Memorandum

To:	**Adrienne Torres, Greater Richmond Transit Company (GRTC)**
From:	VHB
Date:	**February 9, 2024**
Re:	Transit Technical Memo

Downtown Richmond is the most transit- and destination-dense area in the GRTC network, which largely operates as a hub-and-spoke system with downtown as the center of transit activity. Accordingly, more than half of all transfer activity in the system occurs in the downtown core. A permanent Transfer Hub would benefit a substantial number of GRTC customers – consolidating transit activity in proximity to key destinations while facilitating comfortable, convenient, and intuitive transfers. As downtown Richmond continues to transform through renewed investment and arrival of new residents, better organizing downtown transit operations becomes paramount as GRTC seeks to ensure high-quality service and on-time performance. A Transfer Hub also offers an opportunity to introduce a TOD framework that can have a catalytic impact on downtown Richmond and yield benefits beyond transit. Such impact and benefits will be explored in other ongoing analyses and subsequent phases of this study.

This technical memo summarizes VHB's review and analysis of the existing and future GRTC bus program; calculation of associated space needs to support that future program; assessment of candidate sites' viability to support GRTC's transit needs for a permanent Transfer Hub; and identification of other considerations and design standards to inform concept development. VHB's review builds on the Land Use and Zoning Memo drafted by HR&A for this project, which evaluated 18 sites and, accounting for recent or planned development, narrowed the list of candidate sites down to 13.

This memo's findings are intended to serve as one of several components used to help inform site selection for a permanent Transfer Hub in downtown Richmond. The site selection process will feature a multidimensional assessment of candidate sites; as such, the information in this memo should be considered in conjunction with other ongoing analyses related to land use and zoning, market conditions, and TOD-supportive elements.

Following are key takeaways from the transit analysis:

There may be opportunities to reduce the bus loop footprint. A bus bay utilization analysis showed that **the existing transit program could be accommodated with 10 bays instead of the 12 in the existing facility**. Designing the permanent Transfer Hub with 10 bays instead of 12 could reduce the transit program footprint by up to 10,400 SF.

To be a viable candidate, a site must have sufficient land area to accommodate the transit program and should have sufficient residual square footage to support TOD functions. **Based on planning-level space needs estimates for a full Transfer Hub program – inclusive of transit, TOD elements, and zoning requirements – nine candidate sites appear to be large enough to accommodate the Hub, assuming a 10-bay bus loop on one level.**

To support preliminary screening of the candidate sites, VHB assessed each site against a limited set of transit-related selection criteria: capacity to support the full Transfer Hub program and proximity to BRT. **Table 1** provides a summary of each site's performance against these criteria. More detail on the analysis that informed the findings in Table 1 can be found in subsequent sections of this memo.

Table 1: Selection Criteria Assessment Summary

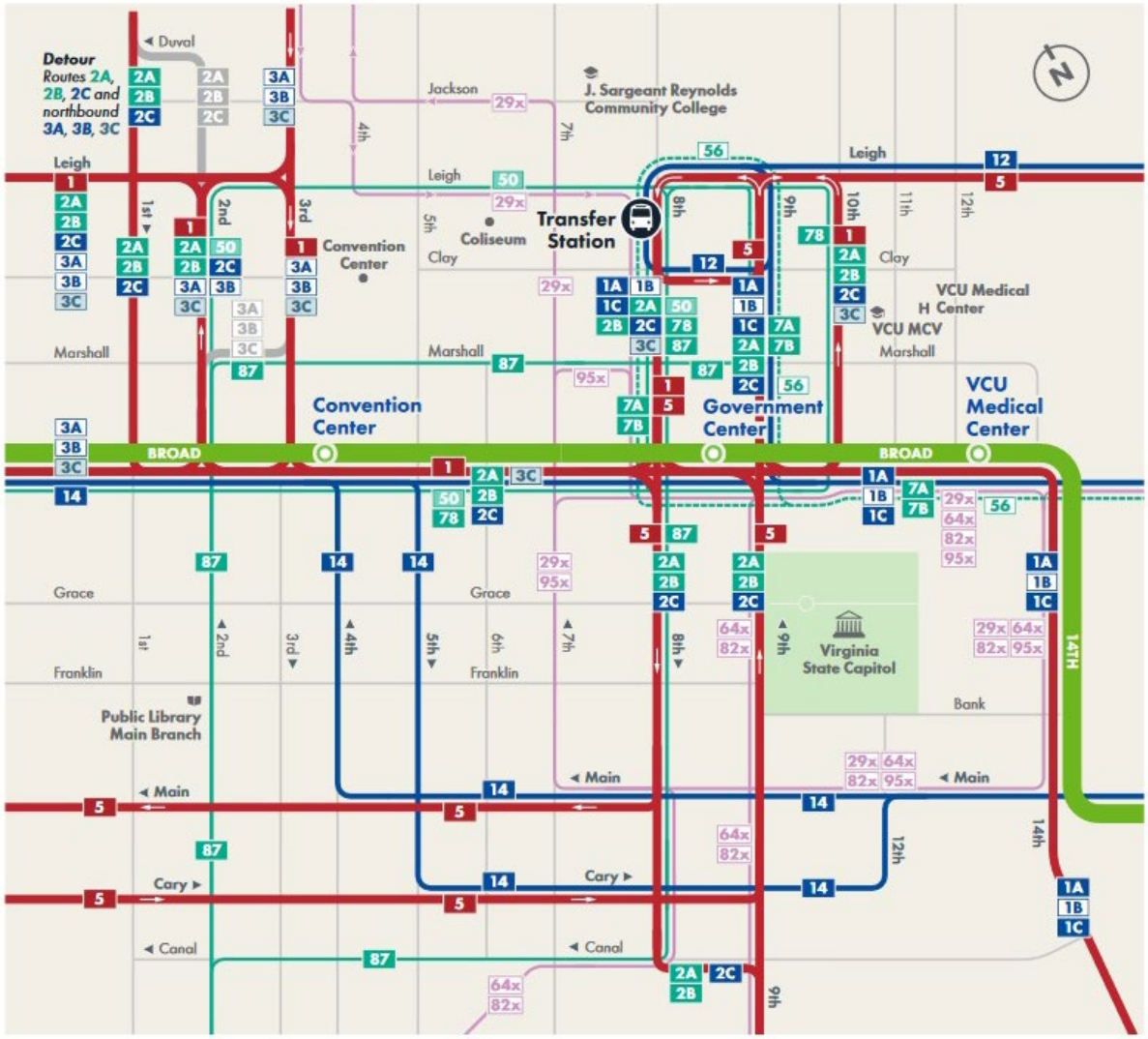
Site	Parcel Size	Accommodates Program (12 bays)	Accommodates Program (10 bays)	Within 5-min walk of E/W BRT	Within 5-min walk of N/S BRT
1	39,580 SF	No	No	Yes	Yes
2	85,310 SF	No	Yes	No	No
3	84,660 SF	No	Yes	No	No
4	45,870 SF	No	No	Yes	Yes
5	85,490 SF	No	Yes	No	Yes
6	83,540 SF	No	Yes	No	Yes
8	90,500 SF	Yes	Yes	Yes	Yes
9	131,120 SF	Yes	Yes	Yes	Yes
11	83,200 SF	No	Yes	Yes	No
13	81,540 SF	No	Yes	Yes	Yes
14	41,130 SF	No	No	Yes	Yes
16	60,200 SF	No	No	Yes	No
18	84,000 SF	No	Yes	No	Yes

