



DISTRICT OF COLUMBIA TRANSIT IMPROVEMENTS ALTERNATIVES ANALYSIS

SCREEN 1 REPORT

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DISTRICT OF COLUMBIA DEPARTMENT OF TRANSPORTATION
WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY



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I. Introduction

The District of Columbia and the Washington Metropolitan Area Transit Authority (WMATA) are conducting a multi-corridor study of transit alternatives in the city. The focus of this study is to define a third transit mode that will provide a network of efficient, high-quality, high-capacity surface transit across the District, thereby offering additional connections between the existing Metrobus and Metrorail systems, as well as to key activity centers throughout the city.

This technical report has three purposes:

- Identify a universe of modes to be considered for evaluation in the Alternatives Analysis;
- Complete a first screening of modes based on compatibility with project policies and general criteria related to overall feasibility;
- Complete a final screening of surviving modes utilizing more detailed engineering analysis and an assessment of the compatibility of the mode with surrounding neighborhoods.

The result of the two-step screening process will be the first phase in identifying the universe of alternative modes to be used in later steps of the study. These alternatives will then be evaluated and compared by using a range of screening criteria that consider potential environmental impacts, cost-effectiveness, support of project goals and objectives and whether the alternative meets the purpose and need for the proposed action.

II. Mode Identification

As noted, the first step in the alternatives analysis process is to identify a universe of modes to be considered for the project. A mode is a system for carrying transit passengers that can be described by specific features that include vertical and horizontal right-of-way requirements, turning radii requirements, vehicle technology, and operational elements such as service frequency and stop spacing. Seven potential modes have been identified for this study: Bus Rapid Transit (BRT), Light Rail Transit (LRT), Streetcar, lightweight Diesel Multiple Unit (DMU), Automated Guided Transit (AGT), Monorail, and Heavy Rail.

Each of the modes identified for this study will be screened against an initial set of evaluation criteria that are discussed in greater detail below (this represents the first screening step identified in the introduction). Modes that meet these criteria will be carried forward for further and more rigorous evaluation in the second screening. Those modes not meeting the evaluation criteria in either the first or second screening will be eliminated from further consideration.

A more detailed description of each of the modes being considered in the analysis is provided below. It should be noted that the service characteristics of, and the markets served by, the different modes often overlap and therefore identifying specific and definitive characteristics for

each mode can be somewhat misleading. The descriptions outlined below identify where these service characteristic and markets served overlaps occur.

III. Modes for Consideration

a. Bus Rapid Transit (BRT)

1. General Characteristics

Bus Rapid Transit (BRT) is a form of rapid transit that uses a system of rubber tired vehicles operating either on dedicated right-of-way, such as exclusive transitways, HOV lanes or expressways, or in mixed traffic on ordinary streets. BRT systems have a unique identity incorporated into their vehicles and passenger facilities, thus providing a distinction between BRT and local bus service that often runs on the same streets. These systems also incorporate the use of Intelligent Transportation Systems (ITS) technology for vehicle location, possible use in providing signal priority, and passenger information. A BRT system typically provides a similar level of service to that of a light rail system in terms of service frequency and stop spacing, but provides the flexibility of using buses.

2. Vehicle Characteristics

BRT vehicles are rubber-tired vehicles that operate on roadways and do not require tracks or other fixed guideway technology. BRT vehicles vary by provider, however, the typical BRT vehicle ranges between 40 to 60 feet in length and 10 to 15 feet in height. The vehicles usually have a distinct identity, differentiating them from regular bus service. In addition, the vehicles typically have easy and fast boarding capabilities, including low floors and multiple door entry and exit, and maximize passenger capacity. BRT vehicles can be powered by a range of fuel sources (including diesel, compressed natural gas (CNG), or hybrid technology) that are contained within the vehicle.

BRT vehicles range in size and therefore so do the number of passengers they can carry. Vehicle capacities range from approximately 60 to 120 passengers per vehicle. This capacity typically reflects a combination of seated and standing passengers on each vehicle.

3. Stop Characteristics

The typical BRT stop amenities include shelters with a unique BRT identity, pertinent passenger information such as route maps and schedules, ITS features such as next bus vehicle arrival information, fare media dispensing machines, trash receptacles, benches and pedestrian level lighting. The stop may also include platforms that could be long enough to accommodate 2 to 3 buses at a time, or may simply utilize an existing sidewalk. Typically the stops would be low to the ground to serve low floor buses. Stops are generally located along curb lanes and would be spaced approximately every ¼ mile in urban areas to 1-mile in suburban areas.

Some stops in urban areas may incorporate the use of curb extensions (also referred to as bulb-outs). Curb extensions are an extension of the sidewalk from the curb of a parking lane to the

edge of the through lane of traffic. Bulb-outs allow busses to board and drop off passengers without leaving the travel lane of the street. This stop configuration minimizes delays associated with buses re-entering mainstream traffic. Bus bulbs also create additional space for waiting passengers, shelters, benches, and other passenger amenities.

