimore Red Line, the next steps will focus on additional analysis to further investigate the different LRT alternatives and select an LPA. The additional analysis and comparison of LRT alternatives, including a No Build Alternative, will be presented in the Supplemental Environmental Impact Statement (SEIS), which will be available for public and agency review and comment.

Table 1: Differentiators in Mode Screening

Category	Measure of Effectiveness	Differentiator for Mode Screening	LRT	BRT
Costs and Effectiveness	Average weekday total projected trips	✓	✓	
	New transit trips	✓	✓	
	Capital costs (2023 $, billions)	✓		✓
	Annualized capital cost per trip (2023 $)	✓	✓	
	Operating and maintenance costs (2023 $, millions)	✓		✓
	Public support	✓	✓	
Transportation and Connectivity	Transit Passenger Capacity	✓	✓	
Equity, Economy, and Environment	Average weekday projected trips from zero-car households	✓	✓	
	Projected reduction in vehicle miles traveled	✓	✓	

INTRODUCTION

The Baltimore Red Line was first identified as a priority for transit investment in Baltimore City and Baltimore County in the 2001 Maryland Comprehensive Transit Plan and the 2002 Baltimore Regional Rail Systems Plan. Subsequently, MTA and the Federal Transit Administration (FTA) comprehensively evaluated the Project in a NEPA review between 2008-2013, which led to a ROD. MTA conducted detailed project design through 2014. FTA rescinded the ROD in 2015 when the project was halted to focus on other statewide priorities.

Importantly, regional, and local planning for an east-west transit project did not cease after the ROD was rescinded. The 2020 Regional Transit Plan once again ranked the project corridor high for near-term transit investment. The Baltimore Red Line was subject to more detailed exploration in the 2022 East-West Corridor Feasibility Study, which confirmed the public's continued support for east-west transit based on the same needs identified in the 2008-2013 FTA NEPA review. The State officially restarted the Project in June 2023.

The re-initiation of the Baltimore Red Line builds upon the extensive technical work and community engagement conducted prior to the cancellation of the Project in 2015. Over 20 years of study, engineering, environmental analyses, and substantial community participation have shaped the Baltimore Red Line Project. The Project Purpose and Need described in the previous 2008 AA/DEIS and 2012 FEIS remains valid. The Purpose and Need of the proposed Project is to provide high-frequency, high-capacity transit service in the corridor in a manner that improves transit efficiency; increases transit accessibility near work and activity centers; enhances connections among existing transit routes; and provides transportation choices in the corridor. In addition, two goals for the Project were identified: (1) support community revitalization and economic development opportunities and (2) support regional goals of improving air quality and promoting environmental stewardship, sustainability, and resiliency. The Project represents a substantial investment in residents' access to jobs, education, services, and economic opportunities.

While many things remain the same, the Project corridor has evolved over time. Changes in the corridor include the following from west to east:

- Baltimore County has purchased portions of Security Square Mall and commenced planning for its redevelopment
- Social Security consolidated its operations in Woodlawn, vacating the Security West building
- Poppleton continued to be redeveloped, including new affordable housing and a private high school
- UM BioPark continued to grow, including construction of the 4MLK biotech lab and office building on Martin Luther King, Jr. Boulevard
- MTA and Baltimore City created dedicated bus lanes in Downtown Baltimore
- Baltimore City began to plan for the redevelopment of Harborplace in the Inner Harbor
- Harbor East and Little Italy experienced growth through dense residential and mixed-use development
- Harbor Point was redeveloped with dense office and mixed-use development
- Canton Crossing continues to be redeveloped, including new construction in the former Red Line alignment
- Baltimore Greenway Trails Network planned development of a shared use path in the former Red Line alignment around Highlandtown/Greektown Station
- Oldham Crossing townhouses were constructed in the former Red Line alignment between the Highlandtown/Greektown and Bayview Stations

These changes, combined with the passage of time since the 2008-2013 FTA NEPA review and changes to pertinent regulatory standards in the past ten years, make it essential to explore several key considerations to make sure the Project meets today's expectations for enhanced mobility and equity.

MTA engaged the public and stakeholders in summer 2023 through five open houses, 20 pop-up events, a public survey, and more than 30 meetings with institutions, elected officials, and community-based organizations. Throughout fall 2023, MTA conducted a series of open house meetings, pop-ups, workshops, and other outreach and engagement activities in parallel with a public survey to gather input on the Preliminary

Alternatives. Public input made clear a strong preference to see the Project advance with LRT as the mode alternative.

Building upon public input gathered during summer 2023, MTA developed and analyzed six Preliminary Alternatives throughout fall 2023. These Preliminary Alternatives were based on the Alternatives in the 2008 AA/DEIS but included modifications to the alignment and station locations. The Preliminary Alternatives included both LRT and BRT modes, as well as combinations of surface and tunneled segments. MTA compared the Preliminary Alternatives' performance using quantitative and qualitative metrics, such as access, travel time, reliability, ridership, cost to build and operate, and implementation time. LRT performed better than BRT across measures of effectiveness, suggesting it is likely to perform strongly for competitive federal funding.

MTA continues to analyze public input and advance additional technical analyses to determine the horizontal alignment (i.e., path of travel) and vertical alignment, including proposed tunneling and surface-running sections; however, moving forward, the focus will be on LRT as the transportation mode for the Project. This document presents the rationale for reconfirming LRT as the mode for the Baltimore Red Line.

PRELIMINARY ALTERNATIVES CONSIDERED

The Baltimore Red Line Preliminary Alternatives were developed in summer 2023 based on alternatives previously proposed in the 2008 AA/DEIS and 2012 Final EIS (FEIS). The Preliminary Alternatives were presented to the public in November 2023. These alternatives included BRT and LRT modes, three paths of travel, and surface and tunnel vertical alignments. The Preliminary Alternatives under consideration included:

- No Build
- Alternative 1: LRT-Tunnel
- Alternative 2A: LRT-Surface North
- Alternative 2B: LRT-Surface South
- Alternative 3: BRT-Tunnel
- Alternative 4A: BRT-Surface North
- Alternative 4B: BRT-Surface South

Figure 1 illustrates the alignment and station locations of the six Preliminary Alternatives. More detailed mapping of the Preliminary Alternatives is included in Appendix A of this memorandum.

Figure 1: Preliminary Alternatives Under Consideration

Six Preliminary Alternatives are under consideration, which combine three alignment options (mapped below) and two modes:

