

# Maintenance Rating Program

Triangle Expressway

February 2022

2021 Fourth Quarter Report



## CONSULTANT CERTIFICATION OF COMPLETION

February 8, 2022

Dennis Jernigan, P.E.  
Deputy Chief Engineer for Highway Operations, NCTA  
1 South Wilmington Street  
Raleigh, NC 27601

### NCTA Triangle Expressway Roadway Maintenance Performance Rating Program; Q4, FY 2021 Rating

This is to certify that I, Ken M. McEntire, PE am an authorized official representative of the company Mott MacDonald, and subconsultant to HNTB North Carolina, P.C. Collaboratively; we serve as the Triangle Expressway Roadway and Facility Maintenance Performance Rating Program Consultants.

I know of my own personal knowledge, and do hereby certify, that the work of the contract described above has been independently performed in accordance with, and in conformity to, the *NCTA Roadway and Facility Maintenance Performance Standards*.

Sincerely,

Mott MacDonald, Inc.

A handwritten signature in blue ink that reads "Ken M. McEntire". The signature is written in a cursive style with a large initial "K" and "M".

Ken M. McEntire, PE  
Principal Project Manager – Operations and Maintenance

1100 Navaho Drive, Suite 125  
Raleigh, NC 27609

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# 1.0 Executive Summary

The North Carolina Turnpike Authority (NCTA) Maintenance Rating Program (MRP) is a maintenance evaluation program for roadway features and toll facilities on the NCTA system. This report presents results from the 2021 Fourth Quarter Assessment of the Triangle Expressway.

The overall 2021 Fourth quarter maintenance rating of the Triangle Expressway was **93.3**, above the NCTA target rating of 90. As shown in **Table 1**, all five elements assessed achieved a rating greater than the target rating of 85.

**Table 1: MRP Element Results for the 2021 Fourth Quarter Assessment**

Element	MRP Rating	Target Rating
Road Surface	98.4	85.0
Unpaved Shoulders and Ditches	98.9	85.0
Drainage	91.7	85.0
Roadside	92.4	85.0
Traffic Control Devices	87.8	85.0
<b>Overall MRP Performance Rating</b>	<b>93.3</b>	<b>90.0</b>

This report also provides a rolling rating of the latest four quarterly inspections of the Triangle Expressway. As presented in **Table 2**, the rolling maintenance rating of the Triangle Expressway was **92.7**.

**Table 2: MRP Rolling Element Results**

Element	Q1 2021 Rating	Q2 2021 Rating	Q3 2021 Rating	Q4 2021 Rating	Rolling Rating
Road Surface	90.5 <sup>1</sup>	96.8 <sup>1</sup>	100.0 <sup>1</sup>	98.4	96.8 <sup>2</sup>
Unpaved Shoulders and Ditches	99.3	99.3	96.8	98.9	98.6
Drainage	88.6	94.0	92.5	91.7	91.7
Roadside	90.6	95.5	91.6	92.4	92.5
Traffic Control Devices	82.2 <sup>1</sup>	92.5 <sup>1</sup>	86.5 <sup>1</sup>	87.8	87.5 <sup>2</sup>
<b>Overall MRP Performance Rating</b>	<b>88.9<sup>1</sup></b>	<b>95.2<sup>1</sup></b>	<b>93.0<sup>1</sup></b>	<b>93.3</b>	<b>92.7<sup>2</sup></b>

<sup>1</sup>Excludes asphalt surface pavement condition as well as markers, striping, and symbols on mainline NC-147 and all ramps/loops.

<sup>2</sup>Excludes quarter ratings for elements listed above.

In addition, the report provides findings of the Green Level Historic District signs inspection. This quarter, two signs were inspected. Both signs were found to be in good physical condition, and the landscaped areas around the signs were maintained in accordance with NCTA MRP standards.

## 2.0 Introduction

The NCTA MRP is a comprehensive planning, measuring, and managing process that provides a means for communicating to managers, stakeholders and customers the impacts of policy and budget decisions on program service delivery.

Using outcome-based performance measures and the service level scale (0 through 100), the inspection results are rated against established thresholds criteria. The program analysis is accomplished using sampling procedures that capture the level of service being provided for individual assets. The evaluation procedure is based on the establishment of threshold conditions that quantify the maximum defect allowed on assets. Over time, the results can be charted to identify work needs and subsequent necessary actions.

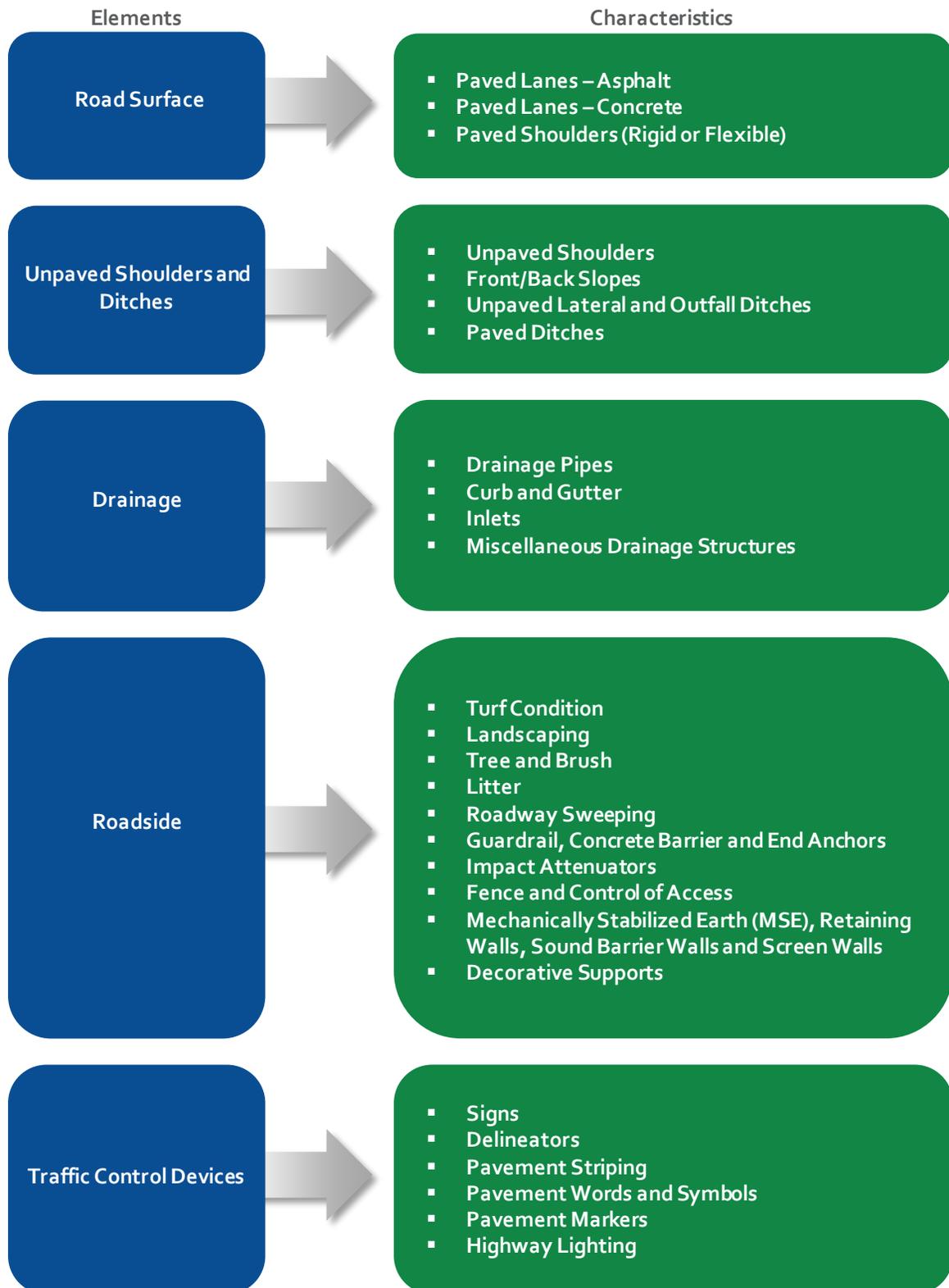
The NCTA performance standards, threshold criteria, and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff, and consultants.

Using field survey information, a maintenance matrix can be developed to show the ties between maintenance activities and the characteristics of various roadway features. The purpose of this evaluation is to provide information that can be used to schedule and prioritize routine maintenance activities and provide uniform maintenance conditions that meet established objectives.

## 3.0 MRP Procedure

Per the *NCTA Roadway and Facility Maintenance Performance Standards V6.3*, roadway assets or characteristics on NCTA facilities have been grouped into elements. These elements and corresponding characteristics are shown in **Figure 1:**

Figure 1: Maintenance Elements and Characteristics



A weighting system has been established to identify the importance of each element and characteristic. This system consists of two weighting factors: one that accounts for the importance of individual characteristics within a given maintenance element (1-9), and one that accounts for the importance of the maintenance elements to the total rating (by % of score). This two-factor system reveals deficiencies among characteristics and elements.

The program analysis is accomplished using statistically valid, random sampling procedures that capture the level of service for individual characteristics, with a 95% confidence level in sampling. The sample characteristics selected are evaluated during quarterly inspections, which are performed during the months of February, May, August, and November to account for dynamic changes in assets during the various seasons. The evaluation process is completed using electronic data collection tablets and is based on established threshold conditions described in the NCTA Roadway and Facility Maintenance Standards V6. Those characteristics that meet or exceed the threshold are coded as PASSING; those that do not meet the threshold are coded as NOT PASSING.

When the evaluation process is completed, the number of PASSING samples and total sample are multiplied by the weighted values (1-9) to determine the actual and possible rating points for characteristics and elements. MRP ratings for elements and characteristics are then calculated as the ratio of the actual rating points to possible rating points. The MRP ratings represent the maintenance level of service currently being provided, as they define the percent of characteristics and elements that meet the maintenance condition standard. For instance, an MRP rating of 83 signifies that 83 percent of the inspected elements/characteristics met the standard.

The overall MRP rating is determined by calculating the sum of the elements' ratings multiplied by the following weighted factors:

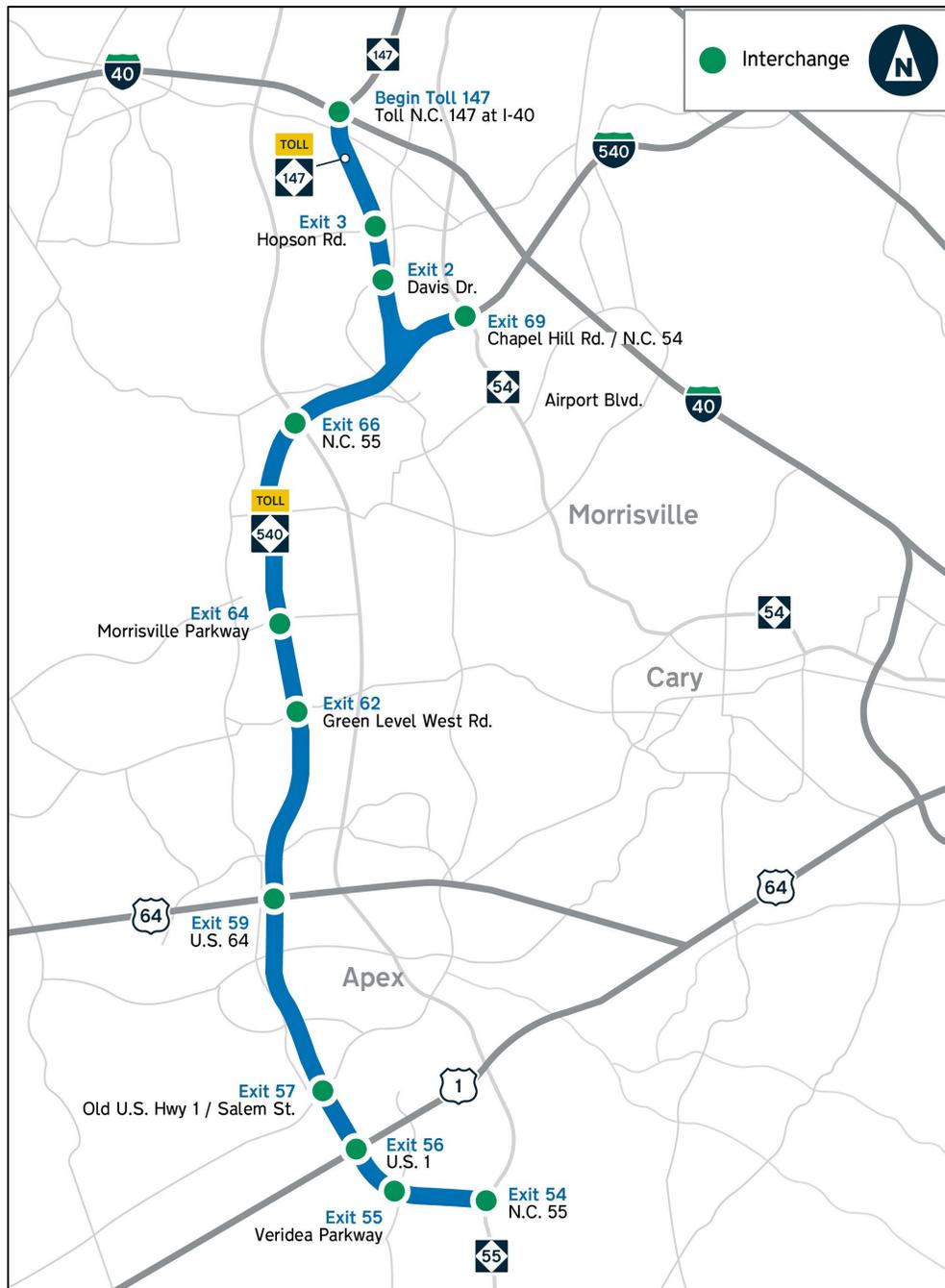
Road Surface =	25%
Unpaved Shoulders =	13%
Drainage =	15%
Roadside =	17%
Traffic Control Devices =	30%
<hr/>	
Total	100%

The NCTA's overall target rating is 90, with elements scoring 85 or higher, and characteristics 80 or higher. In addition to quarterly ratings, the cumulative rolling annual rating is calculated each quarter. This rating is obtained by adding the ratings of the latest four quarterly inspections to compensate for the likelihood of uneven sample sizes.

## 4.0 Triangle Expressway Description

The Triangle Expressway extends for approximately 18.8 miles from the interchange of I-40 and Toll NC-147 in Durham to the NC-55 Bypass near Holly Springs (*Figure 2*). It includes a one-mile segment on Toll NC-540 extending north from the Toll NC-540 / Toll NC-147 interchange to the NC-54 interchange. The Triangle Expressway consists of twelve interchanges and twenty-two all-electronic toll collection zones.

Figure 2: Triangle Expressway Map



## 5.0 Triangle Expressway Asset Inventory Update

Through normal day-to-day maintenance activities and the construction of special projects, roadside assets are continuously being added or modified on the roadway. NCTA coordinates closely with NCDOT Division 5 Maintenance and conducts routine field visits to maintain an accurate asset inventory and ensure the validity of the MRP survey.

During this quarter assets on Toll NC 540 exit ramps to and from NC-55 Bypass were removed from the inventory due to the Complete 540 construction project. **Table 3** presents the updated number of assets that are currently available for inspections.

**Table 3: Asset Inventory**

Assets	Total Inventory	2021 Eligible Inventory
Barriers	799	627
Curb and Gutter	428	397
Decorative Supports	305	298
Drainage	1179	1131
Misc. Drainage	211	200
Fences	508	484
Highway Lighting	435	431
Impact Attenuators	47	45
Inlets	1126	1080
Linear Segments	795	737
Plant Beds	266	261
Paved Ditches	2	2
Pavement Symbols	652	593
Signs	1221	1169
Tree and Brush	603	569
Turf	1074	978
Walls	88	84

## 6.0 MRP Fourth Quarter Assessment

### 6.1 Quarterly Results

The overall 2021 fourth quarter maintenance rating of the Triangle Expressway was 93.3, above NCTA's target overall rating of 90. All elements assessed achieved quarter ratings above the target rating of 85 established for element groups. Furthermore, all characteristics achieved a quarter score above the target rating of 80.

A resurfacing project to improve asphalt pavement condition as well as the condition of pavement striping, characters, symbols, and markers on mainline NC-147 and asphalt surface ramps/loops throughout Triangle Expressway was completed in September 2021. While the project was ongoing, the Paved Lanes Asphalt, Paved Shoulder, Pavement Striping, Pavement Characters and Symbols, and Pavement Markers characteristics were only inspected on pavement surfaces not included in the resurfacing project contract. Once this project was complete, the characteristics rating for the entire facility resumed and was included in the Road Surface element rating, Traffic Control Devices element rating and overall scoring.

It is important to note that these results are only representative of the fourth quarter sample, one of the four surveys to provide an intermediate snapshot of seasonal conditions. Therefore, they are not a statistically valid representation of the assets; only the total of all four quarterly inspections, reported as the rolling rating, provide a 95% confidence level in statistical sampling. The fourth quarter MRP performance ratings for elements and characteristics are presented in *Table 4* and *Table 5*, respectively.

**Table 4: MRP Element Results for Q4 2021**

Element	MRP Rating
Road Surface	98.4
Unpaved Shoulders and Ditches	98.9
Drainage	91.7
Roadside	92.4
Traffic Control Devices	87.8
<b>Overall MRP Performance Rating</b>	<b>93.3</b>

Table 5: MRP Characteristics Results for Q4 2021

Road Surface	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Paved Lanes Asphalt	14	15	9	126	135	93
Paved Lanes Concrete	24	24	9	216	216	100
Paved Shoulder	39	39	5	195	195	100
<b>Element Total</b>				<b>537</b>	<b>546</b>	<b>98.4</b>
Unpaved Shoulders and Ditches	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Unpaved Shoulder	38	39	9	342	351	97
Front/Back Slopes	39	39	6	234	234	100
Lateral and Outfall Ditches, Unpaved	39	39	6	234	234	100
Ditches, Paved	2	2	5	10	10	100
<b>Element Total</b>				<b>820</b>	<b>829</b>	<b>98.9</b>
Drainage	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Drainage Pipes	31	34	7	217	238	91
Curb and Gutter	28	28	6	168	168	100
Inlets	34	38	7	238	266	89
Misc. Drainage Structure	24	28	4	96	112	86
<b>Element Total</b>				<b>719</b>	<b>784</b>	<b>91.7</b>
Roadside	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Turf Condition	49	56	7	343	392	88
Landscaping	25	25	4	100	100	100
Trees and Brush	30	31	4	120	124	97
Litter	36	39	4	144	156	92
Roadway Sweeping	38	39	5	190	195	97
Guardrail, Concrete Barrier, and End Anchors	29	31	9	261	279	94
Impact Attenuators	8	9	9	72	81	89
Fence, Control Access	26	31	7	182	217	84
Retaining Walls and Sound Barrier Walls	13	16	5	65	80	81
Decorative Supports	26	26	5	130	130	100
Graffiti and Stain Removal	44	44	4	176	176	100
<b>Element Total</b>	<b>0</b>	<b>0</b>		<b>1783</b>	<b>1930</b>	<b>92.4</b>
Traffic Control Devices	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q4 Rating
Signs	33	34	7	231	238	97
Delineators	30	39	3	90	117	77
Pavement Striping/Marking	27	39	8	216	312	69
Words and Symbols	43	48	7	301	336	90
Pavement Markers	39	39	9	351	351	100
Highway Lighting	36	41	6	216	246	88
<b>Element Total</b>				<b>1405</b>	<b>1600</b>	<b>87.8</b>

Additionally, **Appendix A** includes maps that present the location of all assets assessed during the fourth quarter. **Appendix B** includes a list of the individual assets that did not achieve their target ratings.

