



NORTH CAROLINA
Turnpike Authority

Maintenance Rating Program

Triangle Expressway

2016 Third Quarter Report

July - September

1 S. Wilmington Street
Raleigh, NC 27601



Last Updated:
November 17, 2016

CONSULTANT CERTIFICATION OF COMPLETION

November 14, 2016

NCTA Director of Toll Road Operations
1 South Wilmington Street
Raleigh, NC 27601

NCTA Triangle Expressway Roadway Maintenance Performance Rating Program; Q3, 2016 Rating

This is to certify that I, Ken M. McEntire, PE am an authorized official representative of the company Asset Management Associates, PLLC, which is a sub-consultant to HNTB North Carolina, P.C. Collaboratively; we are working 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,

A handwritten signature in blue ink that reads "Ken M. McEntire". The signature is written in a cursive style with a horizontal line through the middle of the name.

Ken M. McEntire, PE

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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 2016 Third Quarter Assessment of the Triangle Expressway.

The overall 2016 third quarter maintenance rating of the Triangle Expressway is 93.4, which is above the NCTA target rating of 90. As shown in **Table 1**, all elements assessed achieved a rating greater than the target rating of 85.

Table 1: MRP Element Results for the 2016 Third Quarter Assessment		
Element	MRP Rating	Target Rating
Road Surface	99.1	85.0
Unpaved Shoulders and Ditches	100.0	85.0
Drainage	87.9	85.0
Roadside	90.0	85.0
Traffic Control Devices	90.5	85.0
Overall MRP Performance Rating	93.4	90.0

As part of the NCTA MRP, this report provides a rolling rating of the latest four quarterly inspections of the Triangle Expressway. As presented in **Table 2**, the current rolling maintenance rating of the Triangle Expressway is 93.9.

Table 2: MRP Rolling Element Results					
Element	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Rolling Rating
Road Surface	98	98	100	99	99
Unpaved Shoulders and Ditches	98	98	100	100	99
Drainage	84	93	91	88	89
Roadside	91	92	83	90	89
Traffic Control Devices	92	93	96	90	93
Overall MRP Performance Rating	92.8	94.9	94.7	93.4	93.9

In addition, the report provides findings of the Green Level Historic District signs inspection. Due to construction work this quarter, only three of the four sign locations were inspected. These three sign locations were only inspected for landscape appearance because of missing signs due to vandalism. All landscaped areas at the sign locations were found to be well maintained.

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 through the use of 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.

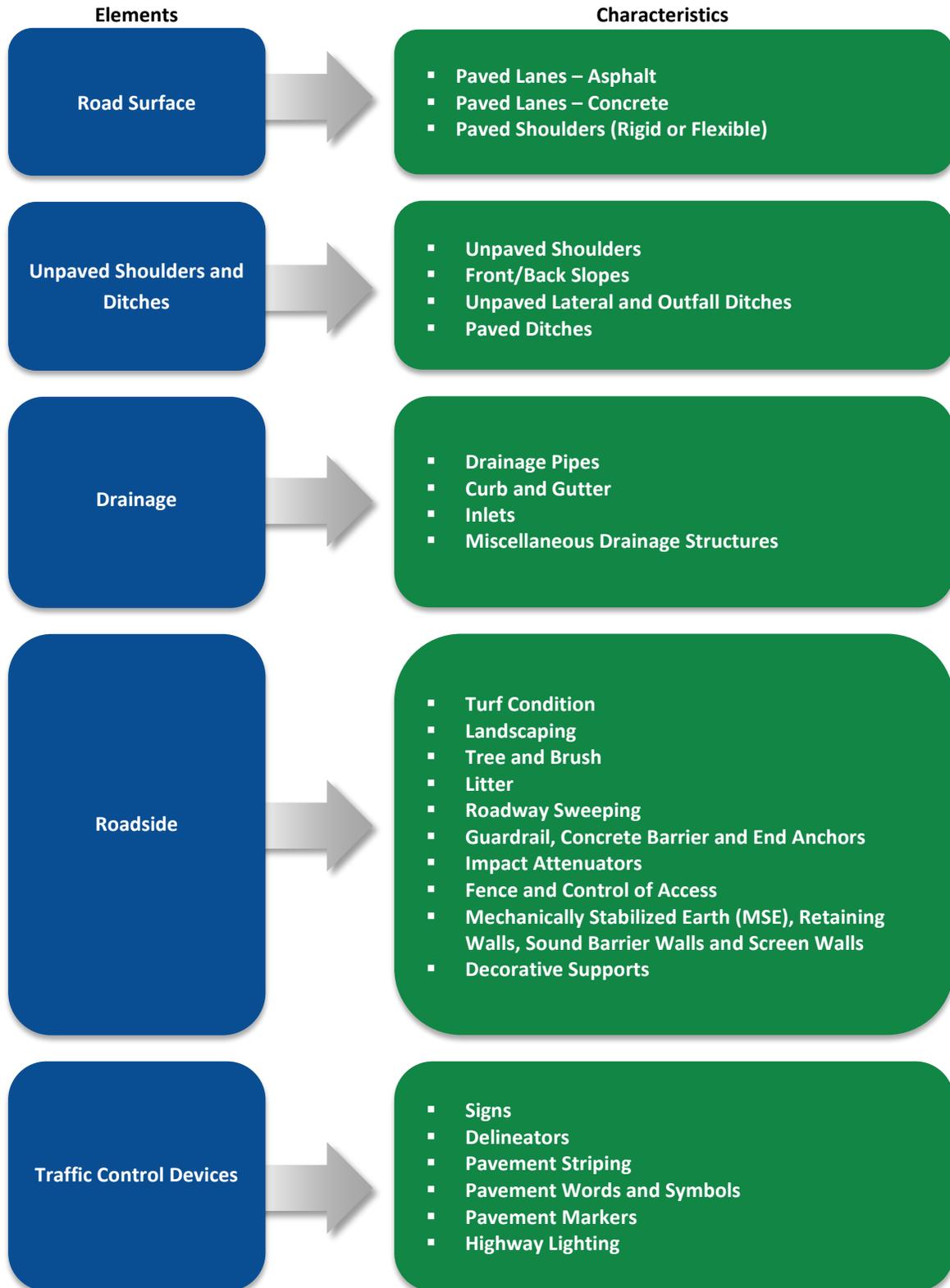
The NCTA performance standards, threshold criteria, and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff and consultants.

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 V4*, roadway assets or characteristics on NCTA facilities have been grouped into elements. These elements and corresponding characteristics can be seen in **Figure 1**:

Figure 1: Maintenance Elements and Characteristics



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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 through the use of 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 V4*. 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, a 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:

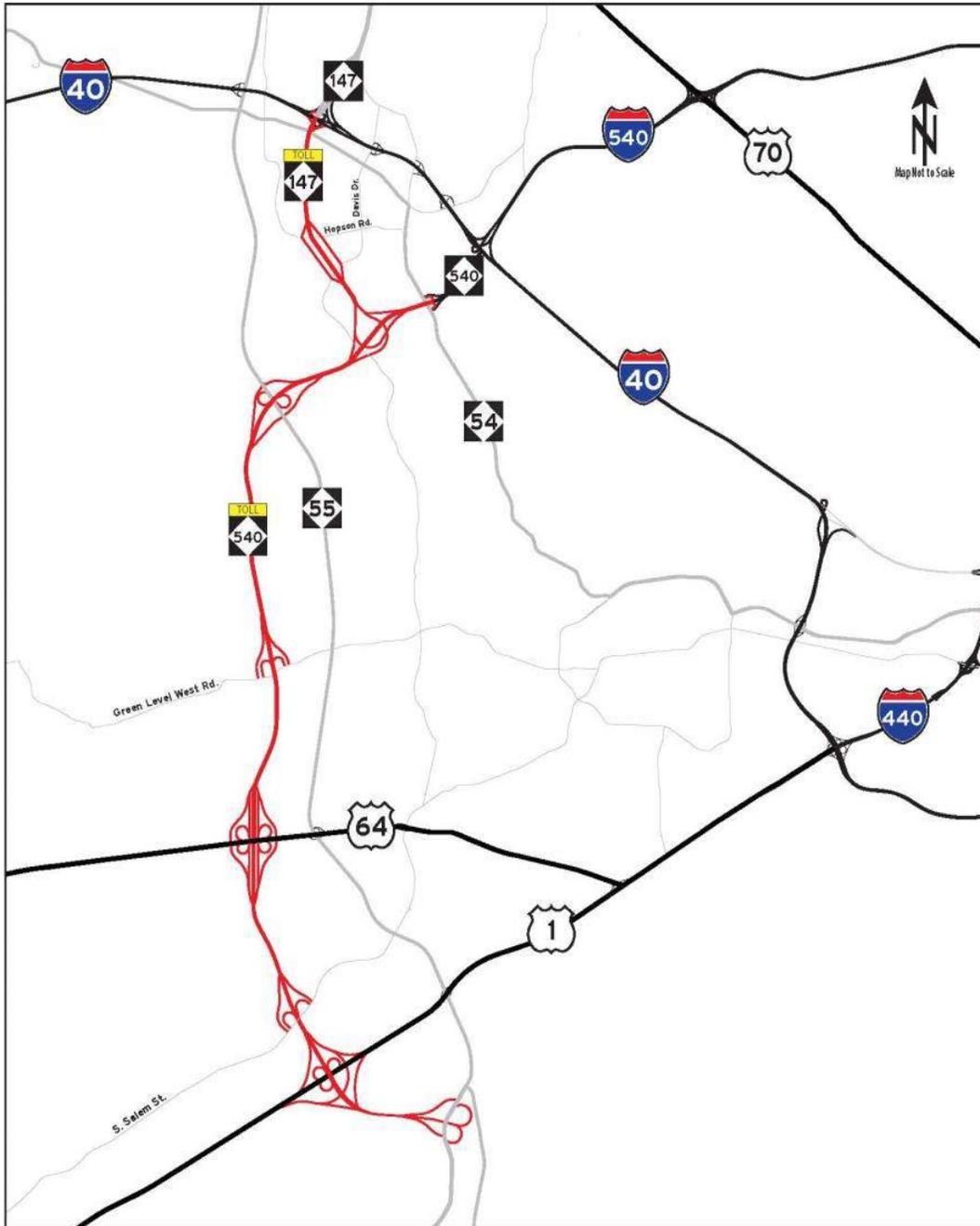
Road Surface =	25%
Unpaved Shoulders =	13%
Drainage =	15%
Roadside =	17%
Traffic Control Devices =	30%
<hr/>	
Total	100%

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 NC-147 in Durham to the NC-55 Bypass near Holly Springs (*Figure 2*). It includes a one-mile segment on NC-540 extending north from the NC-540 / NC-147 interchange to the NC-54 interchange. The Triangle Expressway consists of ten interchanges and eighteen 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.

As mentioned in the second quarter report, all assets located on NC-540 south of US-1 and north of NC-55 Bypass have been temporarily removed from the inventory due to the Access 540 Construction Project. During the third quarter, these assets continued to be excluded from the inventory. **Table 3** presents the number of assets that are currently eligible for inspection.

Table 3: Asset Inventory		
Assets	Total Inventory	2016 Eligible Inventory
Barriers	552	503
Curb and Gutter	235	218
Decorative Supports	243	223
Drainage	1136	1049
Misc. Drainage	181	164
Fences	432	379
Highway Lighting	316	296
Impact Attenuators	39	36
Inlets	968	901
Linear Segments	585	530
Plant Beds	292	286
Paved Ditches	2	1
Pavement Symbols	525	496
Signs	968	879
Tree and Brush	566	509
Turf	1010	923
Walls	113	107

6.0 MRP ASSESSMENT

6.1 Quarterly Results

The overall 2016 third quarter maintenance rating of the Triangle Expressway is 93.4, exceeding NCTA's target overall rating of 90. All elements assessed achieved ratings above the target rating of 85. Miscellaneous Drainage (64), Turf Condition (63) and Highway Lighting (66) are the characteristics that scored below the target rating of 80. It is important to note that these results are only representative of the third 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 at the end of each calendar year, provides a 95% confidence level in statistical sampling. The third quarter MRP performance ratings for elements and characteristics are presented in **Table 4** and **Table 5**, respectively.

Table 4: MRP Element Results for Q3 2016	
Element	Q3 2016 MRP Rating
Road Surface	99.1
Unpaved Shoulders and Ditches	100.0
Drainage	87.9
Roadside	90.0
Traffic Control Devices	90.5
Overall MRP Performance Rating	93.4

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Table 5: MRP Characteristic Results for Q3 2016						
Road Surface	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Paved Lanes Asphalt	14	14	9	126	126	100
Paved Lanes Concrete	28	28	9	252	252	100
Paved Shoulder	41	42	5	205	210	98
Element Total				583	588	99.1
Unpaved Shoulders And Ditches	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Unpaved Shoulder	42	42	9	378	378	100
Front/Back Slopes	42	42	6	252	252	100
Lateral and Outfall Ditches, Unpaved	42	42	6	252	252	100
Ditches, Paved	1	1	5	5	5	100
Element Total				887	887	100.0
Drainage	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Drainage Pipes	33	34	7	231	238	97
Curb and Gutter	22	24	6	132	144	92
Inlets	28	32	7	196	224	88
Misc. Drainage Structure	18	28	4	72	112	64
Element Total				631	718	87.9
Roadside	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Turf Condition	47	75	7	329	525	63
Landscaping	26	26	4	104	104	100
Trees and Brush	33	33	4	132	132	100
Litter	42	42	4	168	168	100
Roadway Sweeping	42	42	5	210	210	100
Guardrail, Concrete Barrier and End	31	31	9	279	279	100
Impact Attenuators	9	9	9	81	81	100
Fence, Control Access	27	28	7	189	196	96
Retaining Walls and Sound Barrier Walls	19	19	5	95	95	100
Decorative Supports	24	25	5	120	125	96
Graffiti and Stain Removal	40	40	4	160	160	100
Element Total				1867	2075	90.0
Traffic Control Devices	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Signs	29	34	7	203	238	85
Delineators	27	29	3	81	87	93
Pavement Striping/Marking	41	42	8	328	336	98
Words and Symbols	30	30	7	210	210	100
Pavement Markers	40	42	9	360	378	95
Highway Lighting	23	35	6	138	210	66
Element Total				1320	1459	90.5

Additionally, **Appendix A** includes maps that present the location of all assets assessed during the second quarter. **Appendix B** includes a list of the individual assets that failed the second quarter inspection.

6.2 Analysis and Recommendations

Elements

During the third quarter, all elements exceeded NCTA's threshold criteria of 85. This quarter's rating for Roadside (90) is 7 points higher than the previous quarter. This increase in scores is related to improvements observed in Turf Conditions (63) which obtained a rating 19 points higher than the previous quarter. However, this quarter's rating for Drainage (88) and Traffic Control Devices (90) decreased by 3 and 6 points, respectively. These elements' low ratings are mostly attributed to low ratings obtained by Miscellaneous Drainage Structure (64) and Highway Lighting (66). Recommendations to improve these ratings are provided in the following section.

Characteristics

This quarter all but three characteristics, Miscellaneous Drainage Structure (64), Turf Condition (63) and Highway Lighting (66) satisfied the NCTA target threshold criteria of 80. A description of the characteristics' conditions and future work planning recommendations are provided below. Pictures of the failures are included in **Appendix B**.