4. Service

Different BRT systems may encompass a range of service parameters such as frequency and span of service but typically provide frequent, all-day service and are used in medium to high volume commute routes. Service typically runs seven days a week and operates with peak headways of 10 minutes or less and midday headways of 15 minutes or less. Service hours are typically at least 16 hours a day. BRT stops are spaced farther apart than local stops and are typically sited to serve major trip generators and attractors along a corridor (including at heavy transfer points with crossing local routes). Ridership can vary but the minimum number of daily corridor boardings to support the service level inherent to BRT would typically be 5,000 daily passengers.

5. Costs

Costs for BRT systems vary depending upon the BRT elements being implemented. BRT systems using a dedicated right-of-way are typically more expensive than arterial median running busways or systems running in mixed traffic. On average, costs range between \$2 million and \$10 million per mile for construction. BRT vehicles can cost between \$300,000 and \$1 million.

b. Streetcar (Historic Trolley)

1. General Characteristics

Streetcars are small rail cars that run on in-street tracks, at-grade with traffic (though in some instances streetcars can take advantage of exclusive right-of-way, for instance in street medians), and are generally smaller than Light Rail Vehicles or other rail vehicles. The smaller rail vehicle and generally slower speeds of streetcars lend themselves to a more intimate feel and are most often utilized for intra-city transportation with relatively frequent stops, including as downtown circulator systems. The smaller capacity, and to some extent the slower operating speeds, generally make streetcars unsuitable for long distance commuter type operations, though vehicle specifications do vary.

2. Vehicle Characteristics

Modern streetcars are sleek, low-floor vehicles with wide doors and large windows such as those in use in Portland, Oregon and Tacoma, Washington. Some streetcars designed with a retro "historic" feel are also popular and include vehicles such as the historic styled streetcars in Tampa, Florida and New Orleans, Louisiana. Most of these vehicles receive their power from an overhead electric wire. Streetcars can range from 30 to 67 feet in length and 8 to 20 feet in

height (to accommodate overhead wire connections). Vehicle features include multiple doors and large windows. The cars can carry between 30 and 204 passengers, based on a combination of seated and standees. Most of these cars can operate singly or in multiple car trains. This type of technology requires between 16 and 25 feet of right-of-way (for both tracks).

3. Stop Characteristics

Streetcar stops are relatively small compared to other rail mode stops. They typically include a small shelter and basic information (fare, route, time table), similar to a regular bus stop. They may also have an off-board fare media dispenser for off-board fare collection. Streetcar stops can be on a platform (approximately 75-feet long and 14-inches high for low floor boarding) or may simply utilize the sidewalk (or a curb extension similar to that described for BRT). Stops are generally located every ¼ to ½ mile along a route.

4. Service

Streetcars provide medium to high volume service for circulators or act as collectors/ distributors of regional transit systems, though some existing streetcar systems also serve a regional commute market. They are intended to provide continuous service throughout the day and often there is no real peak hour, especially for systems providing a circulator function. Typical headways are between 10 and 15 minutes. Average daily ridership is typically between 5,000 and 15,000 per day.

5. Costs

Streetcar systems cost approximately \$10 to \$12 million per mile, although some systems can well exceed those estimates. Vehicles can be bought as restored originals or as new replicas or modern vehicles. Vehicle costs range from \$600,000 to \$3 million.

c. Light Rail Transit (LRT)

1. General Characteristics

Light rail transit (LRT) is a fixed guideway technology that uses electrically powered vehicles. Light rail can operate in a range of right-of-way configurations, including in mixed traffic, semi-exclusive right-of-way or exclusive right-of-way. The alignment can run at ground-level, on elevated structure, or in tunnels.

2. Vehicle Characteristics

LRT typically uses vehicles that receive power from an overhead catenary, which allows them to be integrated with other at-grade transportation modes and pedestrians. LRT vehicles can also use a third rail supply technology, which is similar to the technology used for the existing WMATA heavy rail system. However, while heavy rail operates within a dedicated and grade-separated right-of-way with an exposed top contact third rail power source, such technology

would need to be modified to allow surface third rail power source operations. This would be accomplished by placing the third rail below grade and accessible to the LRV via shoes which would reach below grade to the third rail, like those of a 'J' hook. This system is similar to the technology developed for the old Washington DC and New York City streetcars, which were not permitted to use catenary power sources due to bans on overhead wires. Light rail vehicles (LRV) are generally larger than streetcars and average between 50 and 90-feet in length and 8 to 20-feet in height. LRVs have a capacity of up to 250 passengers (combination of seated and standees), with amenities and characteristics varying by vendor. Light Rail vehicles often run in multiple car trains and thus Light Rail systems can often provide greater passenger carrying capacity than a streetcar system.

3. Stop Characteristics

LRT stops include typical patron amenities such as shelters, off-vehicle fare dispensing machines, passenger information, benches, lighting and trash receptacles. Stops are generally spaced every ½ to 2 miles. Platforms are typically 14-inches high and up to 270-feet in length (to accommodate the length of a three-car train). This type of technology requires between 24 and 28 feet of right-of-way (two tracks).

4. Service

LRT service generally operates on a daily basis with service frequencies of 10 to 15 minutes during the peak and non-peak, respectively. Typical daily ridership averages between 15,000 and 60,000 persons. LRT service is suited to medium to high volume commute routes. LRVs are capable of operating at faster speeds than streetcars, which combined with their greater capacity makes LRT more attractive for use in commuter operations along longer alignments with infrequent stops.