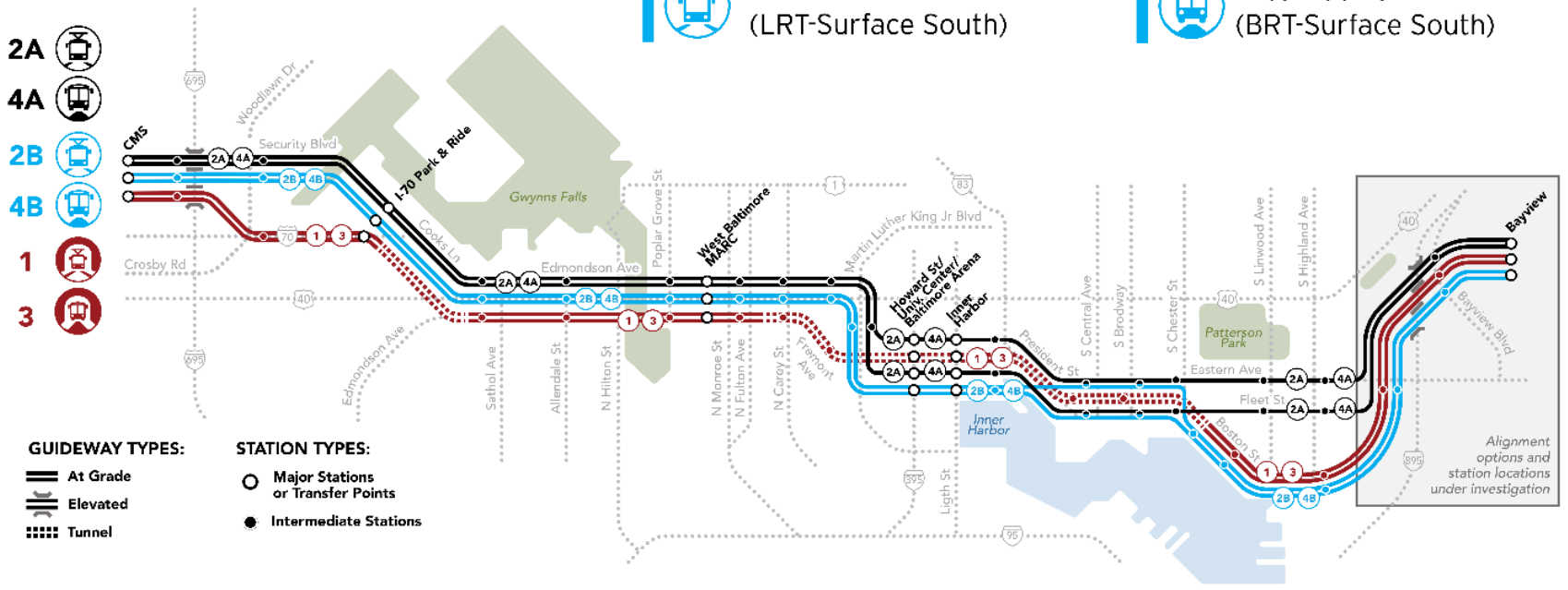
- Light Rail Transit (LRT)
- Bus Rapid Transit (BRT)

Light Rail Transit (LRT)

- **Alternative 1** (LRT-Tunnel)
- **Alternative 2A** (LRT-Surface North)
- **Alternative 2B** (LRT-Surface South)

Bus Rapid Transit (BRT)

- **Alternative 3** (BRT-Tunnel)
- **Alternative 4A** (BRT-Surface North)
- **Alternative 4B** (BRT-Surface South)



No Build

The No Build Alternative is the baseline against which the Preliminary Alternatives are compared. It consists of the existing road and transit network as well as planned and programmed improvements in the region's adopted, financially constrained long-range transportation plan, *Resilience 2050*, adopted by the Baltimore Regional Transportation Board on July 26, 2023. It also includes the following MTA projects either recently completed but not yet incorporated into the region's travel demand model or planned project completions by the 2050 horizon year:

- North Avenue Rising - dedicated bus lanes and transit signal priority on North Avenue
- Fast Forward - dedicated bus lanes on Gay Street, Preston and Biddle Streets, and Pratt and Lombard Streets
- RAISE Transit Priority Project - dedicated bus lanes on segments of the CityLink Blue and Orange bus routes

Preliminary Alternative 1: LRT-Tunnel

Preliminary Alternative 1 was based on the 2012 FEIS LPA 4C (LRT, downtown tunnel and Cooks Lane tunnel and dedicated surface), which included refinements to the 2009 LPA. Preliminary Alternative 1 includes additional alignment refinements to reflect additional engineering analysis and the construction of new residential and commercial buildings in the Canton Crossing and Highlandtown areas.

Horizontal Alignment (i.e., path of travel)

The general alignment follows: Security Boulevard, I-70, Cooks Lane, Edmondson Avenue, US 40, Fremont Avenue, Lombard Street, President Street, Fleet Street, and Boston Street. Alignment options are being considered for the Canton Crossing/Highlandtown area connecting to Bayview. The alignment is the same as Preliminary Alternative 3 (BRT)

Vertical Alignment (i.e., tunnel or surface)

Preliminary Alternative 1 includes the Cooks Lane and Downtown Tunnels. It has elevated segments over I-695 and I-895.

Preliminary Alternative 2A: LRT-Surface North

Preliminary Alternative 2A was based on the 2008 AA/DEIS Alternative 4A (LRT, dedicated surface), with alignment refinements to reflect additional engineering analyses and stakeholder input in Woodlawn, Fells Point, and Bayview areas.

Horizontal Alignment

The general alignment follows: Security Boulevard, Cooks Lane, Edmondson Avenue, US 40, Martin Luther King (MLK) Jr. Boulevard, Baltimore Street/Lombard Street couplet, President Street, and Eastern Avenue/Fleet Street couplet. Alignment options are being considered for the Highlandtown area connecting to Bayview. The alignment is the same as Preliminary Alternative 4A (BRT).

Vertical Alignment

Preliminary Alternative 2A is mostly on the surface. It has an elevated segment over I-895.

Preliminary Alternative 2B: LRT-Surface South

Preliminary Alternative 2B was based on 2008 AA/DEIS Alternative 4A (LRT, dedicated surface), with alignment refinements to reflect additional engineering analyses and stakeholder input in the Woodlawn, Fells Point and Bayview areas.

Horizontal Alignment

The general alignment follows: Security Boulevard, Cooks Lane, Edmondson Avenue, US 40, MLK Jr. Boulevard, Pratt Street, President Street, Eastern Avenue/Fleet Street couplet, and Boston Street. Alignment options are

being considered for the Canton Crossing/Highlandtown area connecting to Bayview. The alignment is the same as Alternative 4B (BRT).

Vertical Alignment

Preliminary Alternative 2B is mostly on the surface. It has elevated segments over I-695 and I-895.

Preliminary Alternative 3: BRT-Tunnel

Preliminary Alternative 3 was based on the 2008 AA/DEIS Alternative 3C (BRT, downtown tunnel + Cooks Lane tunnel + dedicated surface), with alignment refinements to reflect additional engineering analysis and the construction of new developments in the Canton Crossing and Highlandtown areas.

Horizontal Alignment

The general alignment follows: Security Boulevard, I-70, Cooks Lane, Edmondson Avenue, US 40, Fremont Avenue, Lombard Street, Fleet Street, and Boston Street. Alignment options are being considered for the Canton Crossing/Highlandtown area connecting to Bayview. The alignment is the same as Preliminary Alternative 1 (LRT).

Vertical Alignment

Preliminary Alternative 3 includes the Cooks Lane and Downtown Tunnels. It has elevated segments over I-695 and I-895.

Preliminary Alternative 4A: BRT-Surface North

Preliminary Alternative 4A was based on the 2008 AA/DEIS Alternative 3A (BRT, dedicated surface), with alignment refinements to reflect additional engineering analysis and stakeholder input in Woodlawn, Fells Point and Bayview areas.

Horizontal Alignment

The general alignment follows: Security Boulevard, Cooks Lane, Edmondson Avenue, US 40, MLK Jr. Boulevard, Baltimore Street/Lombard Street couplet, President Street, and Eastern Avenue/Fleet Street couplet. Alignment options are being considered for the Highlandtown area connecting to Bayview. The alignment is the same as Preliminary Alternative 2A (LRT).