## 6.2 Quarterly Analysis and Recommendations

### Elements

During the fourth quarter, all elements exceeded NCTA's quarter score threshold criteria of 85. All elements except for Traffic Control Devices received a quarter score above 90.

Road Surface (98.4) experienced an increase in rolling rating 0.7 points higher than the previous quarter's rolling rating. Asphalt resurfacing was completed in September of 2021.

Unpaved Shoulders and Ditches (98.9) experienced a slight increase in rolling rating. The rating for this element was 0.1 points higher than the previous quarter rolling rating. All characteristics within this element continued scoring above 95.

Drainage (91.7) experienced an increase in rolling rating of 0.1 points as well. Misc. Drainage Pipes (81) rolling rating increased from last quarter, continuing to score above the target rating.

Roadside (92.4) increased 0.8 points from the previous quarter's rolling rating. Turf Condition (88) and Retaining Walls and Sound Barrier Walls (81) both experienced increases in rolling ratings from last quarter when both were below scored below the threshold criteria.

Traffic Control Devices (87.8) experienced a 0.6 point increase in rolling rating from the previous quarter. Pavement Striping/Marking (69) and Delineators (77) characteristic rolling ratings both decreased from last quarter rolling rating. Repaving and subsequent striping of all asphalt lanes was completed in September 2021.

Recommendations to improve specific critical characteristic ratings are provided in the following sections.

### Characteristics

This quarter, all but two characteristics, Delineators (77) and Pavement Striping/Marking (70), met the NCTA target threshold criteria of 80. A description of the characteristics' conditions and future work planning recommendations are provided below. Pictures of all characteristic failures are included in **Appendix B**.

Delineators (77 rating –30 of the 39 assets passed): All 9 of the linear sections that did not pass inspection had more than 10% of delineators that were not visible during nighttime observation. Two of the sections that did not pass inspection are presented in **Figure 3**.

**Figure 3: Delineators Condition Inspection Results Sample**



Delineator Maintenance Program:

- 1) Object markers and delineators are inspected by routine patrols and specifically after each mowing cycle for damage.
- 2) Missing and non-reflective object markers are replaced within the annual work program.
- 3) Missing and non-reflective delineators are replaced within 14 calendar days.

Delineator Maintenance and Evaluation Standards:

Object markers and delineators do not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 10% of the post-mounted delineators are offset 4 feet plus or minus 3 inches from the shoulder break point and installed at a uniform height on interchange ramps.
- 2) More than 10% of the object markers or post-mounted delineators lean more than 1 inch per foot of post length.
- 3) More than 10% of the required markers and delineators are missing or unevenly spaced.
- 4) More than 10% of the required delineators are not visible during nighttime observation. (N)
- 5) More than 10% of the post-mounted delineators are installed facing the wrong way.
- 6) More than 10% of the object markers or post-mounted delineators are missing connecting hardware, nuts and bolts.

Pavement Striping (69 rating – 27 of the 39 assets passed): There were 12 pavement striping/markings segments that did not pass inspection, these segments were identified as missing more than 10% of any line segment in the sections, not meeting the required line width, or not reflecting during the nighttime inspection. Two of the pavement striping and marking segments that did not pass inspection are presented in **Figure 4**.

**Figure 4: Pavement Striping Inspection Results Sample**



To maintain a well-defined lane delineation throughout the Triangle Expressway, it is recommended that the maintenance provider consider scheduling pavement striping/markings replacement cycles in accordance with the NCTA Roadway and Facility Maintenance Standards V6, referenced below.

**Maintenance Program:**

- 1) Pavement striping is observed daily and inspected every 4 months for compliance to the standard.
- 2) Worn or missing markings are evaluated for compliance annually, and generally are scheduled on a 3-to-5-year replacement cycle depending on the material.

**Maintenance and Evaluation Standards:**

Pavement Striping/Marking does not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 10% of the length of any line is less than 5.4 inches wide.
- 2) More than 10% of each line is not visible at a distance of 160 feet during nighttime observation.
- 3) More than 10% of the length of any line is missing.
- 4) More than 10% of the length of any line is covered by soil, grass, or debris.

Pavement striping/markings were last installed along Toll NC-540 in the Summer of 2018. Pavement striping/markings were included in the asphalt pavement resurfacing contract which was completed in Fall 2021. A contract for concrete surface pavement marking and striping is scheduled to be let in early 2022.

## 7.0 Current Rolling MRP Rating

### 7.1 Annual Results

The 2021 annual rolling maintenance rating of the Triangle Expressway was **92.7**, exceeding NCTA's target overall rating of 90. All elements exceeded NCTA's rolling rating threshold criteria of 85. Twenty-seven of the twenty-eight characteristic ratings met or exceeded the target rating of 80.

The 2020/2021 results are presented in *Exhibit 1* and *Table 6*. These results are a collection of the four quarterly inspections conducted in the last year.

**Exhibit 1: MRP Element Results for 2020/2021**

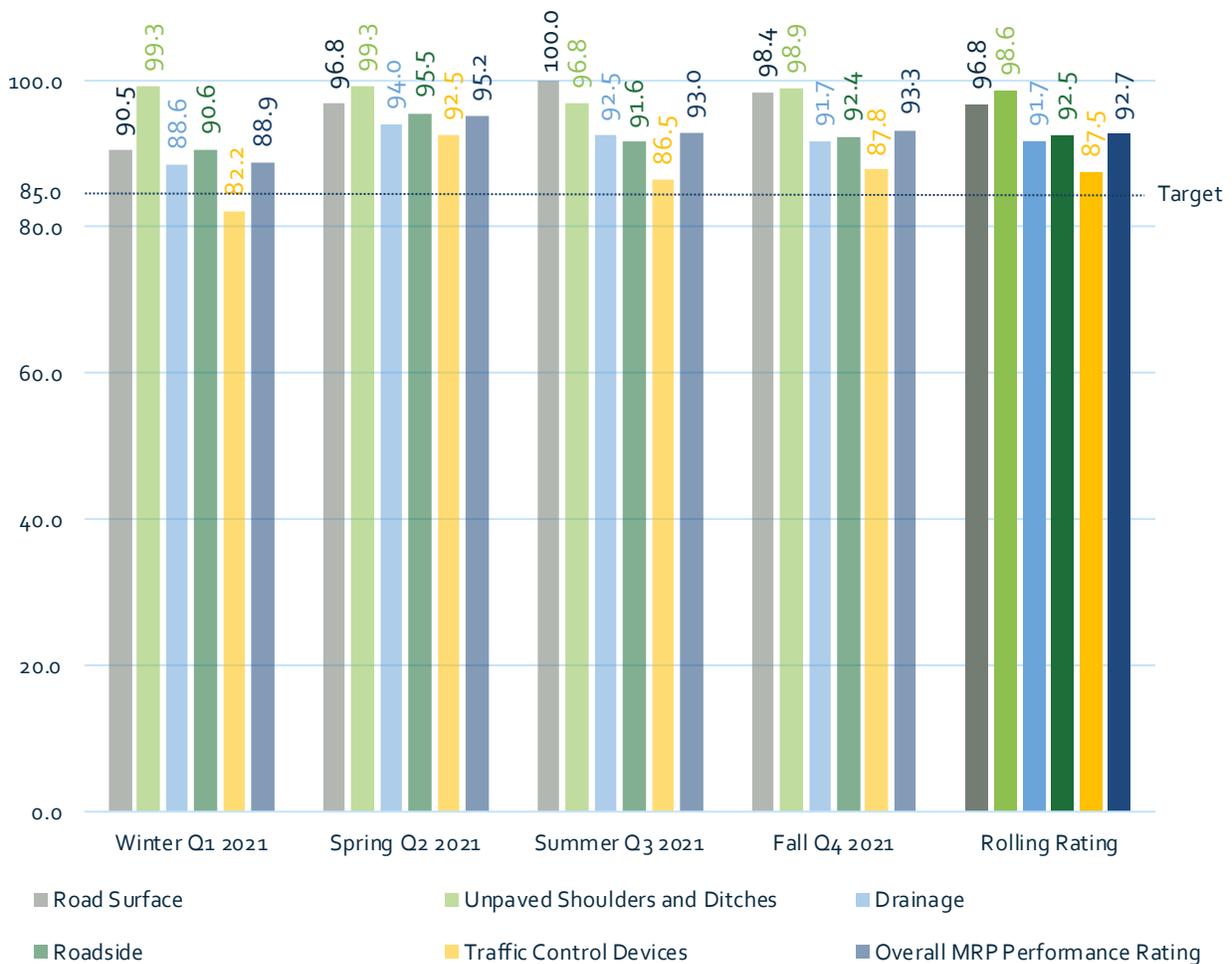


Table 6: MRP Rolling Element Results

Road Surface	Q1 2021 Rating	Q2 2021 Rating	Q3 2021 Rating	Q4 2021 Rating	Rolling Rating
Paved Lanes Asphalt	88 <sup>1</sup>	95 <sup>1</sup>	100 <sup>1</sup>	93	93 <sup>2</sup>
Paved Lanes Concrete	84	95	100	100	96
Paved Shoulder	100 <sup>1</sup>	100 <sup>1</sup>	100 <sup>1</sup>	100	100 <sup>2</sup>
<b>Element Total</b>	<b>90.5<sup>1</sup></b>	<b>96.8<sup>1</sup></b>	<b>100.0<sup>1</sup></b>	<b>98.4</b>	<b>96.8<sup>2</sup></b>
Unpaved Shoulders and Ditches	Q1 2021 Rating	Q2 2021 Rating	Q3 2021 Rating	Q4 2021 Rating	Rolling Rating
Unpaved Shoulder	100	100	93	97	97
Front/Back Slopes	98	100	100	100	99
Lateral and Outfall Ditches, Unpaved	100	98	100	100	99
Ditches, Paved	100	100	100	100	100
<b>Element Total</b>	<b>99.3</b>	<b>99.3</b>	<b>96.8</b>	<b>98.9</b>	<b>98.6</b>
Drainage	Q1 2021 Rating	Q2 2021 Rating	Q3 2021 Rating	Q4 2021 Rating	Rolling Rating
Drainage Pipes	88	97	91	91	92
Curb and Gutter	93	100	100	100	98
Inlets	92	93	95	89	92
Misc. Drainage Structure	75	83	80	86	81
<b>Element Total</b>	<b>88.6</b>	<b>94.0</b>	<b>92.5</b>	<b>91.7</b>	<b>91.7</b>
Roadside	Q1 2021 Rating	Q2 2021 Rating	Q3 2021 Rating	Q4 2021 Rating	Rolling Rating
Turf Condition	81	91	75	88	83
Landscaping	85	96	100	100	95
Trees and Brush	97	100	100	97	98
Litter	88	98	95	92	93
Roadway Sweeping	100	100	100	97	99
Guardrail, Concrete Barrier, and End Anchors	97	93	97	94	95
Impact Attenuators	100	100	100	89	97
Fence, Control Access	80	91	93	84	87
Retaining Walls and Sound Barrier Walls	94	94	69	81	84
Decorative Supports	100	100	100	100	100
Graffiti and Stain Removal	95	100	98	100	98
<b>Element Total</b>	<b>90.6</b>	<b>95.5</b>	<b>91.6</b>	<b>92.4</b>	<b>92.5</b>
Traffic Control Devices	Q1 2021 Rating	Q2 2021 Rating	Q3 2021 Rating	Q4 2021 Rating	Rolling Rating
Signs	89	91	88	97	91
Delineators	75	93	80	77	81
Pavement Striping/Marking	74 <sup>1</sup>	90 <sup>1</sup>	70 <sup>1</sup>	69	76 <sup>2</sup>
Words and Symbols	81 <sup>1</sup>	86 <sup>1</sup>	87 <sup>1</sup>	90	86 <sup>2</sup>
Pavement Markers	93 <sup>1</sup>	100 <sup>1</sup>	100 <sup>1</sup>	100	99 <sup>2</sup>
Highway Lighting	78	93	90	88	87
<b>Element Total</b>	<b>82.2<sup>1</sup></b>	<b>92.5<sup>1</sup></b>	<b>86.5<sup>1</sup></b>	<b>87.8</b>	<b>87.5<sup>2</sup></b>

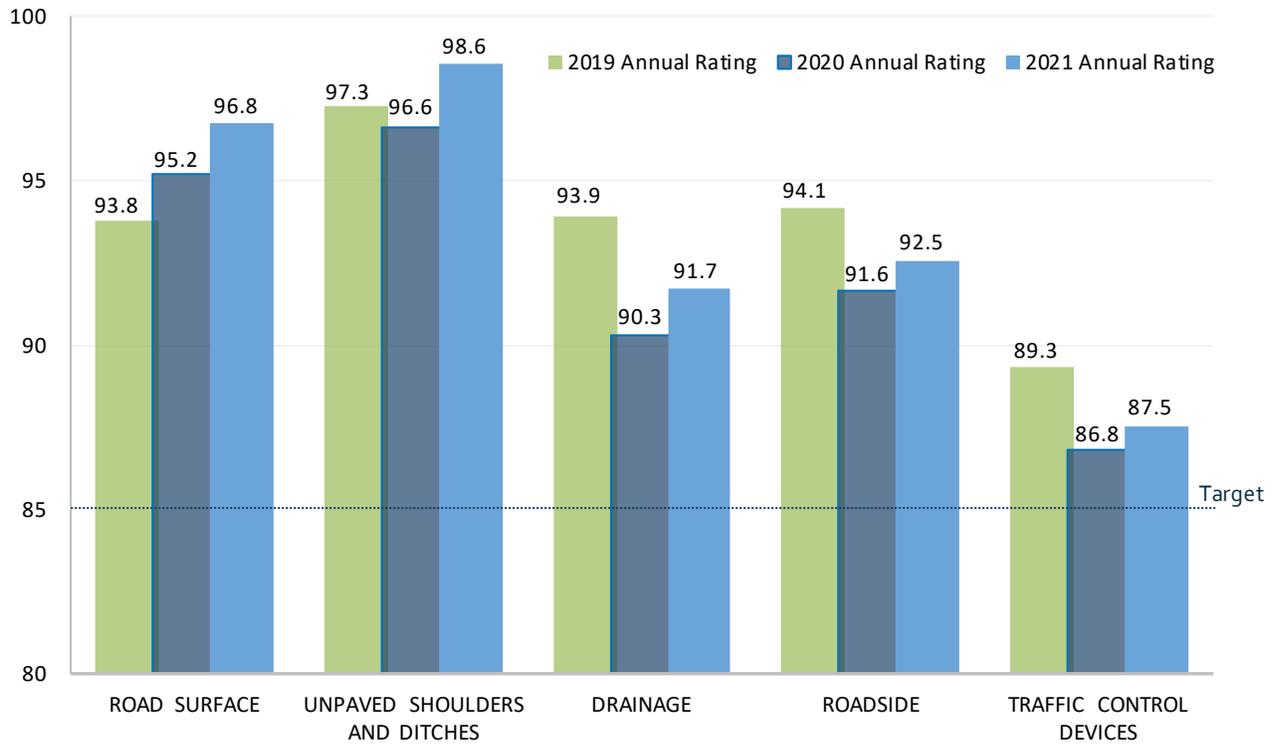
<sup>1</sup>Excludes asphalt surface pavement condition as well as markers, striping, and symbols on mainline NC-147 and all ramps/loops.

<sup>2</sup>Excludes the indicated quarter ratings for characteristics listed above.

## 7.2 Annual Analysis

Based on the combined results of all four quarterly inspections conducted in 2021, all elements exceeded NCTA’s threshold criteria of 85. In addition, all characteristics, apart from Pavement Striping/Marking (76), exceeded the target threshold criteria of 80. **Exhibit 2** shows the comparison in annual element ratings from 2019 to 2021, which shows all elements increasing in rating from 2020 to 2021.

**Exhibit 2: Annual Rating Comparison Chart**



## 8.0 Green Level Historic District Signs

Green Level Historic District signs and surrounding landscaped areas were installed as part of the Triangle Expressway construction project. Currently, NCDOT is maintaining the Green Level Historic District Signs and the Town of Cary is providing maintenance to the landscaped areas surrounding these signs.

### 8.1 Analysis and Recommendations

As part of each quarterly inspection, an assessment team visits the two remaining Green Level Historic District signs to conduct a visual inspection of each sign and ensure they are in good standing. The two signs included in the inspection inventory were found to be in good condition. One of the two landscaped areas were well maintained while the other appeared overgrown, partially obscuring the sign text. *Figure 5* shows the two signs assessed.

Figure 5: Green Level West Historic District Signs, Landscape Areas



## 9.0 Conclusion

This report presents the 2021 fourth quarter assessment of the Triangle Expressway. The NCTA's target ratings are 90 for the rolling rating, 90 for the overall quarter rating, 85 for elements, and 80 for characteristics. The fourth quarter 2021 overall rating was 93.3 and the rolling rating was 92.7, both ratings met the target rating of 90.

All element ratings were above the target ratings for the quarter and rolling assessment. During the fourth quarter assessment, all but three characteristics met or exceeded the target rating of 80. The characteristics that received quarter scores less than 80 includes Delineators (77) and Pavement Striping/Marking (69). Repaving of asphalt surfaces, which includes the replacement of Pavement Markers, Pavement Striping, and Words/Symbols, began in 2020 and was completed in Fall 2021.

To maintain/improve the condition ratings, it is recommended that the pavement striping/markings replacement cycles are completed as planned in the capital budget. Replacement of pavement striping/markings is scheduled to be performed in Spring 2022.

This quarter, the two Green Level Historic District signs inspected were found to be in good condition. The landscaped area surrounding one of the two signs was found to be overgrown and in need of maintenance. The landscape area around the other sign on Green Level Church Road was found to be well maintained.