5. Costs

Typical LRT systems range in cost from \$20 to \$105 million per mile. LRVs can cost between \$2 and \$4 million per vehicle, depending on the vendor and desired specifications.

d. Lightweight Diesel Multiple Unit (DMU)

1. General Characteristics

Lightweight DMU technology uses a self-propelled, diesel powered vehicle that operates on both railroad and in street tracks. It operates like a light rail system instead of the more traditional DMU application, which operates exclusively on railroad right-of-way for commuter rail. Lightweight DMUs provide an alternative to LRVs that use overhead electric catenary for power.

2. Vehicle Characteristics

The lightweight DMU uses a diesel engine and is more fuel efficient than other non-electric rail cars. Other benefits of the lightweight DMU are that they tend to be quieter and have lower emissions than other diesel powered vehicles. Lightweight DMUs can run individually or coupled in sets with coaches and range in length between 90 to 125 feet for one car. They are generally 9.5 to 10 feet wide, and between 15 and 20 feet in height. Passenger capacity ranges from 80 to 200 people depending on design features. The vehicles have similar characteristics to LRVs in terms of capacity, acceleration and braking.

3. Stop Characteristics

Stops associated with Lightweight DMU would have similar characteristics to those identified for a LRT system.

4. Service

Service characteristics would be comparable to a typical LRT service.

5. Costs

System costs would be comparable to LRT systems. Lightweight DMU vehicles range in cost from \$2 to \$3 million.

e. Automated Guideway Transit (People Mover, Personal Rapid Transit, Group Rapid Transit)

1. General Characteristics

Automated Guideway Transit systems are entirely grade separated and run on dedicated right-of-way either underground or on aerial alignment. Automated systems consist of automated, electric-powered driverless vehicles on fixed guideways and provide a high level of service in terms of service frequency. This technology is typically used for circulation service in airports, recreational parks and central business districts.

2. Vehicle Characteristics

Automated guideway transit vehicles vary by system. Some systems use rubber-tired vehicles while others have steel wheels. Propulsion comes from a third rail (electric) while some systems are cable-drawn. Trains consists are typically 2 to 6 cars. Depending on the car size, passenger capacity ranges between 70 and 100 persons. AGT typically requires 8 to 16 feet of right-of-way (single track).

3. Stop Characteristics

Stops are relatively close together with an average spacing of less than ½ mile apart.

4. Service

Service can be scheduled or in response to a passenger activated call button. Trains commonly operate at headways of 60 seconds or less.

5. Costs

On average, AGT systems can cost anywhere between \$40 and \$100 million per mile. AGT vehicle costs vary, but range from \$1.0 to \$2.0 million.

f. Monorail

1. General Characteristics

Monorail systems require entirely grade separated and dedicated right-of-way and are typically on aerial alignment. It is an electric railway of guided transit vehicles operating singly or in multi-car trains. The vehicles are suspended from or straddle a guideway formed by a single beam, rail, or tube. Monorails can be operated by a driver, but most newer systems are fully automated.

2. Vehicle Characteristics

Monorails are typically linked in groups of four cars, with each car ranging from 24 to 40 feet in length. Monorail trains are about 120 feet in length. Vehicles are propelled by electricity. Each car can carry between 35 and 90 passengers. This technology requires approximately 8 to 16 feet of right-of-way (single track).

3. Stop Characteristics

Platforms are typically 36-inches high and 120 feet long (same length as the train). Stops are on aerial alignment with the tracks and therefore require up and down movement of passengers by way of stairs, escalators or elevators. Stops have the same amenities as other mode stops (shelter, information center, benches, etc.). Stops occur every ½ mile to mile.

4. Service

Monorail systems operate on a frequency of every 5 to 10 minutes during peak hours and every 10 to 15 minutes in the off peak.

5. Cost

Monorail systems are estimated to cost between \$40 and \$80 million per mile to construct. Monorail vehicles cost between \$1.0 and \$2.0 million.

g. Heavy Rail

1. General Characteristics

Heavy Rail systems are entirely grade-separated and are on dedicated right-of-way, either on the surface, underground or on aerial alignment. The existing Metrorail system operates surface, underground, and aerial segments along its 103-mile system. Heavy rail provides high level of service and is typically found in densely populated urban centers and in the suburbs as commuter service.

2. Vehicle Characteristics

Washington Metrorail vehicles are 75-feet in length and 10-feet in width, and are typically linked in sets of four or six car trains. Vehicles are propelled by electricity provided by a third rail located within the track ROW.

3. Stop Characteristics

Platforms are level with the train doors and are 600 feet in length, which will allow for expansion to eight car operations. All stations require up and down movement of passengers by way of stairs, escalators or elevators. Stops have a wide range of amenities including off-board fare collection, shelters, information (including real time), benches and passenger information. The Metro operates with a paid area that is reached by passing through fare gates. Stops occur every ½ mile to mile, depending on the area being served.

4. Service

Heavy Rail and Metrorail systems operate on a frequency of every 3 to 6 minutes during peak hours and every 10 to 15 minutes in the off peak.