Vertical Alignment

Preliminary Alternative 4A is mostly on the surface. It has elevated segments over I-695 and I-895.

Preliminary Alternative 4B: BRT-Surface South

Preliminary Alternative 4B was based on 2008 AA/DEIS Alternative 3A (BRT, dedicated surface), with alignment refinements to reflect additional engineering analysis and stakeholder input in the Woodlawn, Fells Point and Bayview areas.

Horizontal Alignment

The general alignment follows: Security Boulevard, Cooks Lane, Edmondson Avenue, US 40, MLK Jr. Boulevard, Pratt Street, President Street, Eastern Avenue/Fleet Street couplet, and Boston Street. Alignment options are being considered for the Brewers Hill/Highlandtown area connecting to Bayview. The alignment is the same as Preliminary Alternative 2B (LRT).

Vertical Alignment

Preliminary Alternative 4B is mostly on the surface. It has elevated segments over I-695 and I-895.

EVALUATION OF MODES

The Preliminary Alternatives described above were screened based on measures of effectiveness described in the next section. The Project Purpose and Need was also considered in the evaluation, which was first

developed in 2008, refined in 2012, and then revisited in 2023. The Project needs formed the basis for the measures of effectiveness and categories for evaluation, which are detailed in the following sections.

Measures of Effectiveness

Measures of Effectiveness are evaluation criteria based on the Project Purpose and Need, goals, federal funding criteria, and operational considerations. Table 2 lists the 22 measures of effectiveness presented to the public in November 2023[1] through a series of Baltimore Red Line community meetings and public open houses. These measures were linked with the Project needs and grouped into three categories for evaluation: Costs and Effectiveness; Transportation and Connectivity; and Equity, Economy, and Environment.

The results for each measure of effectiveness were compared to identify which measures revealed differences in the performance between Preliminary Alternatives. Some measures showed differences in performance based on mode, others based on path of travel or vertical alignment. Table 2 indicates which measures were considered differentiators for mode evaluation, and also notes the differentiators for other alternatives.

The Preliminary Alternatives showed similar results for seven (7) of the 22 measures. Of the remaining 15 measures, **mode was a differentiator for nine (9) measures**. The other differentiators were vertical alignment (five measures) and path of travel (one measure).

Table 2: Baltimore Red Line Measures of Effectiveness

Category	Measure of Effectiveness	Differentiator for Mode/Alternative Evaluation
Costs and Effectiveness	1. Average weekday total projected trips	Yes
	2. New transit trips	Yes
	3. End-to-end travel time (in minutes)	No (vertical alignment differentiates)
	4. Capital costs (2023 $, billions)	Yes
	5. Annualized capital cost per trip (2023 $)	Yes
	6. Operating and maintenance costs (2023 $, millions)	Yes
	7. Annual operating and maintenance cost per trip (2023 $)	No (similar across alternatives)
	8. Implementation time (in years)	No (vertical alignment differentiates)
	9. Public support	Yes
Transportation and Connectivity	10. Dedicated guideway (in percent)	No (similar across alternatives)

[1] Meeting materials are available on the Project website: https://redlinemaryland.com/resources/

Category	Measure of Effectiveness	Differentiator for Mode/Alternative Evaluation
	11. Connections to rail stations	No (vertical alignment differentiates)
	12. Connections to frequent bus routes	No (vertical alignment differentiates)
	13. Transit passenger capacity	Yes
	14. On-street vehicle parking impacts	No (vertical alignment differentiates)
Equity, Economy, and Environment	15. Average weekday projected trips from zero-car households	Yes
	16. Access to transit critical populations	No (path of travel differentiates)
	17. Access to existing jobs	No (similar across all alternatives)
	18. Access to students	No (similar across all alternatives)
	19. Access to households	No (similar across all alternatives)
	20. Access to low-income households	No (similar across all alternatives)
	21. Access to zero-car households	No (similar across all alternatives)
	22. Projected reduction in vehicle miles traveled	Yes

Mode Performance

The following sections describe the measures of effectiveness and performance of the Preliminary Alternatives, with an emphasis on the differences in performance between LRT and BRT modes. Because these alternatives are preliminary, several results are shown as ranges. The results of Preliminary Alternatives that performed well are highlighted in yellow.

Costs and Effectiveness

Average Weekday Projected Total Trips

The FTA's Simplified Trips-on-Project Software (STOPS) projected the average weekday total trips on the Baltimore Red Line for a 2029-2035 opening year depending on the alternative (Table 3). These preliminary estimates were developed using pre-pandemic assumptions to compare the Preliminary Alternatives and will continue to be refined as the Project progresses through planning and design.

Table 3: Average Weekday Total Projected Trips by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Average Weekday Total Projected Trips	0	33,000 - 35,500	29,500 - 31,500	28,500 - 30,000	17,500 - 24,000	12,000 - 16,500	11,500 - 16,000

Average weekday total projected trips are on average 60% greater for LRT than BRT (Table 3). The most significant factor in this difference is the Fixed Guideway Factor, a variable in the STOPS model. Per FTA's STOPS User Guide v2.52 dated January 25, 2023, FTA directs grant applicants to use Full Fixed Guideway Factor for LRT and a Partial Fixed Guideway Factor for BRT which were calibrated within STOPS based on survey results from existing systems within the United States.

New Transit Trips

STOPS projected the increase in weekday transit trips for each Preliminary Alternative (build minus no build) (Table 4). These results represent the new transit trips projected from building each Preliminary Alternative. Projected results for new transit trips include users who previously walked or used automobiles to travel before shifting to the Red Line.

Table 4: New Transit Trips by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
New Transit Trips	0	7,500 - 9,000	6,000 - 7,000	7,000 - 8,000	4,000 - 5,500	2,500 - 3,000	2,500 - 3,500

LRT generates almost double the new transit trips compared to BRT (Table 4).

End-to-End Travel Time

Travel time estimates were developed for the Baltimore Red Line alternatives using industry standard assumptions about LRT and BRT vehicle acceleration, top speed, and dwell time (i.e., door opening and closing times, passenger alighting, door clear checking times, etc.) spent at stations. These estimates represent the end-to-end travel time from Centers for Medicare & Medicaid Services (CMS) to the future Bayview MARC station. The No Build end-to-end travel time is based on a transit trip using MTA's CityLink Blue bus route between CMS and the future Bayview MARC station.

Table 5: End-to-End Travel Time by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
End-to-End Travel Time (minutes)	79	44 - 47	55 - 58	56 - 59	45 - 48	56 - 59	57 - 60

LRT alternatives have end-to-end travel times only one (1) minute less than comparable BRT alternatives (Table 5). Mode is not the differentiator for end-to-end travel time. Tunnel alternatives have shorter travel times than surface alternatives.

Capital, Operating, and Maintenance Costs

Planning-level cost estimates were developed to compare the Preliminary Alternatives.

Capital costs, which include construction materials, labor, equipment, vehicles, and professional services, were developed using the FTA New Starts Standard Cost Categories (SCC) worksheets, which include costs for guideway, stations, support facilities, sitework, systems, land, vehicles, professional services, and appropriate contingencies based on the level of detail available.

Annualized capital costs divide the total capital cost by an annualization factor to account for the average useful life of each type of infrastructure. Annualized capital cost per trip divides the annualized capital cost by projected annual ridership.

Operating costs were developed using the cost allocation methodology from the 2008 Red Line *Operating & Maintenance Cost Technical Report*, updated with inputs from the Baltimore Red Line service plan and MTA Central Light Rail costs reported in the 2023 National Transit Database.