# **Appendix A**

**Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations**

## Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations

Provided below are a series of maps outlining the assets that were a part of this quarter's sample and their corresponding result. Assets are defined by an Inventory ID, which is a unique identifier given to each individual asset. The components that make up the Inventory ID are an asset specific prefix along with a number, such as LS\_1. All assets and their respective prefixes are listed below:

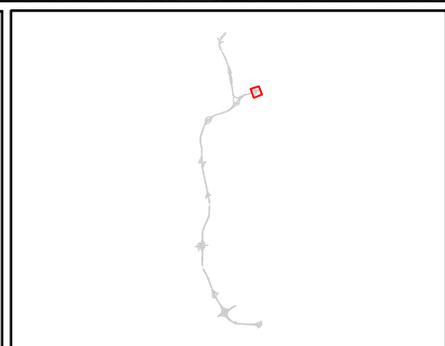
- Guardrail, Concrete Barrier and End Anchors – BR
- Curb and Gutter – CG
- Decorative Supports – DS
- Drainage Pipes – DP
- Misc. Drainage Structures – MDP
- Fence and Control of Access – FN
- Graffiti - GF
- Highway Lighting – HL
- Impact Attenuators – IA
- Inlets – IN
- Landscaping – PB
- Linear Samples – LS
  - Paved Lanes – Asphalt
  - Paved Lanes – Concrete
  - Paved Shoulders
  - Unpaved Shoulders
  - Front/Back Slopes
  - Unpaved Lateral and Outfall Ditches
  - Litter
  - Roadway Sweeping
  - Pavement Striping/Markings
  - Pavement Markers
  - Delineators
- Paved Ditches – PD
- Pavement Words and Symbols – PS
- Signs – SN
- Tree and Brush – TB
- Turf Condition – TF
- MSE/Retaining Walls, Sound Barrier Walls, and Screen Walls – WL