5. Cost

Heavy Rail and Metrorail systems are estimated to cost about \$100 million per mile to construct and Heavy Metrorail cars cost about \$2.5 million each, or roughly \$15 million for one six-car train.

Table 1 summarizes the characteristics of each mode and affiliated stop characteristics.

**Table 1
Mode Characteristics**

| Characteristics | Bus Rapid Transit (BRT) | Streetcar | Light Rail (LRT) | Diesel Multiple Unit (DMU) | Automated Guided Transit (AGT) | Monorail | Heavy Rail (MetroRail) |
|---------------------------|--|--|---|---|---|---|--|
| Application/Market | Medium to High Density population and employment centers. Serves both regional commute and intra-corridor trips. | Medium to High Density population and employment centers. Has multiple functions, including circulator, feeder, intra-corridor trips, and some regional commute trips. | Medium to High Density population and employment centers. Generally serves a regional commute function. | Medium to High Density population and employment centers. Generally serves a regional commute function. | Medium to High Density population and employment centers. Predominantly serves a circulator function. | Medium to High Density population and employment centers. Predominantly serves a circulator function. | High Density population and employment centers. Serves both regional commute and intra-corridor trips. |
| Specific Features | Rubber-tired vehicles w/ distinct identity; Incorporates ITS | Small rail cars that run on tracks at-grade | Rail cars, operating on tracks; segments may be grade separated; corridor length is typically 15-20 miles | Self-propelled transit vehicle, typically runs on existing railroad ROW; however DMU technology can be used in LRT function. | Automated systems on entirely grade separated alignment | Aerial Transit systems on entirely separated and dedicated ROW | Rail cars, operating on entirely grade separated alignment. |
| Vehicle Dimensions | 40 – 60' in length 10 – 15' in height | 30-67' in length 8-20' in height (including overhead wire) | 50-90' in length 8-20' in height (including overhead wire) | <i>In terms of Commuter Rail:</i> 70-125' in length 10-20' in height <i>In terms of LRT:</i> Same as LRT vehicles | 11-58' in length 8-12' in height | 24 -40' in length 9-11' in width | 75' in length 10' in width |

| Characteristics | Bus Rapid Transit (BRT) | Streetcar | Light Rail (LRT) | Diesel Multiple Unit (DMU) | Automated Guided Transit (AGT) | Monorail | Heavy Rail (MetroRail) |
|--------------------------------|--|---|---|---|---|---|---|
| Power Source | Fuel (contained w/in vehicle); Some run on hybrid technology | Overhead electricity | Electricity either with overhead or third rail power source | Diesel Engine with fuel contained within the vehicle. | Electric current | Electric current | Electric current |
| Vehicle Capacity | 60 – 100 passengers (seated/standees) | 30 – 200 passengers (seated/standees) | 70-250 passengers (seated/standees) | <i>Commuter Rail:</i> 80-400 passengers <i>LRT:</i> Same as LRT vehicles | 48-205 passengers (seated/standees) | 35-152 passengers (seated/standees) | 68-120 passengers (seated/standees) |
| Vehicles per Linked Set | Single unit vehicles (some are bi-articulated buses) | Single unit vehicles (new technology can also run in trains) | Singly or in short trains (1-4 cars) | Singly or in short trains | Varies on system and demand | Singly or in short trains | Varies up to six cars in a train. |
| Operating Environment | Sometimes in dedicated lanes either on street or in separate ROW. Can also run in mixed traffic. | Tracks built in street, typically sharing lanes with mixed traffic. Can also have exclusive right-of-way in areas such as street medians. | Dedicated trackbed either on street or in separate ROW | Uses existing railroad tracks or dedicated trackbed in separate ROW. May also run in mixed traffic. | Entirely dedicated ROW & grade separated (tunneled or aerial) | Entirely dedicated ROW & grade separated (aerial alignment) | Entirely dedicated ROW & grade separated (tunneled, surface, or aerial) |
| Required ROW | 11-12' /lane | 16-25'/single track 22-40'/double track | 16-25'/single track 22-40'/double track | 16-25'/single track 22-40'/double track | 8-16'/single track 16-35'/double track | 8-16'/single track 16-35'/double track | 16-25'/single track 22-40'/double track |