Although LRT is more expensive than BRT in absolute terms, LRT is more cost effective than BRT (Table 6). Capital cost effectiveness compares the annualized Project capital costs with the annual trips on the Project. Preliminary Alternative 1 has an annualized capital cost per trip that is 20 percent less than Preliminary Alternative 3. Preliminary Alternatives 2A and 2B have annualized capital costs per trip that are 22 percent less than Preliminary Alternatives 4A and 4B respectively.

Annual operating and maintenance costs per trip on their own are not a differentiator, with a range of less than eight (8) percent between alternatives.

Table 6: Capital, Operating, and Maintenance Costs by Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Total Capital Costs (2023 $, billions)	0	5.9 - 7.2	3.4 - 4.6	3.2 - 4.3	4.1 - 5.7	2.0 - 2.7	1.9 - 2.6
Annualized Capital Cost per Trip (2023 $)	0	21	14	14	26	18	18
Annual Operating & Maintenance Costs (2023 $, millions)	0	46	38	39	26	19	19
Annual Operating & Maintenance Cost per Trip (2023 $ millions)	0	4.2	4.0	4.2	3.9	4.2	4.3

Implementation Time

The time needed to implement a Preliminary Alternative was estimated based on professional engineering judgment and completed projects of similar size, scope, and complexity. The estimated time to implement includes:

- additional planning to select a preferred alternative,
- development of and completion of the NEPA process,
- preliminary engineering,
- final design,
- construction, and
- testing/commissioning to reach the first day of operations.

Estimated implementation time is within one year between comparable BRT and LRT Preliminary Alternatives (i.e., those with similar paths of travel and tunnel/surface vertical alignments) (Table 7). The difference in implementation time between tunnel and surface alternatives is greater than the difference between BRT and LRT.

Table 7: Implementation Time by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Years to Implement the Project	0	9 - 12	7 - 9	7 - 9	9 - 11	6 - 8	6 - 8

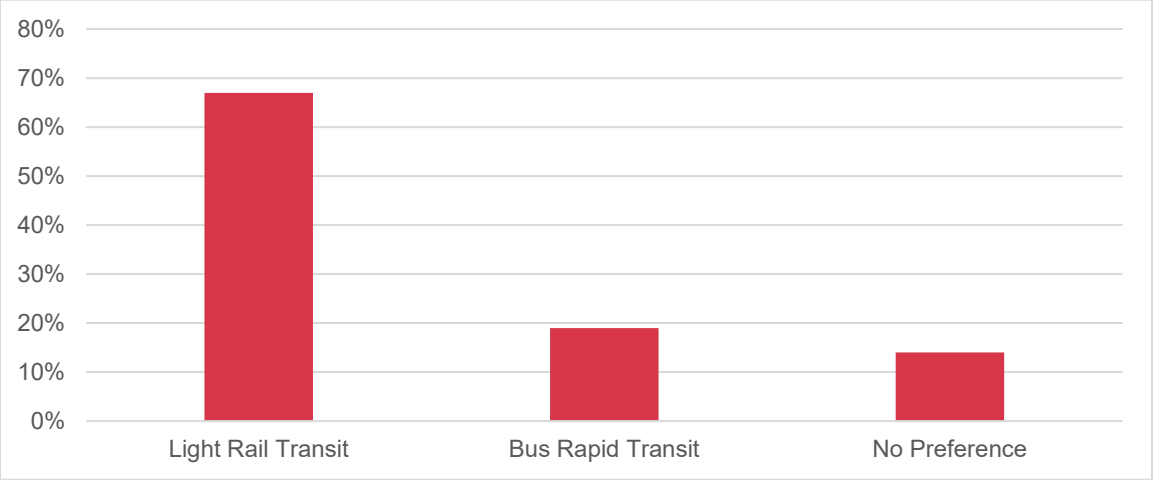
Public Support

In summer and fall 2023, more than 5,500 people were outreached and engaged through nine (9) open houses, 42 pop-up meetings, 17 community association presentations, and door-to-door canvasing. Preference for LRT was documented in meeting notes, comment cards, and event activities across the corridor.

In a survey conducted as part of the public outreach in fall 2023, respondents were asked for their mode preference (Figure 2). Of the 3,418 respondents, 67 percent expressed a preference for LRT, compared to 19 percent who expressed a preference for BRT (Figure 3). The remaining 14 percent expressed no mode preference.

Figure 2: Mode Preference Survey

Figure 3: Mode Preference Survey Results



The same survey offered respondents an opportunity to provide additional input on the Project in open format. Analysis of the 1,214 comments from respondents showed that 25 percent of the comments supported LRT, compared to only two (2) percent supporting BRT. Support for LRT was the most common theme found in the comments. Additionally, more than ten (10) percent of commenters recognized the cost or extended time that LRT would require for construction, but believed these should not be limiting considerations. Commenters spoke of "fully investing" in Baltimore.

Transportation and Connectivity

Dedicated Guideway

Concept plans for the Preliminary Alternatives identify which segments have dedicated guideway, which includes all segments where there would be a transitway physically separated from other traffic using curbs, medians, posts, raised rumble strips, off-street alignments, or tunnels.

All Preliminary Alternatives have dedicated guideway for 90-100 percent of their length (Table 8). Mode is not the differentiator for dedicated guideway. Instead, tunnel versus surface is the largest differentiator for dedicated guideway, with tunnel alternatives having a greater percentage of dedicated guideway than surface alternatives.

Table 8: Percent Dedicated Guideway by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Percent Dedicated Guideway	N/A	95 - 100%	90 - 95%	90 - 95%	95 - 100%	90 - 95%	90 - 95%

Connections to Rail Stations

The Preliminary Alternatives were analyzed for their connections to existing rail stations on Metro Subway, Light Rail, and MARC Train. Existing rail stations within 1/4 mile (straight line distance) of Red Line stations were counted.

The Preliminary Alternatives would have between four (4) and six (6) connections to existing rail stations (Table 9). Mode is not the differentiator for rail connections. Instead, horizontal and vertical alignments are the main differentiators. Surface alternatives have more rail connections than tunnel alternatives, and the Surface North alignment has one more rail connection than the Surface South alignment.

Table 9: Number of Connections to Rail Stations by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
# of Connections to Rail Stations within 1/4 mile	N/A	4 West Baltimore MARC Convention Center Light Rail Camden Station MARC Charles Center Metro Subway	6 West Baltimore MARC Lexington Market Metro Subway Baltimore Arena Light Rail Camden Station MARC Charles Center Metro Subway Shot Tower Metro Subway	5 West Baltimore MARC Convention Center Light Rail Camden Station MARC Charles Center Metro Subway Shot Tower Metro Subway	4 West Baltimore MARC Convention Center Light Rail Camden Station MARC Charles Center Metro Subway	6 West Baltimore MARC Lexington Market Metro Subway Baltimore Arena Light Rail Camden Station MARC Charles Center Metro Subway Shot Tower Metro Subway	5 West Baltimore MARC Convention Center Light Rail Camden Station MARC Charles Center Metro Subway Shot Tower Metro Subway

Connections to Frequent Bus Routes

The Preliminary Alternatives were analyzed for their connections to frequent bus routes, defined as existing bus routes arriving every 15 minutes or better during weekday AM peak, weekday midday, and weekday PM peak periods. Frequent bus routes within 350 feet of Red Line stations, a distance approximating the length of a city block, were counted.