Miscellaneous Drainage (64 rating – 10 of the 28 assets failed). Out of the 28 miscellaneous drainage structures inspected 9 failed because of obstruction and 1 failed because of erosion. Two of the failing miscellaneous drainage structures are presented in **Figure 3**.

Figure 3: Miscellaneous Drainage Failures



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Most obstruction failures are a result of inadequate gradient flow away from the edge drain outlets. In order to avoid affecting the natural flow of water near the drainage features, it is recommended that outlet elevations be checked against the outflow ditch elevations to ensure positive drainage. Appropriate grading of the ditch line may be necessary to provide positive flow.

In accordance with *NCTA Roadway and Facility Maintenance Standards V4* reference below, it is recommended that the maintenance provider plan annual cleaning of these drainage features to remove any debris or overgrown vegetation. Additionally, it is recommended that the maintenance provider schedule repairs of the erosion soil buildup problems that have been identified along the ditch line near and adjacent to the outlet.

Miscellaneous Drainage Maintenance Program Standards:

- 1) Miscellaneous Drainage Structures shall be inspected during routine patrols
- 2) Clear all outlets to edge drains annually
- 3) Schedule cleanouts and repairs during inspections

Miscellaneous Drainage Evaluation Standards:

Miscellaneous Drainage Structures do not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 50% of the structure (length and depth) is obstructed or blocked
- 2) End protection has deteriorations, erosions, washouts or buildups adversely affecting the natural flow of water

Turf Condition (63 rating – 28 of the 75 assets failed). Out of the 75 turf areas inspected, 10 failed because of height and 19 failed because of bare ground. Two of the failing turf areas are presented in *Figure 4*.

Figure 4: Turf Failures



In order to reduce overgrown turf areas and prevent scalping of the turf surface, it is recommended that mowing heights continue to be closely monitored during each mowing cycle, pursuant to the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

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Maintenance Program:

- 1) Roadside mowing should occur as often as necessary to conform to the evaluation standard at all times. Mowing shall be in accordance with the NCTA approved mowing patterns and must not exceed the mowing lines identified by the approved stakes. These stakes are identified with a 15 inch white top. The maintenance provider shall review and confirm clarity to the NCTA (in writing) for strict adherence to the approved mowing pattern prior to each mowing season.
- 2) Turf grass shall be cut to a height of six inches (6) with a maximum tolerance of two (2) inches plus or minus.
- 3) Maintain roadway mowing 5 feet behind guardrail, unless otherwise specified by landscaping stakes.
- 4) Where landscaping has been established, or around the natural enhancement areas, mowing shall conform to the established contours with smooth flowing transitions.
- 5) Roadside trimming shall occur around all traffic appurtenances including, but not limited to guardrail, sign posts, light standards, and ITS devices.
- 6) Chemical applications:
 - a. Winter:
 - i. Apply limestone.
 - ii. Apply fertilizer.
 - b. Spring:
 - i. Apply pre and post emergent broadleaf weed control in accordance to the manufacturer's recommendations in April.
 - ii. Bare ground areas shall be scheduled for seeding in as necessary.
 - c. Fall:
 - i. Apply post-emergence herbicides to select locations in accordance to the manufactures recommendations in August.
 - ii. Bare ground areas shall be seeded in the fall as needed.

Maintenance and Evaluation Standards:

Turf does not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 2% of the vegetation exceeds a uniform height of 12 inches. Minimum height not less than 4 inches.
- 2) More than 25% of the undesirable vegetation is present within the mowing limits of the area.
- 3) Noxious weeds present.
- 4) More than 50 cumulative SF of bare ground is present in the turf evaluation area.

This past summer, NCDOT Division 5 Landscape Unit planted a combination of Fescue, Bermuda, and Centipede grass on bare ground areas throughout the Triangle Expressway using a drill-seeding method. In order to help establish and promote a healthy and strong turf, the landscape unit also fertilized all turf areas within the facility's mowing limits. Positive results from these efforts were observed during the Third Quarter MRP evaluation. Turf areas now look more attractive and new development of Centipede 'runners' have been observed in bare areas, which with continued fertilization are anticipated to eventually fill in along many bare ground areas. However, results from these efforts may not always

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be immediate as centipede is slow growing and multiple cycles of fertilizing may be needed to fully establish growth.

Highway Lighting (66 rating – 12 of the 35 assets failed). Out of the 35 highway lights inspected, 10 failed because of non-functioning luminaries and 2 failed for missing or damaged parts. Two of the failing highway lights are presented in *Figure 5*.

Figure 5: Highway Lighting Failures



In order to avoid future damage, mowers should be advised to use caution in and around lighting appurtenances. All non-functioning or damaged highway lights noted by inspectors shall be repaired and/or replaced in accordance with the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Highway Lighting Maintenance Program Standards:

- 1) Perform night patrol once a month, and identify any outages. A monthly “Lighting Outage Report” shall be submitted by the maintenance provider to the NCTA by the 30th of each month. All bulb outages must be replaced within 48 hours.
- 2) Perform cleaning of glassware at the same time as any routine maintenance function or diagnostic action is performed.
- 3) Replace any light poles damaged by traffic within 5 days or within 14 days if any foundations need pouring.

Maintenance and Evaluation Standards:

Highway and Sign Lighting do not meet the maintenance standards when any of the following criteria is observed:

- 1) Any electrical inspection plate, access panel cover, exposed electrical wire, or pull box cover are not properly secured in place.
- 2) More than 10% of the total luminaries are not functioning during nighttime observation. (N)
- 3) More than 10% of the poles are damaged or missing.
- 4) Rodent screen protection is not in place.

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Further examination is needed on the frequency of repeated circuit-wide outages as a result of buried conduit wiring eroding earlier than expected for a normal life-cycle of 10-15 years. Maintenance personnel have observed and indicated that water intrusion in the conduit is a major culprit. This would indicate a problem with the conduit not being sealed properly. It may be necessary to run new conduit along with re-wiring the circuit portions that continue to exhibit frequent outages. Further study is recommended as problems continue.

Another common problem is photo-sensor cells that routinely malfunction and are being replaced as needed. It is recommend that a full system-wide replacement be scheduled as photo-cells have a short life span and would need replacing on a routine cycle. Proactive cyclical measures can minimize the need for reactive responses and minimize multiple call-outs of crews.

7.0 ROLLING MRP RATING

The current rolling maintenance rating of the Triangle Expressway is 93.9, exceeding NCTA's target overall rating of 90. All element ratings exceeded the target rating of 85. Also, all but three characteristic ratings met or exceeded the target rating of 80. Ratings for Miscellaneous Drainage Structure, Turf Condition, and Highway Lighting are 64, 62 and 75, respectively.

The cumulative rolling results are presented in **Tables 6 and 7**. These results are a collection of the four latest quarterly inspections.

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Table 6: MRP Rolling Characteristic Results					
Road Surface	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Rolling Rating
Paved Lanes Asphalt	98	100	100	100	99
Paved Lanes Concrete	100	100	100	100	100
Paved Shoulders	93	95	100	98	96
Element Total	97.9	98.3	100.0	99.1	98.6
Unpaved Shoulders And Ditches	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Rolling Rating
Unpaved Shoulders	95	98	100	100	98
Front/Back Slopes	100	95	100	100	99
Lateral and Outfall Ditches, Unpaved	100	100	100	100	100
Paved Ditches	100	100	100	100	100
Element Total	97.8	97.7	100.0	100.0	98.8
Drainage	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Rolling Rating
Drainage Pipes	85	97	91	97	92
Curb and Gutter	84	100	96	92	93
Inlets	94	97	100	88	95
Misc. Drainage Structures	63	66	63	64	64
Element Total	83.8	92.6	91.0	87.9	88.8
Roadside	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Rolling Rating
Turf Condition	66	73	44	63	62
Landscaping	97	100	96	100	98
Trees and Brush	100	100	100	100	100
Litter	100	100	100	100	100
Roadway Sweeping	100	100	100	100	100
Guardrails and Concrete Barriers	100	100	89	100	98
Impact Attenuators	100	100	100	100	100
Fence and Control Access	90	93	100	96	95
Retaining, Sound and Screen Walls	95	89	94	100	95
Decorative Supports	88	100	95	96	95
Graffiti and Stain Removal	100	100	100	100	100
Element Total	90.5	92.1	83.4	90.0	89.1
Traffic Control Devices	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Rolling Rating
Signs	88	91	90	85	88
Delineators	88	89	91	93	91
Pavement Striping/Marking	100	100	100	98	99
Words and Symbols	100	100	100	100	100
Pavement Markers	90	100	100	95	96
Highway Lighting	78	69	88	66	75
Element Total	92.2	93.5	96.1	90.5	93.1

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Table 7: MRP Rolling Element Results					
Element	Q4 2015 Rating	Q1 2016 Rating	Q2 2016 Rating	Q3 2016 Rating	Rolling Rating
Road Surface	98	98	100	99	99
Unpaved Shoulders and Ditches	98	98	100	100	99
Drainage	84	93	91	88	89
Roadside	91	92	83	90	89
Traffic Control Devices	92	93	96	90	93
Overall MRP Performance Rating	92.8	94.9	94.7	93.4	93.9

8.0 GREEN LEVEL HISTORIC DISTRICT SIGNS

The four Green Level Historic District signs and surrounding landscaped areas were installed as part of the Triangle Expressway construction projects. 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, assessors visit the four Green Level Historic District signs to conduct a visual inspection of each sign and ensure they are in good standing. During this quarter, the sign located near the intersection of Green Level Church Road and Green Level West Road was excluded from the inspection inventory due to inaccessibility to the sign because of construction work in the area. The three signs included in the inspection inventory were only inspected for landscape appearance because two of the three signs were vandalized and the other sign was temporarily removed to be used as a sample to replace the vandalized signs. All landscaped areas at the location of the signs were found to be well maintained (*Figure 6*). NCTA is in the process of replacing all signs.

Figure 6: Green Level West Historic District Signs, Landscape Areas



9.0 CONCLUSION

This report presents the 2016 third quarter and the current cumulative rolling assessment of the Triangle Expressway. The NCTA's target ratings are 90 overall, 85 for elements, and 80 for characteristics. The third quarter 2016 overall rating is **93.4** and the cumulative rolling rating is **93.9**. The quarterly and cumulative rolling ratings for this quarter are currently above the target rating of 90.

This quarter, all element ratings were above the target rating for both the quarterly and the rolling results. All characteristic's quarterly ratings exceeded the target rating of 80 with the exception of Miscellaneous Drainage Structure (64), Turf Condition (63), and Highway Lighting (66). Similarly, based on the cumulative rolling assessment ratings, Miscellaneous Drainage Structure (64), Turf Condition (62), and Highway Lighting (75) fell below the threshold.

In order to improve the quarterly and rolling ratings, it is recommended that at least once per year the maintenance provider plan to remove any debris or overgrown vegetation that may impair outflow from the shoulder drain outlets. It is also recommended that all erosion soil buildup problems identified along the ditch line near and adjacent to the outlets be repaired. Additionally, it is recommended that outlet elevations be checked against the outflow ditch elevations to ensure positive drainage and prevent drain outlets from backing up with water. Applicable grading of the ditch line may be necessary in order to provide positive flow.

In addition, it is recommended that the maintenance provider repair and/or replace all damaged or missing highway lighting parts. Further examination is needed on the frequency of repeated circuit-wide outages as a result of buried conduit wiring eroding earlier than expected for a normal life-cycle of 10-15 years. It is also recommended that mowing heights continue to be closely monitored during each mowing cycle and that the NCDOT Division 5 Landscape Unit continues to fertilize bare areas to promote new growth.

It is further noted that routine attention and planning should be given to the nighttime visibility program. While the rating for Pavement Striping continues to exceed the target rating, the lifespan of epoxy paint and reflective pavement markers (RPM's) is 3 to 5 years. Pavement striping was installed along portions of the Triangle Expressway over 4 years ago and therefore, preparations should be made in the budget and work schedule for maintenance replacement.

This quarter, only three of the four Green Level Historic District sign locations were inspected due to construction work. The three sign locations were only inspected for landscape appearance because of missing signs due to vandalism. All landscaped areas at the sign location were found to be well maintained. NCTA is currently working towards replacing all Green Level Historic District signs that were vandalized.

Appendix A

Triangle Expressway 2016 Third Quarter Asset Assessment Locations

Appendix A: Triangle Expressway 2016 Third 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 2016 Third Quarter Asset Assessment Locations

