

**APPENDIX A:  
ANALYSIS OF TECHNICAL FEASIBILITY OF ALTERNATIVES**

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## APPENDIX A: TECHNICAL FEASIBILITY

### Memorandum

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Date: **May 2, 2011**

By: Steve Kley, PE (AECOM)

To: Mark Niles, AICP (AECOM)

Subject: **Potomac Yard Metrorail Station EIS, Technical Review of Trackwork Alignment Alternatives.**

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This document serves as a memorandum, describing the process followed in performing the technical feasibility analysis review of the Potomac Yard Metrorail Station Alignment Alternatives. The analysis was performed by myself and others under my supervision.

The objective was to evaluate for engineering feasibility, each track alignment alternative as provided in the document titled, "Technical Memorandum, Analysis of Station Location Alternatives", dated May 15, 2009, and an additional alternative added during a scoping meeting in February 2011. For purposes of this analysis, the track design was reviewed to determine compliance with design criteria, and constructability requirements.

Prior to beginning the analysis, relevant design criteria were compiled. As well, constructability requirements were defined, and AECOM met with WMATA personnel to discuss and verify these requirements. That criteria and assumptions are included in Section 1.0 of this Document.

Alignments A, B1, B2, B3, C1, C2, D1, D2, as provided in .dwg format, were evaluated for underground, at grade and aerial options. Alignment D3, was sketched based on meeting notes and was evaluated for underground at grade and aerial options. Existing WMATA Blue and Yellow alignment horizontal and vertical alignment were provided in .dwg format, and used to establish line and grade at tie in locations. Contour information was provided and used to develop existing ground elevations. CSXT top of rail elevations, and the depth elevation of Four Mile Run were not provided.

Based on the analysis, the following was determined:

1. Alignment options A, B1, B2, and B3, all at grade are feasible, noting that each option involves some level of construction phasing challenges.
2. Alignment options A, B1, B2, and B3, underground and aerial are not feasible due to constructability issues.
3. Alignment options C1, C2, D1, and D2 underground, aerial, and at grade are not feasible due to vertical clearance criteria, and constructability issues.
4. It appears that alignment option D3 can be developed to meet the technical criteria requirements.

Detailed findings of the analysis are provided in an Evaluation Table and supporting graphics which are included as Sections 2.0 and 3.0 of this memorandum.

## 1.0 DETAILED TECHNICAL CRITERIA

The technical feasibility evaluation measures focus on the WMATA design criteria document, WMATA Manual of Design Criteria (WMDC), and relevant CSXT Criteria as related to horizontal alignment, vertical alignment, clearance required, and construction phasing. Additional criteria are based on standards set as part of the 2010 *Potomac Yard Metrorail Station Concept Development* Study, experience from the Dulles Metrorail Extension project, and applicable Virginia standards for bridge clearance. Design criteria elements used to evaluate the alignments are defined and described as follows:

### 1.1 General Constraints

- A. The Consultant has identified the following existing elements which will be considered as physical constraints, and as such, are assumed not be modified in this study:
  - i. Maintain existing roadway lines and grades.
  - ii. Maintain existing CSXT track lines and grades.
  - iii. North tie-in: Maintain existing Metrorail Airport Station location, and meet alignment criteria adjacent to the station.
  - iv. South tie-in: Maintain existing portal configuration near Potomac Greens Drive and Fitzhugh Way.
- B. The Consultant has identified the following general assumptions/criteria for use in developing alignment alternatives:
  - i. Special Trackwork: Each Alternative shall consider installation of a double Number 8 cross-over on one end of the proposed station platform. If physical constraints preclude inclusion of the cross-over, the alignment shall not be considered flawed, however a notation shall be made for reduction in operational flexibility.
  - ii. Inclusion of a pocket track shall not be considered.
  - iii. Construction of temporary, parallel trackage necessary for construction phasing is to be minimized. Such alignments shall not encroach on CSXT right-of-way or on environmentally sensitive areas such as National Park Service land.
  - iv. For construction of new alignments, CSXT criteria may apply. For location of proposed Metrorail piers or abutments adjacent to CSXT tracks, the abutments / piers must locate parallel to the CSXT alignment. The abutments and piers shall be placed as follows: (Data from CSXT Criteria for Overhead Bridges)
    - 25 feet from nearest track on one side
    - 40 feet from nearest track on the opposite side (to accommodate an additional track)

### 1.2 Track Speed

- A. 75 mph desirable
- B. 30 mph absolute minimum
- C. Track speed will be set in 5 mph increments at this level of design.