Existing Conditions

Downtown Service and Temporary Transfer Facility

GRTC provides 21 fixed local and express routes and 1 BRT line (The Pulse) in downtown Richmond. **Figure 1** shows the GRTC bus network in downtown Richmond.

Figure 1: Map of Existing GRTC Downtown Bus Network



Source: GRTC

GRTC opened a temporary downtown transfer center (hereafter referred to as the "existing facility") in September 2023. The existing facility, located on 8th Street and Clay Street, replaced the former on-street transfers that were located on 9th Street between Marshall and Leigh Streets. The existing facility is served by 17 routes, all of which provide local service. **Table 2** provides a summary of service types, terminal and through service, and average headways for each route that serves the existing facility.

Table 2: Existing Transfer Facility Bus Program

Bus Bay	Route No.	Service Type	Route Type	Avg. Weekday Layover (mins)	Avg. Headways (mins)		
					Weekday	Saturday	Sunday
B	1	Local	Terminal	5	15	15	30
C	1A	Local	Terminal	1	30	30	45
B	1B	Local	Terminal	3	30	30	-
C	1C	Local	Terminal	4	30	30	45
D/E	2A	Local	Thru	4	60	60	60
D/E	2B	Local	Thru	4	60	60	60
D/E	2C	Local	Thru	4	30	30	60
J	3C	Local	Thru	11	30*	30*	30
F	5	Local	Thru	6	15	30	30
H	7A	Local	Terminal	7	60	60	60
H	7B	Local	Terminal	7	60	60	60
K	12	Local	Terminal	8	30	30	30
I	14	Local	Thru	6	30	30	30
L	50	Local	Terminal	12	40	40	40
J	56	Local	Terminal	-	90	-	-
G	78	Local	Terminal	9	45	60	60
G	87	Local	Terminal	5	60	60	60