| Characteristics | Bus Rapid Transit (BRT) | Streetcar | Light Rail (LRT) | Diesel Multiple Unit (DMU) | Automated Guided Transit (AGT) | Monorail | Heavy Rail (MetroRail) |
|--------------------------------|---|--|--|--|--|--|---|
| Service | Peak headways of 10 minutes or less; midday headways of 15 or less | Operate continuously, no peak hour; headways b/t 10 & 15 minutes | Peak headways of 10 minutes or less; midday headways of 15 or less | Same as LRT | Schedule or in response to passenger activated call button' headways of 60 seconds or less | Peak headways of 5-10 minutes; off-peak headways 10-15 minutes | Peak headways of 5 minutes or less; midday headways of 15 or less |
| Average Daily Ridership | 5,000 - 15,000/day | 5,000 - 15,000/day | 15,000 – 219,000/day | 15,000 – 60,000/day | Varies | Varies. Las Vegas averages 50,000 / day | Varies – Metrorail carries approx 600,000 daily |
| Capital Costs per mile | \$2 - \$10 million (exclusive lanes have higher costs) | \$10-\$12 million | \$20-\$105 million | Similar to LRT | \$40-\$100 million | \$40-\$80 million | \$100 million |
| Cost per Vehicle | \$300,000 - \$1 million | \$600,000-\$3 million | \$2-\$4 million | Similar to LRT | \$1-\$2 million | \$1-\$2 million | \$2.5 million |
| Stop Characteristics | | | | | | | |
| Stop Spacing | 125' in urban areas to 1 mile in suburban areas | ¼ to ½ mile | ½ to 2 miles | ½ to 2 miles | Less than ½ mile | ½ to 1 mile | ½ to 1 mile |
| Platform dimensions | Varies depending on bus volumes & length of vehicles; Most have a low platform to serve low-floor buses. Can use existing sidewalk or bulb out for second lane running. | 75' long/14" high | 100'long/ 14" high (may be longer, depending upon volume/train length) | 100'long/ 14" high (may be longer, depending upon volume/train length) | 100'long/ 36" high | 120' long/36"high | 600' long/ 20'-30' in width |

| Characteristics | Bus Rapid Transit (BRT) | Streetcar | Light Rail (LRT) | Diesel Multiple Unit (DMU) | Automated Guided Transit (AGT) | Monorail | Heavy Rail (MetroRail) |
|----------------------------------|---|--|---|---|---|---|---|
| Typical Station Amenities | Shelter, ITS, information, benches, trash collection, lighting, off-vehicle fare collection | Small shelter, basic information (fare, route, time table) | Shelter, off-vehicle fare collection, information benches, lighting | Shelter, off-vehicle fare collection, information benches, lighting | Predominately used in airports/Theme parks – amenities vary | Predominately used in airports/Theme parks – amenities vary | Shelter, ITS, information, benches, trash collection, lighting, off board fare collection |

Source: U.S. Department of Transportation, "Candidate Vehicle Technologies for Alternative Transportation Systems," Grand Rapids, MI Study, Regional Transportation Alternatives Plan for East Tennessee - Final Report, Technology Assessment.

IV. Mode Screening – First Step

As noted in the introduction, the first step in the mode screening involves the screening out of those modes that would not be feasible within the basic policy parameters and assumptions of the study, which are described by the criteria outlined below. If a mode did not meet each of these criteria, then it was considered to be infeasible and was dropped from further evaluation. The criteria used in this first step of the mode screening included:

- Surface running Transit System. The selected mode(s) should be entirely surface running. The District of Columbia Department of Transportation and WMATA have stated a preference for a surface running transit system to limit costs and to limit visual impacts and related issues associated with aerial alignments.
- Engineering feasibility. The selected mode(s) and affiliated stop requirements must be able to fit within the existing corridor Right-of-Way, both vertically and horizontally. A policy of the project is that there will be no right-of-way acquisition.
- Neighborhood Compatibility. The selected mode(s) must be compatible with adjacent neighborhoods from the perspective of both horizontal and vertical scale.

Surface running transit systems are defined as those systems that can operate at-grade and do not require running on dedicated and grade separated right-of-way. Such systems include BRT, Streetcars, LRT and lightweight DMU. Automated Guideway Transit and Monorail systems require grade separation above or below the ground because their driverless technologies do not allow for mixed traffic running due to safety issues. Heavy rail requires grade separation for service quality and safety reasons.

The engineering feasibility analysis completed for this step involved the examination of the horizontal and vertical space limitations of each of the proposed alignments strictly on an engineering basis; in other words, does the proposed mode fit in the available right-of-way within each corridor (both vertically and horizontally). This screening step looks **only** at whether the mode can fit in the available right-of-way. The effects of the proposed action are examined in greater detail in the next screening phase. A sample of horizontal cross-sections for each mode and alignment are shown in Appendix A and summarized in Table 2.

The neighborhood compatibility analysis examined the overall scale of each proposed mode within each of the study corridors. Each of the corridors has a particular visual identity, such as low rise residential, high-density office, commercial, etc. The size and scale of proposed vehicles, running way requirements and stops should be in keeping with the character of neighborhoods in and adjacent to the study corridors.

Table 2 summarizes the results of first step of the mode screening.

| Table 2 Mode Screening - First Step | | | | | | | |
|--|------------|------------------|------------|------------------------|------------|-----------------|-------------------|
| Criteria | BRT | Streetcar | LRT | Lightweight DMU | AGT | Monorail | Heavy Rail |
| Surface-Running | Yes | Yes | Yes | Yes | No | No | No |
| Engineering Feasibility | | | | | | | |
| Sufficient Cross Section | | | | | | | |
| <i>Horizontal</i> | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| <i>Vertical</i> | Yes | Yes | Yes | Yes | No | No | No |
| Sufficient space for Passenger facilities | | | | | | | |
| <i>Horizontal</i> | Yes | Yes | Yes | Yes | No | No | No |
| <i>Vertical</i> | Yes | Yes | Yes | Yes | No | No | No |
| Neighborhood Compatibility | | | | | | | |
| <i>Scale</i> | Yes | Yes | Somewhat | Somewhat | No | No | No |
| <i>Visual/aesthetic compatibility</i> | Yes | Yes | Somewhat | Somewhat | No | No | No |