Mode is not the differentiator for frequent bus connections. Instead, tunnel versus surface is the main differentiator for frequent bus connections, with surface alternatives having nine (9) to 11 more frequent bus connections (Table 10). Surface alternatives have more stations, enabling more connections.

Table 10: Connections to Frequent Bus Routes by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Connections to Frequent Bus	N/A	35	46	44	35	46	44

Transit Passenger Capacity

BRT capacity varies based on factors such as quantities of seats and doors, as well as load standards. Based on available peer data, average seating and standing capacity of an articulated BRT bus is 97 passengers.[2] Per the Baltimore Red Line service plan[3], which matches the 2012 FEIS 2035 Operating Plan, operating BRT at a peak period frequency of seven (7) minutes would provide a capacity of 1,600 riders per peak hour.

A single LRT car has a seating and standing capacity of 141 passengers, so an LRT train consisting of two (2) cars would have a total capacity of 282 passengers. Per the Baltimore Red Line service plan[3], which matches the 2012 FEIS 2035 Operating Plan, operating LRT at a peak period frequency of 7 minutes would provide a capacity of 4,800 riders per peak hour.

Hourly light rail ridership in Baltimore, Philadelphia, Jersey City, and Boston shows that peak hour ridership through a two-hour peak period comprises approximately 20-30% of the total weekday ridership. Applying that estimate at maximum capacity BRT could serve 11,000 to 17,000 passengers per day and LRT could serve 32,000 to 48,000 to passengers per day.

Comparing opening year projected ridership, based on pre-pandemic travel patterns, to estimated daily capacity, only LRT will have sufficient capacity (Table 11). At an identical service frequency to LRT, BRT would be over capacity. For the BRT Preliminary Alternatives to achieve similar capacity utilization as the LRT Preliminary Alternatives, BRT peak period frequencies would need to be approximately four (4) minutes. Operating at this frequency would increase the chance of BRT vehicles bunching and platooning (grouping traveling vehicles together), which would negatively affect reliability and may undermine the efficiency of the transit service.

Table 11: Transit Passenger Capacity

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Average Weekday Total Projected Trips	0	33,000 - 35,500	29,500 - 31,500	28,500 - 30,000	17,500 - 24,000	12,000 - 16,500	11,500 - 16,000
Estimated Daily Capacity	0	32,000 - 48,000	32,000 - 48,000	32,000 - 48,000	11,000 - 17,000	11,000 - 17,000	11,000 - 17,000
Estimated Capacity Utilization	0	74 - 103%	66 - 92%	63 - 89%	141 - 159%	97 - 109%	94 - 105%

On-Street Vehicle Parking Impacts

Concept plans for the Preliminary Alternatives identify where existing on-street vehicle parking spaces would be repurposed for the Baltimore Red Line. Approximately 50-60 percent of parking impacts occur in residential areas.

Mode is not the differentiator for on-street vehicle parking impacts. Instead, tunnel versus surface is the differentiator. Tunnel alternatives have the least on-street vehicle parking impacts, followed by Surface South alternatives (Table 12). Surface North alternatives have the most on-street vehicle parking impacts.

[2] Based on peer BRT systems operated by AC Transit, CapMetro, CTtransit, IndyGo, MBTA, Omnitrans, and TransFort.
[3] Based on 2012 FEIS 2035 Red Line Operating Plan. The Red Line service plan will be updated as the study progresses.

Table 12: Reduction in On-Street Vehicle Parking Spaces by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Reduction in On-Street Vehicle Parking Spaces	0	20 - 30	210 - 700	130 - 430	20 - 30	210 - 700	130 - 430

Equity, Economy, and Environment

Average Weekday Projected Trips from Zero-Car Households

STOPS projected the average weekday projected trips from zero-car households for each preliminary alternative using U.S. Census American Community Survey 2016-2020 5-year estimates, regional travel data from Baltimore Metropolitan Council (BMC) and the proposed Baltimore Red Line alignment, station locations and service plan.

Across the Preliminary Alternatives, the low end of LRT ridership projections is at least twice that of corresponding BRT alternatives (Table 13). The high end of ridership projections for Alternatives 2A and 2B is also twice that of the corresponding BRT alternatives. The LRT alternatives are projected to attract a greater share of their ridership from zero-car households (Table 13).

Table 13: Average Weekday Projected Trips from Zero-Car Households

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Average Weekday Projected Trips from Zero-Car Households	0	12,000 - 13,500	11,500 - 12,500	11,000 - 12,000	6,000 - 8,000	4,500 - 6,000	4,000 - 6,000
Average Weekday Projected Trips from Zero-Car Households as Percentage of Total	0	36 - 38%	39 - 40%	39 - 40%	33 - 34%	36 - 38%	35 - 38%

Access to Transit-Critical Populations

Transit-critical populations are zero-car households or those who do not have readily available transportation options. The Preliminary Alternatives were analyzed using U.S. Census American Community Survey 2016-2020 5-year estimates for the access they provide to the following transit critical populations:

- Low-income population (less than 150 percent of the poverty line)
- Minority population (non-white and non-Hispanic)
- Limited English proficiency population
- Adults aged 65 and older population
- One or more disabilities population

- Zero-car households

Table 14 provides the sum of transit-critical populations within 1/2 mile of proposed Red Line stations.

Table 14: Access to Transit-Critical Populations by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Transit-Critical Populations within 1/2 mile of Stations	0	136,000	151,000	143,000	136,000	151,000	143,000

Mode is not the differentiator for transit-critical populations. Instead, path of travel is the differentiator, with the Surface North alternatives performing best, followed by Surface South, then Tunnel alternatives. In addition to the Surface alternatives having more stations, which increases access, the Surface North alignment travels through areas with greater transit-critical populations.

Access to Existing Jobs, Students, and Households

The Preliminary Alternatives were analyzed for the access they provide to existing jobs, students, all households, low-income households, and zero-car households. Table 15 provides the sum of these jobs, populations, and households within 1/2 mile of Red Line stations.

Table 15: Access to Existing Jobs, Students, and Households by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Existing Jobs within 1/2 mile of Stations	0	137,000	141,000	138,000	137,000	141,000	138,000
Students within 1/2 mile of Stations	0	12,000	13,000	13,000	12,000	13,000	13,000
Total Households within 1/2 mile of Stations	0	43,000	48,000	45,000	43,000	48,000	45,000
Low-Income Households within 1/2 mile of Stations	0	17,000	20,000	18,000	17,000	20,000	18,000
Zero-Car Households within 1/2 mile of Stations	0	11,000	18,000	12,000	11,000	18,000	12,000

Mode is not a differentiator for access to existing jobs, students, all households, low-income households, and zero-car households. Surface alternatives offer slightly more access than tunnel alternatives because they have more stations, but the Preliminary Alternatives all offer similar access.

Reduction in Vehicle Miles Traveled

STOPS projected the change in auto passenger miles traveled for each Preliminary Alternative (build minus no build). These outputs were converted to auto vehicle miles traveled (VMT) by dividing by the average vehicle occupancy for the region (1.32) obtained from the BMC's regional model for the 2019 AM peak period.

LRT generates a greater reduction in auto VMT compared to BRT (Table 16). This greater reduction in VMT produced by LRT will help reduce traffic congestion and help reduce greenhouse gas emissions.