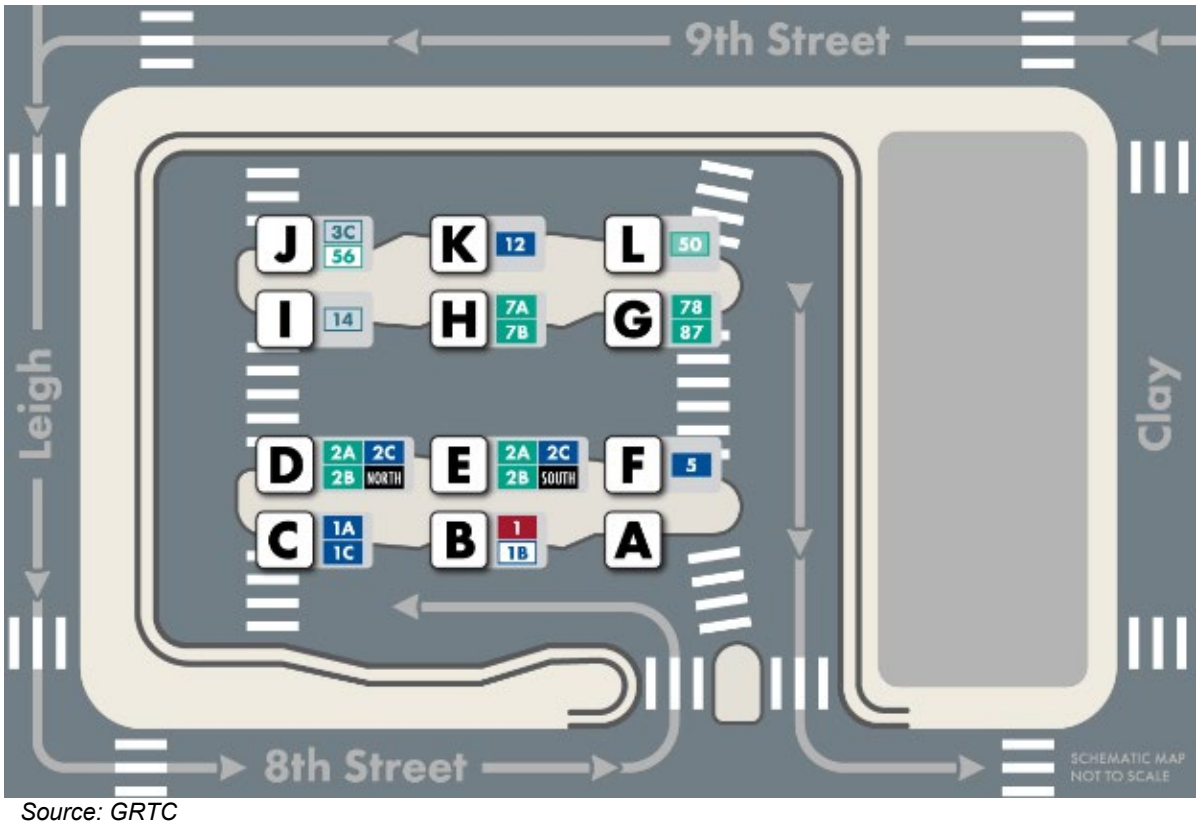
* Evening Service Only.

The existing facility features 12 bus bays and can accommodate up to 10 standard buses and 2 articulated buses. The existing facility has one access/egress point located on 8th Street. Buses circulate one-way clockwise on the outside loop and two-way in the center drive aisle. Bay A is currently unassigned due to challenges accessing the bay from the facility entrance, as a bus must circulate the entirety of the loop to access the bay.

The facility features two restrooms for bus operators, shelters at each bay, and e-paper displays with wayfinding and real-time bus information displays. There is a 44-foot pullout area along the 8th Street side of the facility with two marked parking spaces for GRTC service and administration vehicles.

Figure 2 shows the layout and bay assignments in the existing facility.

Figure 2: Existing Transfer Facility Layout and Bay Assignments



Source: GRTC

Based on anecdotal feedback provided by bus operators and customers to GRTC staff since the opening of the facility, the experience has been overwhelmingly positive. Highlighted benefits include the self-contained, off-street location; station signage and real-time bus information displays; proximity and consolidation of transfers; temporary restrooms for operators; and shelters for waiting riders.

Thus far, challenges have primarily related to service disruptions due to the facility's single point of access/ egress, in which even a minor crash or mechanical issue can lead to temporary shutdown of the facility and relocation of service to on-street stops. The existing facility also does not have sufficient space to accommodate GRTC's four express routes, all of which serve on-street stops in other downtown locations.

Bus Bay Utilization Analysis

VHB conducted an analysis of General Transit Feed Specification (GTFS) data to assess the bus bay utilization on a typical weekday at the existing facility. The GTFS data was used to calculate the number of buses serving each bay throughout the day, including the amount of time each bus spent laying over in the bay. **Figure 3** displays the bus bay usage over the course of a weekday.

The summary figure does not include Bus Bay A, since it presently has no assigned routes due to challenges accessing the bay as described above.

In general, the existing facility sees steady usage throughout a typical weekday. Turnover tends to be frequent primarily due to relatively short layovers, which are 5 minutes or less for a majority of routes. Crowding in the facility does not appear to be a concern, as the maximum number of vehicles in the facility is 6 (based on a 5-minute average). Field observations conducted in October 2023 support this finding.