### 1.3 Horizontal Alignment (Track Layout):

- A. Horizontal Tangent Between Curves: (WMDC 11.4.2)
- i. 200 feet desirable
  - ii. 75 feet absolute minimum
- B. Horizontal Tangent At Station Platforms:
- i. 730 feet total, comprised of:
    - 600 feet at the station platform (WMDC 11.4.2)
    - 65 feet either end of the station platform (WMDC 11.4.2)
  - ii. 80 feet minimum between end of station platform and point of switch, special trackwork (WMDC 11.8.4)
- C. Horizontal Tangent at Special Trackwork: (WMDC 11.8.4)
- i. 80 feet minimum between point of switch and end of station platform as indicated above.
  - ii. 40 feet minimum between point of switch and point of horizontal curve.
  - iii. Note that per WMDC 11.8.4, the absolute minimum tangent length of 10 on direct fixation track was not considered in this study due to the level of design of the study.
- D. Horizontal Curvature
- i. Horizontal curve radius, curve length, superelevation, underbalance, and spiral lengths shall be set to accommodate the minimum Track Speeds as indicated above.
  - ii. Horizontal curve radius: (WMDC 11.5.1)
    - Desired minimum radius: 1000 feet
    - Absolute minimum radius: 755 feet
    - Radius of adjacent tracks, in double track guideway shall not be concentric. It is desired that the curves maintain the same radius, however, if they must be different, the inside curve radius shall be set greater than the inside curve radius.
  - iii. Horizontal curve length: (WMDC 11.5.1)
    - Minimum curve length shall be the greater of the lengths listed below:
      - $L_c = 100$  feet.
      - $L_c$  shall not be less than one half the sum of the connecting spiral lengths. (Not in criteria, but good engineering practice).
  - iv. Superelevation:
    - The relationship between Superelevation ( $E_a$ ), Underbalance ( $E_u$ ), Track Speed ( $V$ ), and Curve Radius ( $R$ ) is defined using the following equation:
      - $E_u = (4.011 * V^2/R) - E_a$  (WMDC 11.6.3)
      - Where  $E_u$  is in inches,  $V$  is in mph,  $R$  is in feet,  $E_a$  is in inches
    - Underbalance criteria is as follows : (WMDC 11.6.5)
      - $E_u$  desirable: 0 inches
      - $E_u$  maximum: 4 – 1/2 inches absolute maximum
      - $E_u$  shall never be less than 0 inches.
    - Superelevation criteria is as follow: (WMDC 11.6.4)

- o  $E_a \text{ min} = \frac{1}{2}$  inch
  - o  $E_a \text{ max in tunnel} = 4$  inches
  - o  $E_a \text{ max at grade or on aerial structure} = 6$  inches.
  - When the above mentioned criteria for underbalance and superelevation can not be met, either the curve radius must be increased, or the track speed must be reduced.
- E. Spiral Transition Curves
- i. All horizontal circular curves shall contain spiral transition curves. Spiral transition curves shall be used to transition both superelevation and lateral acceleration,
  - ii. Minimum length of spiral curve shall be the greater of the lengths as determined by the formula listed as follows: (WMDC 11.5.2)
    - $L_s = 50 * E_a$
    - $L_s = 1.22 * E_u * V$
    - $L_s = 100$  feet
    - Where,  $E_a$  = superelevation (in),  $E_u$  = underbalance (in),  $V$  = track speed (mph).

#### 1.4 Vertical Alignment (Track Profile):

- A. Vertical Tangent Between Vertical Curves: (WMDC 11.7.5)
- i. 100 feet absolute minimum
- B. Vertical Tangent At Station Platforms:
- i. 730 feet total, comprised of:
    - 600 feet at the station platform (WMDC 11.4.2)
    - 65 feet either end of the station platform (WMDC 11.4.2)
    - Note, WMDC 11.4.2 defines horizontal tangent length. WMDC does not specify vertical tangent lengths in station platforms. However, ADA requirements will require similar tangent lengths.
- C. Vertical Tangent at Special Trackwork:
- i. All special trackwork components shall locate in vertical tangent.
  - ii. 40 feet minimum between point of switch and point of vertical curve. (WMDC 11.8.4)
  - iii. Note that per WMDC 11.8.4, the absolute minimum tangent length of 10 on direct fixation track was not considered in this study due to the accuracy level of design for the study.
- D. Vertical Grades: (WMDC 11.7.1)
- i. 4.0% maximum except at station platform.
  - ii. 0.35% minimum at direct fixation and tunnel sections
  - iii. 0.00% minimum at-grade, ballasted sections
  - iv. At station platforms, 2.0% maximum, 0.35% minimum.