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset

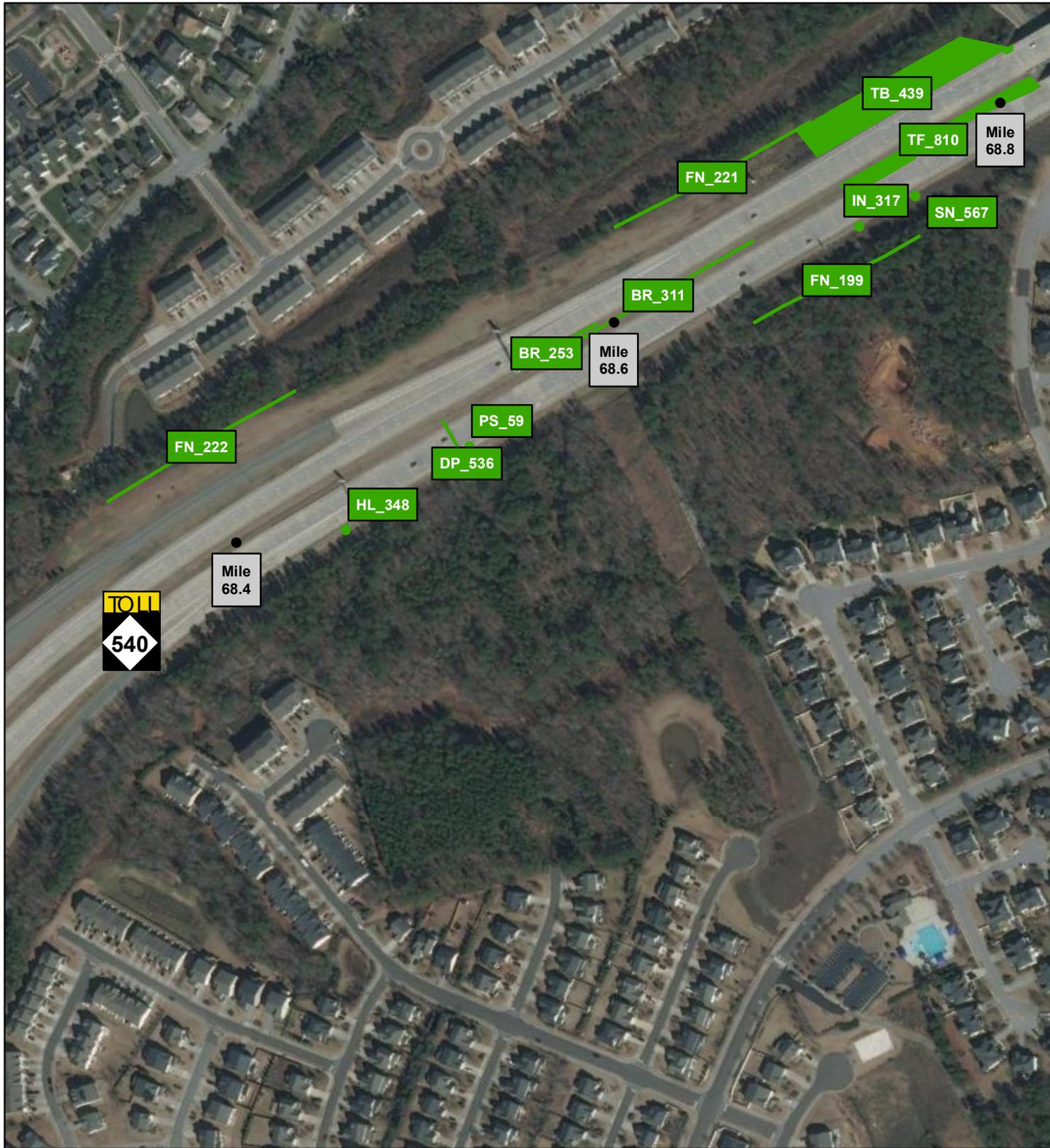






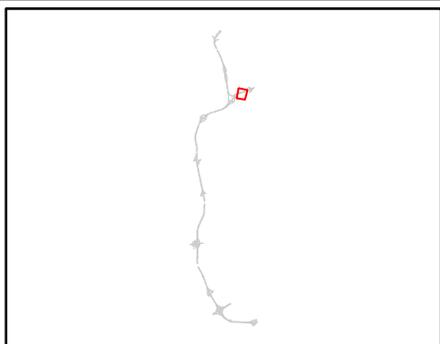
A1

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

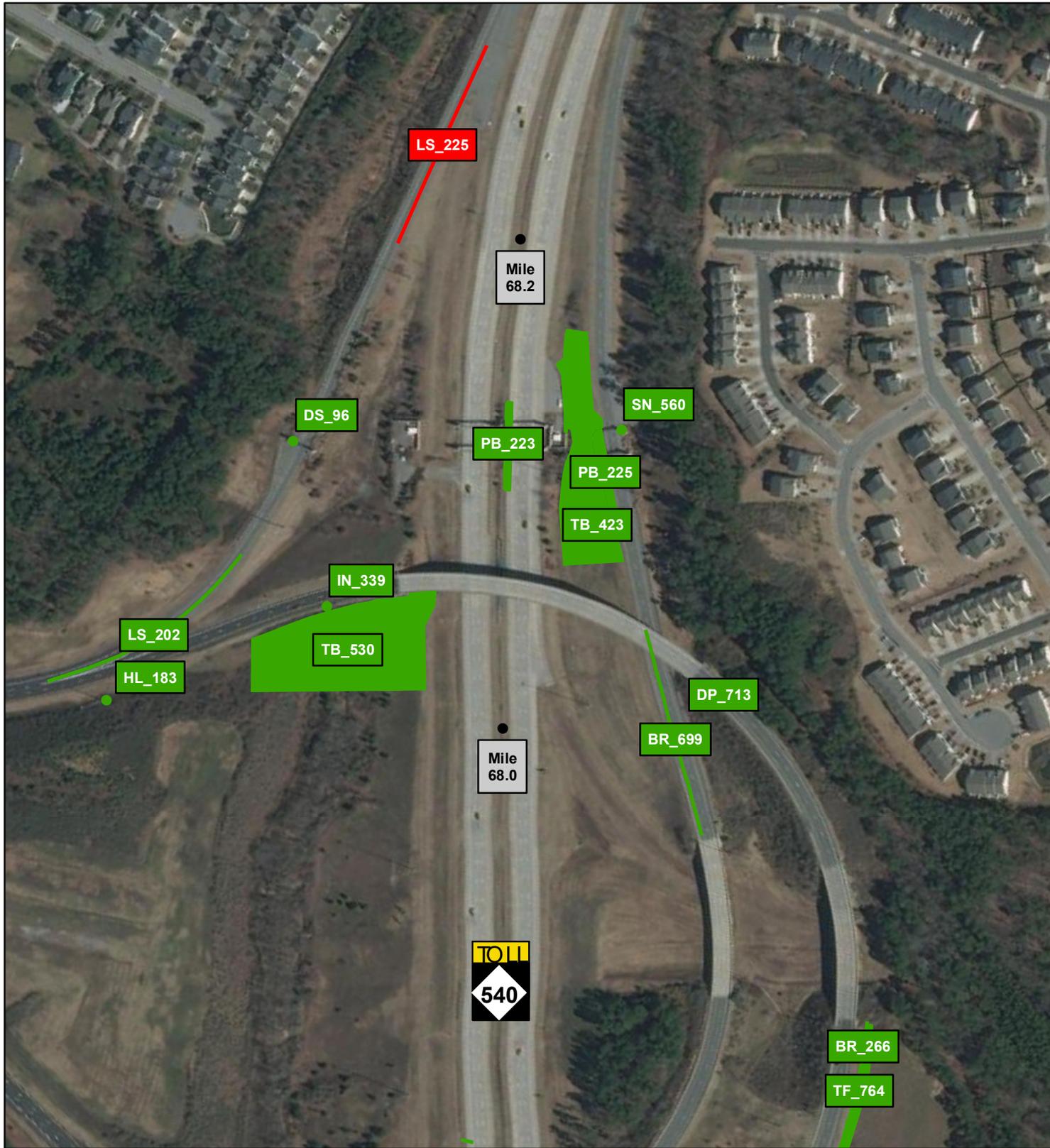
-  Failing Asset
-  Passing Asset



NORTH CAROLINA  
**Turnpike Authority**

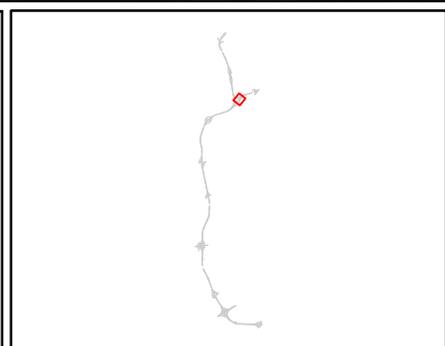
A2

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

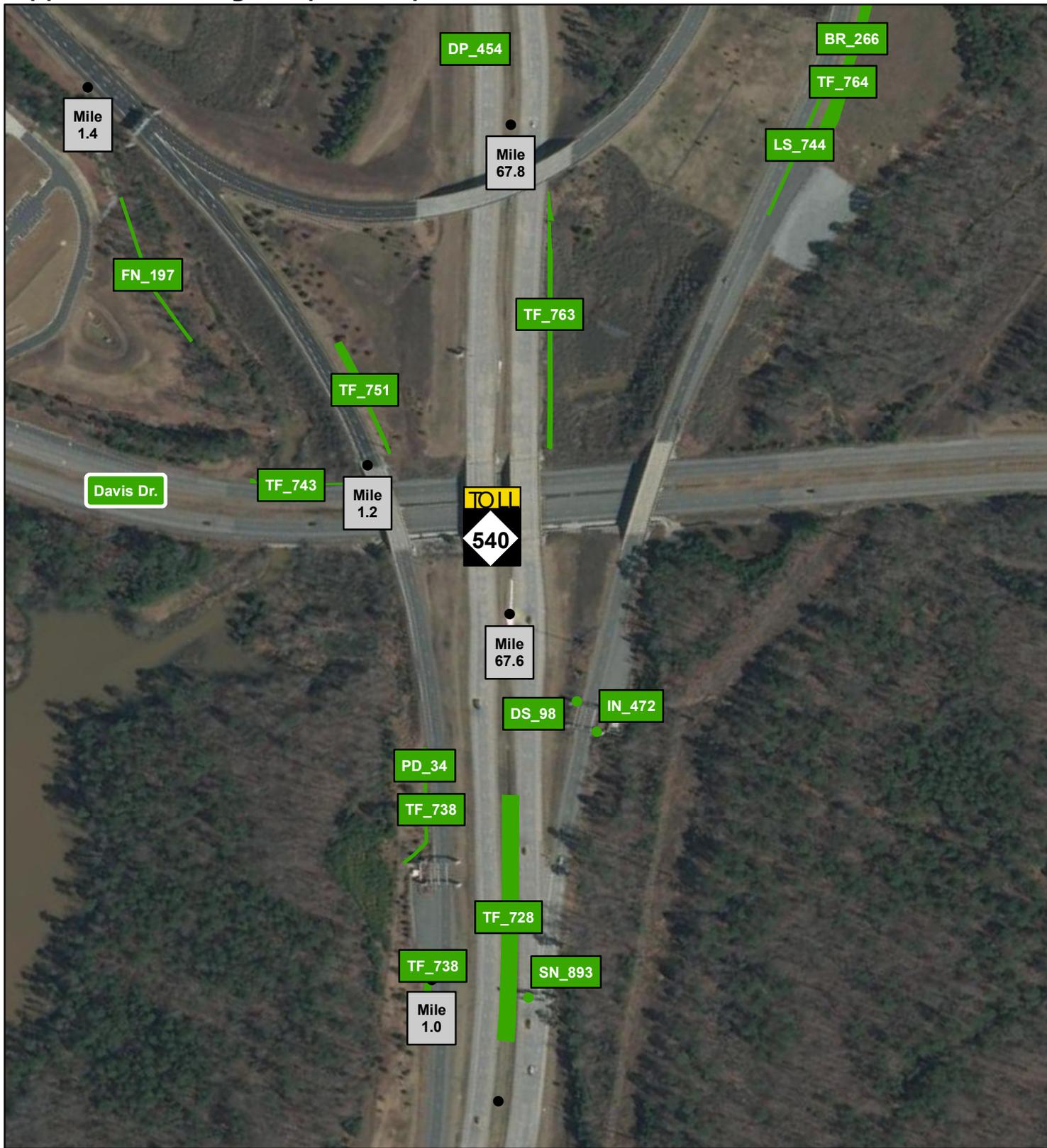
-  Failing Asset
-  Passing Asset



**NORTH CAROLINA**  
**Turnpike Authority**

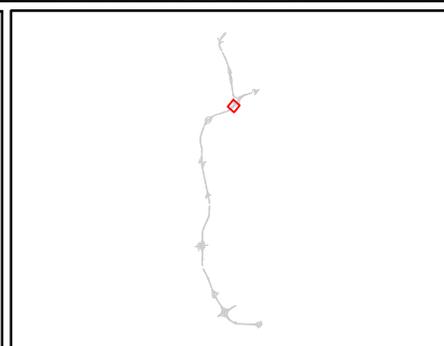
A3

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

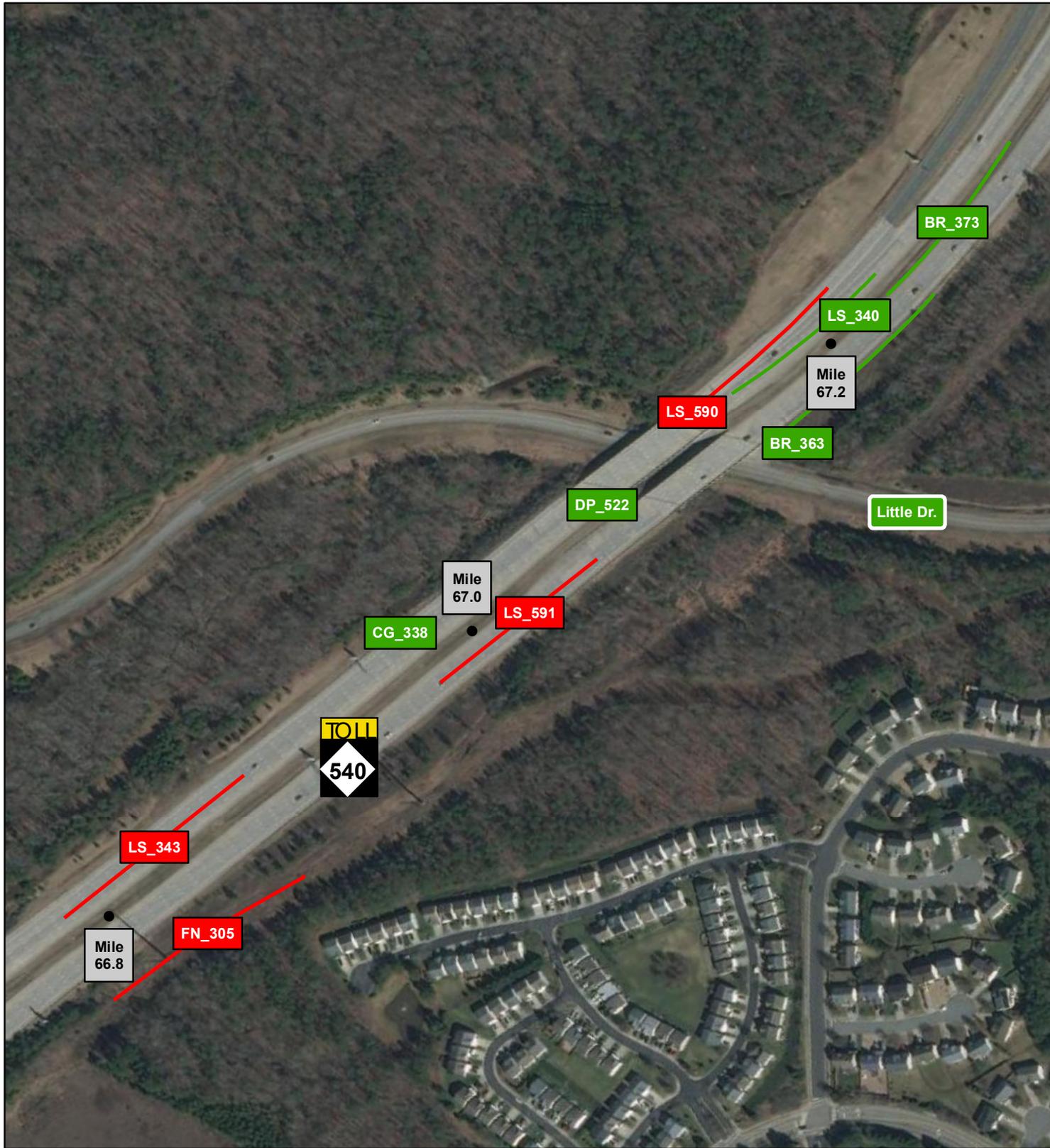
- Failing Asset
- Passing Asset



NORTH CAROLINA  
**Turnpike Authority**

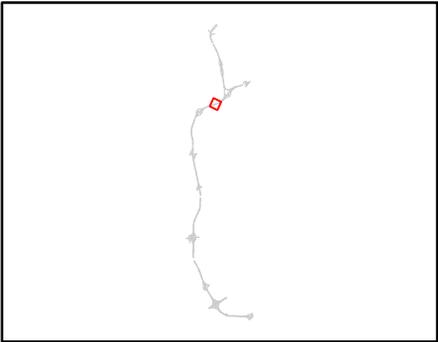
A4

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

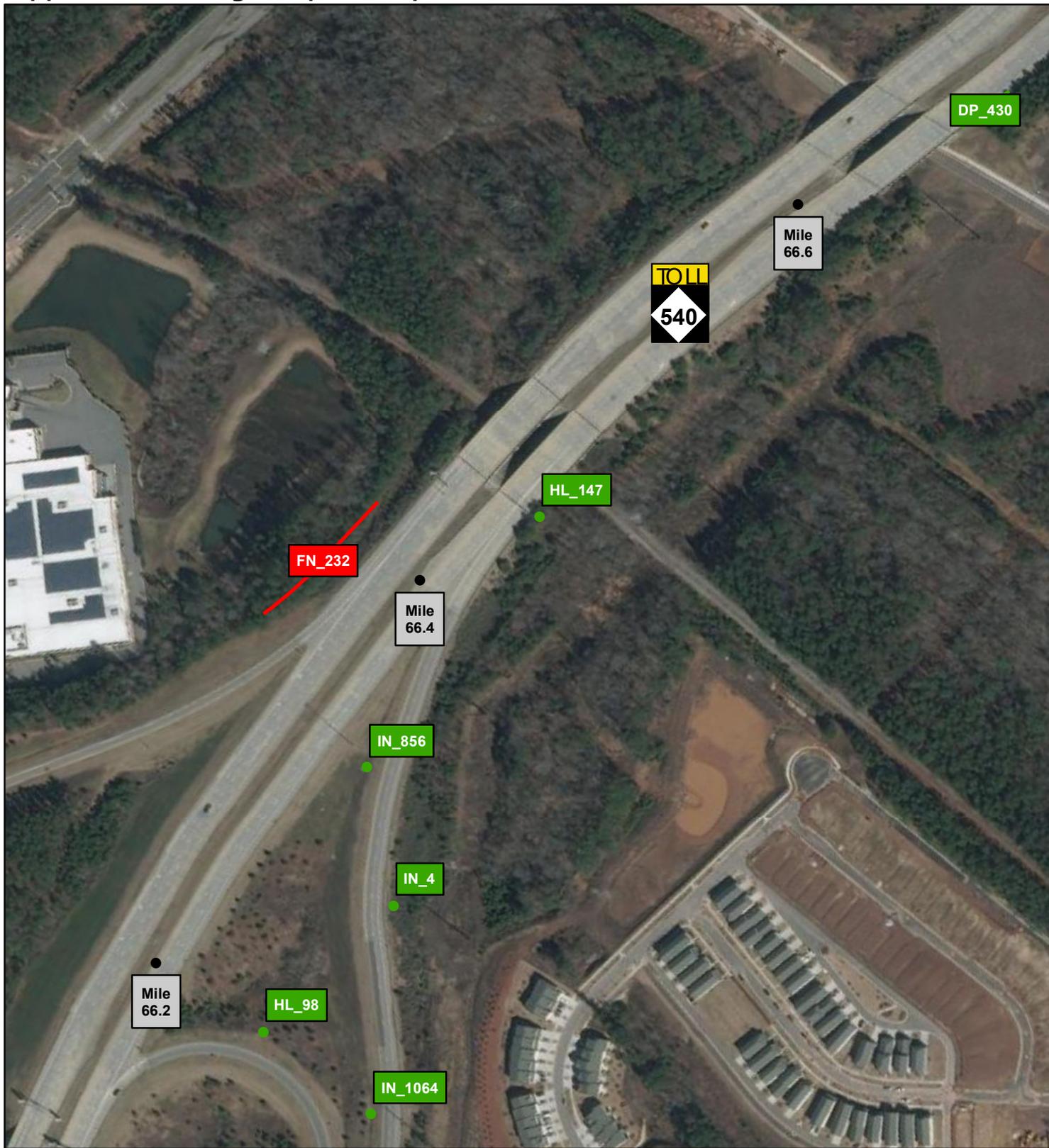
-  Failing Asset
-  Passing Asset


NORTH CAROLINA  
**Turnpike Authority**

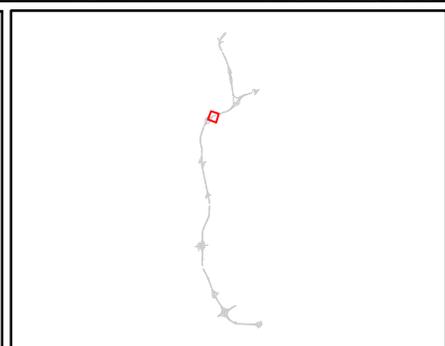
A5

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

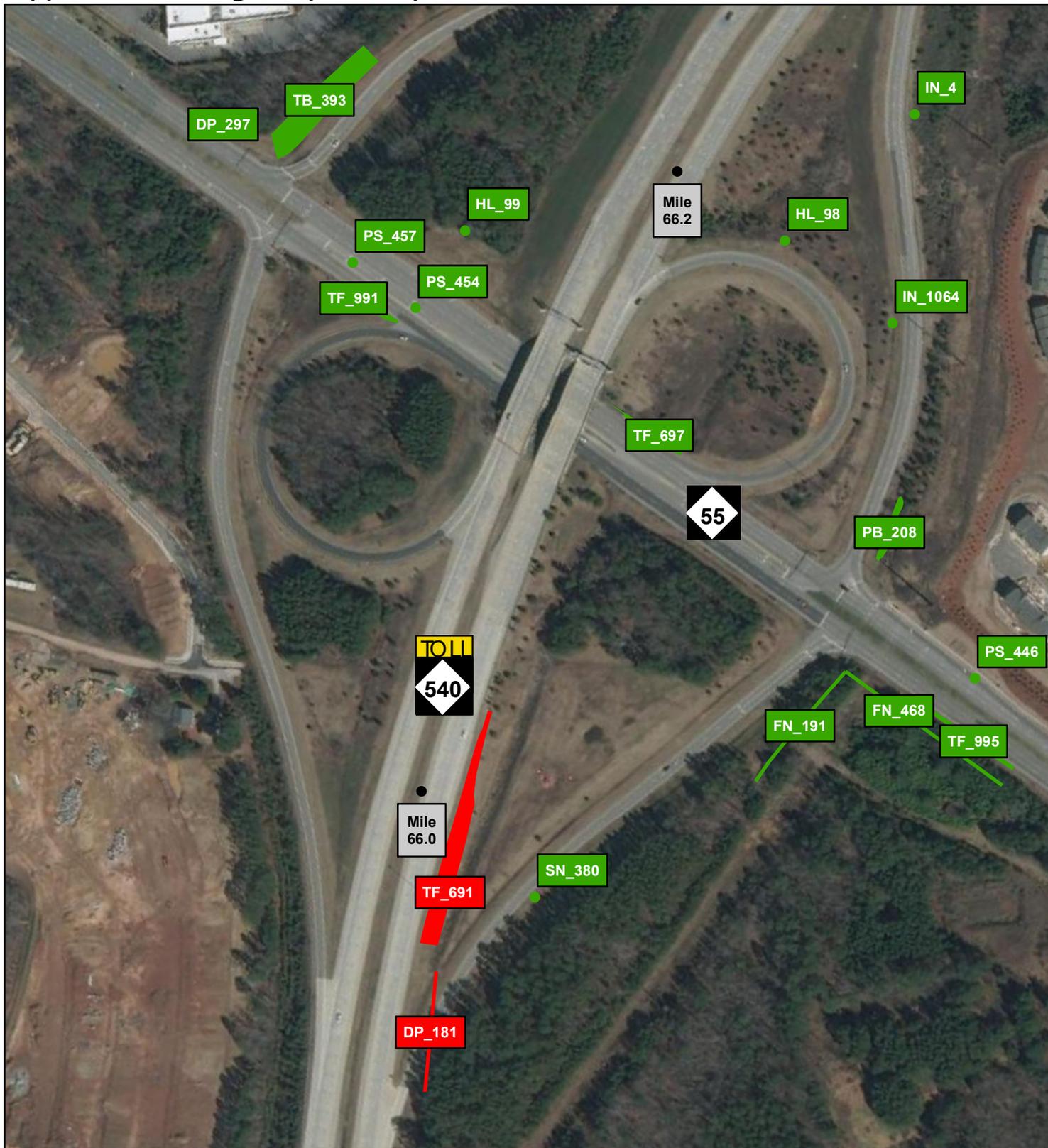
-  Failing Asset
-  Passing Asset



NORTH CAROLINA  
**Turnpike Authority**

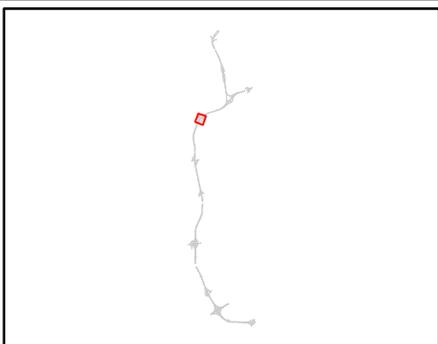
A6

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset



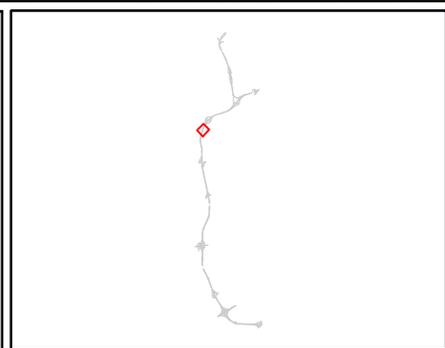

A7

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



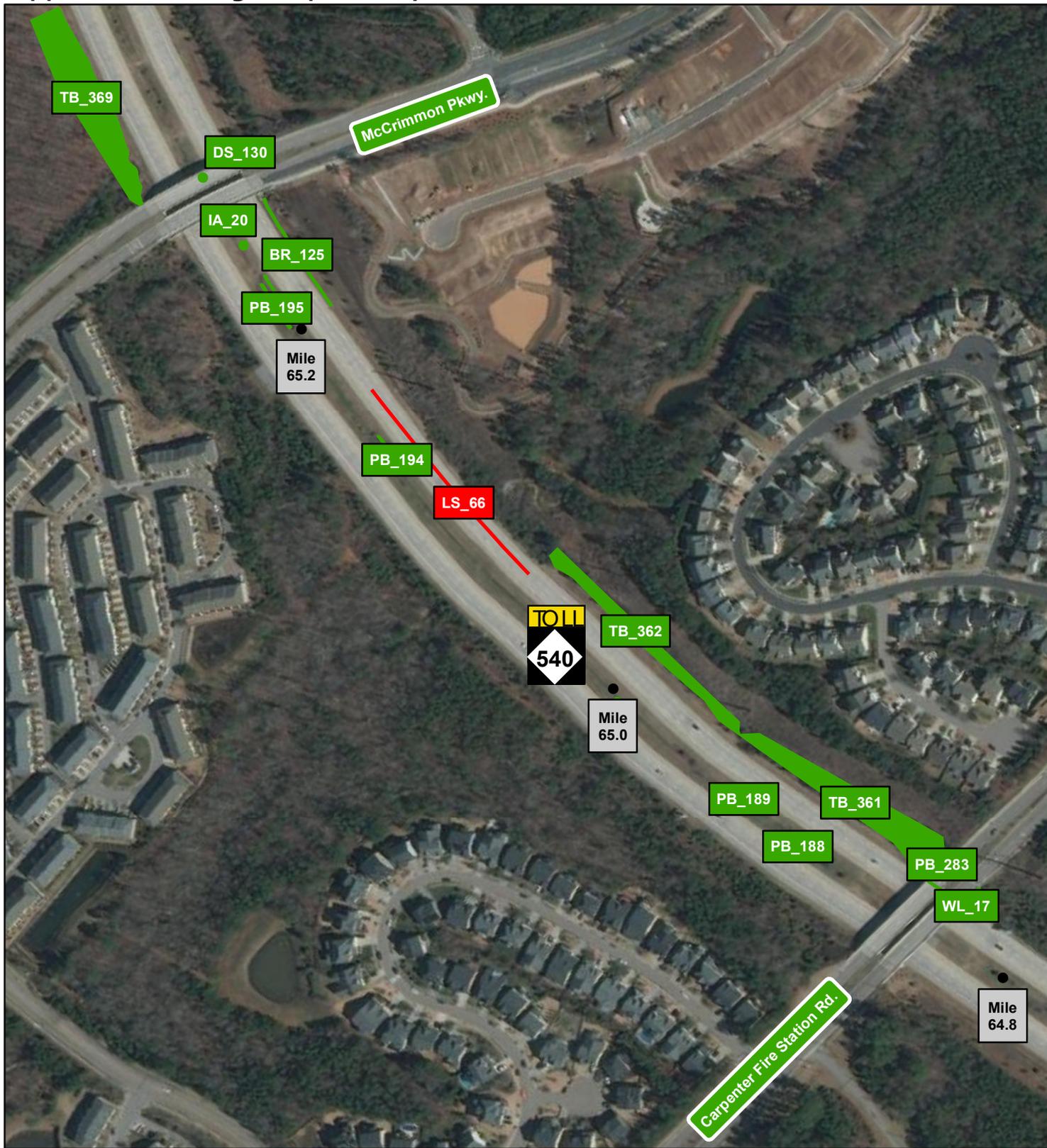
## Legend

- Failing Asset
- Passing Asset



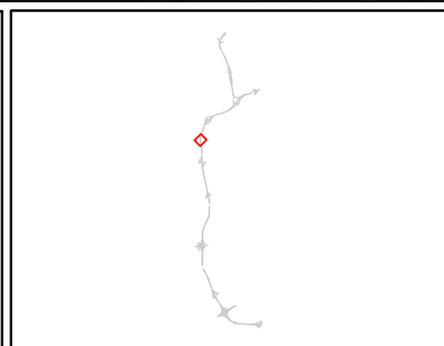
A north arrow pointing towards the top right and the logo for the North Carolina Turnpike Authority, which includes a stylized road graphic and the text "NORTH CAROLINA Turnpike Authority".