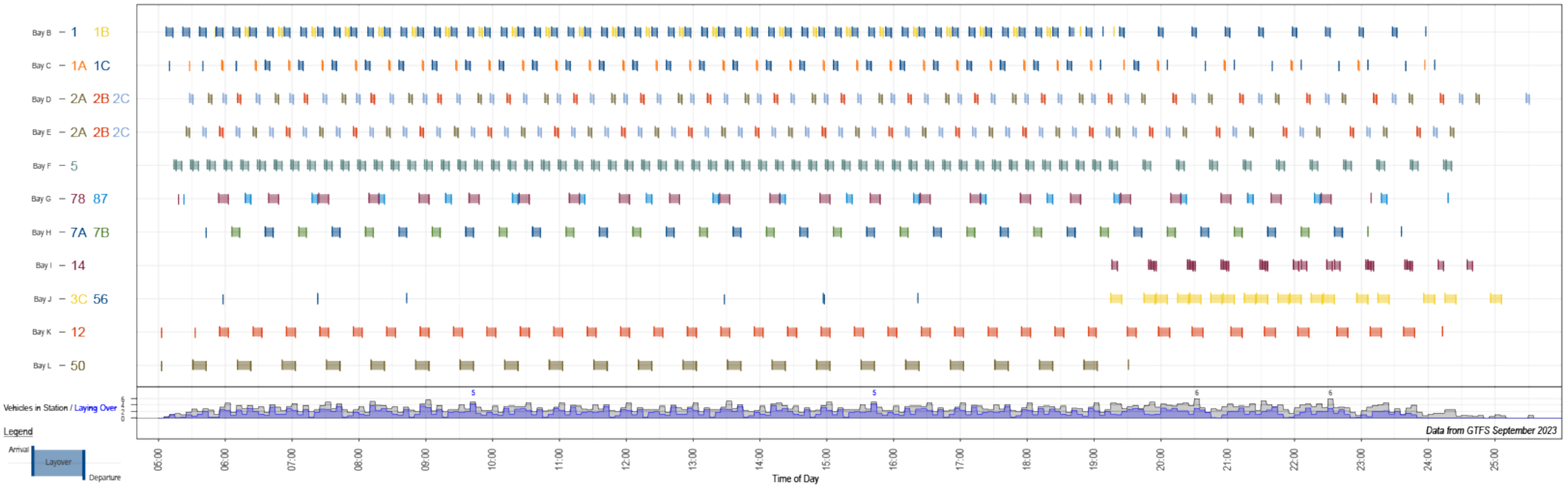
The GTFS data shows that 16 of the 17 routes serving the existing facility have scheduled layovers or schedule adjustments in the facility, including the 6 through routes. A majority of routes have layovers of 5 minutes or less. Two routes – Route 3C, which only operates evenings, and Route 50 – have layovers longer than 10 minutes. Route 1A has a nominal scheduled layover of 1 minute.

Most of the bays in the existing facility are well utilized without demonstrating crowding, suggesting a relatively efficient alignment between bus program and bay assignment. **Three bays – Bay I, J, and L – have periods of relative underutilization and may offer an opportunity for bay consolidation.**

- Bay I (Route 14) has no bus service until after 7 pm.
- Bay J (Routes 56 and 3C) has very limited service outside of evening hours.
- Bay L (Route 50) has no service after 7:30 pm.

Combining Route 14 (Bay I) and Route 50 (Bay L) into a single bay would reduce the number of bays by one. Given that one bus bay is already out of active service, that would reduce the total number of bays needed to accommodate the existing bus program from 12 to 10.

Figure 3: Existing Transfer Facility Weekday Bay Utilization



Future Bus Program Summary

This section of the memo focuses only on required transit elements and other potential supplemental transit-supportive elements at the Transfer Hub. Additional footprint will be required to support overbuild beyond the transit-related space needs summarized here.

Service Changes

The most impactful changes to downtown transit service in the next five years are centered on existing and proposed BRT routes.

GRTC is actively planning for a new north-south BRT line that will intersect the existing east-west Pulse line at a downtown location to be determined. In October 2023, GRTC announced the locally preferred alignment for the northern and southern portions of the line, however, GRTC will conduct further study for the new BRT line's alignment and station locations in downtown Richmond. Construction on the line is expected to begin in 2029 and be completed in 2032.

While GRTC has planned for significant system growth over the next five years, most of that growth will not impact local bus service in the downtown area. As a result, the future bus program serving a permanent Transfer Hub is expected to generate comparable demand and bus bay requirements as the existing program.

Space Needs for Transit Program

Given that GRTC does not have formal bus loop or bus bay design standards, VHB used the existing GRTC facility and guidelines from GoTriangle and WMATA to calculate a planning-level space requirement. This planning-level figure is expressed on a per bus bay basis – since the number of bus bays is the key determinant of space needs for a bus facility – and is inclusive of not only bus bays but also internal roadways for bus circulation, driveways for bus access/egress, and bus platforms and islands.

The planning-level space requirement is 5,200 square feet (SF) per bay. **Table 3** shows the existing facilities that were used in calculating the per-bay figure. It should be noted that the actual space requirements for bus bays will depend on the geometry of the permanent Transfer Hub.

Table 3: Planning Level Per-Bay Space Needs Estimate

Facility	Agency	TOD Overbuild?	Approx. Size (SF)	No. of Bays	SF/Bay
Temporary Downtown Transfer Center	GRTC	No	60,000	12	5,000
Raleigh Union Station (RUS Bus)	GoTriangle	Yes	35,000	8	4,375
Bethesda Metrorail Station	WMATA	Yes	61,000	10	6,100
Brookland Metrorail Station	WMATA	No	65,000	11	5,909
Fort Totten Metrorail Station	WMATA	No	45,000	10	4,500
Friendship Heights Metrorail Station	WMATA	Yes	35,000	6	5,833
Southern Avenue Metrorail Station	WMATA	No	70,000	14	5,000
				Average	**5,245**

New Facility Transit Needs

GRTC has expressed a strong preference for the inclusion of certain elements and amenities in the design of a permanent Transfer Hub, as summarized in **Table 4**. These items may impact the planning-level space requirement beyond that identified in **Table 3**.