- E. Vertical Curves:
- i. Minimum length of vertical curve shall be the greater of the lengths as determined by the formula listed as follows: (WMDC 11.7.4)
  - ii.  $L_{vc} = (G_2 - G_1) * 100$ 
    - Where  $L_{vc}$  = minimum vertical curve length
    - $G_2 - G_1$  = algebraic difference of grades in percent
  - iii.  $L_{vc} = 200$  feet.
    - Note: for initial screening/evaluation of alignment and station options, assumed vertical curve begins at a point along the horizontal alignment that is separated by 15 feet from the existing track alignment.

## 1.5 Special Trackwork

- A. Special Trackwork Geometry shall be in accordance with a standard WMATA No. 8 turnout having the following characteristics:
- PS – PITO distance = 30.00 feet
  - Turnout angle = 7d9'10"

## 1.6 Clearances

This measure will consider whether each alternative would have sufficient horizontal clearance from fixed wayside objects or freight trains on adjacent tracks, and whether each alternative would have sufficient vertical clearance when passing over or under features such as the CSXT tracks and Four Mile Run. This measure also includes the depth of tunneling required to pass under Four Mile Run. The WMATA design criteria document, WMATA Manual of Design Criteria (WMDC), will be identified as referenced.

- A. Horizontal Clearances:
- i. Several WMDC contains various clearance scenarios. The below general criteria shall govern:
    - Open Sections, at grade – fenced alignment:
      - 10.5 feet, centerline of track to face of fence in horizontal tangent. (WMDC 11.12.4)
      - 12 feet centerline of track to face of fence in horizontal curve.
    - Tunnel and Elevated structures:
    - At this level of design, horizontal clearance at these type of alignment types shall not be considered. However, the overall guideway widths shall be assumed to extend 12 feet from centerline of outside tracks.
  - ii. Horizontal Clearance to existing roadways:
    - Open Sections, at grade – Same as open sections at grade – fenced alignment.
    - Open Sections, at grade – adjacent to CSXT trackage:
      - 50 feet centerline of Metrorail track to centerline of CSXT track. Assumes provision for future CSXT track at 15 feet offset to existing track, 25 feet clear from future CSXT track to 1.5 foot wide by 6 foot high crashwall and 8.5 feet clear from crashwall to Metrorail track. (While not written criteria, the Consultant has experienced this direction from CSXT on previous projects.

- B. Vertical Clearances – Metrorail over facility – STRUCTURAL DEPTH
  - i. For purposes of this study, the following assumptions will be made with respect to the relationship between top of rail, Metrorail, and bottom of Metrorail bridge structure:
  - ii. Span length up to 120 feet:
    - 10 feet (from Dulles Extension Project)
  - iii. Span length between 120 feet and 150 feet (WMATA maximum structure length):
    - 12 feet (from Dulles Extension Project)
- C. Vertical Clearances – Metrorail over facility – CLEARANCES
  - i. Minimum clear dimension to roadway in the state of Virginia:
    - 16.5 feet
  - ii. Minimum clear dimension to top of rail CSXT track:
    - 23 feet (Data from CSXT Criteria for Overhead Bridges)
- D. Vertical Clearances – Metrorail under roadway or railroad
  - i. 23 feet
- E. Vertical Clearances – Metrorail under FAA height restriction
  - i. Metrorail alignment including station elements shall not be placed greater than 80 feet above existing ground to meet the requirements of the FAA height restrictions associated with Ronald Reagan Washington National Airport
- F. Vertical Clearance – Metrorail in tunnel under CSXT
  - i. 25 feet, top of Metrorail to top of CSXT rail.
- G. Vertical Clearance – Metrorail in tunnel under Four Mile Run Waterway
  - i. 40 feet, from normal water surface elevation to top of rail

## 1.7 Track Centers:

- A. In double track, guideway, where no obstruction exists between tracks, the track centers shall be set at 14 feet apart. Adjustment for chording in horizontal curvature shall not be considered at this level of design, however, adjacent curves shall be set with equal radius (not concentric), so the widening of track centers due to this method of curve design should be sufficient.
- B. In single guideway, where physical barriers locate between tracks, the horizontal clearance criteria shall apply for clearance adjacent to track.
- C. In double track guideway in adjacent tunnel structures, the track / tunnel sections shall be set based on the existing soil structure, and tunnel width. Due to the limited knowledge of the existing soil conditions at this level of design, track centers in this type of guideway shall be set at 40 feet minimum.
- D. At center station platforms, track centers shall be set 40.454 feet apart.
- E. At side station platforms, track centers shall be as indicated in 1.7 A. above.