Table 16: Projected Reduction in Auto VMT by Preliminary Alternative

	No Build	1: LRT-Tunnel	2A: LRT-Surface North	2B: LRT-Surface South	3: BRT-Tunnel	4A: BRT-Surface North	4B: BRT-Surface South
Projected Reduction in Auto VMT	0	29,000 - 39,000	22,500 – 29,000	28,000 - 33,000	17,000 - 20,000	13,000 - 14,000	12,000 - 13,000

RECOMMENDED MODE

Justification for Recommending LRT

Based on the measures of effectiveness results, public input received, and the reasons summarized below, MTA reconfirms LRT as the transit mode for the Project. The rationale for recommending LRT as the preferred modal alternative for the Project is consistent with the justification for selecting LRT as the mode for the LPA in the 2012 FEIS. The current recommendation is supported by updated ridership and performance data, as well as strong public feedback (Table 17).

Table 17: Differentiators in Mode Screening

Category	Measure of Effectiveness	Differentiator for Mode Screening	LRT	BRT
Costs and Effectiveness	Average weekday total projected trips	✓	✓	
	New transit trips	✓	✓	
	Capital costs (2023 $, billions)	✓		✓
	Annualized capital cost per trip (2023 $)	✓	✓	
	Operating and maintenance costs (2023 $, millions)	✓		✓
	Public support	✓	✓	
	Transit passenger capacity	✓	✓	

Category	Measure of Effectiveness	Differentiator for Mode Screening	LRT	BRT
Equity, Economy, and Environment	Average weekday projected trips from zero-car households	✓	✓	
	Projected reduction in vehicle miles traveled	✓	✓	

Higher Projected Ridership

LRT alternatives have consistently higher weekday projected ridership than corresponding BRT alternatives (i.e., those with similar paths of travel and tunnel/surface vertical alignments). Preliminary Alternative 1 (LRT-Tunnel) is projected to have a weekday ridership 11,500-15,500 greater than Preliminary Alternative 3 (BRT-Tunnel). Preliminary Alternatives 2A and 2B (LRT-Surface North/South) have weekday ridership 14,000-17,500 greater than Preliminary Alternatives 4A and 4B (BRT-Surface North/South). In some cases, LRT weekday ridership is twice that of the comparable BRT alternative.

Much Stronger Public Support

Of the 3,418 respondents who provided written comments during the Fall 2023 Open Houses on the Preliminary Alternatives, 67 percent expressed a preference for LRT. Only 19 percent expressed a preference for BRT. Additionally, the majority of people who participated in Summer 2023 engagement events expressed support for LRT.

Better Cost Effectiveness

Annual operating and maintenance costs per trip are similar for LRT and BRT. However, annualized capital cost per trip was approximately 20 percent less for LRT alternatives than corresponding BRT alternatives because projected ridership was much greater for LRT.

More Projected New Transit Trips

LRT alternatives demonstrated consistently greater potential to generate new transit trips than BRT alternatives. All of the LRT alternatives are projected to attract more new transit trips than corresponding BRT alternatives (i.e., those with similar paths of travel and tunnel/surface vertical alignments). Preliminary Alternative 1 (LRT-Tunnel) have new transit trips 3,700-4,700 greater than Preliminary Alternative 3 (BRT-Tunnel). Preliminary Alternatives 2A and 2B (LRT-Surface North/South) have new transit trips 2,800-5,300 greater than Preliminary Alternatives 4A and 4B (BRT-Surface North/South). Preliminary Alternative 2B (LRT-Surface South) is projected to generate twice as many new transit trips as the comparable BRT alternative.

Transit Passenger Capacity

LRT would equip the MTA to handle the needs of base year ridership projections and accommodate future ridership growth. In contrast, BRT would be over capacity based on pre-pandemic ridership projections. With identical frequencies in the service plans for LRT and BRT, capacity is limited by the size of the vehicle. A single BRT vehicle, LRT vehicle, and two-car LRT train could transport 97, 141, and 282 people, respectively.

Higher Projected Trips from Zero-Car Households

LRT alternatives are projected to have consistently higher projected trips from zero car households than corresponding BRT alternatives (i.e., those with similar paths of travel and tunnel/surface vertical alignments). Preliminary Alternative 1 (LRT-Tunnel) have trips from zero-car households 5,500-6,000 greater than Preliminary Alternative 3 (BRT-Tunnel). Preliminary Alternatives 2A and 2B (LRT-Surface North/South) are projected to generate at least twice as many trips from zero-car households than Preliminary Alternatives 4A and 4B (BRT-Surface North/South).

Greater Reduction in Auto Vehicle Miles Traveled

LRT alternatives are projected to result in greater reductions to vehicle miles traveled than BRT alternatives. These reductions to VMT would result in greater reductions in carbon dioxide emissions that cause climate change and particulate matter linked with respiratory disease.

Changes since the FEIS

The 2012 FEIS included additional reasons for selecting LRT as the mode for the LPA. The justification for not including these in this mode recommendation is described below.

Travel Times

In the 2012 FEIS, LRT was proposed to have faster travel times than BRT. MTA has since updated its assumptions about BRT operations and found that, so long as BRT vehicles are provided with similar priority within the right-of-way, its travel times are similar to LRT. End-to-end travel time is still approximately one (1) minute less for the LRT alternatives than the BRT alternatives, but this difference was not enough to be a differentiator for determining the preferred mode.