Source: DMJM+HARRIS April 2004

Yes = Meets Criteria

No = Does Not Meet Criteria

V. Modes Eliminated from Further Consideration – First Step of Mode Screening Results

Based on the first step in the mode screening analysis, three modes have been eliminated from further consideration, Monorail, AGT and Heavy Rail. The first reason (in addition to others outlined below) for removing these three modes is because they can not feasibly be run on the surface (a project requirement) in the dense urban environment of the study corridors. Although these modes are proven technologies in effectively transporting people in high-density areas, they can not operate as all surface running transit systems. AGT and Monorail are fully automated driverless technologies and therefore can not run in mixed traffic conditions for safety reasons. Heavy rail must also have exclusive grade separated right-of-way for quality of service and safety reasons, which is simply not feasible in densely populated city neighborhoods. The need for a surface running transit system is based on the narrow corridor right-of-way, height restrictions, and limited resources available to construct an aerial or underground transit system. This requires a technology that can safely and effectively operate in an alignment with other vehicles and in all roadway conditions. The surface running system would in effect need to operate with a driver in mixed traffic at all crossings. Monorail and AGT would require separate grade crossings at each intersection within each corridor. Heavy Rail would require an exclusive and grade separated right-of-way.

A second reason for eliminating Monorail and AGT was its incompatibility with surrounding residential neighborhoods. Grade separation for these two modes is typically achieved through an aerial structure. Aerial structures in many of the corridors would have a significant and unacceptable negative impact on adjacent low rise residential neighborhoods.

AGT, or People Mover, and Monorail, was also eliminated based on the automated component of their technology in relation to the safety and security impacts that would result in the corridor. Although AGT and People Mover can operate at street level, these automated driverless technologies work must run in dedicated and grade-separated environments for safety reasons. As with Monorail, the need for grade separation would result in a running way significantly out of scale with the neighborhoods being served.

For heavy rail, the unacceptable impact on neighborhoods of an aerial structure as well as the length of trains was an additional reason for removing the mode in this first screening step.

Based on this analysis, the modes remaining for further evaluation in the second step of the mode screening are BRT, LRT, light DMU, and streetcar.

VI. Mode Screening – Second Step

In this step of the mode screening process, the remaining modes, BRT, LRT, Streetcar, and DMU are examined in more detail, especially with regard to impacts to neighborhoods and impacts to structures and properties adjacent to the study corridors. More extensive engineering analysis was completed to allow for this more detailed assessment of potential impacts within each corridor. The screening criteria used in this step of the mode screening process include:

- Traffic Impacts
- Neighborhood Scale and Impacts to Adjacent Structures and Properties
- Parking Impacts
- Transit Capacity Issues
- Community Support

As noted, the purpose of this process step is to complete a final screening of modes that are not feasible in the corridors selected for analysis in the DCAA. In the next process step, the surviving modes will be paired with corridors to develop alternatives that will be assessed within the context of an evaluation framework that focuses on project goals and objectives. The alternatives surviving that first evaluation will then be evaluated within the context of an even more rigorous evaluation framework that will focus on cost-effectiveness, social and environmental impacts, compatibility with policy decisions, and success in meeting project goals and objectives.

The findings of the analysis relative to each of the screening criterion used in this step of the mode screening process are outlined below.

a. Traffic Impacts

While all of the modes under consideration would operate in mixed traffic, BRT, Streetcar, LRT, and DMU differ in vehicle capacity, size, and width. The width of the vehicle could determine whether or not the existing street configuration can be preserved, or whether an additional lane or lanes would be lost due to mode cross-section requirements. In general, based on the narrower width of the required streetcar cross-section, streetcar would have an advantage over the other two rail modes in preserving travel lanes (cross-sections for each mode for select 'choke points' along the corridors are included in Appendix A. These cross-sections provide a good understanding of the different lane configurations that will be possible for each mode at these selected points. The description of the "program vehicle" for each mode is included as Appendix C. The data included in Appendix C for each modal "program vehicle" outlines the horizontal and vertical dimensions that were used for completing the screening analysis). The capacity of each mode may also have an impact on traffic as longer or more frequent consists may be needed to meet passenger demand. A fuller understanding of this potential impact will await ridership forecasts for each study corridor.

Overall, similar impacts to traffic would occur with the addition of any of the remaining rail modes, in each of the corridors under consideration (the possible exception to this is Streetcar in select locations since streetcars have a narrower width requirement than the other rail modes, thus providing a greater opportunity to preserve existing lane configurations). The similar traffic impact results for each of the remaining rail modes prevents use of this criterion to eliminate modes.

It should be noted that this evaluation assumed that bulb-outs (also known as curb extensions) would be used at stops in all corridors. In addition to being essential for rail or BRT operations (assuming the removal of street parking required for an all-curb running operation would result in unacceptable impacts to vehicle storage requirements), bulb-outs provide the added community benefits of preserving on-street parking and enhancing the pedestrian environment by narrowing the distance required to cross the street. Bulb-outs also have an added advantage of being used as depository for snow during inclement weather.