Table 4: Required Elements in Permanent Transfer Hub

Element/Amenity	Space Needs Intensity	Included in Per-bay Space Estimate?
Multiple access/egress points	Moderate	Yes
Operator restrooms	Moderate	Yes
Operator break room	Moderate/High	No
Parking for GRTC service vehicles	Moderate	Yes (2 spaces)
Charging capability for electric transit vehicles	Moderate/High	No
Two bay for 60' articulated buses	Moderate	Yes
Real-time bus info displays	Minimal	Yes

GRTC staff have indicated a preference for avoiding two-way internal circulation in a permanent Transfer Hub but acknowledged that parcel size and geometric considerations may require two-way travel.

GRTC expects the current practice of buses laying over in their assigned bays to carry over to a permanent Transfer Hub.

Other Transit-Supportive Infrastructure and Amenities

Based on input from GRTC staff, there are a number of potential elements and amenities that are not required but that may provide additional transit function support for the Transfer Hub. **Table 5** lists each supporting element and its associated planning-level space needs.

Table 5: Other Support Infrastructure/Amenities Considerations

Element/Amenity	Space Needs Intensity	Included in Per-bay Space Estimate?
Storage space	Moderate	No
TVM machines	Minimal	No
Conditioned space for GRTC staff	High	No
Conditioned space for waiting customers	High	No
GRTC staff parking	High	No
Retail/amenities for transit customers	High	No

Options for Optimizing Transit Footprint and Layout

Depending on which site is ultimately selected, there may be an opportunity to optimize the design of the Transfer Hub to make additional space available to support TOD uses. **Reducing the number of bays in the facility from 12 to 10 – in line with the finding from the bus bay utilization analysis indicating that 10 bays are sufficient to accommodate the existing program – could reduce the transit program footprint by up to 10,400 SF.**

New Facility Configuration

The Project Team explored four different transit facility configurations to be considered in the site evaluation and selection process. **Table 6** summarizes the four configurations and their implications for space needs, transit operations, cost, and customer experience.

Table 6: New Facility Configuration Types

Configuration Type	Description
Single Level – Full Program	• Similar to the existing temporary facility, this configuration accommodates the full transit program (10-12 bays) on a single level housed entirely off-street • Enables streamlined access, circulation, and loop layout • Would require approximately 54,000 SF for a 10-bay program • Enhances customer experience through proximity of transfers and intuitive navigation
Single Level – Substantial On-Street Program	• Accommodates only a portion of the transit on site, supplemented with several on-street stops; operational efficiency varies widely depending on proximity and connectivity of on-site facility and on-street stops • Allows for a smaller transit facility footprint, but has adverse implications for the streetscape and non-transit ground-floor uses • Split program may adversely affect customer experience due to longer and less intuitive transfers, potential multimodal conflicts
Multilevel – Separate Facilities	• Accommodates the full transit program on site, but a lack of vehicular connectivity between levels reduces operational efficiency • May allow for a somewhat reduced ground-floor transit facility footprint, but only if on-site grade differential limits need for ramping; any multilevel facility on a relatively flat site introduces space inefficiencies due to need for extensive ramping to access upper level • Requires additional concrete depth/reinforcement where the levels are stacked, which may entail substantially higher cost depending on the extent of overlap between the levels • Spreading the transit program across multiple levels adversely impacts customer experience by making some transfers lengthier and less intuitive; these challenges are more pronounced for customers with mobility limitations
Multilevel – Internal Circulation	• Accommodates the full transit program on site with full internal vehicular connectivity between levels; spreading the transit program across multiple levels may entail longer travel times for some routes • Introduces substantial space inefficiencies, as approximately 9,000 SF are needed for internal ramping between levels • Requires additional concrete depth/reinforcement throughout the facility, which drives costs up substantially • Spreading the transit program across multiple levels adversely impacts customer experience by making some transfers lengthier and less intuitive; these challenges are more pronounced for customers with mobility limitations • Due to cost and space inefficiency, this option is highly impractical in a constrained urban core

More specific details on configuration, layout, and orientation of a Transit Hub are site dependent and will vary from site to site based on parcel size and shape, topography, and surrounding transportation network, among other factors. Those specifics will be fleshed out for a select number of candidate sites that are advanced for further consideration and analysis in the next phase of this study.

Table 7 provides a summary assessment of each facility configuration based on space needs, operational efficiency, cost, and customer experience.

Table 7: Facility Configuration Summary Assessment

Configuration Type	Parcel SF Impact	Operational Efficiency	Cost Efficiency	Customer Experience
Single Level – Full Program	Moderate	High	High	High
Single Level – Substantial On-Street Program	Low*	Moderate/High	High	Low/Moderate
Multilevel – Separate Facilities	Moderate	Moderate	Low	Low
Multilevel – Internal Circulation	High	Low	Low	Low

* Has higher impacts on streetscape

Transit-related Site Selection Criteria

The Project Team has developed a series of criteria across multiple categories – site control and assembly, transit considerations, and development capacity – for use in assessing the suitability of candidate sites to house a permanent Transfer Hub. This section of the tech memo includes analysis associated with those selection criteria related to transit. Any findings associated with selection criteria in this section should be examined in concert with other land use and zoning, market conditions, and site suitability considerations.

Program Capacity

To be a viable candidate, a site must have sufficient land area to accommodate the transit program and should have sufficient residual square footage to support TOD functions. VHB assessed the capacity of each candidate site to accommodate a Transit Hub using the space needs assumptions summarized in the Future Transit Program section. This assessment also included assumptions related to zoning and TOD-supportive space needs provided by HR&A and Design Collective. The consideration of transit, zoning, and TOD-supportive space needs together provides a more complete picture of the minimum program needed a Transit Hub that includes TOD.