## 1.8 Constructability and Phasing:

This measure reviews whether construction of each alternative would result in service disruptions, to existing infrastructure, including:

- A. Blue and Yellow Line Metrorail service between the Ronald Reagan National Airport and Braddock Road Metrorail stations.
  - Note: A Metrorail service disruption is considered major if it exceeds 52 hours (a typical weekend track outage).
- B. Existing roadways
- C. Existing CSXT railroad
- D. Other Infrastructure Elements:
  - i. Utilities
  - ii. Businesses

This measure also considers whether there are any impediments to construction at a specific site, including the ability to bring materials or equipment to the site, and available space for construction staging.

2.0 DETAILED TABLE OF INITIAL TECHNICAL SCREENING

Table A-1: Technical Feasibility

| Track Alignment and Clearance Technical Feasibility |             | Meets Technical Requirements       | Complies with General Constraints | Complies with Track Speed Criteria | Complies with Horizontal Track Alignment Criteria | Complies with Vertical Track Alignment Criteria   | Includes Special Trackwork | Complies with Horizontal Clearance Criteria | Complies with Vertical Clearance Criteria | Complies with Track Center Criteria | Constructability and Phasing Difficulty (Minor, Moderate, Major, and Fatal Flaw)  |
|---|-------------|------------------------------------|-----------------------------------|------------------------------------|---|---|----------------------------|---|---|-------------------------------------|---|
| Metrorail Station Alternative A                     | underground | No - Constructability              | -                                 | -                                  | -   | No -Proposed horizontal alignment matches existing horizontal alignment. Requires closing existing Metrorail Yellow and Blue lines for entire construction cycle.   | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle   |
|   | at grade    | Yes – Constructability limitations | Yes                               | Yes                                | Yes   | Yes, However requires significant (about 3000') of re-profiling existing track to achieve proposed vertical alignment. Would require staging plan that phased the vertical re-profiling in multiple outages.      | Yes                        | Yes   | Yes                                       | Yes                                 | Major - 1. Station Construction Activities Adjacent to Live Metrorail and CSXT railroad 2. Re-Profiling 3000' (+) of Live Track To Achieve Vertical Criteria. |
|   | aerial      | No - Constructability              | -                                 | -                                  | -   | No - Proposed horizontal alignment matches existing horizontal alignment. Requires closing existing Metrorail Yellow and Blue lines for entire construction cycle.  | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle   |
| Metrorail Station Alternative B1                    | underground | No - Constructability              | -                                 | -                                  | -   | No - Proposed horizontal alignment locates within clearance envelope of existing horizontal alignment. Requires existing Metrorail Yellow and Blue lines to be out of service for most of the construction cycle. | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle   |
|   | at grade    | Yes – Constructability limitations | Yes                               | Yes                                | Yes   | Yes- Requires lengthy shifting of existing alignment (up to 1800'). Would require staging plan that phased shifting each track under separate outages.  | Yes                        | Yes   | Yes                                       | Yes                                 | Major - Requires Legthy (up to 1800+ feet) Alignment Shifts. These Alignment Shifts Will be Difficult to Achieve in the 52 Hour Outage / Window.              |
|   | aerial      | No - Constructability              | -                                 | -                                  | -   | No - Proposed horizontal alignment locates within clearance envelope of existing horizontal alignment. Requires existing Metrorail Yellow and Blue lines to be out of service for most of the construction cycle. | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle   |