User Benefit

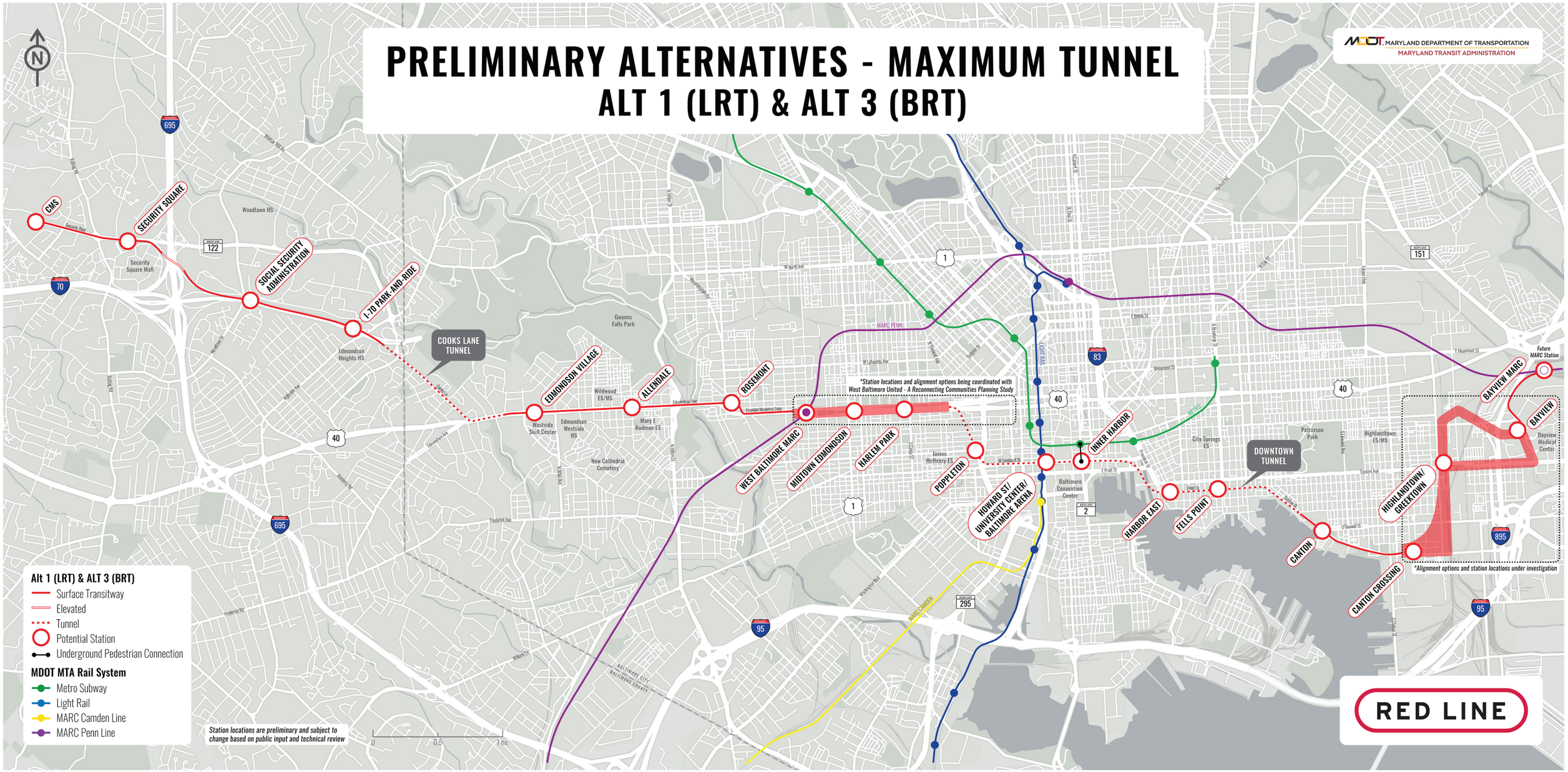
In the 2012 FEIS, LRT demonstrated greater annual user benefit than BRT. In 2013, FTA finalized an update to the regulation and policy guidelines of the CIG Program, an FTA discretionary grant funding program. This update eliminated the user benefit calculation, returning to a method of measuring cost effectiveness that is easier to measure and does not favor longer routes. Thus, MTA is instead accounting for cost effectiveness using the current method.

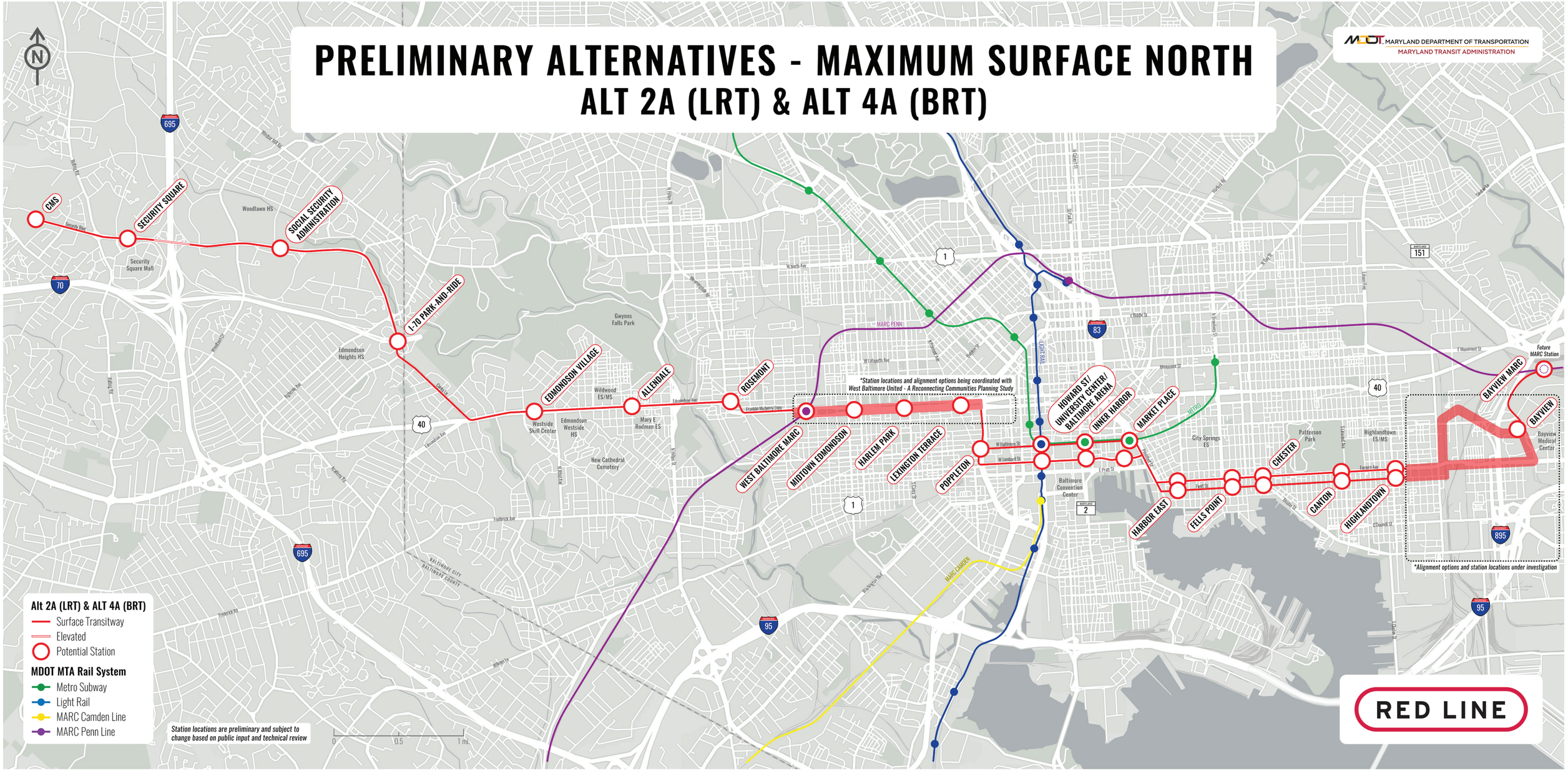
NEXT STEPS

Following this mode recommendation, MTA will focus on additional analyses to further investigate the different LRT alternatives to select an LPA. Throughout 2024 and documented through the NEPA process, MTA will be evaluating operational and environmental impacts of the three LRT Alternatives to determine the most appropriate alignment, including the extent to which the Project may include surface or tunneled segments.