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset







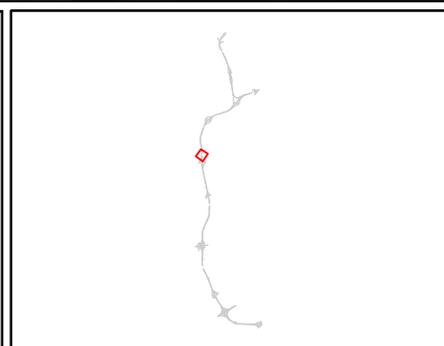
A9

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



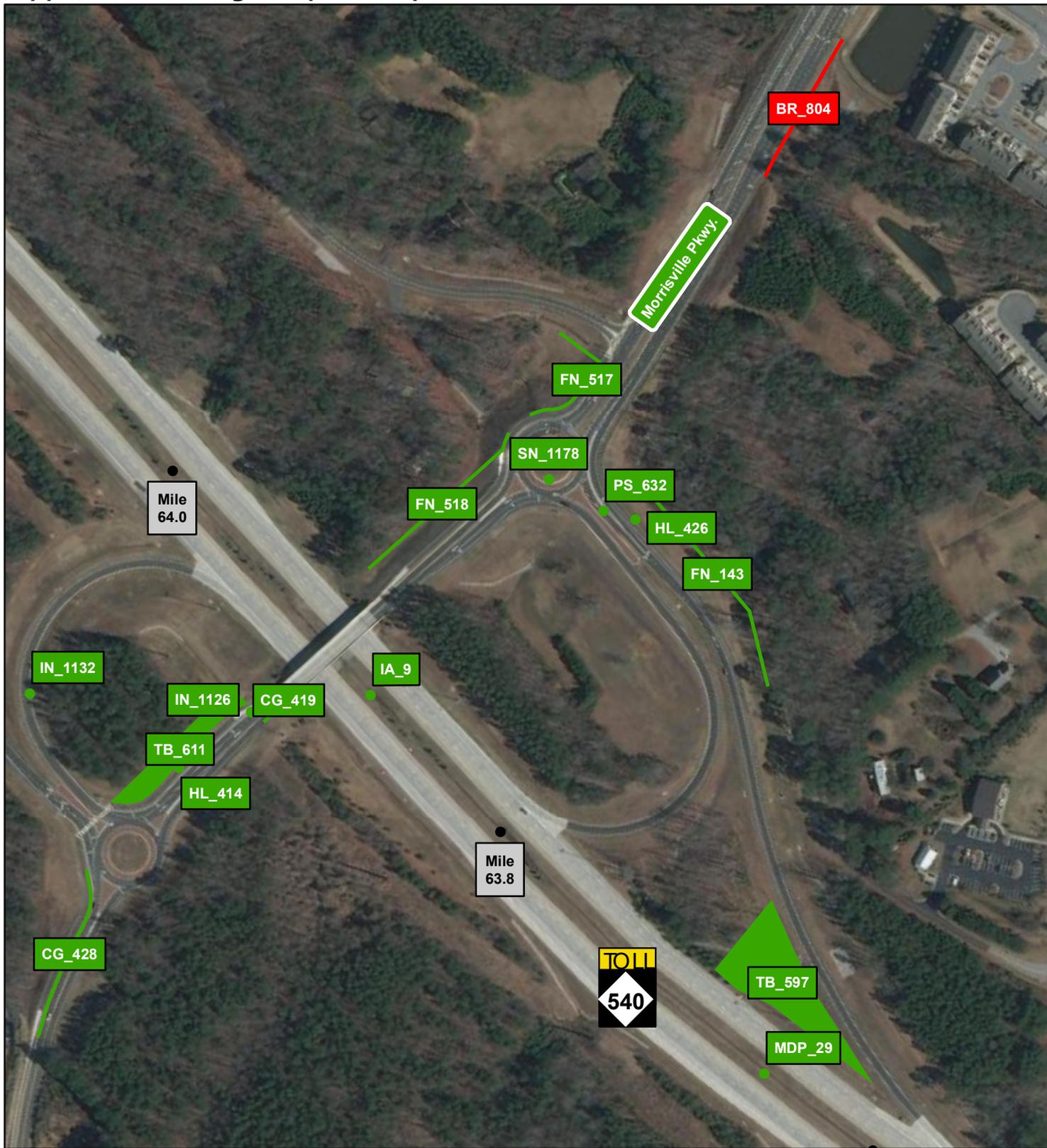
## Legend

-  Failing Asset
-  Passing Asset

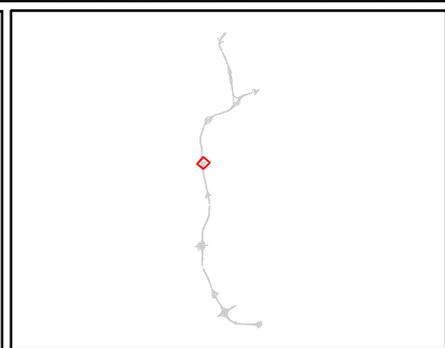

A10

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



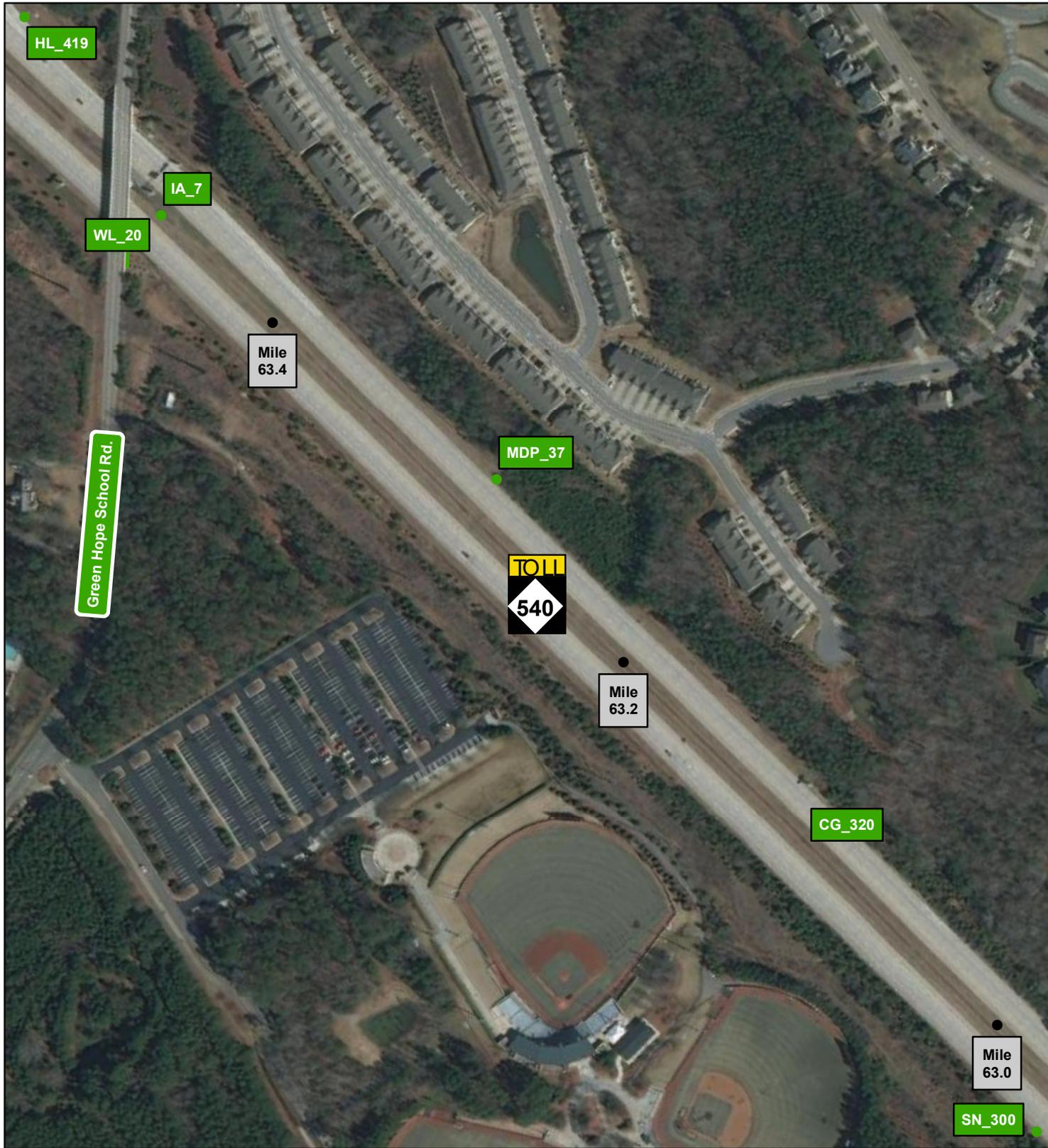
## Legend

- Failing Asset
- Passing Asset



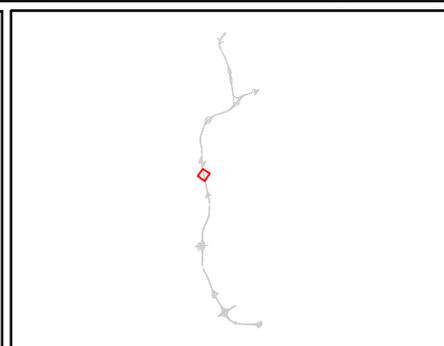
A11

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

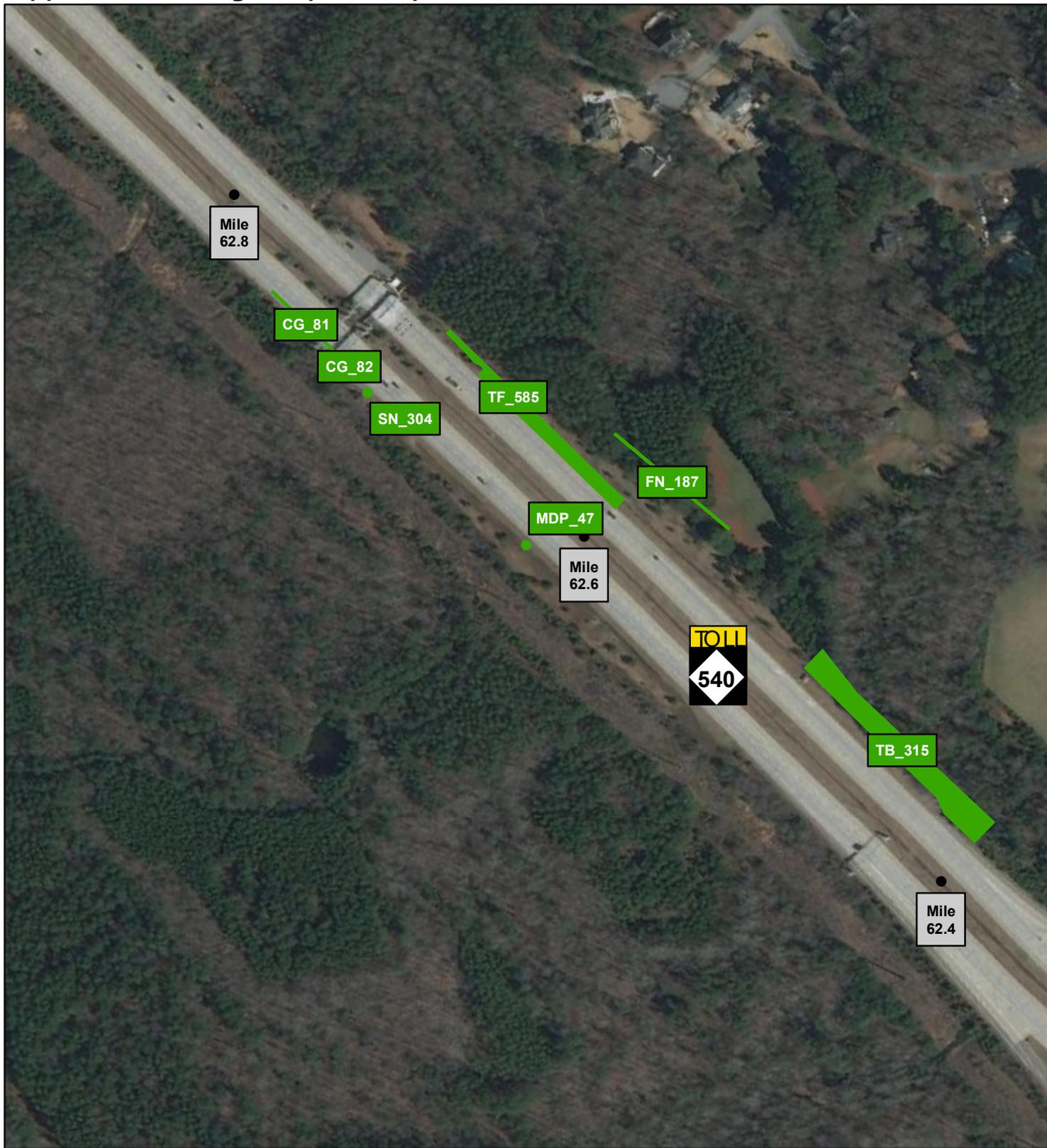
- Failing Asset
- Passing Asset



The logo for the North Carolina Turnpike Authority is displayed, featuring a stylized road graphic and the text 'NORTH CAROLINA Turnpike Authority'. A north arrow is also present above the logo.

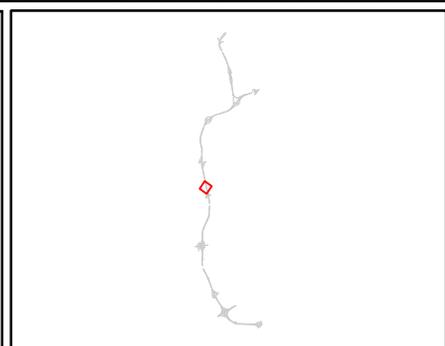
A12

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

-  Failing Asset
-  Passing Asset

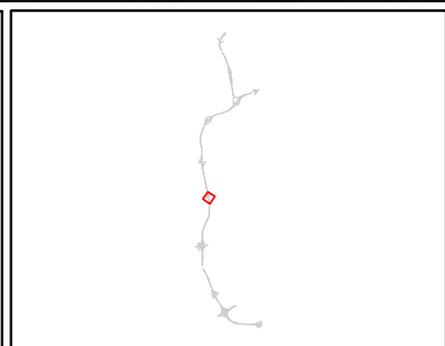

A13

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



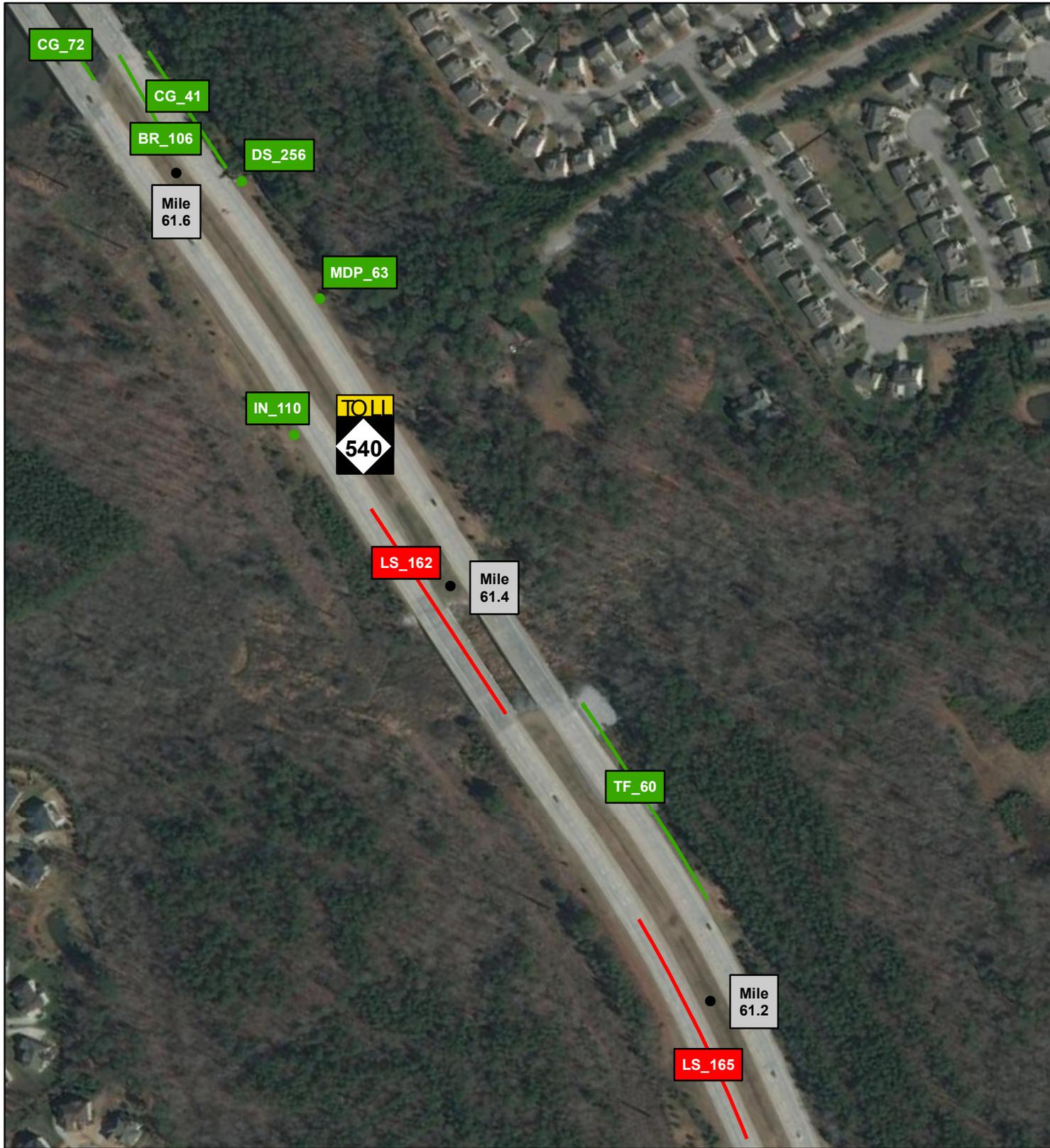
## Legend

- Failing Asset
- Passing Asset



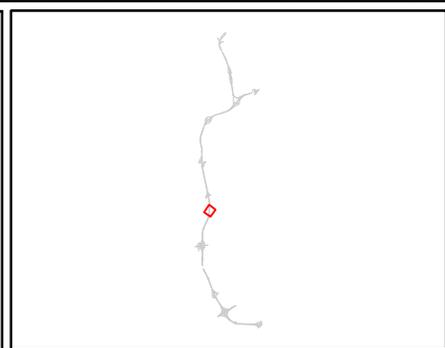
A14

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

-  Failing Asset
-  Passing Asset



The logo for the North Carolina Turnpike Authority, featuring a stylized road and the text "NORTH CAROLINA Turnpike Authority". A north arrow is also present.