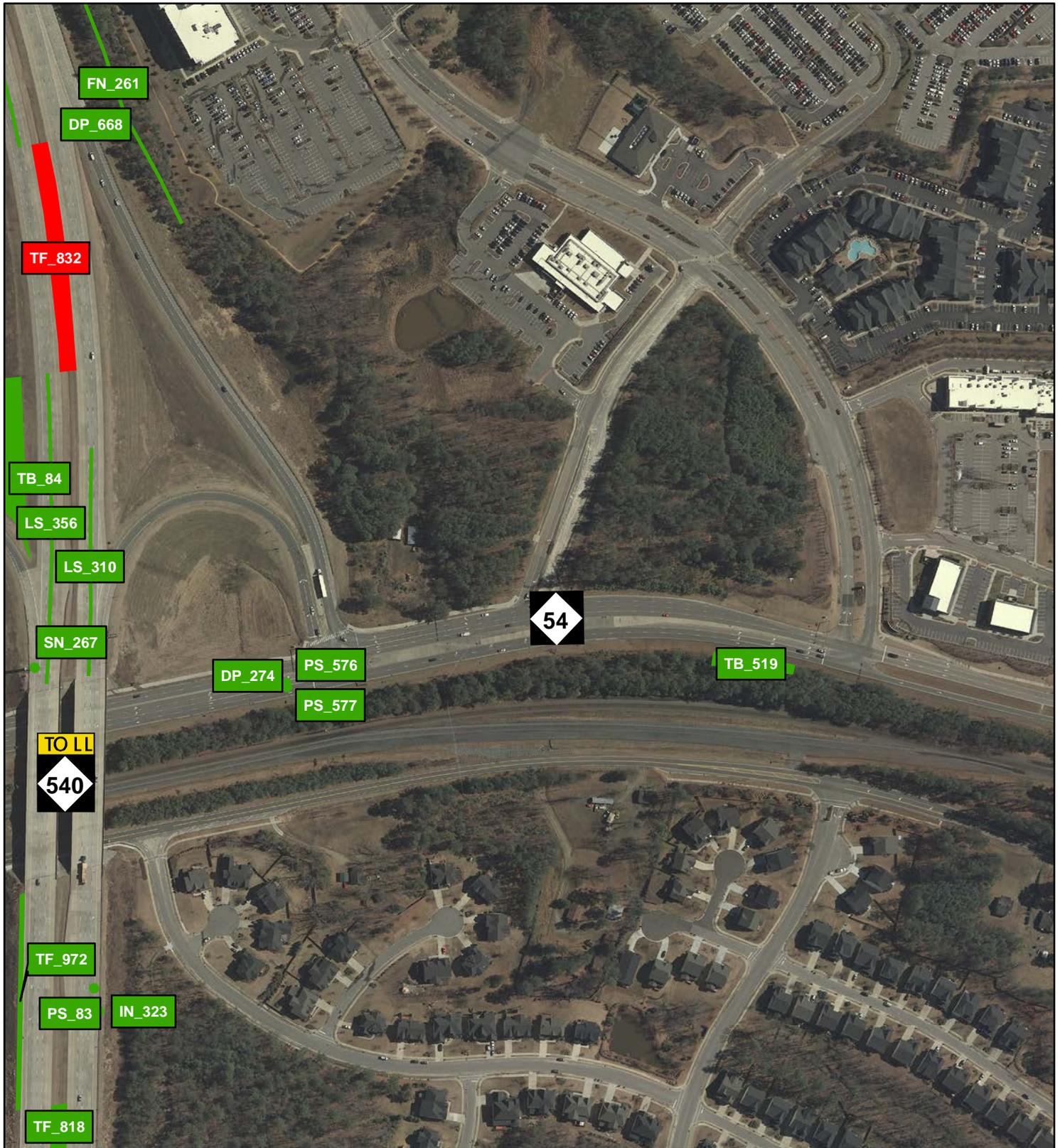


Legend

- Failing Asset
- Passing Asset

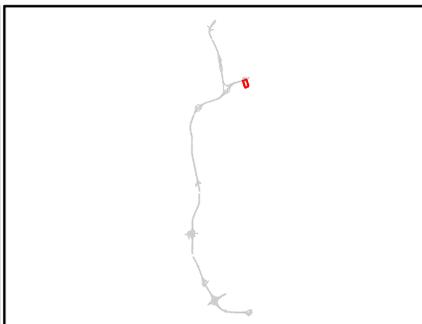


Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

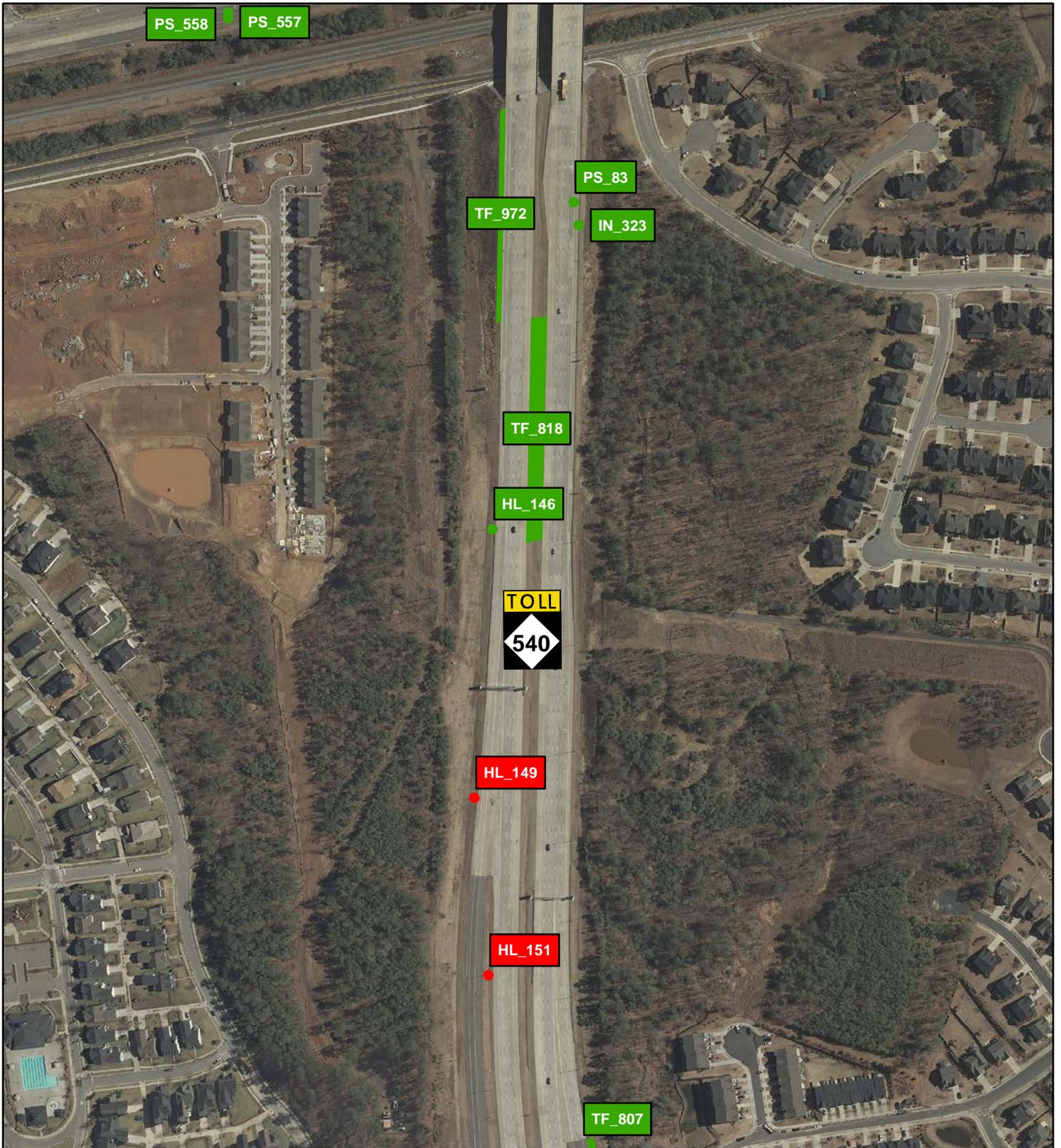


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

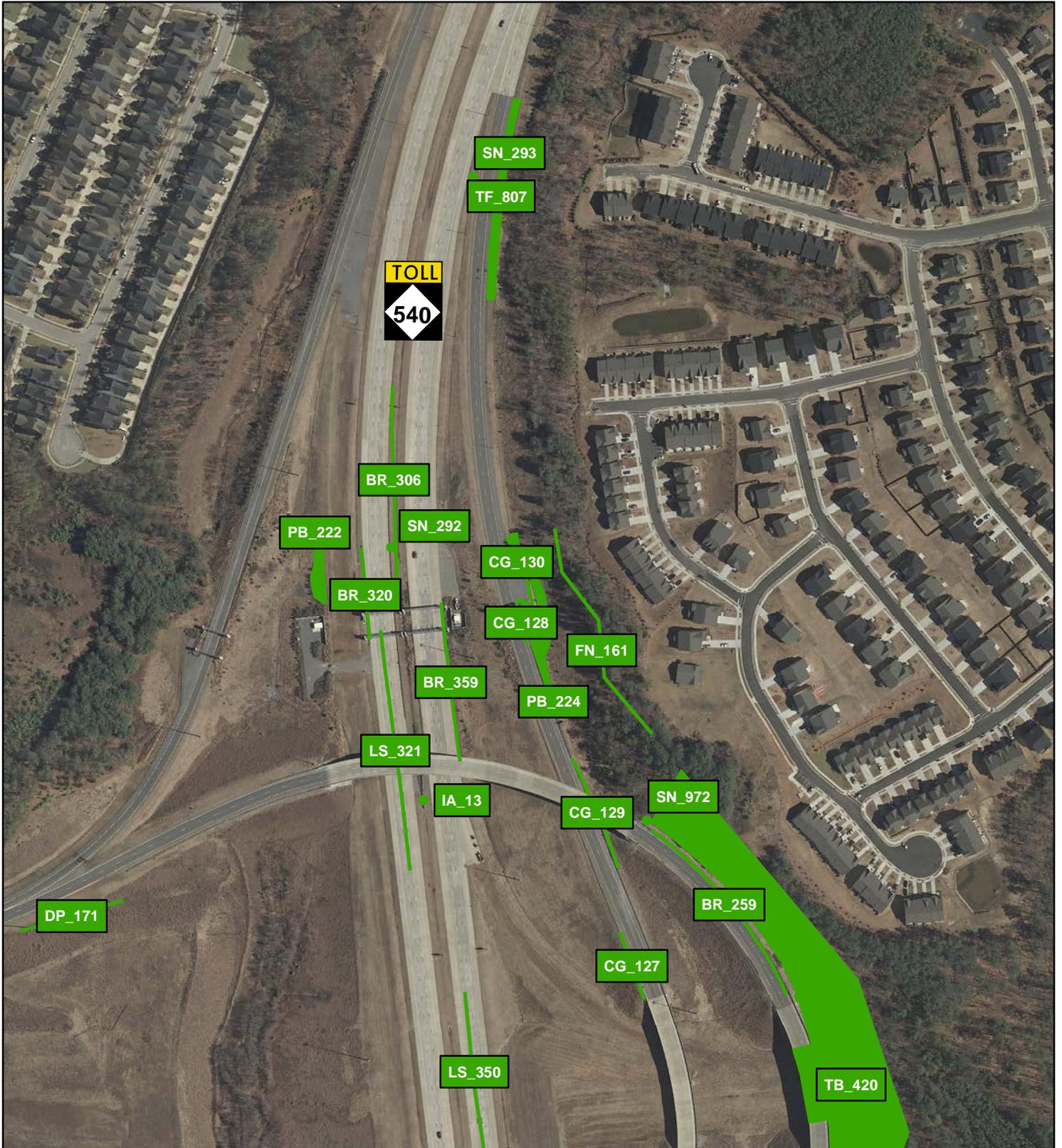


Legend

-  Failing Asset
-  Passing Asset

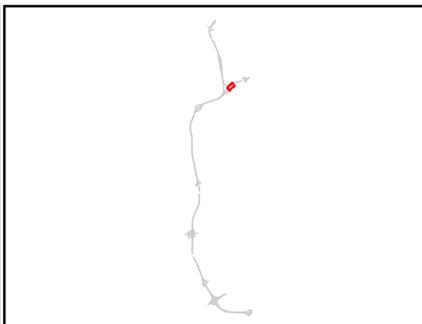


Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