Following are the assumptions used in determining a planning-level program for the Transit Hub, inclusive of TOD:

- Transit
  - 5,200 SF per bay, inclusive of internal roadways for bus circulation, driveways for bus access/egress, and bus platforms and islands
  - 2,000 SF of back of house operations space for GRTC (The specific program is unknown, however may include driver restrooms, mechanical and A/V equipment rooms, etc.)
- Zoning
  - Open space requirements per City of Richmond code (varies by site)
  - Setback requirements per City of Richmond code (varies by site)
- TOD-supportive
  - 13,750 SF for Mixed-use Building Footprint
  - 3,400 SF for ramping up to above-ground parking

Table 8 summarizes the transit, zoning, and TOD-supportive space needs estimate for each site. Residual SF shows the approximate additional area available on a site beyond the space needed for the minimum program, with a positive value indicating the site is likely large enough to accommodate the minimum program and a negative value generally meaning a site may be too small. Note that the minimum program space needs for any site are subject to adjustment based on more detailed information related to program elements and site conditions.

Based on this planning-level assessment, only two sites – Site 8 and Site 9 – appears to have sufficient space to accommodate a Transfer Hub with TOD, assuming a 12-bay bus loop. **However, designing the Transfer Hub with 10 bays would reduce the program footprint such that eight sites appear to be sufficiently large, with another (Site 13) very close to being able to accommodate the program.**

Four sites (1, 4, 14, and 16) do not appear to meet program capacity needs even with the 10-bay bus loop.

Table 8: Selection Criteria Assessment – Program Capacity

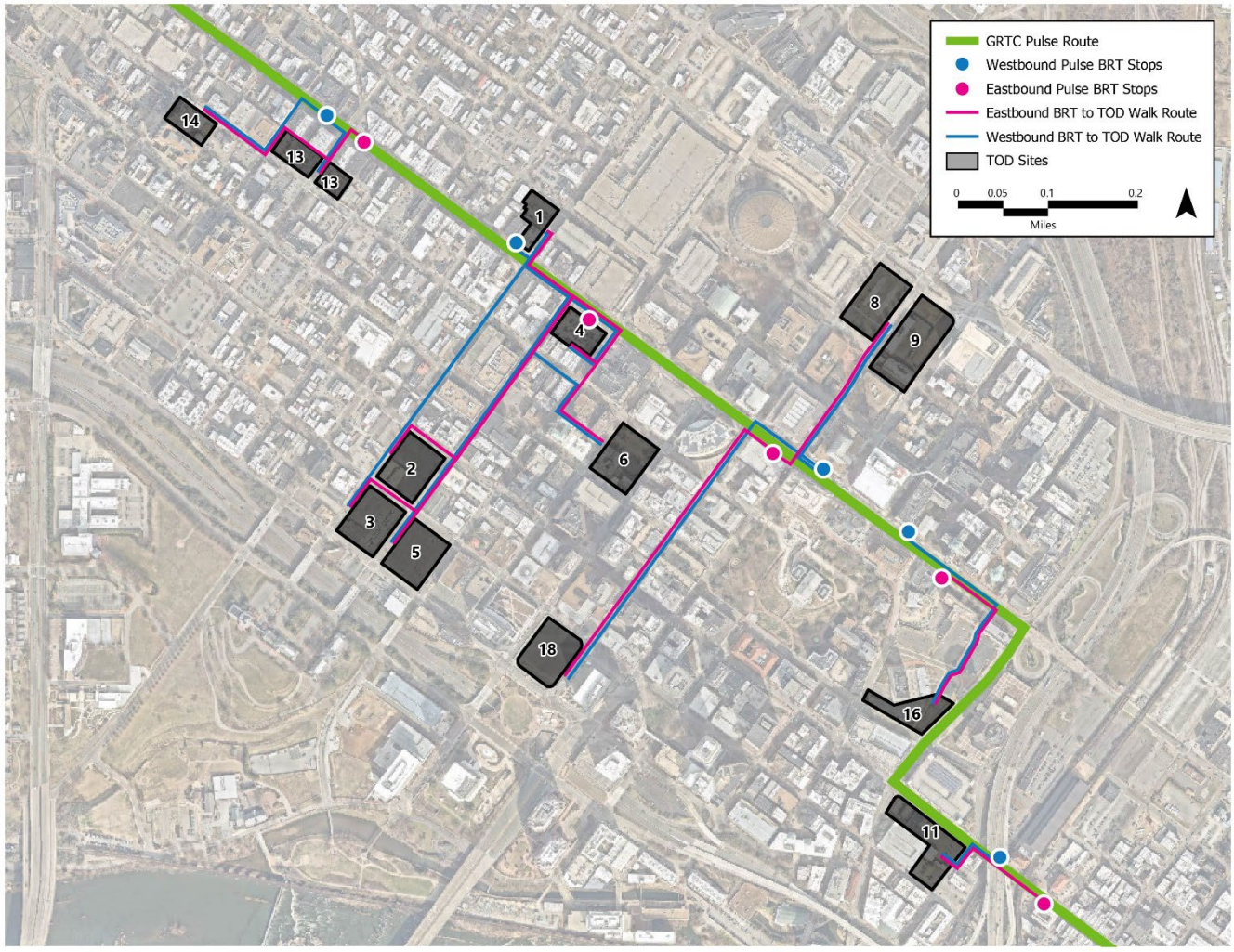
Site	Parcel Size	Req'd Open Space & Setback	Min. Floorplate for TOD	12-bay Bus Loop	10-bay Bus Loop	Residual SF (12-bay loop)	Residual SF (10-bay loop)
1	39,580 SF	5,166 SF	17,150 SF	64,400 SF	54,000 SF	(47,136)	(36,736)
2	85,310 SF	10,075 SF	17,150 SF	64,400 SF	54,000 SF	(6,315)	4,085
3	84,660 SF	10,023 SF	17,150 SF	64,400 SF	54,000 SF	(6,913)	3,487
4	45,870 SF	6,270 SF	17,150 SF	64,400 SF	54,000 SF	(41,950)	(31,550)
5	85,490 SF	10,089 SF	17,150 SF	64,400 SF	54,000 SF	(6,149)	4,251
6	83,540 SF	9,933 SF	17,150 SF	64,400 SF	54,000 SF	(7,943)	2,457
8	90,500 SF	9,050 SF	17,150 SF	64,400 SF	54,000 SF	(100)	10,300
9	131,120 SF	13,112 SF	17,150 SF	64,400 SF	54,000 SF	36,458	46,858
11	83,200 SF	5,000 SF	17,150 SF	64,400 SF	54,000 SF	(3,350)	7,050
13	81,540 SF	10,723 SF	17,150 SF	64,400 SF	54,000 SF	(10,733)	(333)
14	41,130 SF	5,890 SF	17,150 SF	64,400 SF	54,000 SF	(46,310)	(35,910)
16	60,200 SF	8,816 SF	17,150 SF	64,400 SF	54,000 SF	(30,166)	(19,766)
18	84,000 SF	9,970 SF	17,150 SF	64,400 SF	54,000 SF	(7,520)	2,880