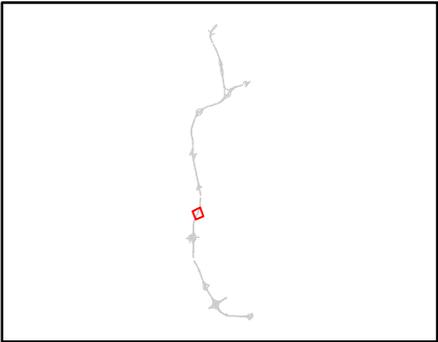
A15

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset

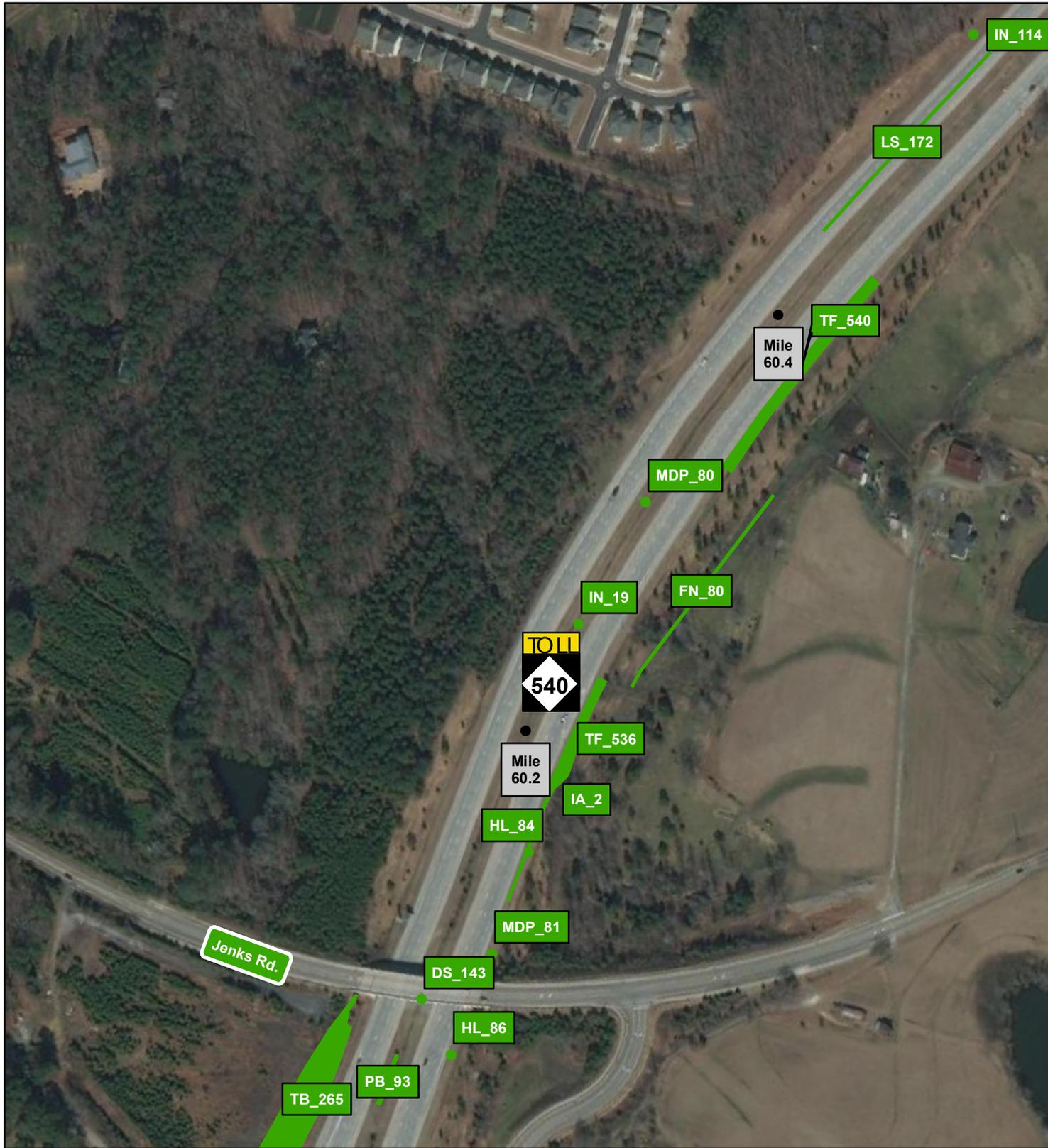






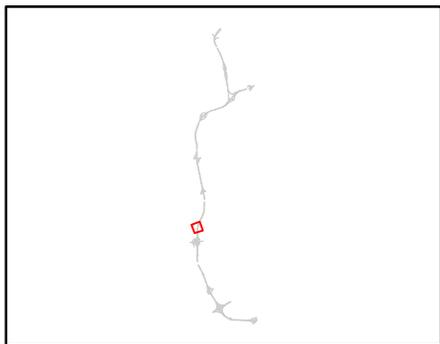
A16

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



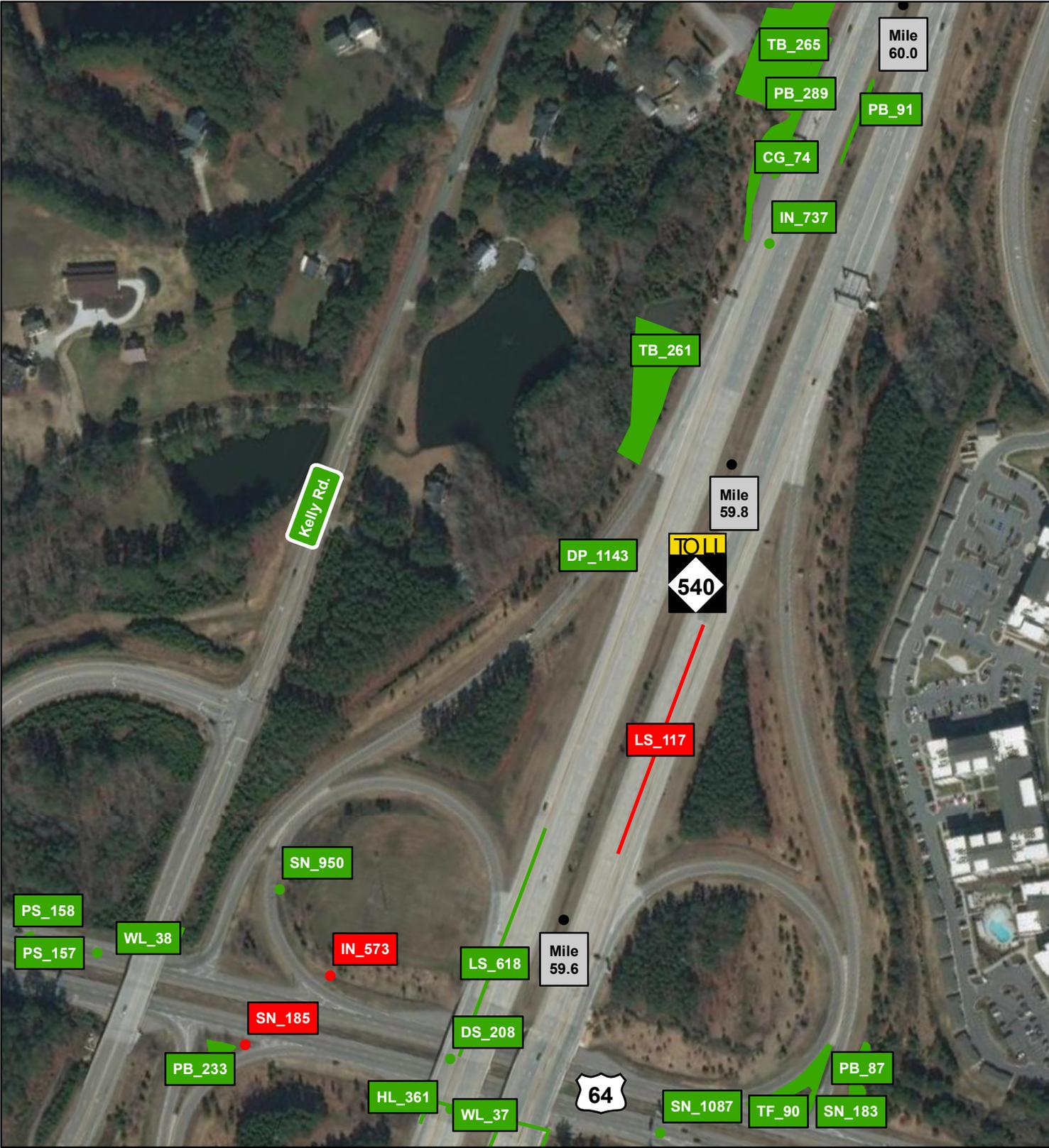
## Legend

-  Failing Asset
-  Passing Asset

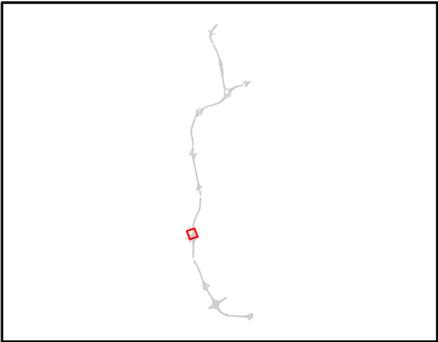

A17

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset



NORTH CAROLINA  
**Turnpike Authority**

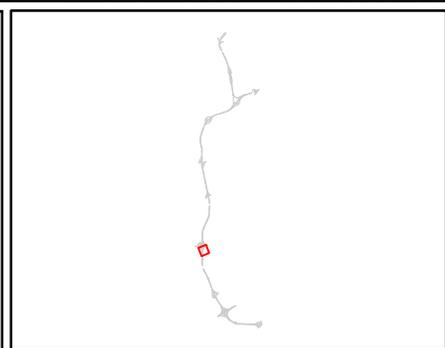
A18

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset



Logo for the North Carolina Turnpike Authority, featuring a stylized road and the text "NORTH CAROLINA Turnpike Authority". A north arrow is also present.