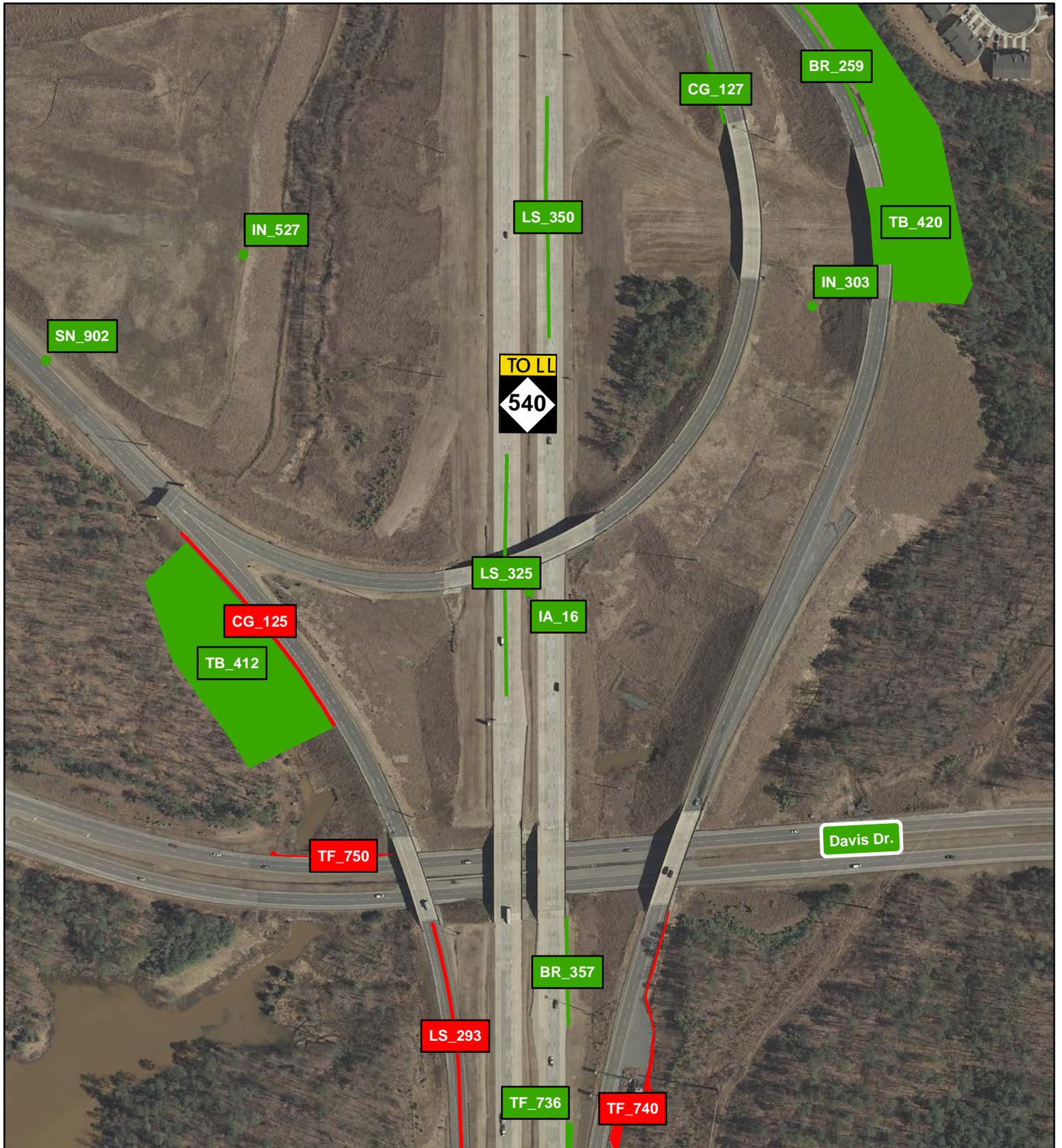


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

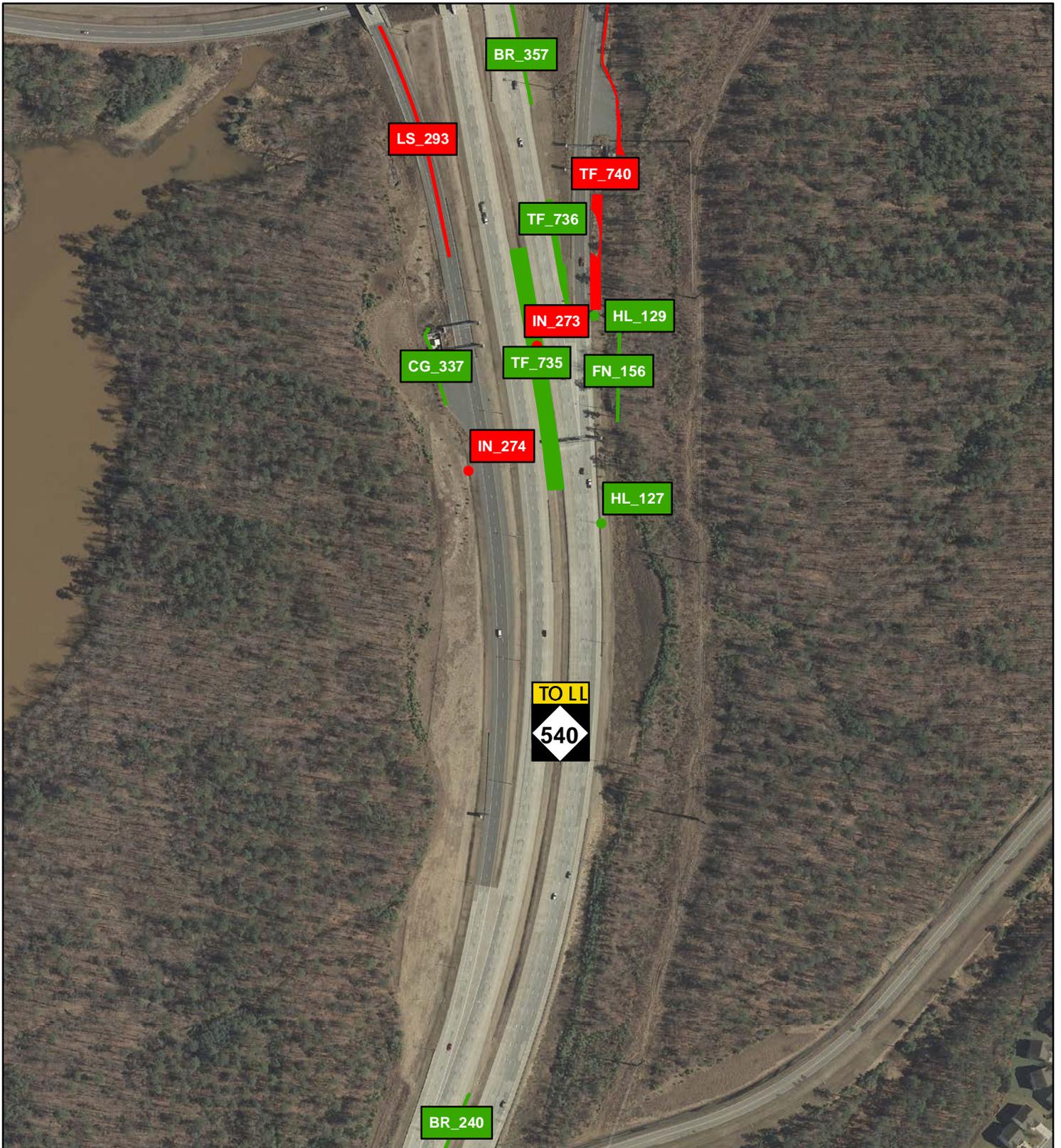


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

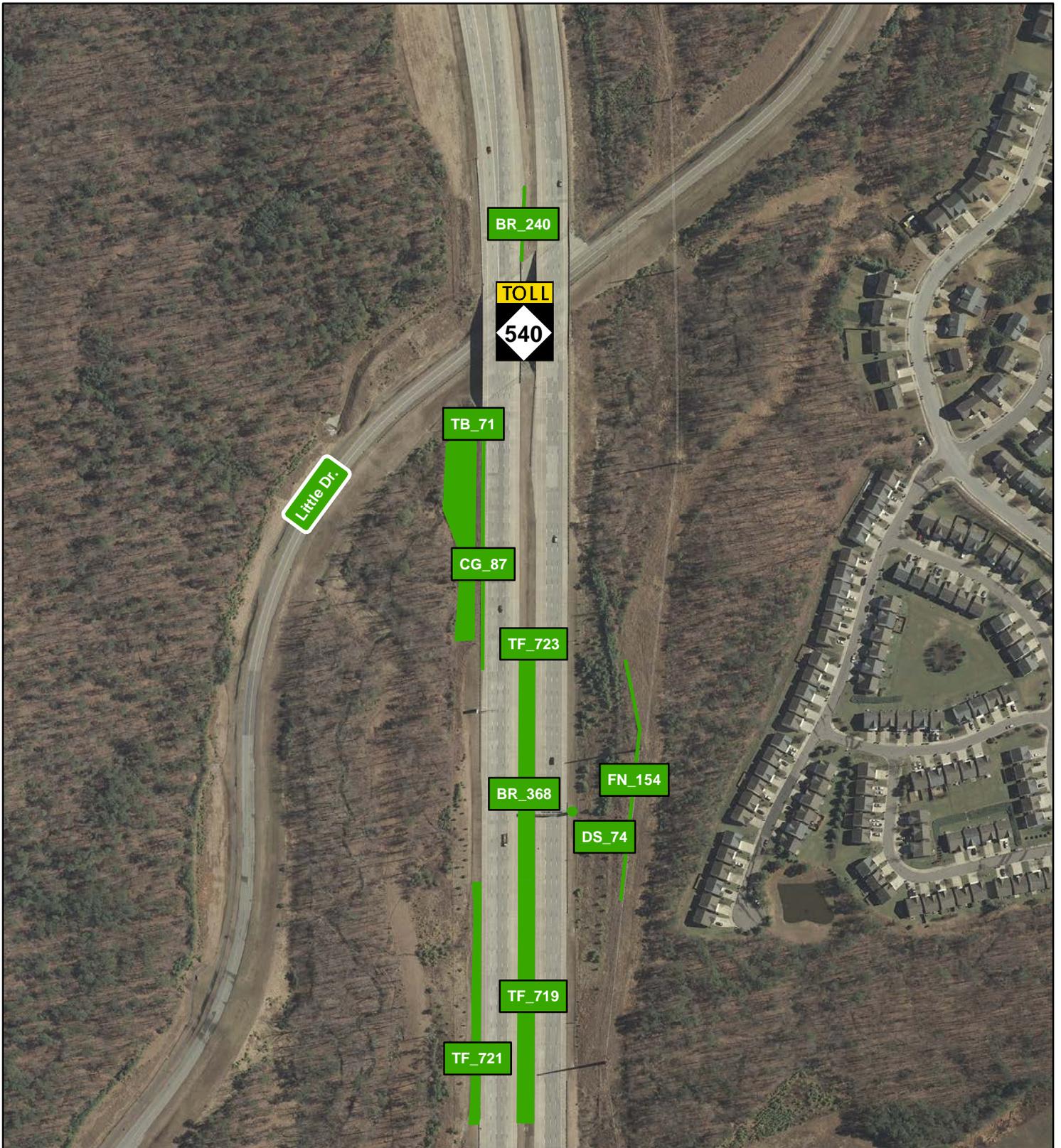


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

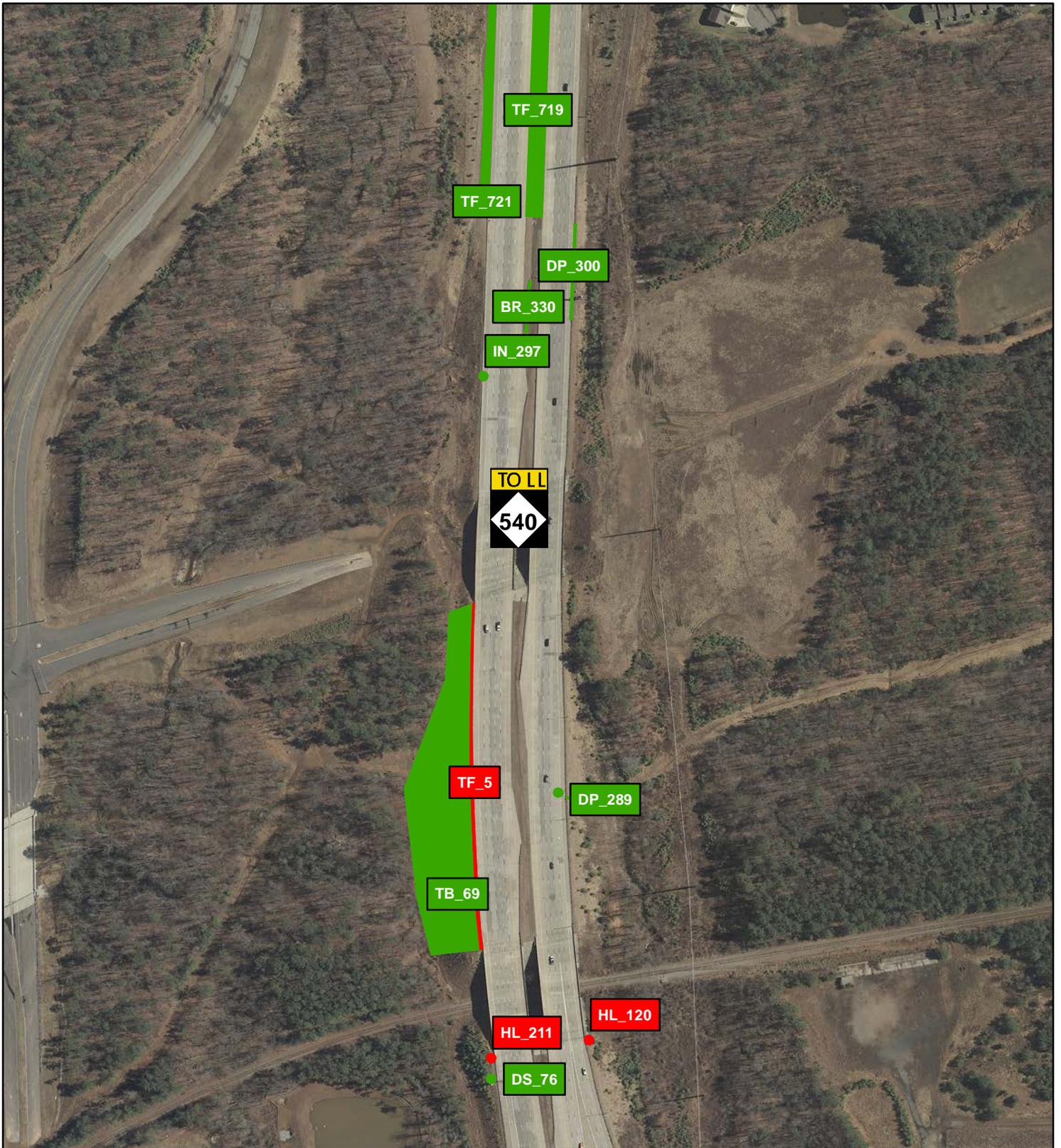


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

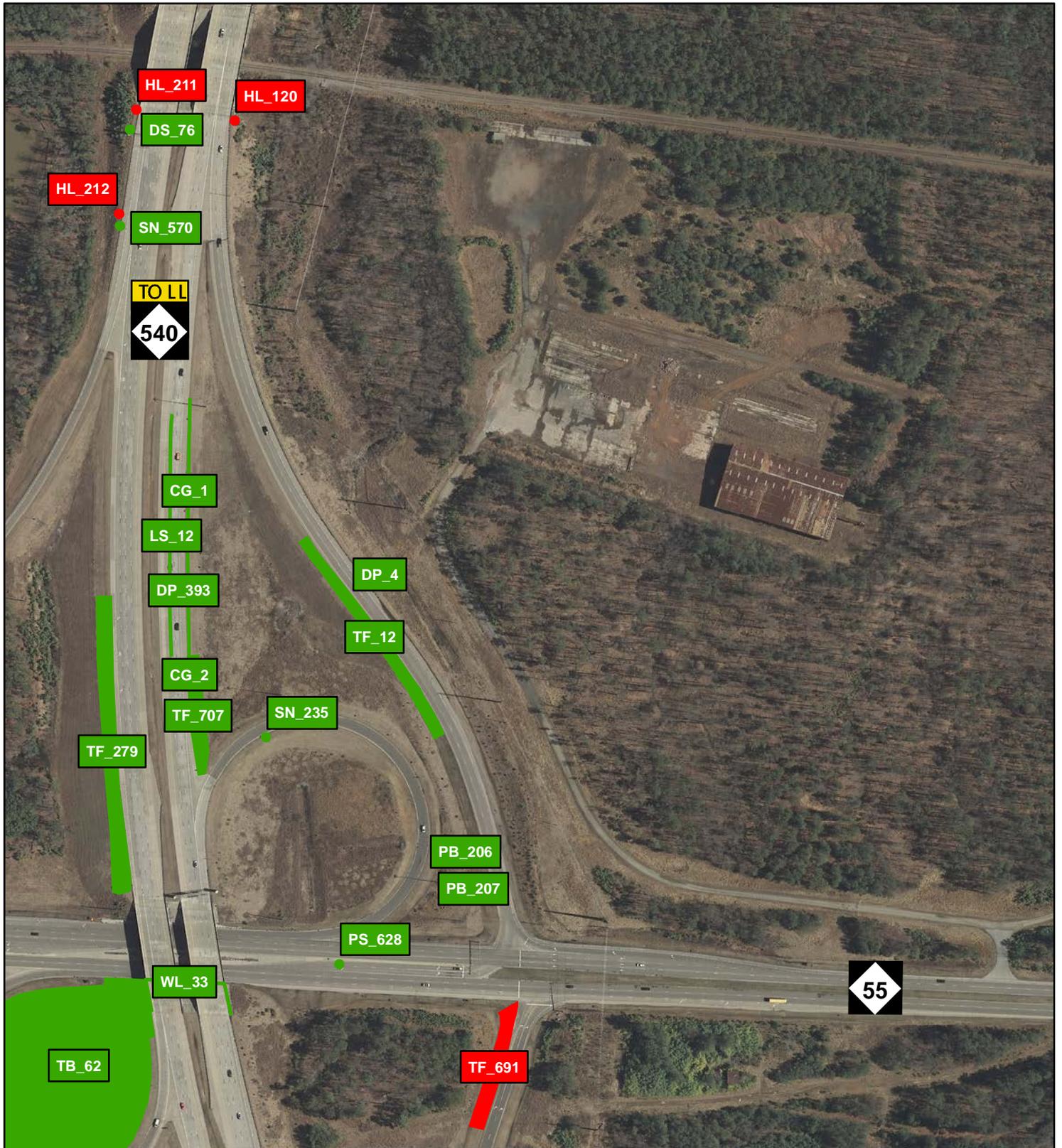