| Track Alignment and Clearance Technical Feasibility |             | Meets Technical Requirements       | Complies with General Constraints | Complies with Track Speed Criteria | Complies with Horizontal Track Alignment Criteria | Complies with Vertical Track Alignment Criteria   | Includes Special Trackwork | Complies with Horizontal Clearance Criteria   | Complies with Vertical Clearance Criteria | Complies with Track Center Criteria | Constructability and Phasing Difficulty (Minor, Moderate, Major, and Fatal Flaw)   |
|---|-------------|------------------------------------|-----------------------------------|------------------------------------|---|---|----------------------------|---|---|-------------------------------------|--|
| Metrorail Station Alternative B2                    | underground | No - Constructability              | -                                 | -                                  | -   | No - Proposed horizontal alignment locates within clearance envelope of existing horizontal alignment. Requires existing Metrorail Yellow and Blue lines to be out of service for most of the construction cycle.               | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle  |
|   | at grade    | Yes – Constructability limitations | Yes                               | Yes                                | Yes   | Yes - Requires lengthy shifting of existing alignment (up to 1400'). Would require staging plan that phased shifting each track under separate outages.   | Yes                        | yes - HOWEVER, station Ancillary Facilities Will Need to be Tight on West Side, Adjacent to CSXT. Clear Distance From CSXT to Back of Platform is About 63'. Criteria Allows 50'. | Yes                                       | Yes                                 | Major - Requires Legthy (up to 1400+ feet) Alignment Shifts. These Alignment Shifts Will be Difficult to Achieve in the 52 Hour Outage / Window. |
|   | aerial      | No - Constructability              | -                                 | -                                  | -   | No - Proposed horizontal alignment locates within clearance envelope of existing horizontal alignment. Requires existing Metrorail Yellow and Blue lines to be out of service for most of the construction cycle.               | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle  |
| Metrorail Station Alternative B3                    | underground | No - Constructability              | -                                 | -                                  | -   | No - Proposed horizontal alignment locates within clearance envelope of existing horizontal alignment. Requires existing Metrorail Yellow and Blue lines to be out of service for most of the construction cycle.               | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle  |
|   | at grade    | Yes                                | Yes                               | Yes                                | Yes   | Yes - Requires shifting existing alignment to achieve proposed alignment at 3 locations. Each shift is up to 550' maximum. Possible option to reduce proposed work, and number of track shifts to 2, at south end of alignment. | Yes                        | Yes   | Yes                                       | Yes                                 | Moderate - Requires Legthy (up to 600+ feet) Alignment Shifts. These Alignment Shifts Will be Challenging to Achieve in the 52 Hour Outage.      |
|   | aerial      | No - Constructability              | -                                 | -                                  | -   | No - Proposed horizontal alignment locates within clearance envelope of existing horizontal alignment. Requires existing Metrorail Yellow and Blue lines to be out of service for most of the construction cycle.               | -                          | -   | -   | -                                   | Fatal Flaw - Require Closing Existing Metrorail Yellow and Blue Lines for Entire Construction Cycle  |

| Track Alignment and Clearance Technical Feasibility |             | Meets Technical Requirements                 | Complies with General Constraints | Complies with Track Speed Criteria | Complies with Horizontal Track Alignment Criteria | Complies with Vertical Track Alignment Criteria   | Includes Special Trackwork | Complies with Horizontal Clearance Criteria | Complies with Vertical Clearance Criteria   | Complies with Track Center Criteria | Constructability and Phasing Difficulty (Minor, Moderate, Major, and Fatal Flaw)   |
|---|-------------|--|-----------------------------------|------------------------------------|---|---|----------------------------|---|---|-------------------------------------|--|
| Metrorail Station Alternative C1                    | underground | No – Vertical Clearance and Constructability | No                                | No                                 | No  | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1100' required, 350' provided. Constructability: Tie to north end aerial structure requires unacceptable out of service period. | -                          | -   | No-does not provide sufficient distance to achieve clearance under CSXT at south end, 1100' required, 350' provided.  | -                                   | North End; Proposed Alignment Requires Reconstruction of Existing WMATA Curved Aerial Structure South of Reagan National Airport, Requiring Extensive Out of Service Period. |
|   | at grade    | No – Vertical Clearance and Constructability | -                                 | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: as indicated in Underground and Aerial options.   | -                          | -   | No- south end 1, similar issues to underground options.   | -                                   | -  |
|   | aerial      | No – Vertical Clearance and Constructability | -                                 | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1300' required, 350' provided. Constructability: Tie to north end aerial structure requires unacceptable out of service period. | -                          | -   | No-does not provide sufficient distance to achieve clearance over CSXT at south end, 1300' required, 350' Provided.   | -                                   | -  |
| Metrorail Station Alternative C2                    | underground | No – Vertical Clearance                      | No                                | No                                 | No  | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1100' required, 350' provided; north end - 1100' required, 0' provided.   | -                          | -   | No-does not provide sufficient distance to achieve clearance under CSXT at south end, 1100' required, 350' required, and to achieve clearance under CSXT at the north end 1100' required, 50' provided. | -                                   | -  |
|   | at grade    | No – Vertical Clearance                      | -                                 | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: as indicated in Underground and Aerial options.   | -                          | -   | No- south end and north end, similar issues to aerial and underground options.  | -                                   | -  |
|   | aerial      | No – Vertical Clearance                      | -                                 | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1300' required, 350' provided; north end - 1400' required, 0' provided.   | -                          | -   | No-does not provide sufficient distance to achieve clearance over CSXT at south end, 1300' required, 350' Provided.   | -                                   | -  |