From the point of view of traffic operations, the use of bulb-outs will result in lowered automobile capacity during peak period traffic operations because bulb-outs result in the removal of a peak direction travel lane during peak hours (in corridors where parking is restricted during peak hours in the peak traffic direction). It should be noted, however, that even though automobile capacity is lowered, total person throughput capacity on the roadway increases significantly through the facilitation of more efficient transit service in the corridor. The benefit to total carrying capacity of the transportation facility is created by providing vehicle storage space all day and eliminating the automobile and transit conflict at stops. Also, transit stops will be spaced further apart and at far side locations where possible, further decreasing the opportunity for automobile and transit vehicle conflicts.

The alternative to bulb-outs is to have full curb running operations. As noted above, this would involve the removal of all on-street parking along the proposed corridors. The evaluation of this

type of operational configuration revealed no difference in traffic impacts between the modes under consideration. However, as compared to the bulb-out operation, traffic level of service would be closer to existing level of service because of the retention of the peak direction, peak period travel lane. A policy decision has been made, however, that full curbside running will not be utilized because of the unacceptable impacts to on-street parking.

FINDINGS – NO MODES SCREENED OUT BASED ON TRAFFIC IMPACTS

b. Neighborhood Scale/Impacts to Adjacent Structures

In analyzing the remaining modes for compatibility with neighborhood scale, the elements considered in the analysis included the combined width of the street from curb to curb, the width of the sidewalks, the size of adjacent buildings, and building uses. For each mode, vehicle size and associated required infrastructure (such as the catenary system) were compared to the overall built environment in which it would operate. In addition to vehicle size, each vehicle's turning radii was also evaluated to determine whether each mode could make the necessary turning movements required to move from corridor to corridor (or within corridors) without impacting adjacent buildings or properties.

The first consideration when assessing compatibility with neighborhood scale was the cross-section for each mode within each of the study corridors. The cross section considered in the analysis was the existing curb to curb street width, based on the policy direction that all modes would be required to fit into the existing curb-to-curb right-of-way. As the cross sections in Appendix A show, all rail modes can be fit into the existing curb-to-curb right of way (though with varying impacts to the existing lane configuration), and therefore no rail modes were screened out based on this test.

The second consideration in assessing compatibility with neighborhood scale was whether there would be any direct impacts to adjacent structures or properties based on a mode turning from one corridor segment to another or within a corridor segment. This analysis was based on the turning radii of the "program vehicle" for each mode and assumed that turns from each corridor segment to another are essential to support the requirement for interoperability, meaning that vehicles must be able to go from one corridor segment to another to achieve operational flexibility as well as the ability to access multiple potential maintenance facility sites. Plan views of the impacts on adjacent structures or properties of turning vehicles are included in Appendix B. Data on the Program vehicles is contained in Appendix C. As the plans in Appendix B show, two modes, LRT and DMU, will impact adjacent properties or structures when turning from one corridor segment to another (or when making turns within corridor segments). These types of impacts are considered a fatal flaw based on the policy that no existing structure or adjacent property is to be impacted by the transit improvements. Therefore, given these impacts, DMU and LRT are eliminated from further consideration based on impacts to adjacent structures or properties that would result from vehicles turning from one corridor segment to another, or from vehicles making turns within corridor segments.

The third test in assessing compatibility with neighborhood scale would be how each mode relates to the visual or aesthetic qualities associated with each neighborhood. This does not relate to the visual appearance of the vehicles of each mode, since a streetcar, light rail vehicle, or bus can be made to look historic or futuristic based on system requirements, but rather whether each mode would fit the specific characteristics of surrounding neighborhoods. Based on the size and bulk of the program vehicles used in the analysis, DMU is recommended for elimination from further evaluation because the bulk of the vehicle would be out of scale and inconsistent with many of the historic neighborhoods in which it would run.

FINDINGS – LRT ELIMINATED BASED ON IMPACTS TO ADJACENT STRUCTURES OR PROPERTIES RELATED TO TURNING REQUIREMENTS. DMU ELIMINATED BASED ON TURNING REQUIREMENTS AND IMPACTS TO ADJACENT NEIGHBORHOODS RESULTING FROM SIZE AND BULK OF VEHICLE.

Parking Impacts

Parking along each of the corridors would be affected to some degree by the necessary second lane running configuration assumed for the systemwide analysis. This impact is based on the removal of parking near intersections to allow for a bulb-out (also known as a curb extension). This bulb-out will be used at stop locations to allow for transit vehicles to board passengers without having to pull to the curb. The impacts to parking should be relatively minimal for two reasons; first, many of these future transit stops will be at existing bus stops, where parking is already prohibited; second, stops will be spaced further apart than existing bus stops, and thus the impacts will not occur every block. However, since all modes will run in this second lane configuration, the impacts to parking will generally be the same (some differences in impacts will occur because of different vehicle lengths that, in turn, will result in different bulb-out lengths) and thus no mode has been screened out due to unacceptable parking impacts.

FINDINGS – NO MODES SCREENED OUT BECAUSE OF PARKING IMPACTS

Capacity Issues

The passenger carrying capacity of each mode within a corridor depends on vehicle size, if mode vehicles can be combined into trains, and the frequency of service within the corridor. An important consideration in evaluating alternatives is to determine if each mode can feasibly provide the capacity necessary to meet projected demand.