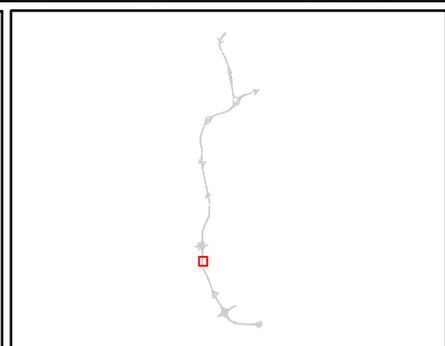
A19

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset

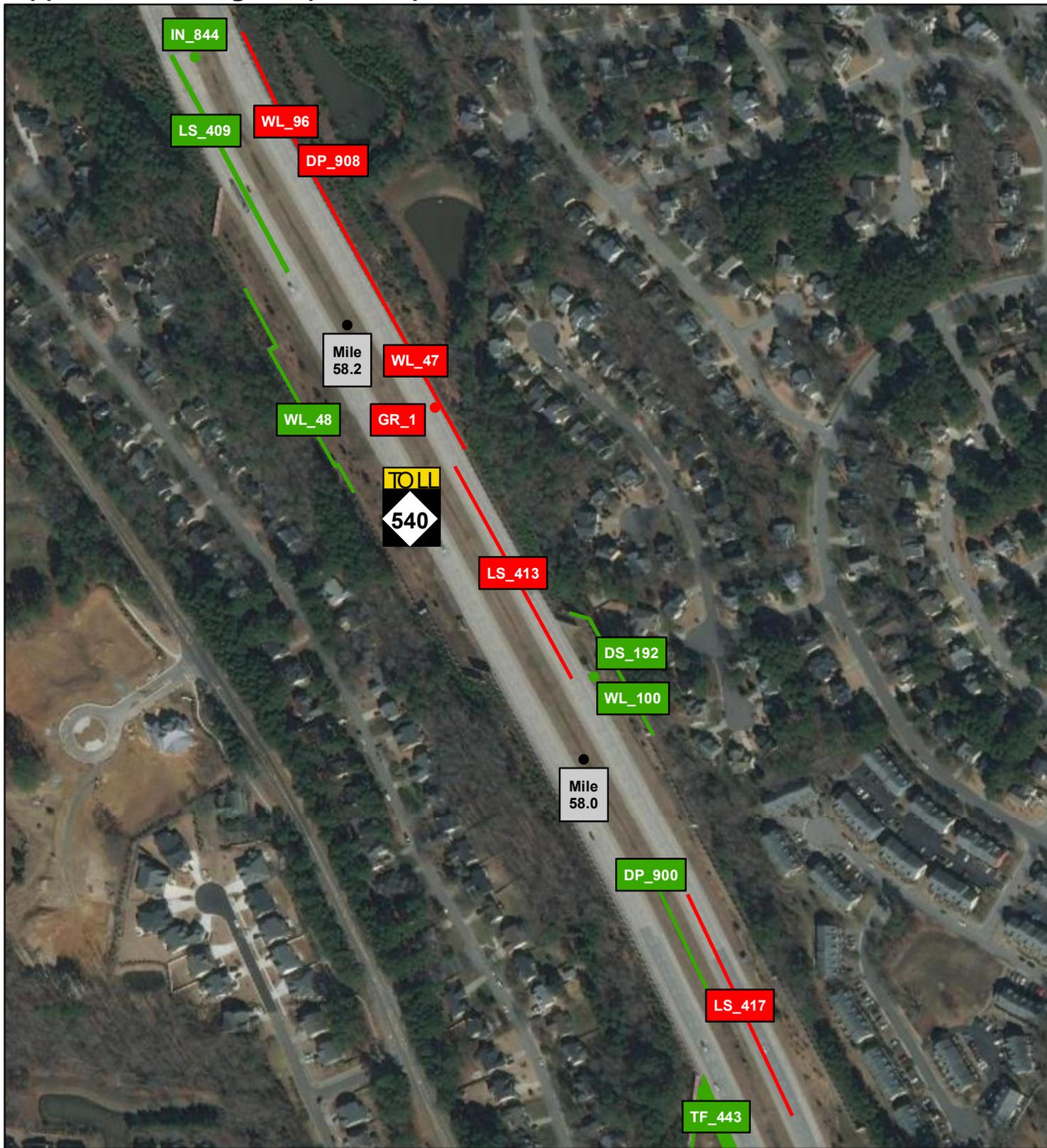






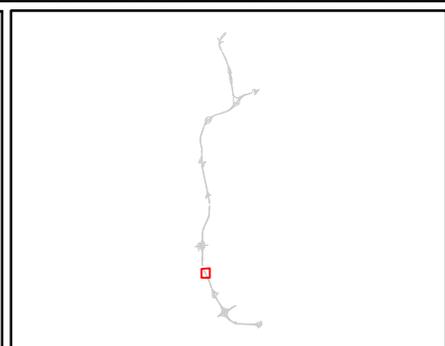
A20

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset

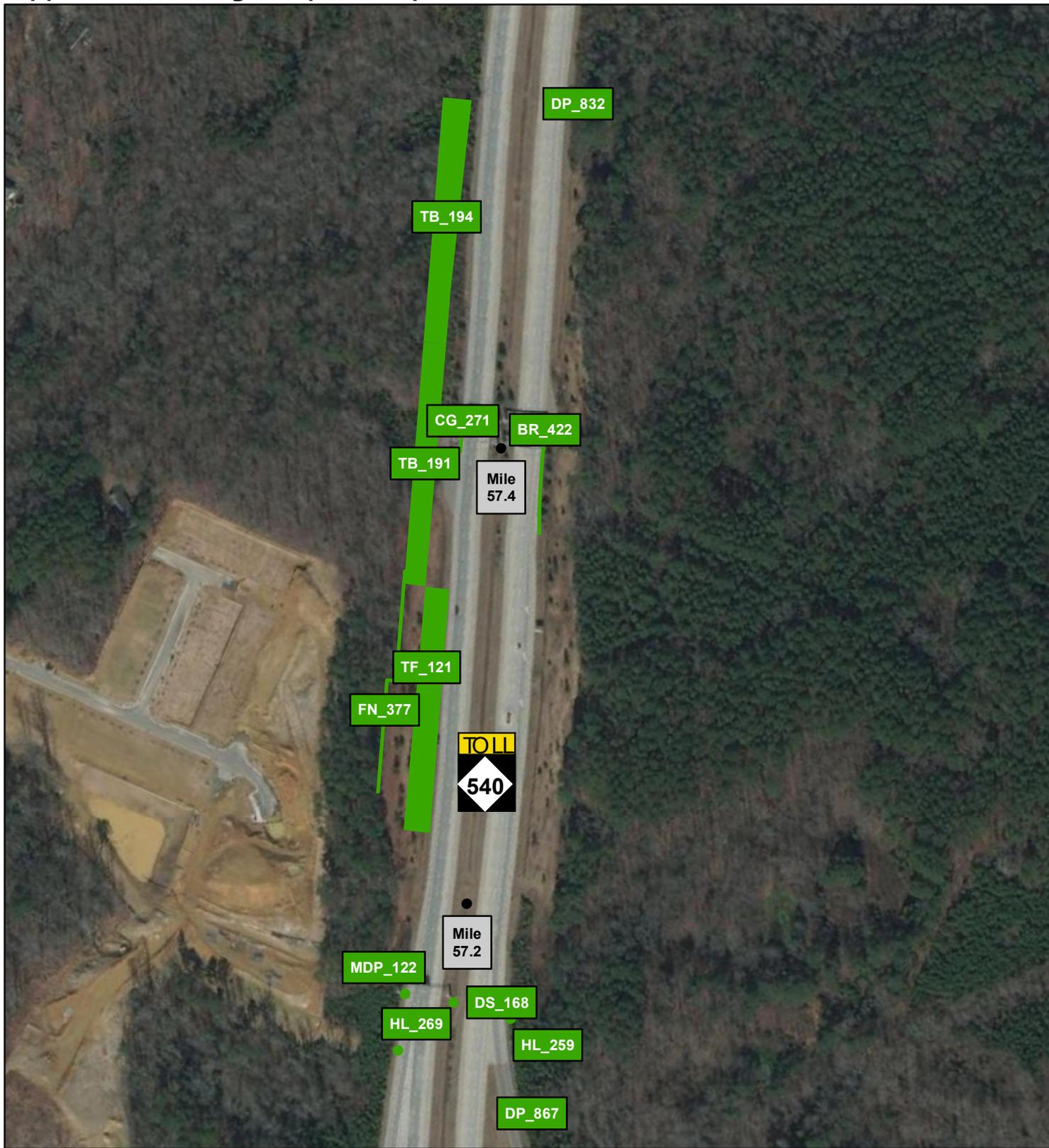






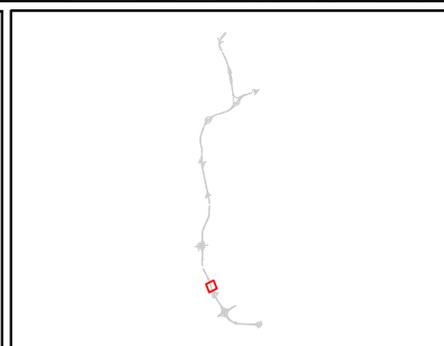
A21

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset

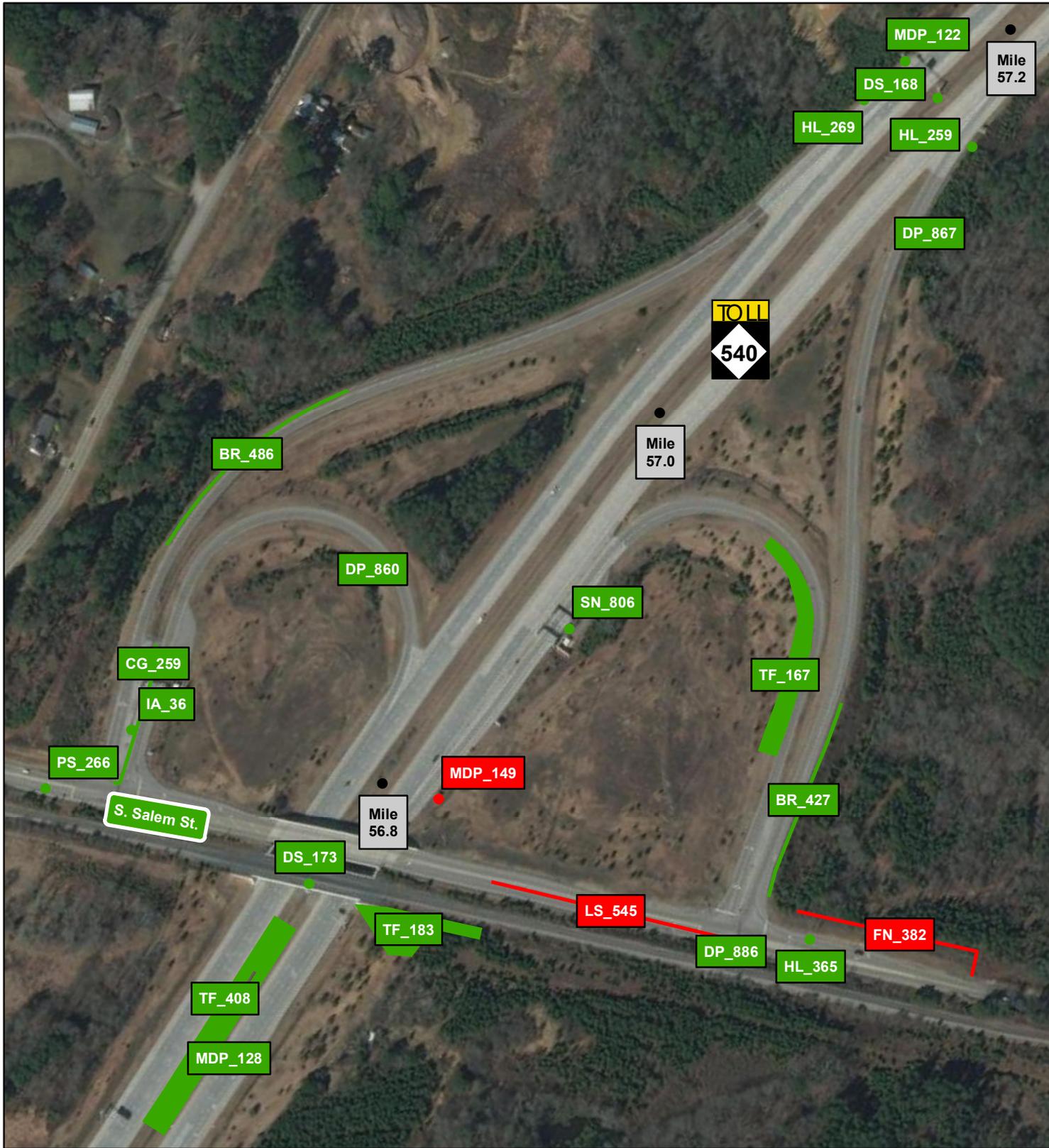






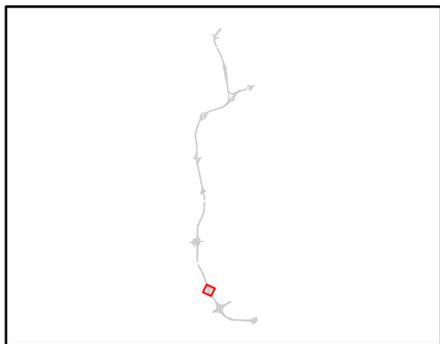
A22

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

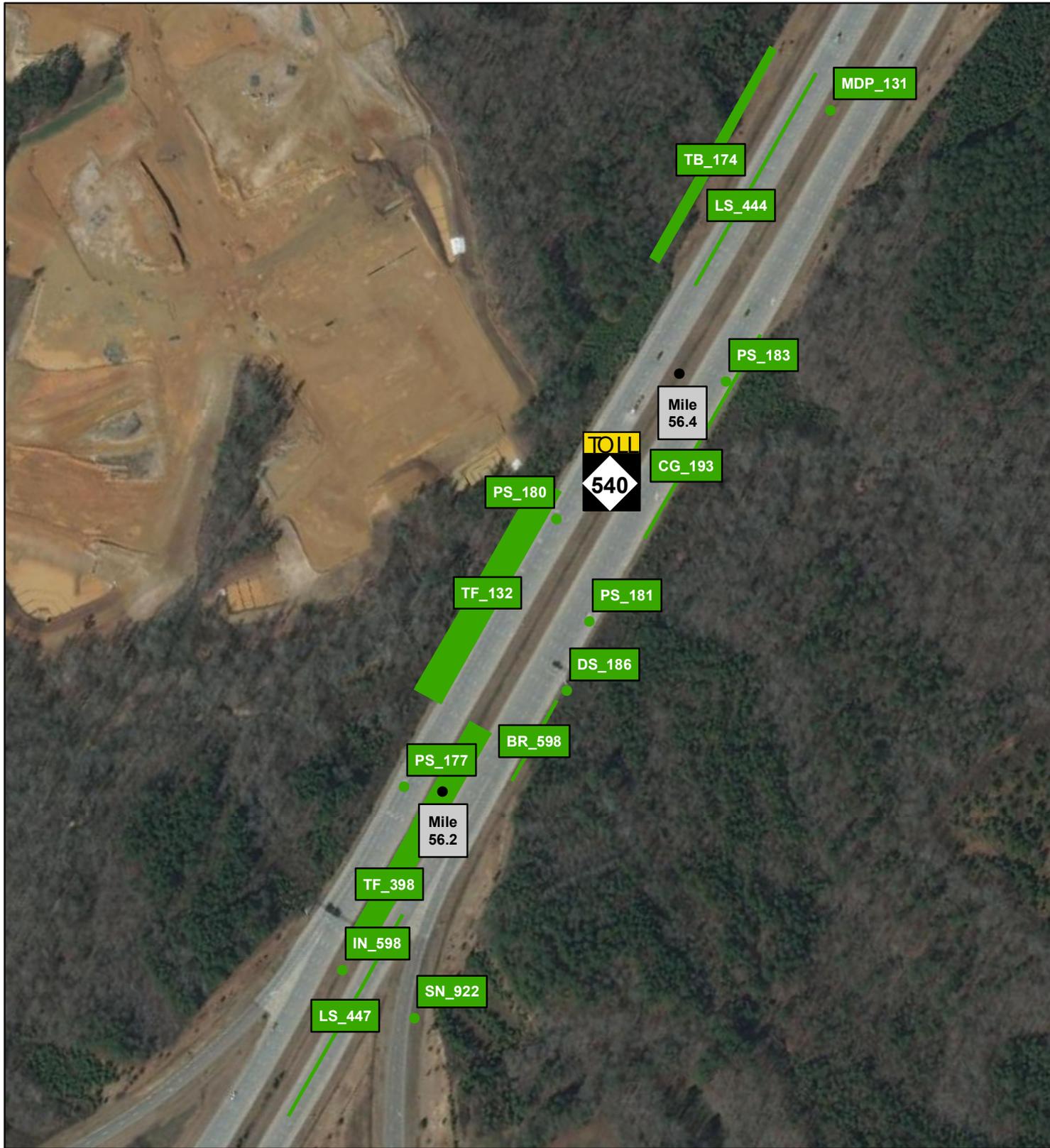
- Failing Asset
- Passing Asset



**NORTH CAROLINA**  
**Turnpike Authority**

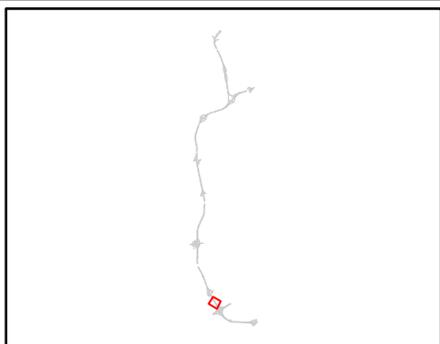
A23

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

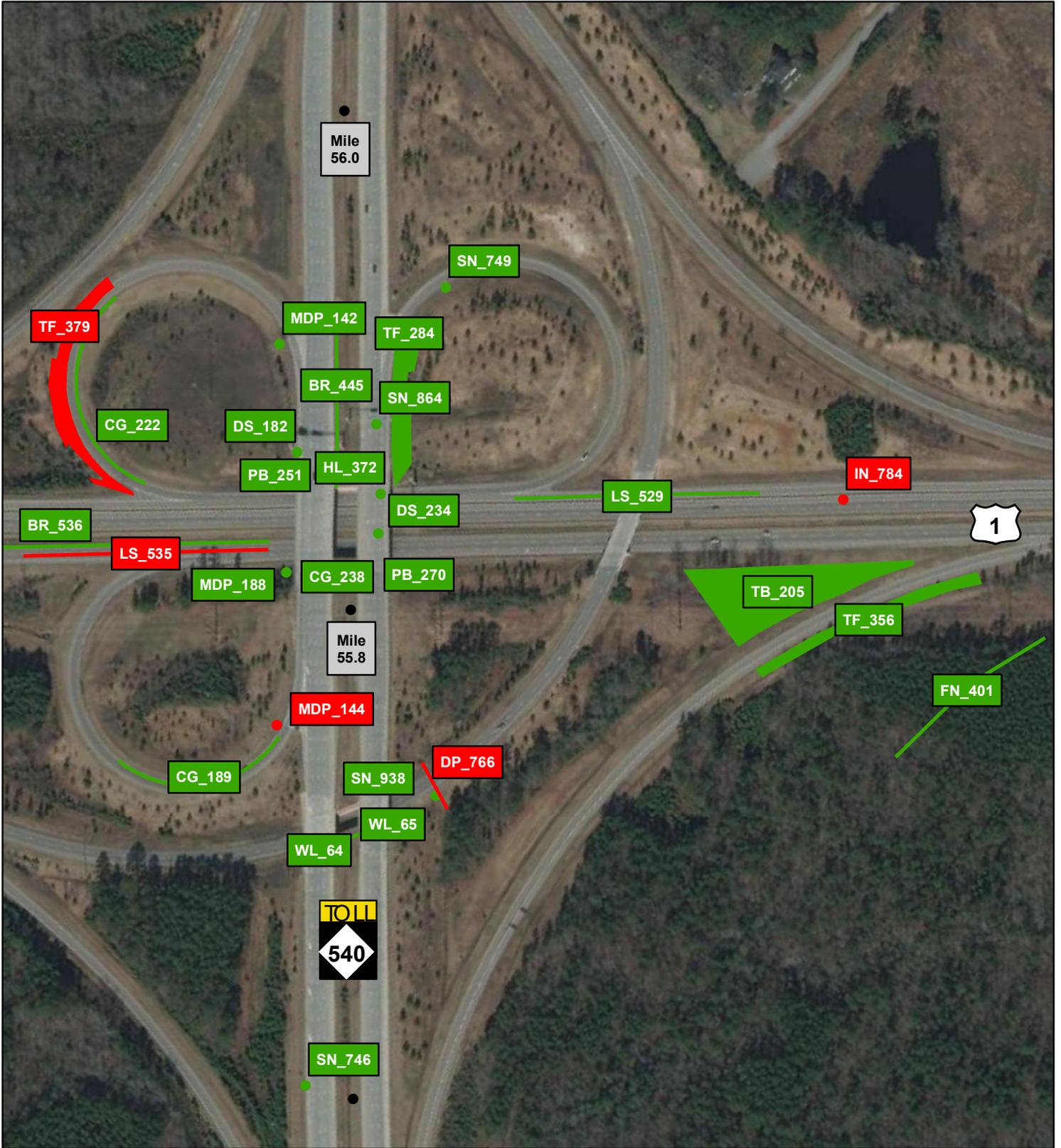
- Failing Asset
- Passing Asset



**NORTH CAROLINA Turnpike Authority**

A24

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset

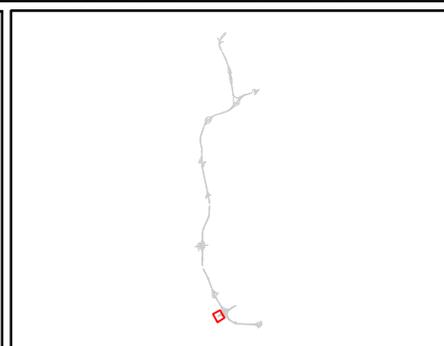


# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

-  Failing Asset
-  Passing Asset


NORTH CAROLINA  
**Turnpike Authority**

A26

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations

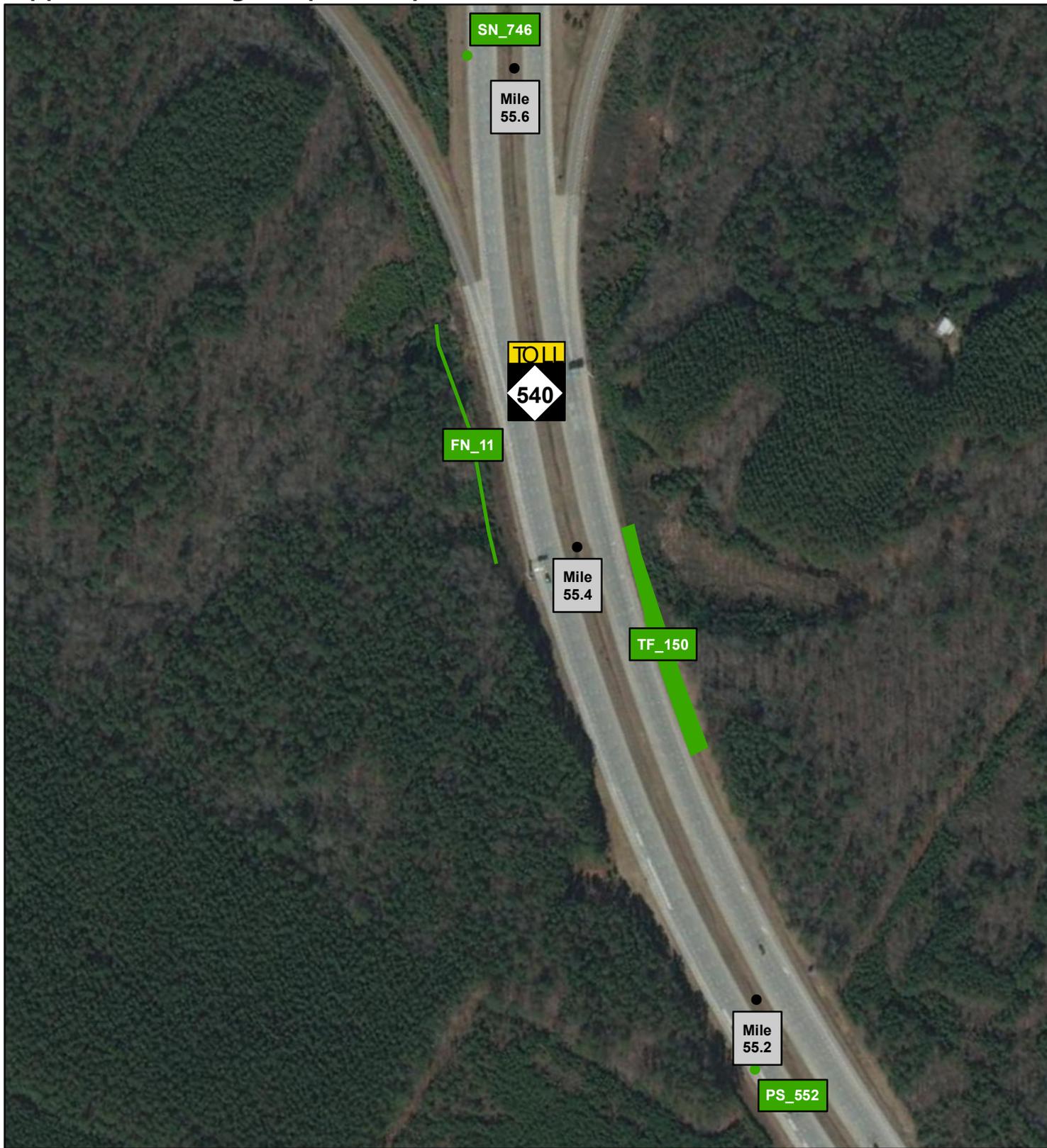


## Legend

-  Failing Asset
-  Passing Asset

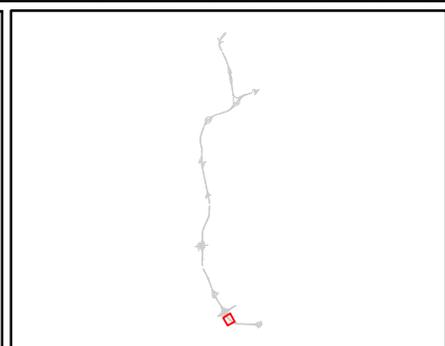


# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

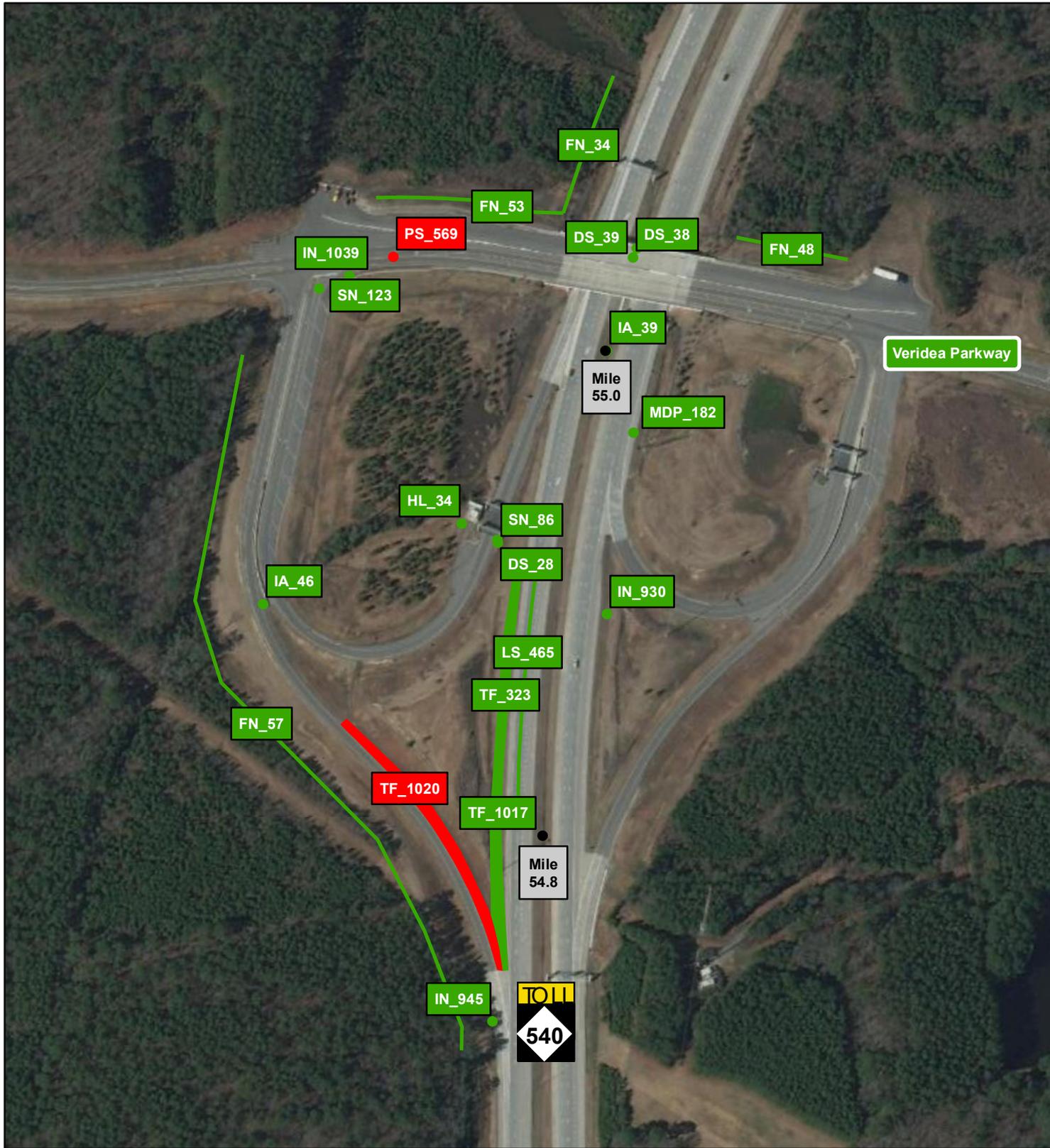
-  Failing Asset
-  Passing Asset



**NORTH CAROLINA**  
**Turnpike Authority**

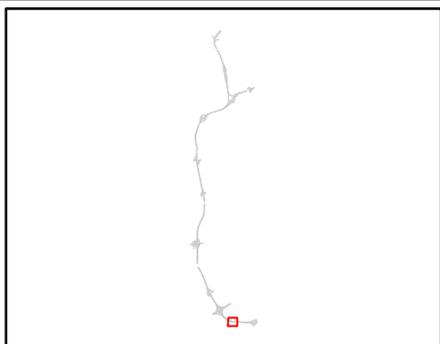
A28

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

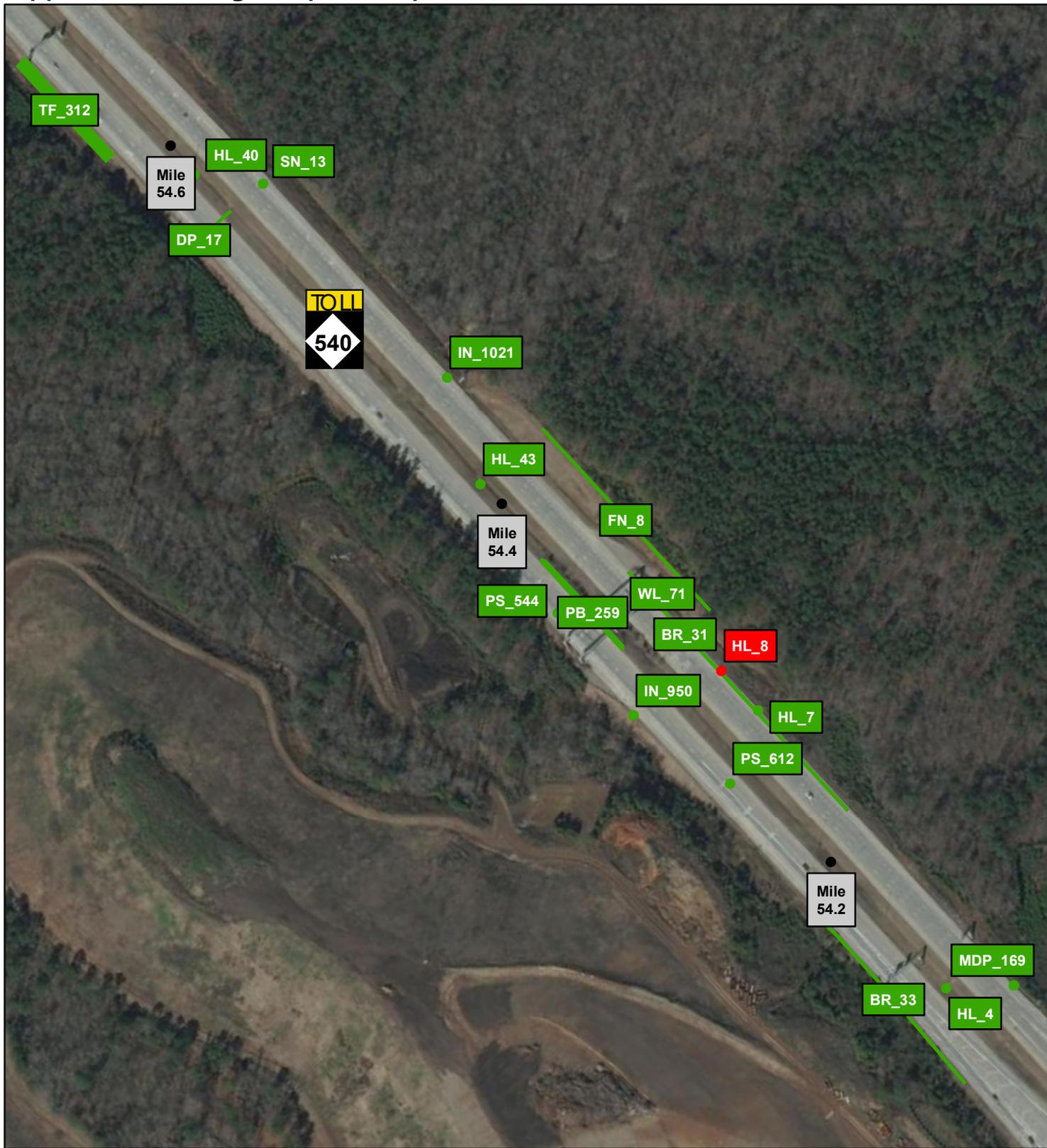
- Failing Asset
- Passing Asset



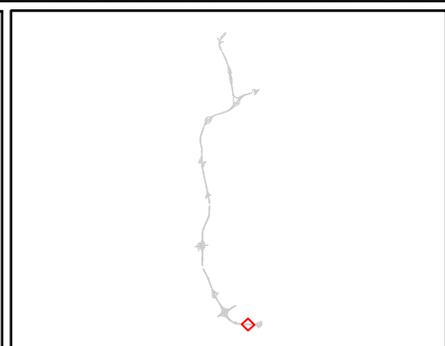

A29

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

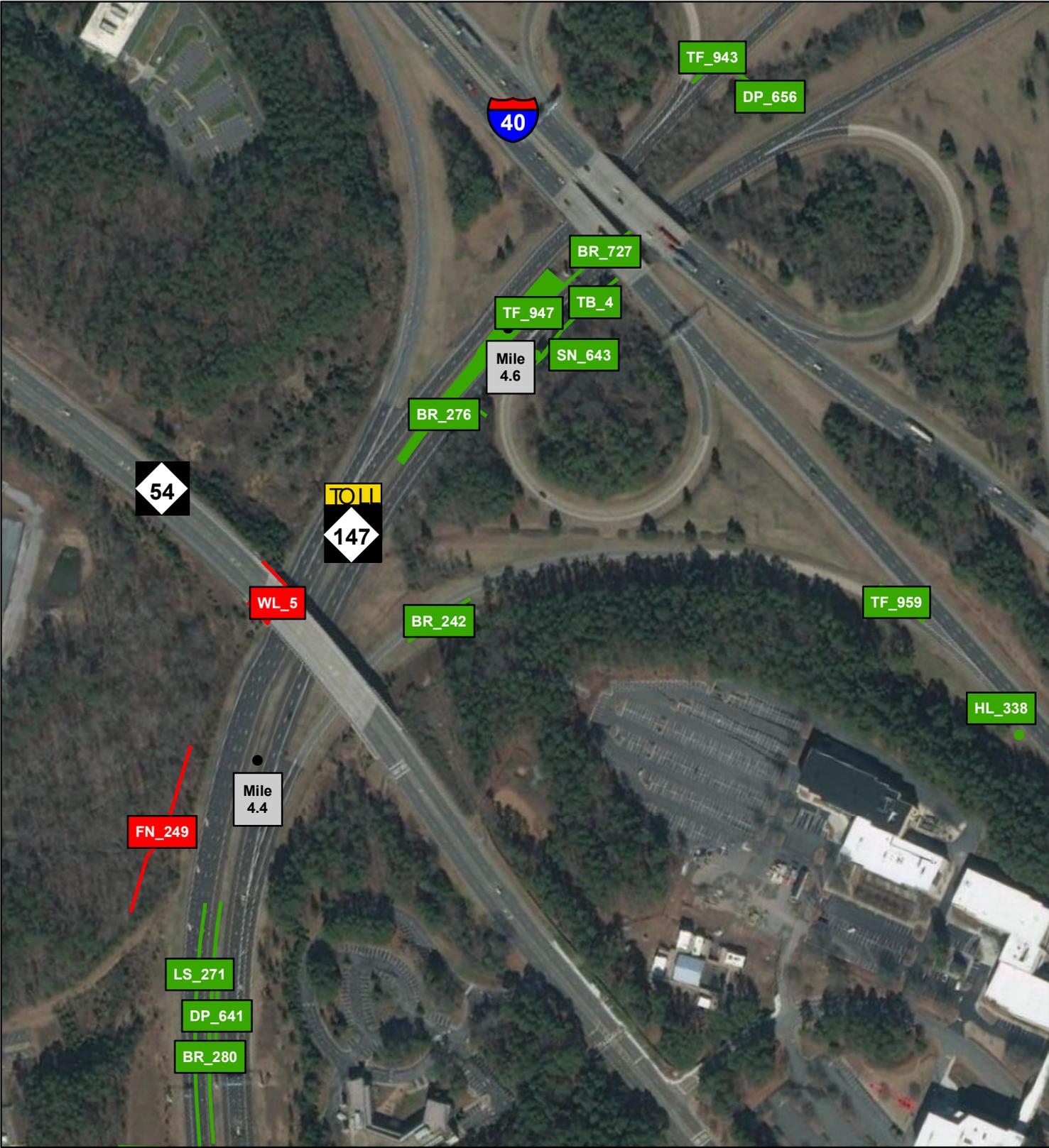
- Failing Asset
- Passing Asset



**NORTH CAROLINA**  
**Turnpike Authority**

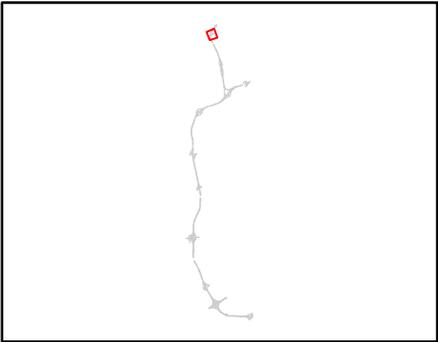
A30

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset







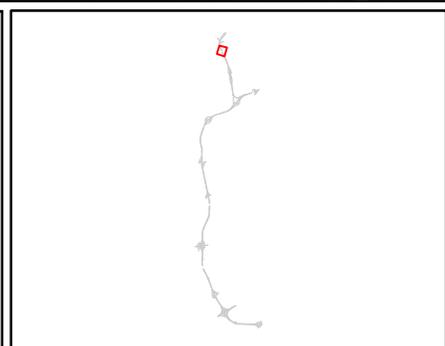
A31

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

-  Failing Asset
-  Passing Asset



NORTH CAROLINA  
**Turnpike Authority**

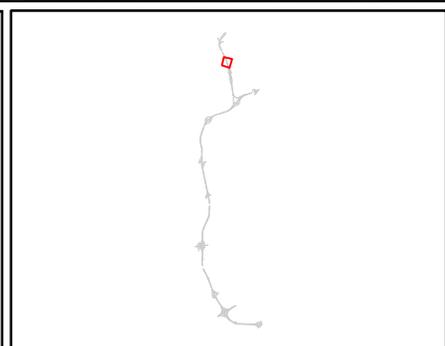
A32

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset

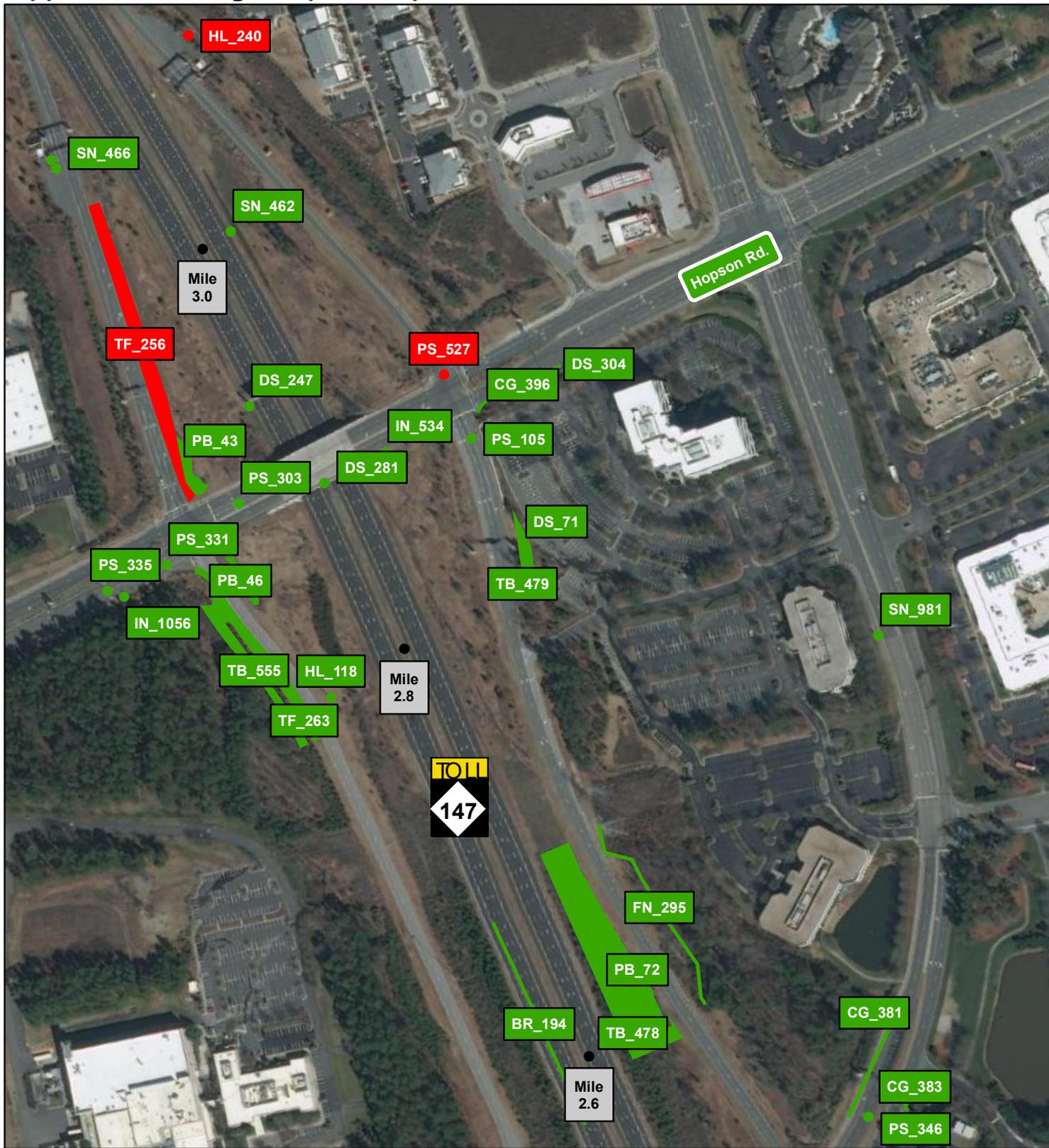






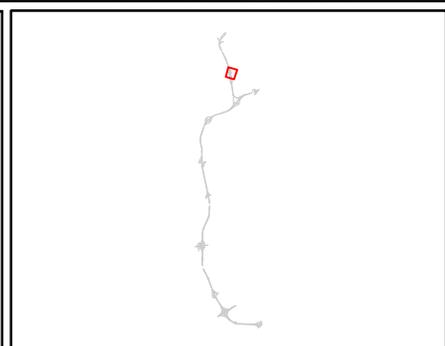
A33

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset



Logo for the North Carolina Turnpike Authority, featuring a stylized road and the text "NORTH CAROLINA Turnpike Authority". A north arrow is also present.

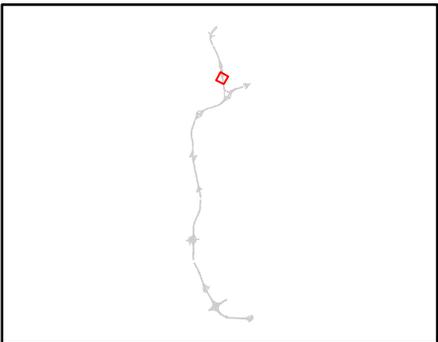
A34

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset







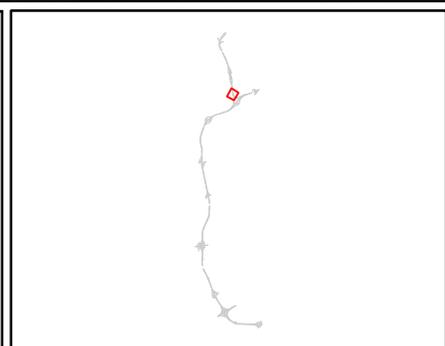
A35

# Appendix A: Triangle Expressway 2021 Fourth Quarter Asset Assessment Locations



## Legend

- Failing Asset
- Passing Asset







A36

## **Appendix B**

**Triangle Expressway 2021 Fourth Quarter Table Results of Assets Failing  
MRP**

## Appendix B: Triangle Expressway 2021 Fourth Quarter Table Results of Assets Failing MRP

Provided below are a series of tables outlining the existing failures that occurred throughout the facility. Assets are defined by an Inventory ID, which is a unique identifier given to each individual asset. The components that make up the Inventory ID are an asset specific prefix along with a number, such as LS\_1. The Inventory ID and GIS Reference Page number correspond to the provided map packets and allow for quick location of particular asset failures. Photos of failures were provided when applicable.

All assets and their respective prefixes are listed below:

Guardrail, Concrete Barrier and End Anchors (BR).....	1
Curb and Gutter (CG).....	2
Decorative Supports (DS).....	3
Drainage Pipes (DP).....	4
Misc. Drainage Structure (MDP).....	5
Fence and Control of Access (FN).....	6
Graffiti (GR).....	8
Highway Lighting (HL).....	9
Impact Attenuators (IA).....	11
Inlets (IN).....	12
Landscaping (PB).....	13
Paved Lanes – Asphalt (LS).....	14
Paved Lanes – Concrete (LS).....	14
Paved Shoulders (LS).....	14
Unpaved Shoulders (LS).....	15
Front/Back Slopes (LS).....	15
Unpaved Lateral and Outfall Ditches (LS).....	15
Litter (LS).....	16
Roadway Sweeping (LS).....	17
Pavement Striping (LS).....	18
Pavement Markers (LS).....	21
Delineators (LS).....	22
Delineators (LS).....	23
Paved Ditches (PD).....	24
Pavement Words and Symbols (PS).....	25
Signs (SN).....	26
Tree and Brush (TB).....	27
Turf Condition (TF).....	28
MSE/Retaining Walls, Sound Barrier Walls, and Screen Walls (WL).....	30

## Guardrail, Concrete Barrier and End Anchors (BR)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Guardrail	BR_498	Missing Parts		A26
2	Guardrail	BR_804	Functional Damage		A11

## Curb and Gutter (CG)

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#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

## Decorative Supports (DS)

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#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

## Drainage Pipes (DP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Drain	DP_181	Obstruction		A7
2	Drain	DP_766	Erosion		A25
3	Drain	DP_908	Obstruction		A21

## Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Shoulder Drain	MDP_67	Obstruction		A16
2	Shoulder Drain	MDP_70	Obstruction & Rodent Screen		A16
3	Shoulder Drain	MDP_144	Obstruction & Rodent Screen		A25