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

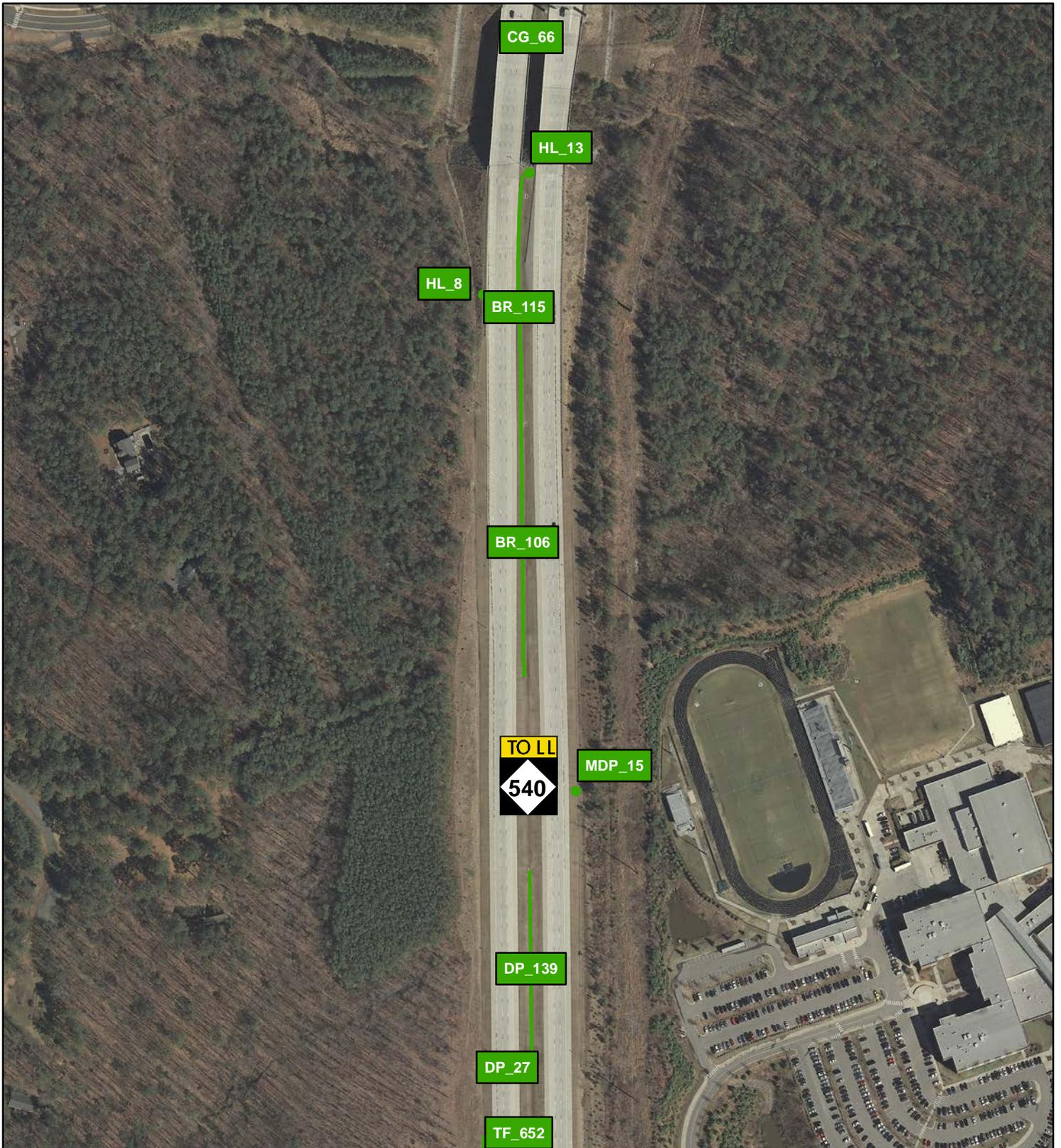


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

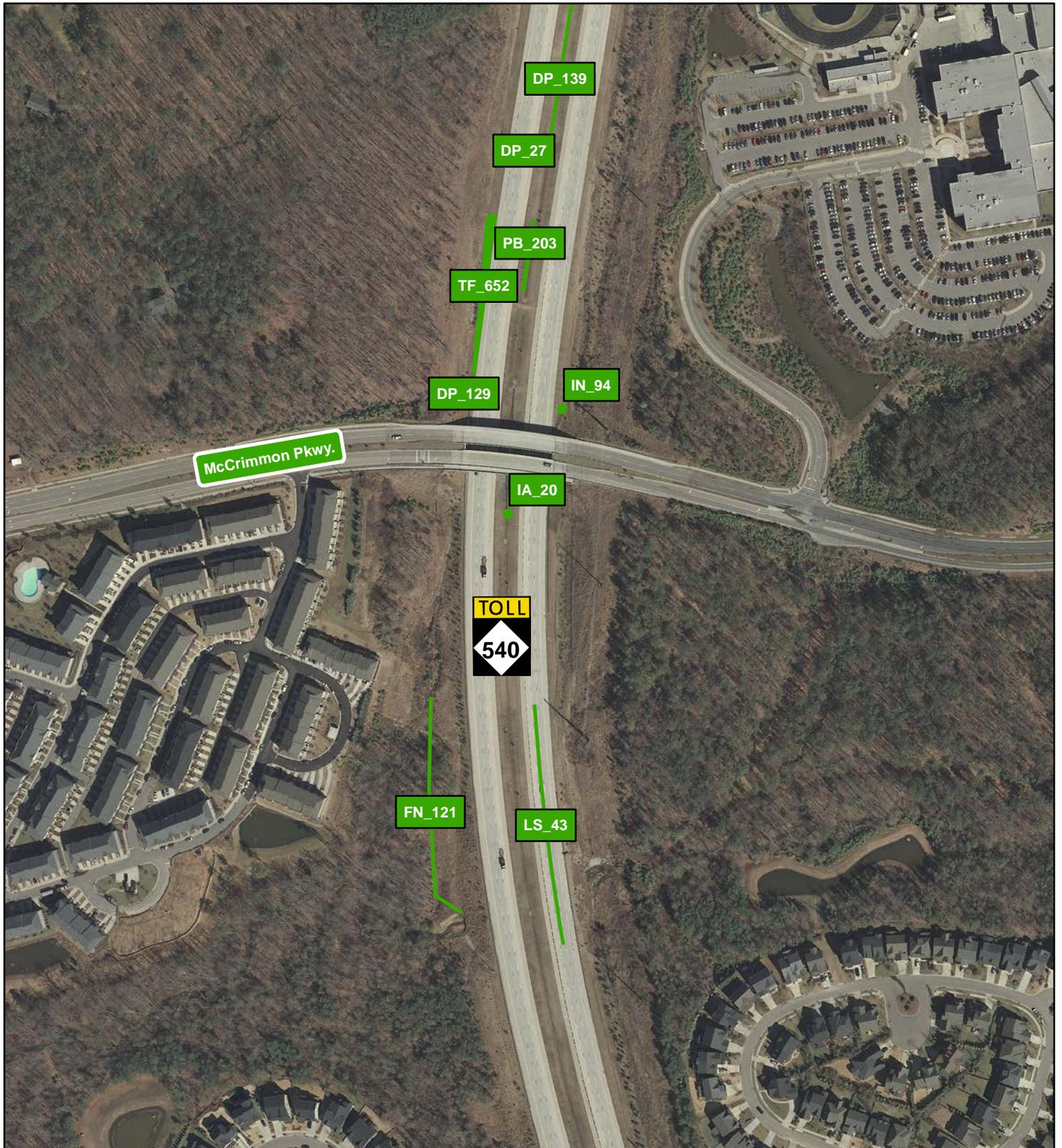


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

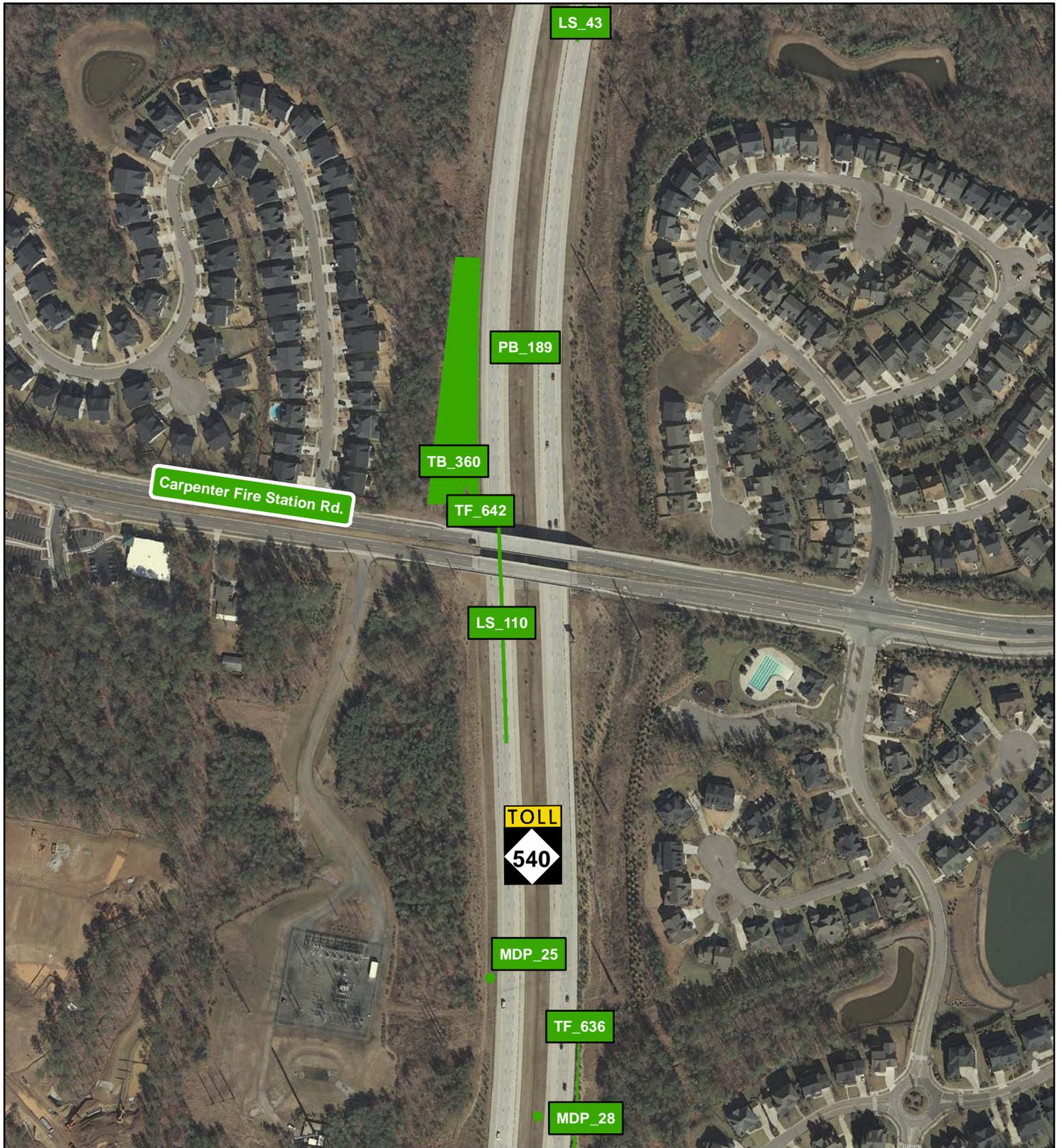


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

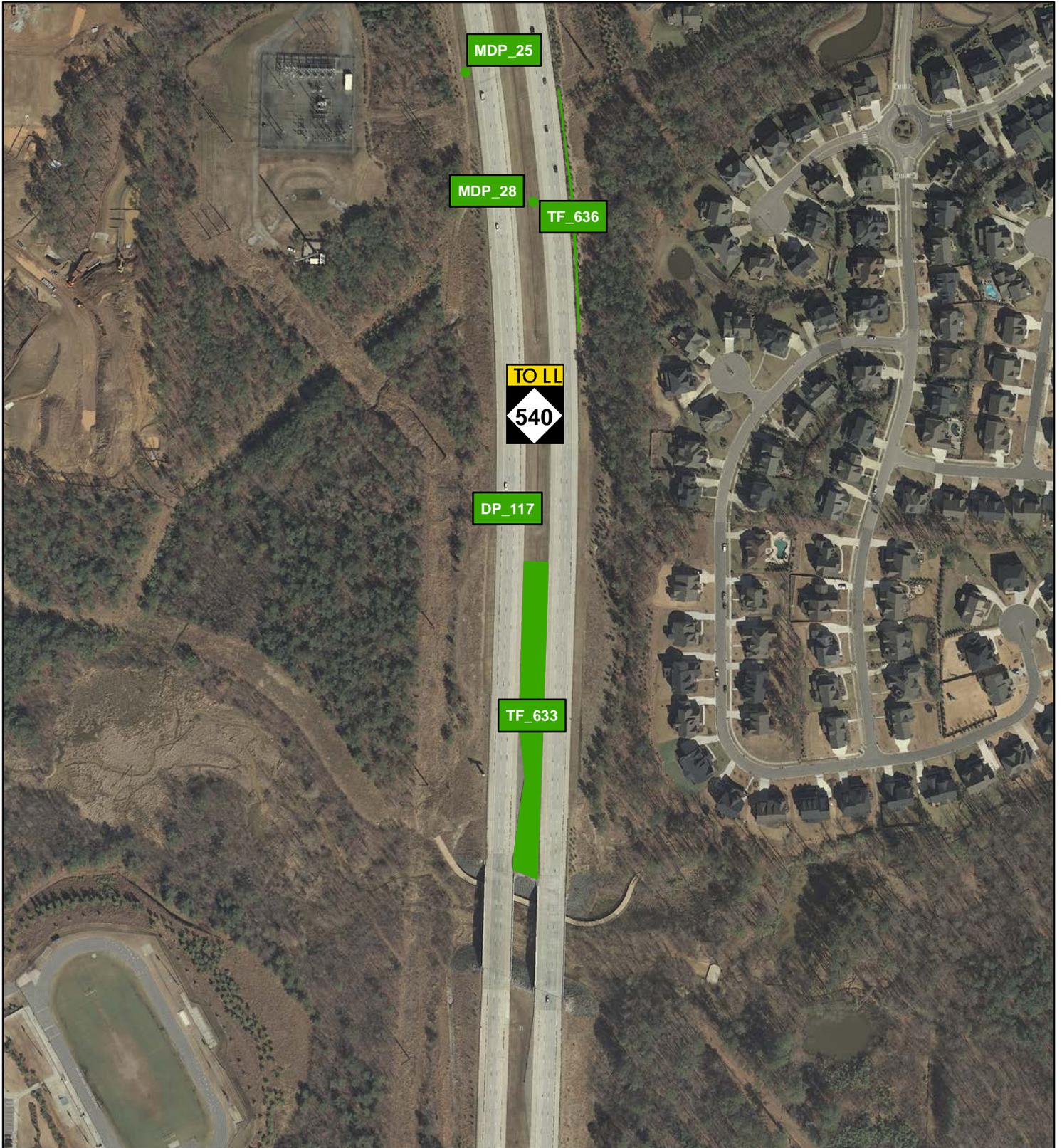


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