| Track Alignment and Clearance Technical Feasibility |             | Meets Technical Requirements         | Complies with General Constraints | Complies with Track Speed Criteria | Complies with Horizontal Track Alignment Criteria | Complies with Vertical Track Alignment Criteria   | Includes Special Trackwork | Complies with Horizontal Clearance Criteria | Complies with Vertical Clearance Criteria  | Complies with Track Center Criteria | Constructability and Phasing Difficulty (Minor, Moderate, Major, and Fatal Flaw) |
|---|-------------|--------------------------------------|-----------------------------------|------------------------------------|---|---|----------------------------|---|--|-------------------------------------|--|
| Metrorail Station Alternative D1                    | underground | No – Vertical Clearance              | No                                | No                                 | No  | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1100' required, 350' provided; north end - 1100' required, 0' provided. | -                          | -   | No-does not provide sufficient distance to achieve clearance under CSXT at south end, 1100' required, 350' provided, and to achieve clearance under CSXT at north end; 1100' Required, 0' Provided.      | -                                   | -  |
|   | at grade    | No – Vertical Clearance              | -                                 | -                                  | -   | No -Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: as indicated in Underground and Aerial options.                                      | -                          | -   | No- south end and north end, similar issues to aerial and underground options.   | -                                   | -  |
|   | aerial      | No – Fatal Flaw – Vertical Clearance | -                                 | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1300' required, 400' provided; north end - 1300' required, 0' provided. | -                          | -   | No-does not provide sufficient distance to achieve clearance over CSXT at south end, 1300' required, 400' provided, and to achieve clearance over CSXT at north end; 1300' Required, 0' provided.        | -                                   | -  |
| Metrorail Station Alternative D2                    | underground | No – Vertical Clearance              | No                                | No                                 | No  | No -Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1100' required, 100' provided; north end - 1400' required, 0' provided.  | -                          | -   | No-does not provide sufficient distance to achieve clearance under CSXT at south end, 1100' required, 100' provided, and to achieve clearance under Four Mile Run and CSXT; 1400' Required, 0' Provided. | Yes                                 | -  |
|   | at grade    | No – Vertical Clearance              | -                                 | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: as indicated in Underground and Aerial options.                                     | -                          | -   | No- south end and north end, similar issues to aerial and underground options.   | -                                   | -  |
|   | aerial      | No – Vertical Clearance              | -                                 | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: south end - 1300' required, 100' provided; north end - 1300' required, 0' provided. | -                          | -   | No-does not provide sufficient distance to achieve clearance over CSXT at south end, 1300' required, 100' provided, and to achieve clearance over CSXT at north end; 1300' Required, 0' provided.        | Yes                                 | -  |

| Track Alignment and Clearance Technical Feasibility |             | Meets Technical Requirements | Complies with General Constraints | Complies with Track Speed Criteria | Complies with Horizontal Track Alignment Criteria | Complies with Vertical Track Alignment Criteria  | Includes Special Trackwork | Complies with Horizontal Clearance Criteria | Complies with Vertical Clearance Criteria  | Complies with Track Center Criteria | Constructability and Phasing Difficulty (Minor, Moderate, Major, and Fatal Flaw)                     |
|---|-------------|------------------------------|-----------------------------------|------------------------------------|---|--|----------------------------|---|--|-------------------------------------|--|
| Metrorail Station Alternative D3                    | underground | No                           | No                                | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance: north end - 1400' required, 900' provided.   | -                          | -   | No - does not provide sufficient distance at north to achieve clearance under Four Mile Run; 1400' Required, 900'  | -                                   | -  |
|   | at grade    | No                           | No                                | -                                  | -   | No - Vertical Alignment Geometry - insufficient distance to achieve vertical clearance on west side of CSXT: south end - 1300' required, 600' provided, north end - 1300' required, 250' provided. | -                          | -   | No - does not provide sufficient distance to achieve clearance under CSXT at south end - 1300' required, 600' provided, at north end - 1300' Required, 250'. | -                                   | -  |
|   | aerial      | Yes                          | Yes                               | Yes                                | Yes   | Yes  | Yes                        | Yes   | Yes  | Yes                                 | Moderate - construction of aerial structure over existing Metrorail and CSXT will present challenges |