APPENDIX A
PRELIMINARY ALTERNATIVES MAPPING

MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION


PRELIMINARY ALTERNATIVES - MAXIMUM TUNNEL
ALT 1 (LRT) & ALT 3 (BRT)
MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION
CMS
SECURITY SQUARE
SOCIAL SECURITY ADMINISTRATION
I-70 PARK-AND-RIDE
COOKS LANE TUNNEL
EDMONDSON VILLAGE
ALLENDALE
ROSEMONT
WEST BALTIMORE MARC
MIDTOWN EDMONDSON
HARLEM PARK
POPPLETON
HOWARD ST/ UNIVERSITY CENTER/ BALTIMORE ARENA
INNER HARBOR
HARBOR EAST
FELLS POINT
DOWNTOWN TUNNEL
CANTON
CANTON CROSSING
HIGHLANDTOWN/ GREEKTOWN
BAYVIEW
BAYVIEW MARC
Future MARC Station
*Station locations and alignment options being coordinated with West Baltimore United - A Reconnecting Communities Planning Study
*Alignment options and station locations under investigation
Alt 1 (LRT) & ALT 3 (BRT)
Surface Transitway
Elevated
Tunnel
Potential Station
Underground Pedestrian Connection
MDOT MTA Rail System
Metro Subway
Light Rail
MARC Camden Line
MARC Penn Line
Station locations are preliminary and subject to change based on public input and technical review
0
0.5
1 mi
RED LINE


PRELIMINARY ALTERNATIVES - MAXIMUM SURFACE NORTH
ALT 2A (LRT) & ALT 4A (BRT)
MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION
CMS
SECURITY SQUARE
SOCIAL SECURITY ADMINISTRATION
I-70 PARK-AND-RIDE
EDMONDSON VILLAGE
ALLENDALE
ROSEMONT
WEST BALTIMORE MARC
MIDTOWN EDMONDSON
HARLEM PARK
LEXINGTON TERRACE
POPPLETON
HOWARD ST/ UNIVERSITY CENTER/ BALTIMORE ARENA
INNER HARBOR
MARKET PLACE
HARBOR EAST
FELLS POINT
CHESTER
CANTON
HIGHLANDTOWN
BAYVIEW MARC
BAYVIEW
Future MARC Station
*Station locations and alignment options being coordinated with West Baltimore United - A Reconnecting Communities Planning Study
*Alignment options and station locations under investigation
Woodlawn HS
Security Square Mall
Edmondson Heights HS
Gwynns Falls Park
Wildwood ES/MS
Westside Skill Center
Edmondson Westside HS
Mary E Rodman ES
New Cathedral Cemetery
Baltimore Convention Center
City Springs ES
Patterson Park
Highlandtown ES/MS
Bayview Medical Center
MARC PENN
MARC CAMDEN
LIGHT RAIL
METRO
BALTIMORE CITY
BALTIMORE COUNTY
Alt 2A (LRT) & ALT 4A (BRT)
Surface Transitway
Elevated
Potential Station
MDOT MTA Rail System
Metro Subway
Light Rail
MARC Camden Line
MARC Penn Line
Station locations are preliminary and subject to change based on public input and technical review
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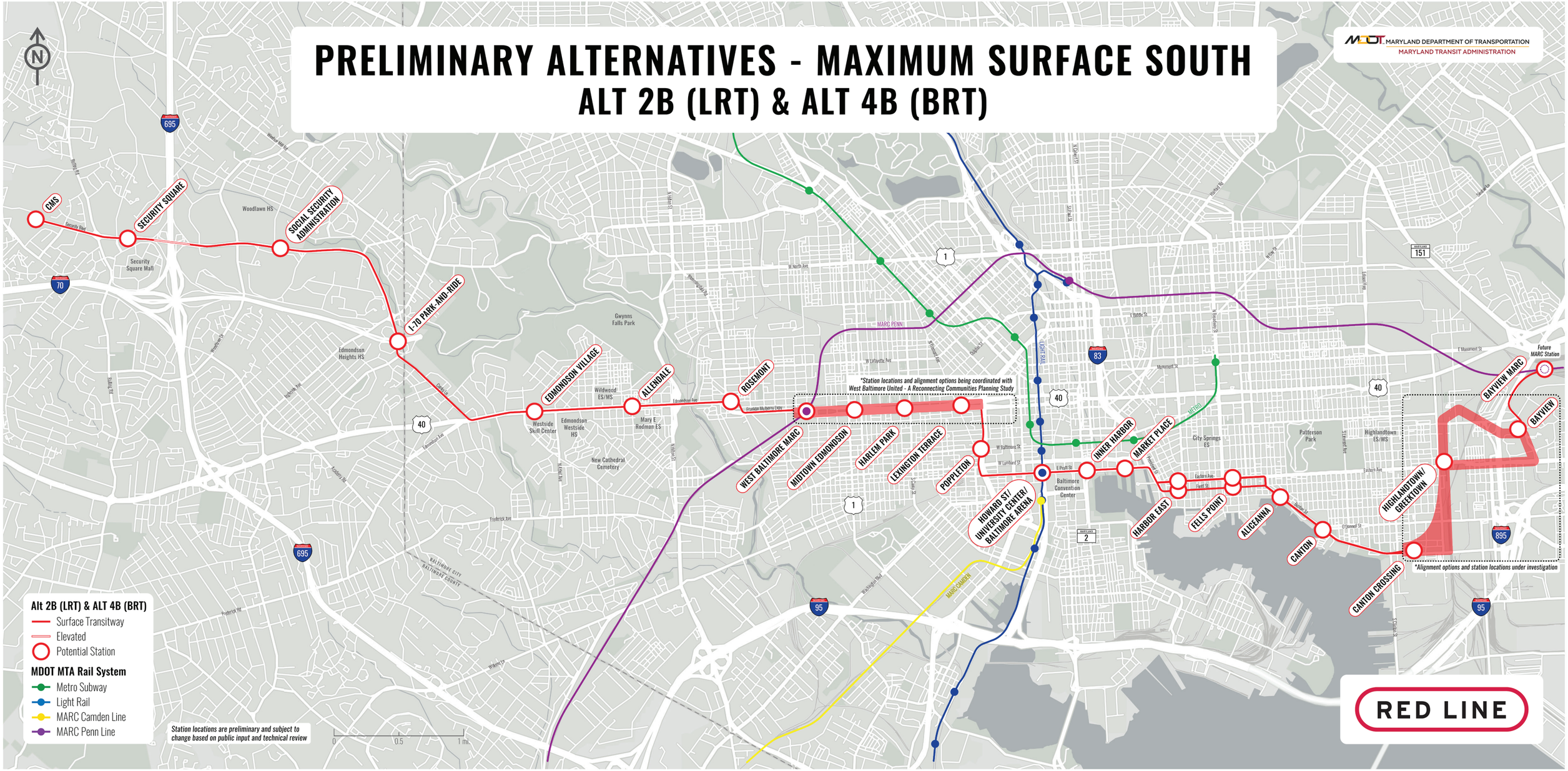
0.5
1 mi
RED LINE


PRELIMINARY ALTERNATIVES - MAXIMUM SURFACE SOUTH
ALT 2B (LRT) & ALT 4B (BRT)
MDOT MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND TRANSIT ADMINISTRATION
CMS
SECURITY SQUARE
SOCIAL SECURITY ADMINISTRATION
I-70 PARK-AND-RIDE
EDMONDSON VILLAGE
ALLENDALE
ROSEMONT
WEST BALTIMORE MARC
MIDTOWN EDMONDSON
HARLEM PARK
LEXINGTON TERRACE
POPPLETON
HOWARD ST/ UNIVERSITY CENTER/ BALTIMORE ARENA
INNER HARBOR
MARKET PLACE
HARBOR EAST
FELLS POINT
ALIGEANNA
CANTON
CANTON CROSSING
HIGHLANDTOWN/ GREEKTOWN
BAYVIEW
BAYVIEW MARC
Future MARC Station
*Station locations and alignment options being coordinated with West Baltimore United - A Reconnecting Communities Planning Study
*Alignment options and station locations under investigation
RED LINE
Alt 2B (LRT) & ALT 4B (BRT)
Surface Transitway
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Potential Station
MDOT MTA Rail System
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Light Rail
MARC Camden Line
MARC Penn Line
Station locations are preliminary and subject to change based on public input and technical review
0
0.5
1 mi.