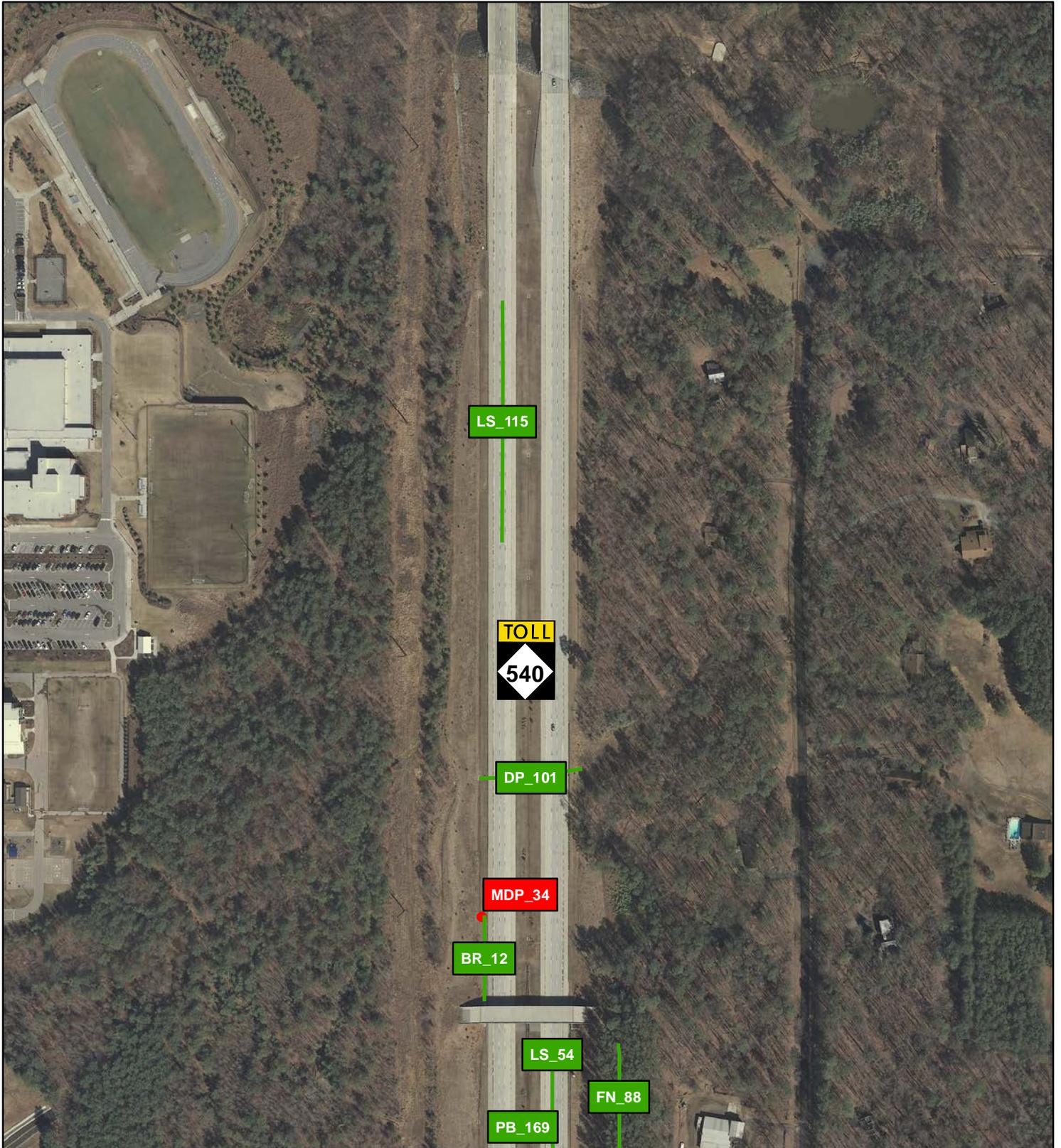


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

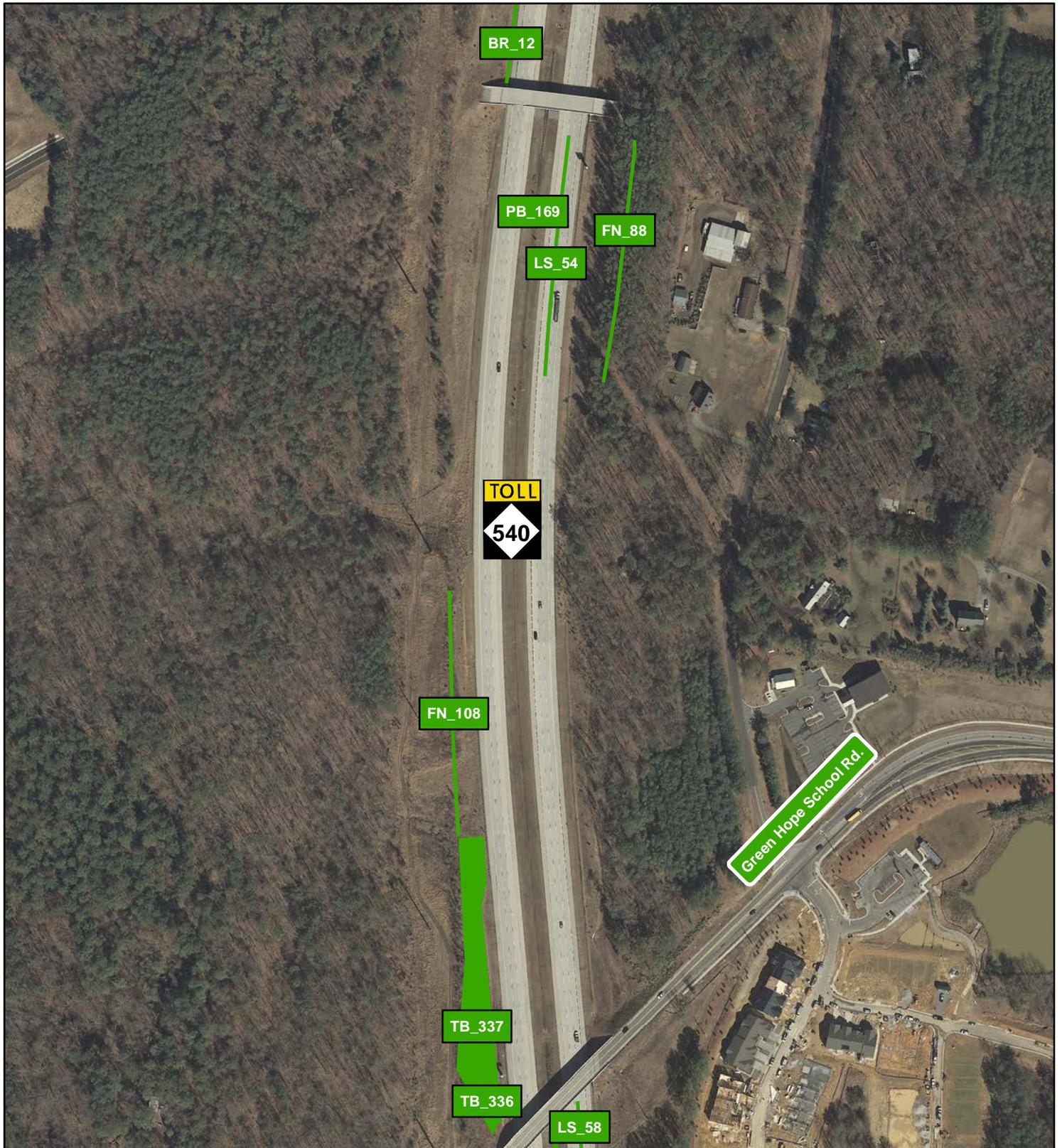


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

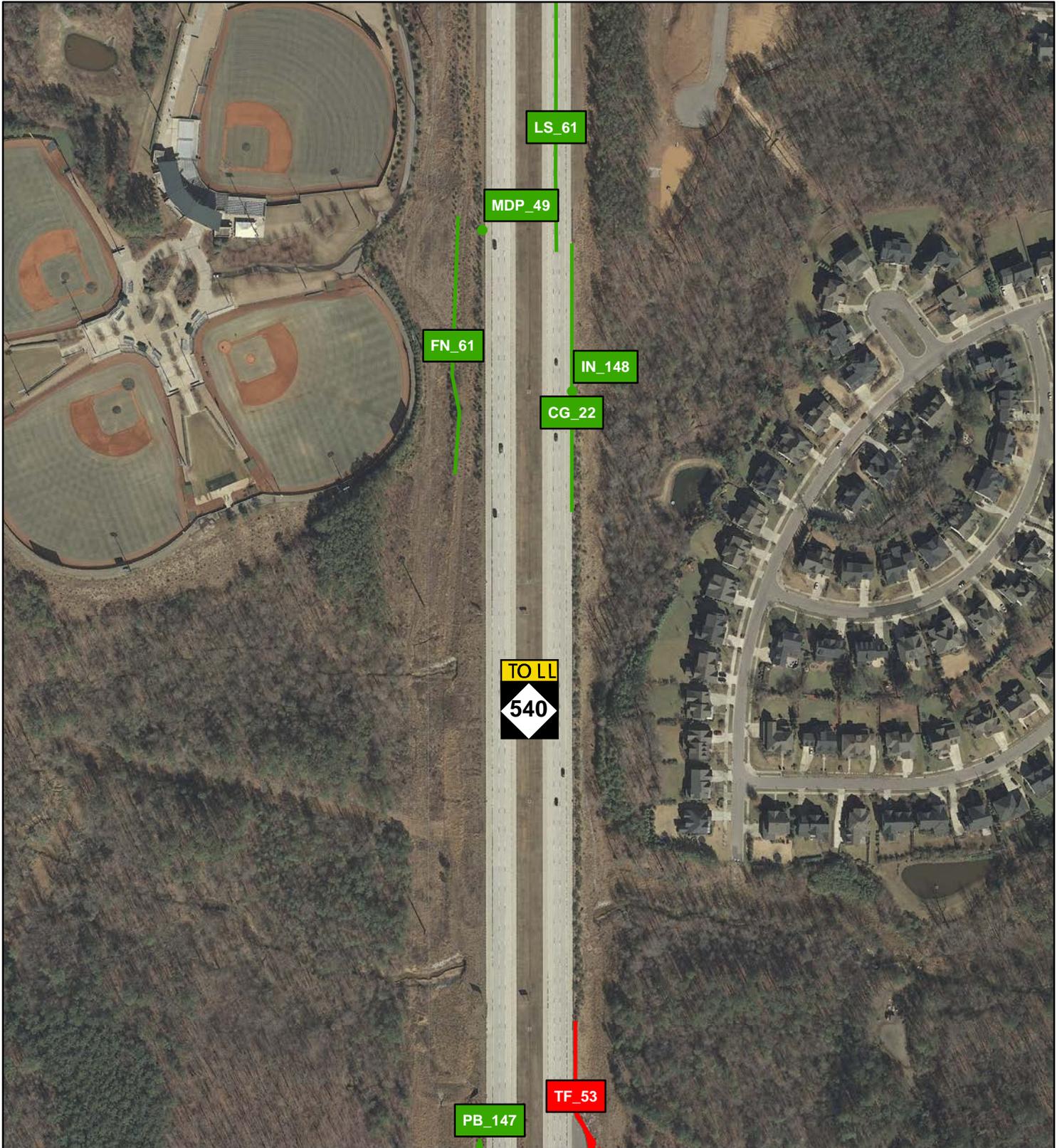


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

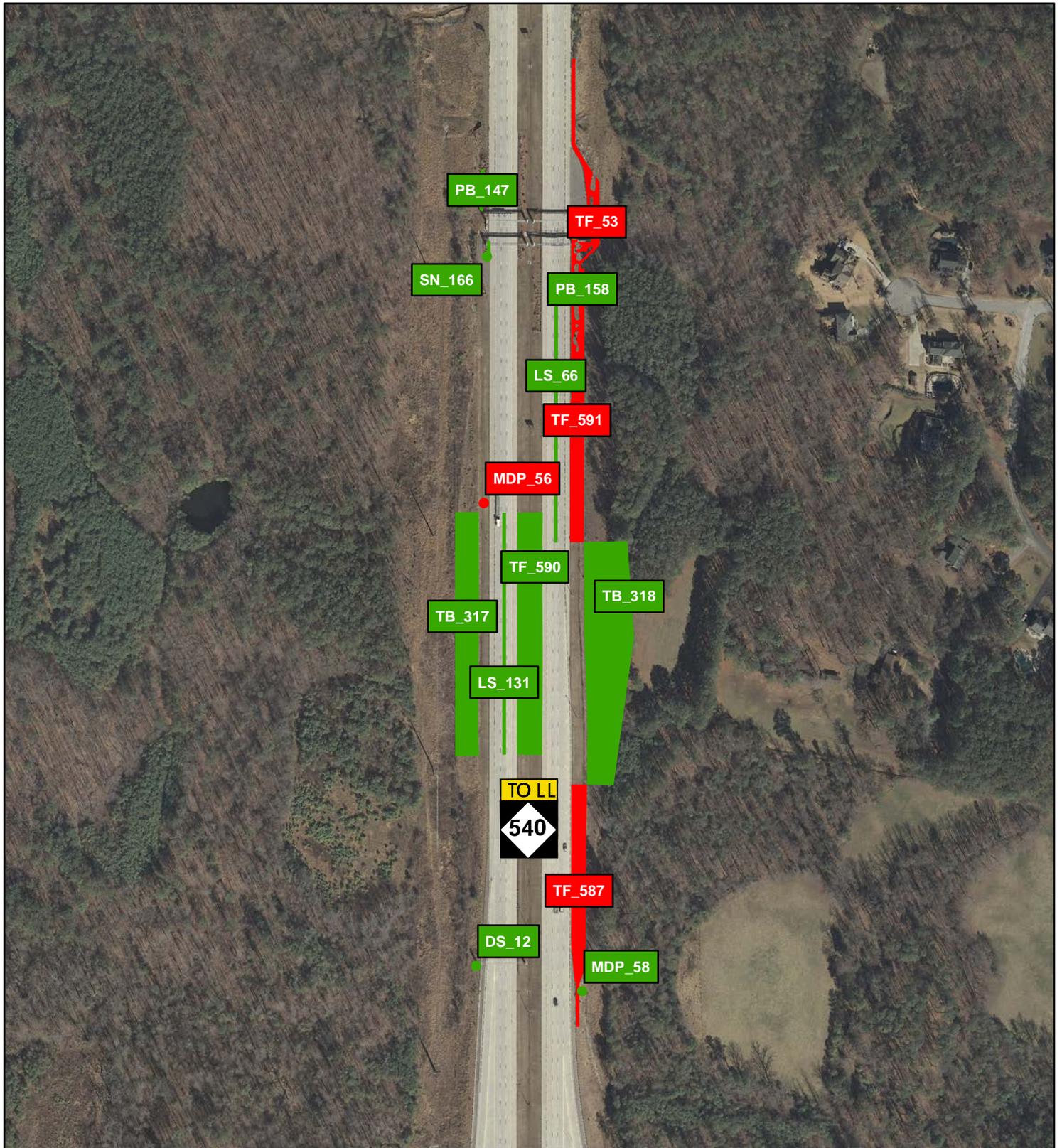


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

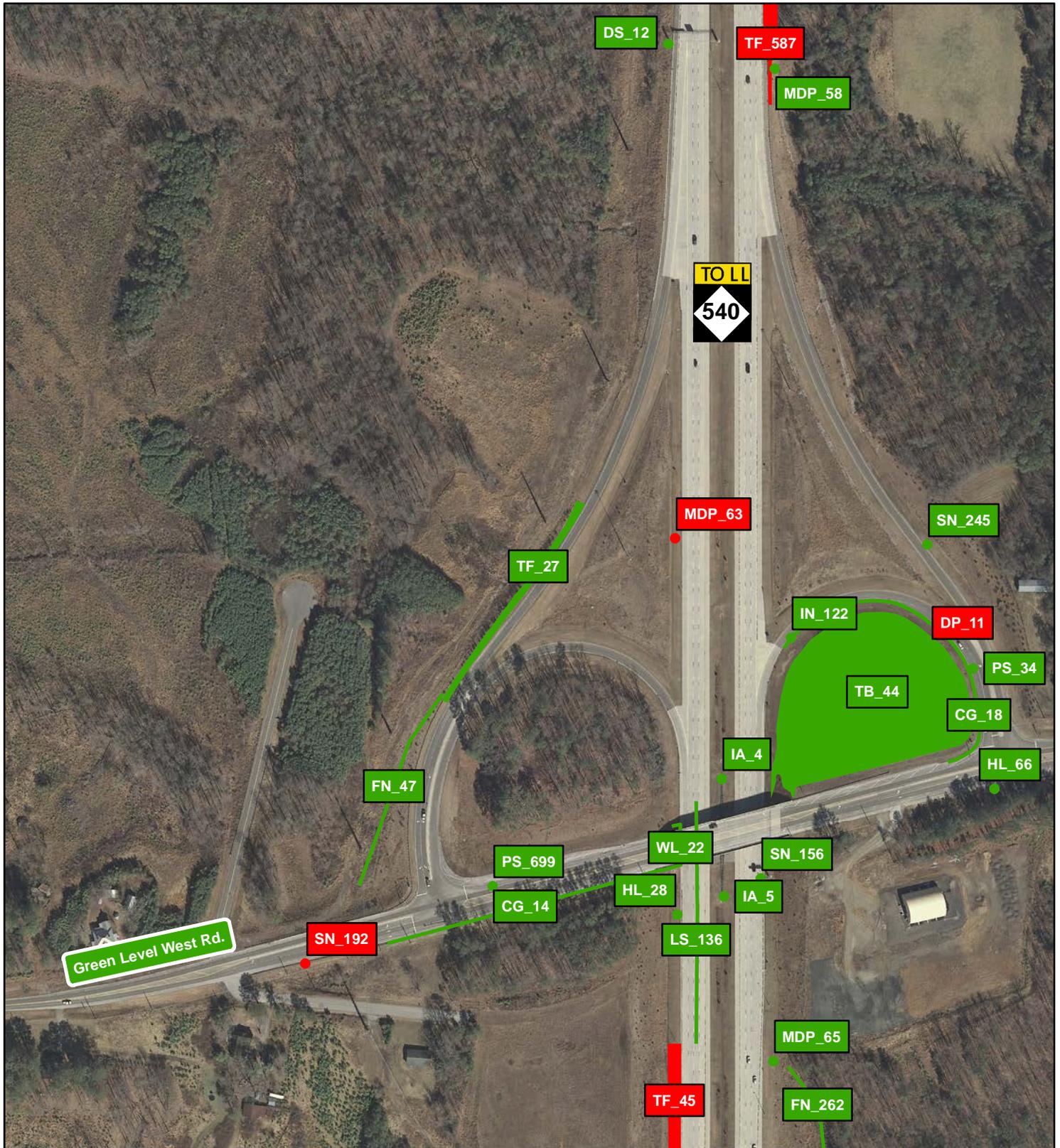


Legend