Proximity to East/West BRT

Since the BRT system will continue to feature dedicated on-street station infrastructure, neither the existing east-west nor the planned north-south Pulse line is expected to utilize the permanent Transfer Hub. However, given that the Pulse is the region's premier transit amenity and serves as a critical transit spine through downtown Richmond, it is essential that the permanent Transfer Hub be located in close proximity to the existing Pulse line. For the purposes of this planning-level assessment, a site is considered proximate if it is within a 5-minute walk of BRT.

Figure 4 shows the walk routes between the candidate sites and the nearest eastbound and westbound Pulse stations.

Figure 4: Walk Routes from Candidate Sites to nearest BRT Stations



VHB averaged the walk times from the centerpoint of each candidate site to the nearest eastbound and westbound Pulse station, assuming a walking speed of 4 feet per second. **Table 9** shows those average walk times for each candidate site and differentiates between sites within and beyond a 5-minute walk.

Eight of the 13 candidate sites are located within a 5-minute walk, on average, of the nearest set of stations for the east-west Pulse line. Of these eight sites, two (Sites 11 and 16) feature relatively steep grades between the site and the Pulse line, which may have an adverse impact on walk times. Site 6 is located just outside the 5-minute walkshed of the nearest east/west BRT stations.

Table 9: Selection Criteria Assessment – Proximity to East/West BRT

	Average Walk Time to Nearest Eastbound & Westbound BRT Stops	
Site #	**Within 5 mins.**	**Beyond 5 mins.**
1	3 minutes	
2		8 minutes
3		9 minutes*
4	3 minutes	
5		9 minutes*
6		6 minutes
8	5 minutes	
9	5 minutes	
11	3 minutes*	
13	2 minutes	
14	5 minutes	
16	5 minutes*	
18		10 minutes*