4	Shoulder Drain	MDP_149	Rodent Screen		A23

## Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Woven	FN_232	Fence Hole		A6
2	Chain Link	FN_249	Hole Height		A31
3	Woven	FN_305	Fence Hole		A5
4	Woven	FN_382	Fence Hole		A23

## Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Woven	FN_408	Hole Height		A19

## Graffiti (GR)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete Barrier	GR_1	Graffiti	 A photograph showing a long, low concrete barrier running alongside a red brick wall. The barrier has some white graffiti on its surface. The ground is paved, and there are some orange traffic cones visible in the distance.	A21

## Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Single Roadway	HL_8	Missing Parts		A30
2	Single Roadway	HL_52	Missing Parts		A8
3	Single Roadway	HL_78	Part Damage		A14
4	Single Roadway	HL_125	Missing Parts		A125

## Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Single Roadway	HL_240	Missing Parts		A34

## Impact Attenuators (IA)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Impact Attenuator	IA_28	Twisted Blocks		A19

## Inlets (IN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Inlet	IN_573	Obstruction		A18
2	Inlet	IN_712	Obstruction		A20
3	Inlet	IN_763	Obstruction		A26
4	Inlet	IN_784	Obstruction		A25

## Landscaping (PB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

### Paved Lanes – Asphalt (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

### Paved Lanes – Concrete (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_590	Joint Malfunction		A5

### Paved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

## Unpaved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_545	Drop Off		A23

## Front/Back Slopes (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

## Unpaved Lateral and Outfall Ditches (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

## Litter (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_162	Litter – 3CF		A15
2	Asphalt	LS_225	Litter – 3CF		A3
3	Concrete	LS_591	Litter – 3CF		A5

## Roadway Sweeping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_534	Material Accumulation	 A photograph showing a road with a concrete barrier on the right side. There is a visible accumulation of material on the shoulder of the road. The sky is clear and blue, and there are trees in the background.	A26

## Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_42	Line Missing, Nighttime Visibility		A14
2	Concrete	LS_63	Line Missing, Nighttime Visibility		A8
3	Concrete	LS_66	Line Missing, Nighttime Visibility		A9
4	Concrete	LS_117	Line Missing		A18

## Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Concrete	LS_138	Line Missing, Nighttime Visibility		A10
6	Concrete	LS_165	Line Missing, Nighttime Visibility		A15
7	Concrete	LS_403	Line Missing, Nighttime Visibility		A20
8	Concrete	LS_413	Line Missing, Nighttime Visibility		A21

## Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Concrete	LS_417	Line Missing, Nighttime Visibility		A21
10	Concrete	LS_605	Line Missing, Nighttime Visibility		A10
11	Concrete	LS_613	Line Missing, Nighttime Visibility		A19
12	Concrete	LS_639	Line Missing		A19

## Pavement Markers (LS)

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#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

## Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_250	Missing, Nighttime Reflectivity		A33
2	Asphalt	LS_343	Nighttime Reflectivity	Not Available for Nighttime Failure	A5
3	Concrete	LS_386	Missing, Nighttime Reflectivity		A27
4	Asphalt	LS_534	Missing, Nighttime Reflectivity		A26
5	Asphalt	LS_535	Missing, Nighttime Reflectivity		A25

## Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
6	Asphalt	LS_545	Nighttime Reflectivity		A23
7	Asphalt	LS_605	Missing, Nighttime Reflectivity		A10
8	Concrete	LS_613	Nighttime Reflectivity	Not Available for Nighttime Failure	A19
9	Concrete	LS_639	Nighttime Reflectivity	Not Available for Nighttime Failure	A19

## Paved Ditches (PD)

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#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
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This asset did not produce any failures.

## Pavement Words and Symbols (PS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Left Turn	PS_409	Daytime Assessment & Nighttime Reflectivity		A1
2	Only	PS_420	Daytime Assessment & Nighttime Reflectivity		A1
3	Left Turn	PS_421	Daytime Assessment & Nighttime Reflectivity		A1
4	Ped Xing	PS_527	Daytime Assessment & Nighttime Reflectivity		A34
5	Left Turn	PS_569	Nighttime Reflectivity	Not Available for Nighttime Failure	A29

## Signs (SN)

#	Sign Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Merge	SN_185	Height Requirement, Sign Support		A18

# Tree and Brush (TB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Tree and Brush	TB_564	Barrier Clearance		A8

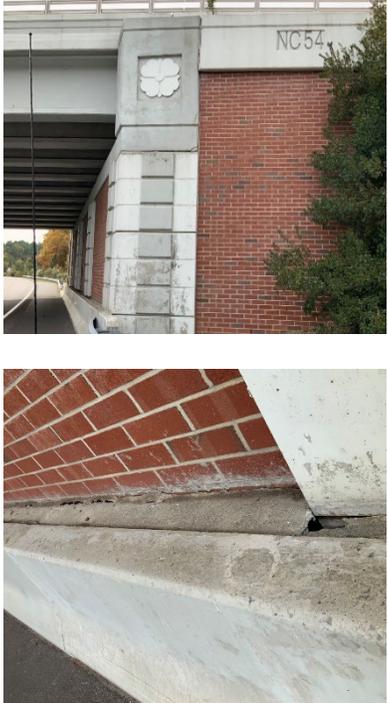
## Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Turf	TF_23	Bare Ground		A8
2	Turf	TF_256	Bare Ground		A34
3	Turf	TF_379	Bare Ground		A25
4	Turf	TF_691	Bare Ground		A7

### Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_841	Bare Ground		A36
6	Turf	TF_852	Bare Ground		A35
7	Turf	TF_1020	Bare Ground		A29

## MSE/Retaining Walls, Sound Barrier Walls, and Screen Walls (WL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Bridge Wall	WL_5	Unsealed Cracks/Joints		A31
2	Sound Wall	WL_47	Unsealed Cracks/Joints		A21
3	Sound Wall	WL_96	Unsealed Cracks/Joints		A21