As would be expected, higher capacity modes such as LRT and DMU can meet demand capacity with longer headways than can lower capacity modes such as Streetcar. A preliminary evaluation of the Georgia Avenue corridor, based on existing bus ridership, showed the need for 5 DMU or LRT vehicles per hour to meet peak hour demand, 6 BRT vehicles, and 6 Streetcar vehicles, depending on the size and configuration of the vehicles. These vehicle requirements would result in headways of 12 minutes for LRT and DMU, 10 minutes for BRT, and 10 minutes for Streetcar (these capacity requirements assume local buses will continue to run in the corridor. Further, it was assumed that 25% of existing demand in the corridor would continue to

ride local buses, while 75% would shift to the new service). Based on this analysis, it does not appear that any mode is infeasible from a capacity point of view and therefore no modes have been screened out based on capacity.

FINDINGS – NO MODES SCREENED OUT BECAUSE OF LACK OF PASSENGER CARRYING CAPACITY

Community Support

Community support refers to the level of support or opposition from elected officials, residents, and business community to each mode. In some cities, business support for light rail in the form of project funding and sponsorship of stations has greatly influenced the selection of mode. To date, there has been no strong community opposition voiced relative to any of the surviving modes and therefore no modes have been screened out based on community opposition or support.

FINDINGS – NO MODES SCREENED DUE TO UNUSUALLY STRONG COMMUNITY SUPPORT OR OPPOSITION

Results and Recommendations

Based on the analysis outlined above, the second step of the mode screening process has resulted in the elimination of two additional modes under consideration, DMU and LRT. While DMU and LRT both represent high-quality rail transit modes, the size of the vehicles and their large turning radii make them incompatible with the alignments under consideration. While DMU and LRT may have worked in one or two of the alignments, the system inter-operability requirement dictates that any mode found infeasible in one or more corridors would be eliminated from further consideration.

Two modes remain under consideration for further evaluation, BRT and Streetcar.

The summary table below shows the results of the screening evaluation with pluses representing areas in which the mode met the requirements of the screening criteria and minuses where the mode failed.

Screening Summary

| Criterion | BRT | LRT | DMU | Streetcar |
|---|-----|-----|-----|-----------|
| Traffic Impacts | Yes | Yes | Yes | Yes |
| Neighborhood Scale/Impacts to Adjacent Structures | Yes | No | No | Yes |
| Parking Impacts | Yes | Yes | Yes | Yes |
| Capacity Issues | Yes | Yes | Yes | Yes |
| Community Support | Yes | Yes | Yes | Yes |

Yes = Results in Acceptable Impacts
No = Results in Unacceptable Impacts

Appendix A

Cross Sections

Note: Appendix A included on a separate CD

Appendix B

Plan Views – Turns

Note: Appendix B included on a separate CD.

Appendix C

Program Vehicle Data

Program Vehicle Specifications

Bus Rapid Transit

- A. Prototype vehicle basis: Irisbus-Matra-Alstom Civism, as supplied to Las Vegas RTC

- B. Length: 60.70 ft.
- C. Width: 8.37 ft.
- D. Height (not including overhead catenary): 10.83 ft.
- E. Maximum speed: N/A
- F. Minimum radius (not including back-end swing) = 40.00 ft.
- G. Minimum lane width (tangent) 11.00 ft.
- H. Maximum grade 8 %

Vehicle Dimension Drawings on Next Page

Streetcar

| | |
|--|--|
| A. Prototype vehicle basis: | Skoda-Inekon Astra, as supplied to Portland Oregon |
| B. Length | 65.60 ft. |
| C. Width | 8.00 ft. |
| D. Height (not including overhead catenary) | 11.71 ft. |
| E. Maximum speed | 45 mph |
| F. Minimum radius | 60.00 ft. |
| G. Minimum Lane Width (tangent - dynamic envelope) | 10.75 ft. |
| H. Maximum Grade | 6% |

Vehicle Dimension Drawings on Next Page

Light Rail

| | |
|--|---|
| A. Prototype vehicle basis: | Siemens S70, as supplied to Metro Houston |
| B. Length | 90.00 ft. |
| C. Width | 8.71 ft. |
| D. Height (not including overhead catenary) | 12.42 ft. |
| E. Maximum speed | 65 mph |
| F. Minimum radius | 90.00 ft. |
| G. Minimum Lane Width (tangent - dynamic envelope) | 11.50 ft. |
| H. Maximum Grade | 6% |

Vehicle Dimension Drawings on Next Page

Light Diesel Multiple Unit

| | |
|--|---|
| A. Prototype vehicle basis: | Bombardier-Stadler GTW 2/6, as supplied to NJT for River Line |
| B. Length | 90.00 ft. |
| C. Width | 8.71 ft. |
| D. Height (not including overhead catenary) | 12.42 ft. |
| E. Maximum speed | 60 mph |
| F. Minimum radius | 132.00 ft. |
| G. Minimum Lane Width (tangent - dynamic envelope) | 11.50 ft. |
| H. Maximum Grade | 6% |

Vehicle Dimension Drawings on Next Page