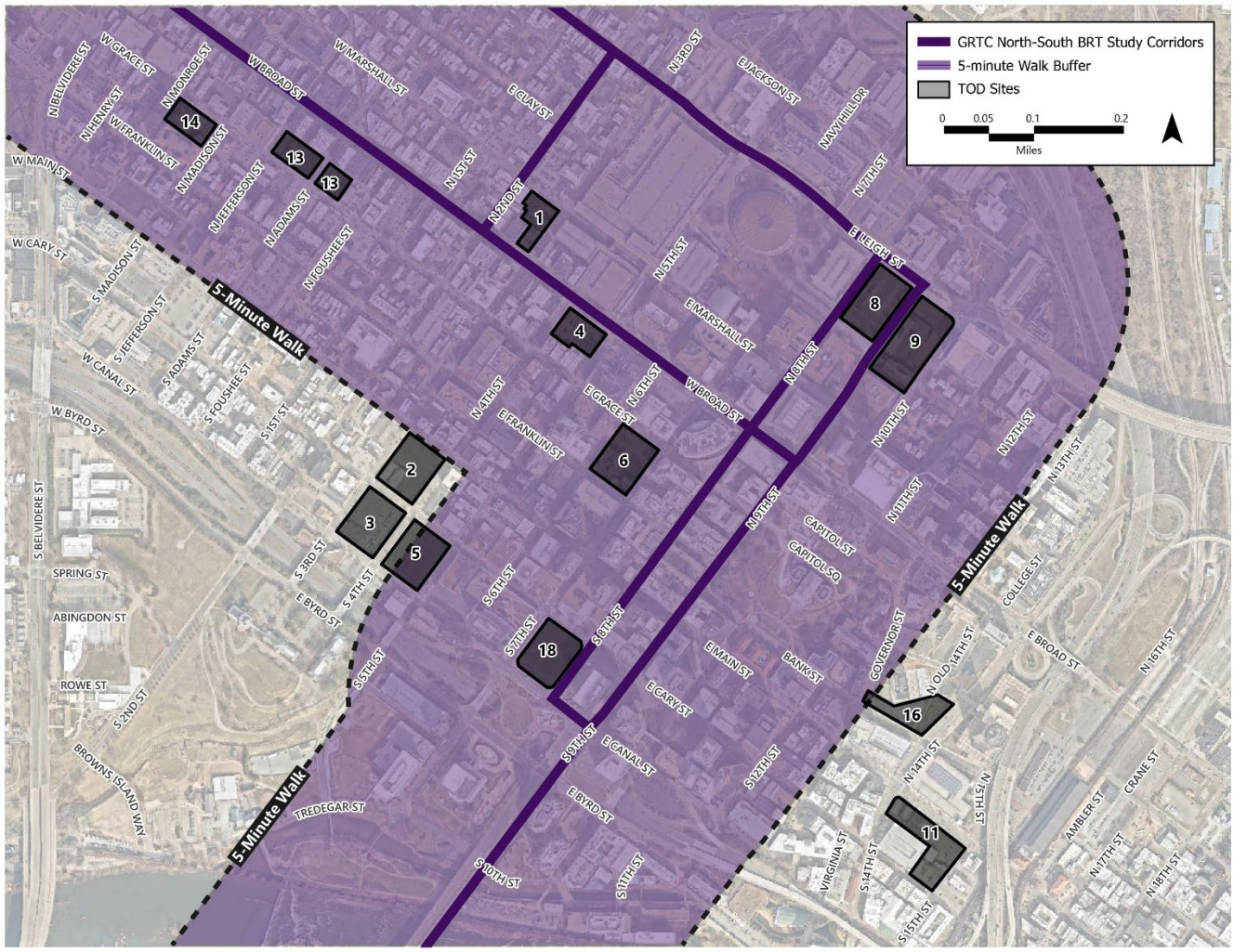
* Walk route has an average slope >5%, indicating relatively steep uphill grades to reach BRT from the candidate site

Proximity to North/South BRT

In October 2023, the GRTC Board of Directors approved the recommended alignment for the planned second BRT corridor north and south of downtown Richmond. The exact alignment of the north/south BRT through downtown has not been finalized, but GRTC has narrowed the options to a limited number of options that feature some combination of 8th/9th Streets, Broad Street, and Leigh Street. Station locations for the north/south line have not yet been determined.

The map in **Figure 5** shows the candidate sites' proximity to the North/South BRT study corridors. Nine of the 13 candidate sites are located within a 5-minute walk of a north/south BRT study corridor. Note that walk times were measured to the nearest point of a BRT study corridor and do not consider station locations, which are undetermined at this time; some of the candidate sites on the edges of the 5-minute buffer in Figure 5 likely will fall outside the 5-minute walkshed of the north/south BRT stations.

Figure 5: Selection Criteria Assessment – Proximity to North/South BRT



Alignment with Bus Network

The siting of a permanent Transfer Hub at a different location than the existing facility will impact bus travel time for most or all routes serving the Transfer Hub. In certain cases, increased travel time can have operational and capital implications if that travel time cannot be reasonably accommodated with the existing equipment, headways, and routing/stop configuration on that route. The location of the new transfer hub may positively or negatively impact travel times – as routes realign to accommodate the transfer hub.

GRTC has designed its route headways and cycle lengths (round-trip travel time) to optimize equipment use across the network. This means that, on any given route, there is limited flexibility to accommodate additional travel time without doing one or more of the following: reducing layover time, adding a vehicle to the route, reducing service frequency (increasing headways), or adjusting/shortening the route in other locations to make up for the additional travel time.

Table 10 summarizes each route's tolerance for a reduction in layover time based on existing headways and cycle lengths. The table shows most routes have sufficient layover time to absorb a 5-minute increase in travel time, assuming each route needs a minimum of 6 minutes of layover time per cycle. Routes 1A, 1B, 56, and 87 demonstrate the lowest capacity to absorb travel time increases without other adjustments such as adding equipment, eliminating stops, or truncating the route.

Table 10: Travel Time Increase Tolerance by Route

Route	Cycle Time (mins.)	Avg. Headways (mins.)	Layover per Cycle (mins.)	Tolerance for 5-min Travel Time Increase
1	75	15	19	Moderate
1A	90	30	7	Low/None
1B	90	30	10	Low/None
1C	90	30	16	Moderate
2A	180	60	57	High
2B	240	60	96	High
2C	150	30	24	Moderate
3C	150	30	18	Moderate
5	90	15	15	Moderate
7A	120	60	20	Moderate
7B	120	60	17	Moderate
12	90	30	18	Moderate
14	120	30	13	Moderate
50	80	40	26	Moderate
56	90	90	6	Low/None
78	90	45	29	Moderate
87	120	60	10	Low/None

VHB will conduct a GIS analysis to calculate travel time impacts by route for a select number of candidate sites that are advanced for further consideration and analysis in the next phase of this study.