-  Failing Asset
-  Passing Asset

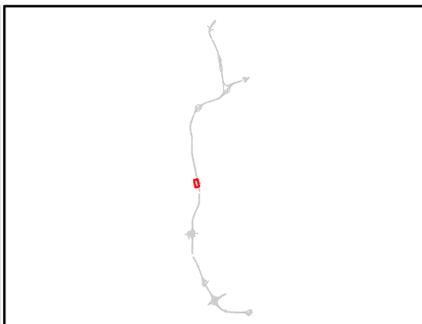


Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

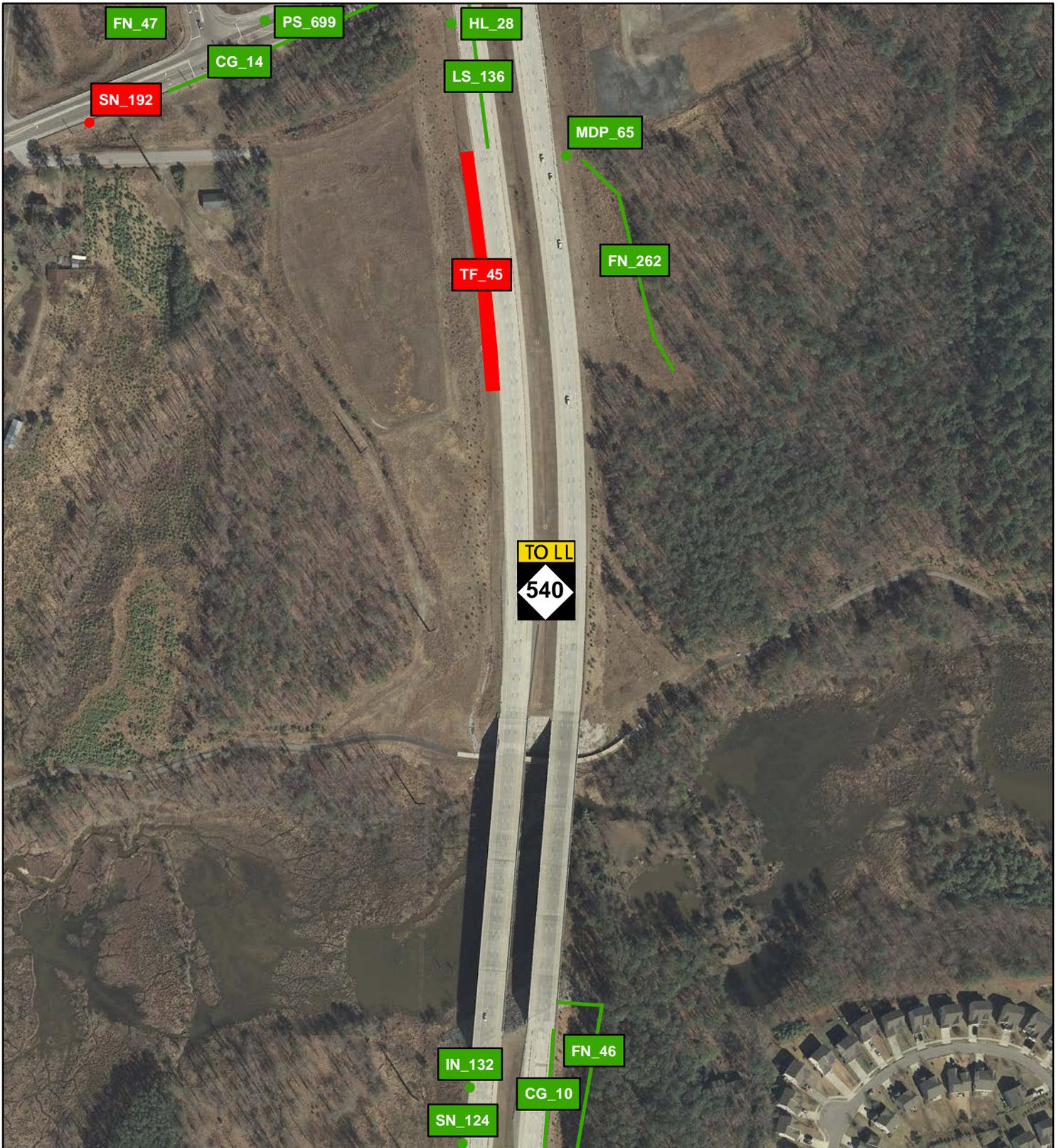


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

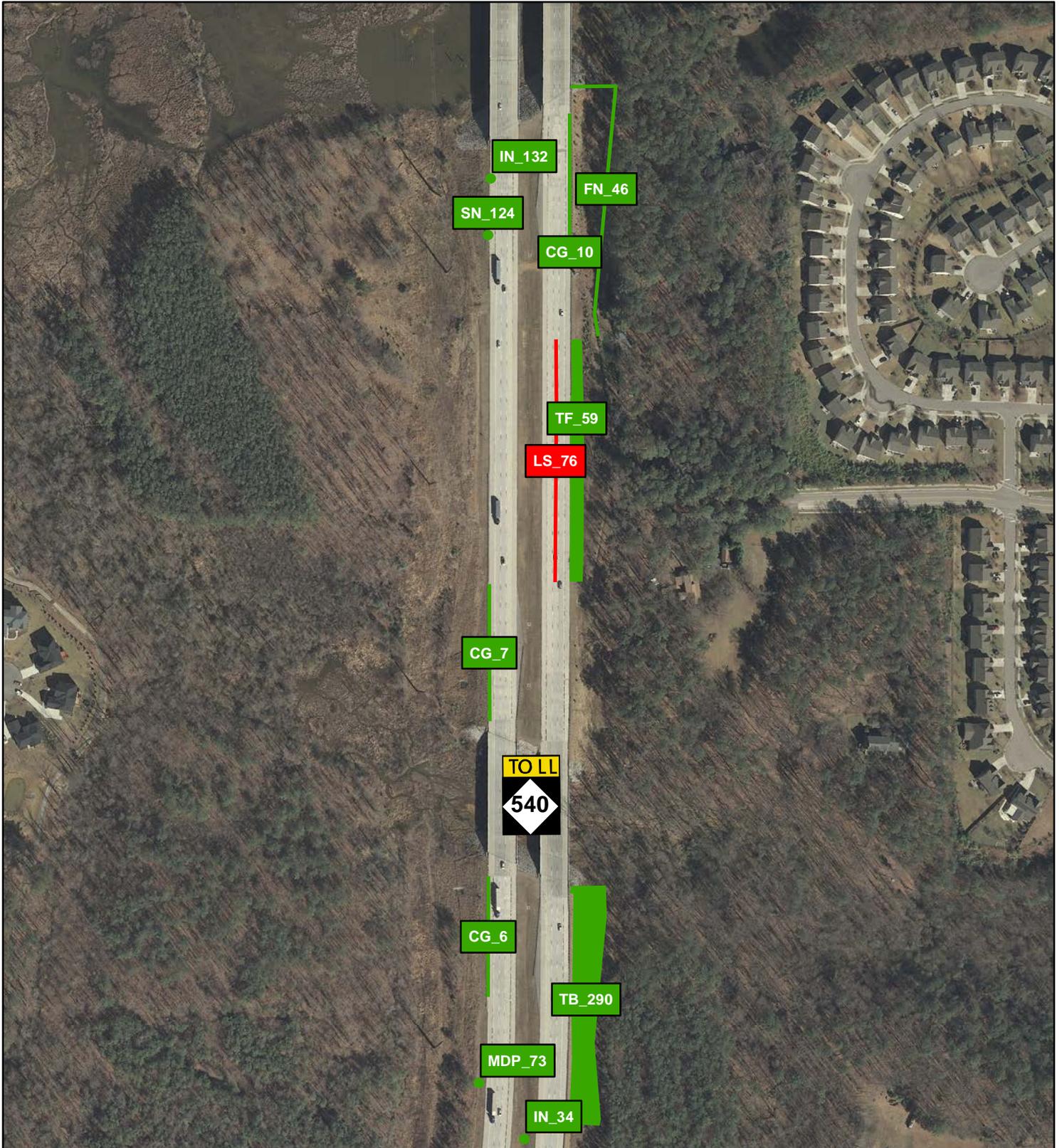


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

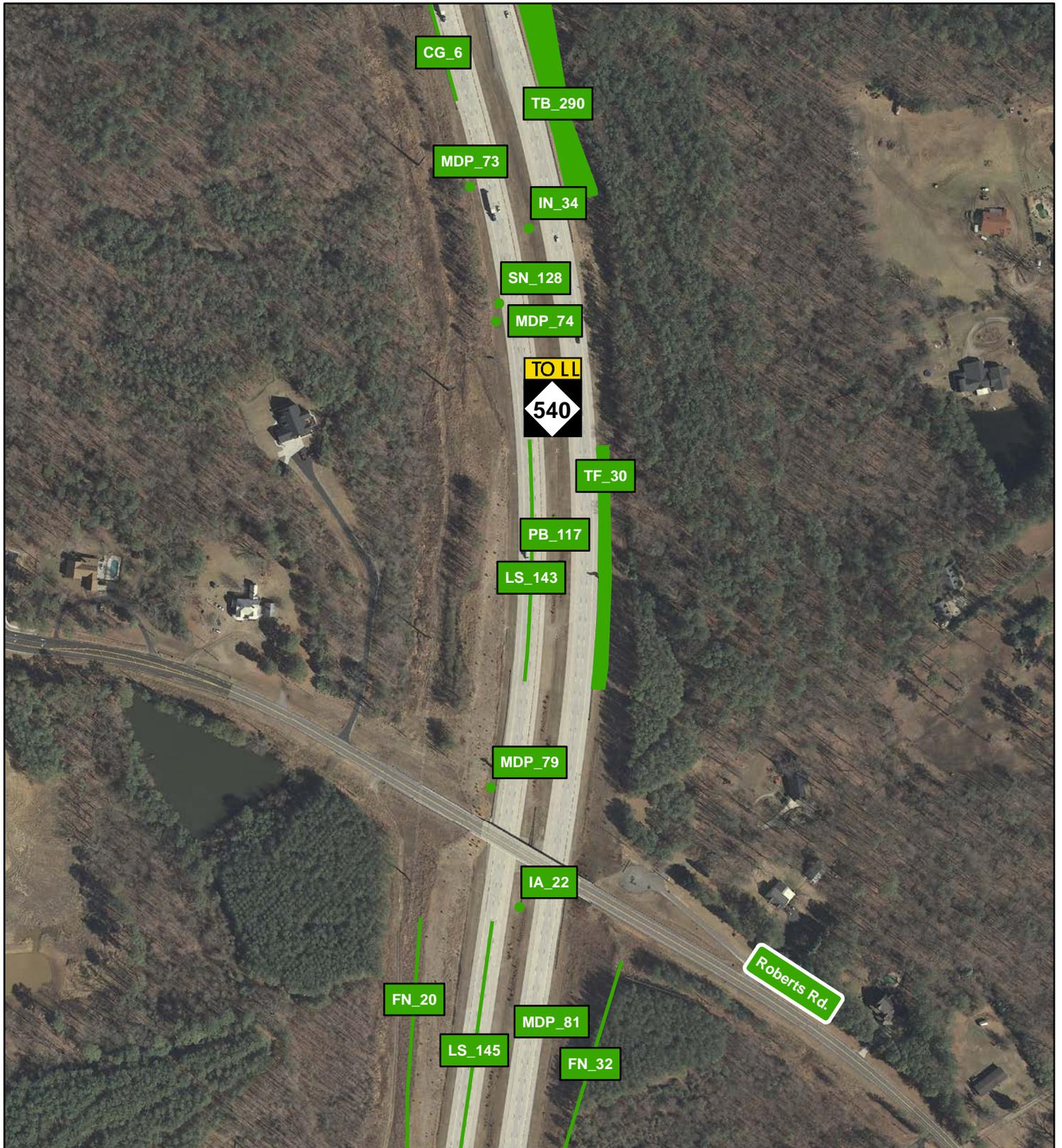


Legend

-  Failing Asset
-  Passing Asset

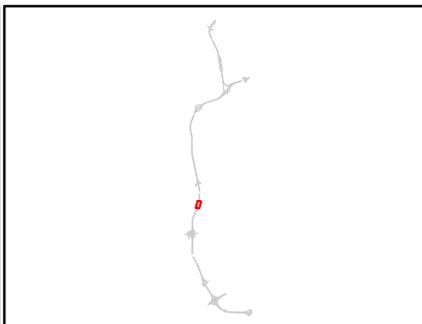


Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

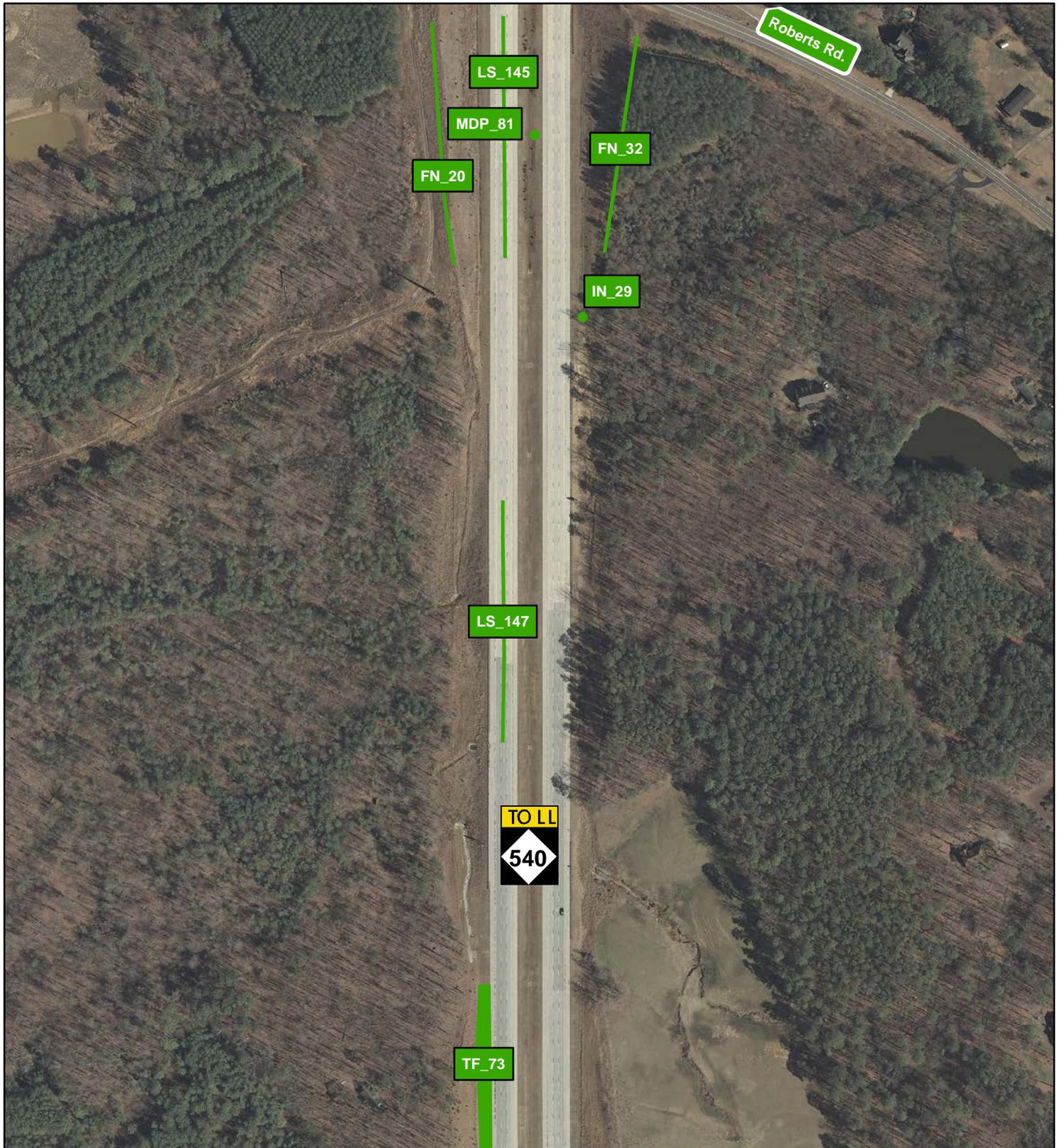


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

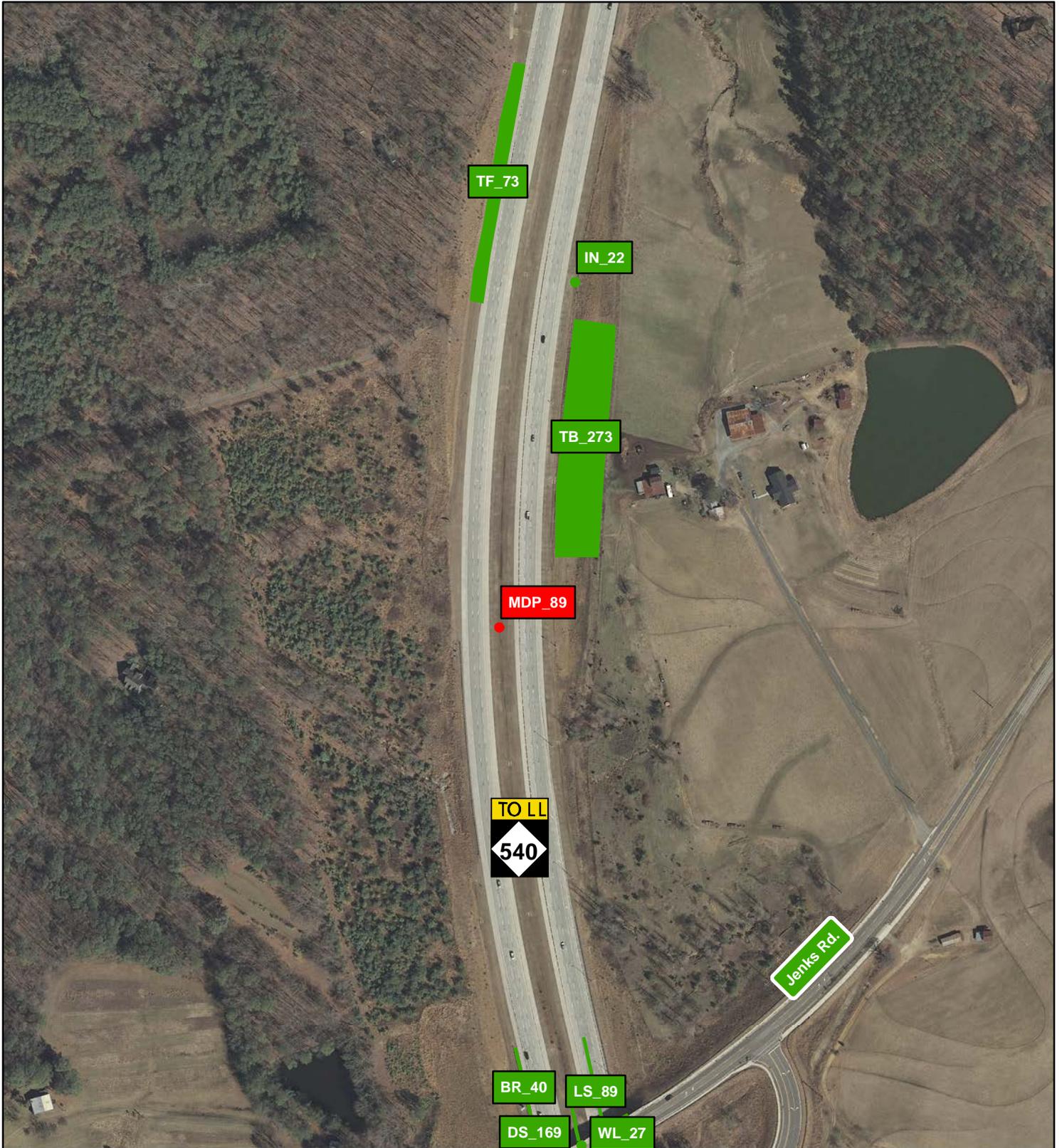


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

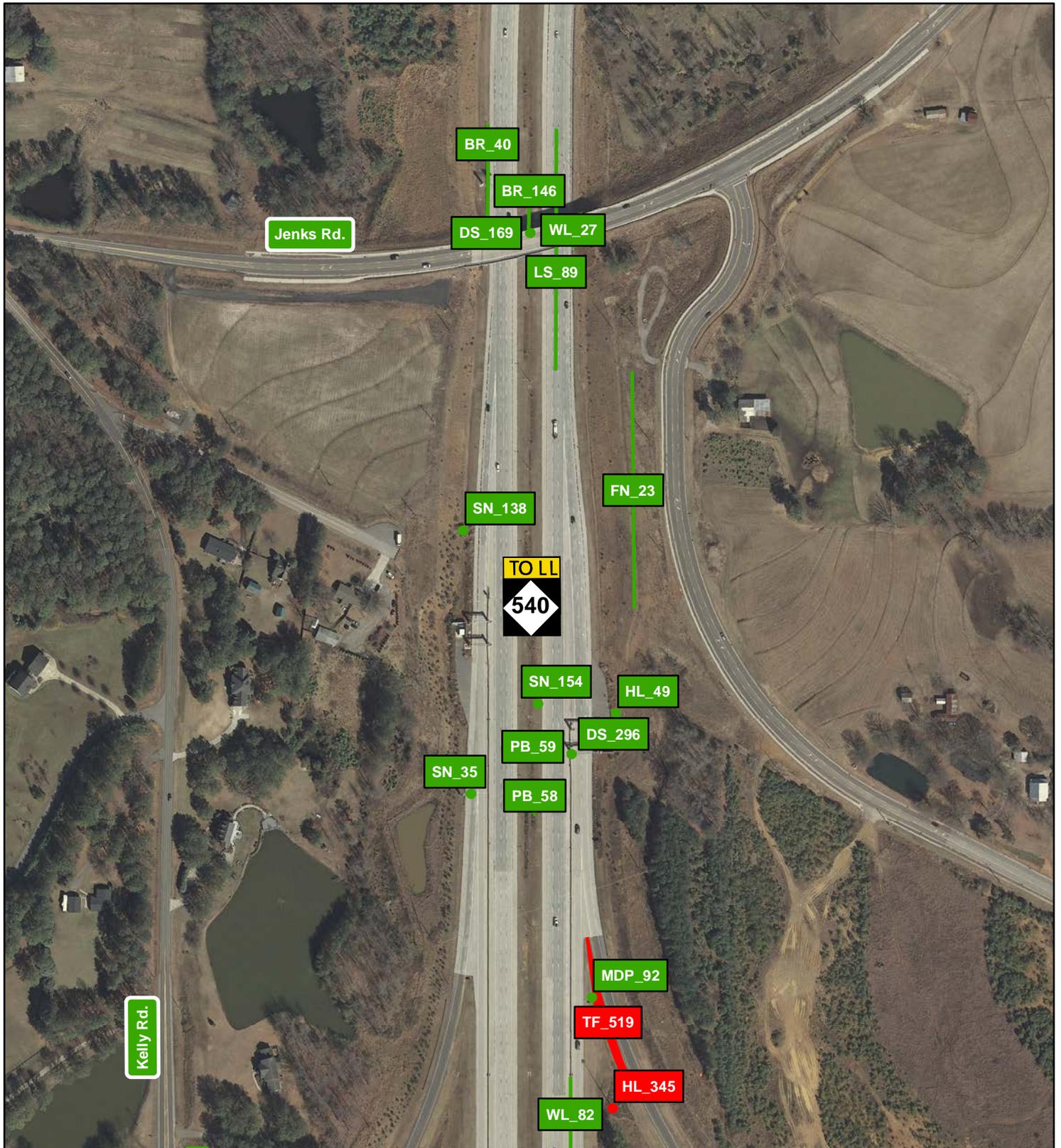


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

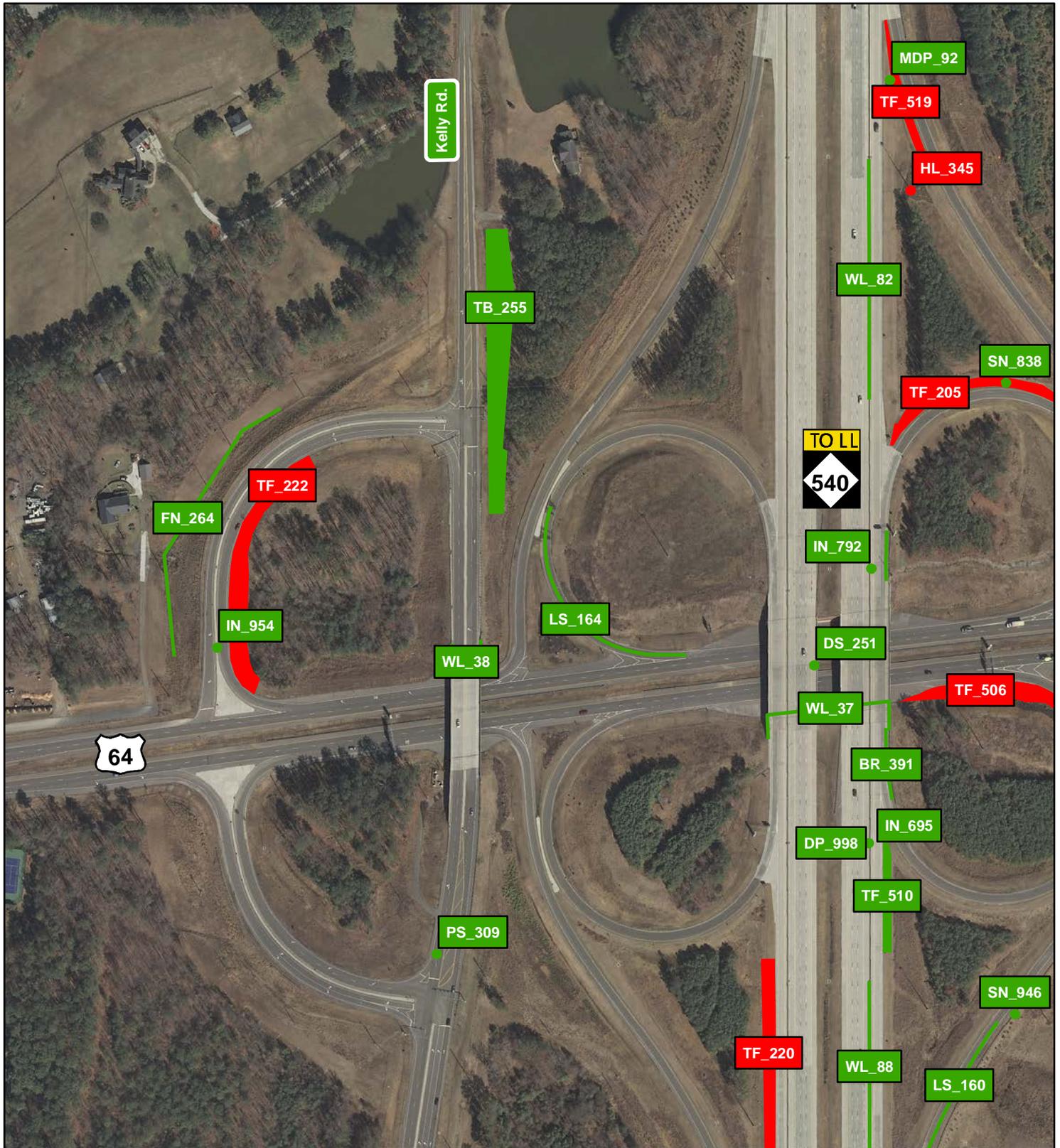


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

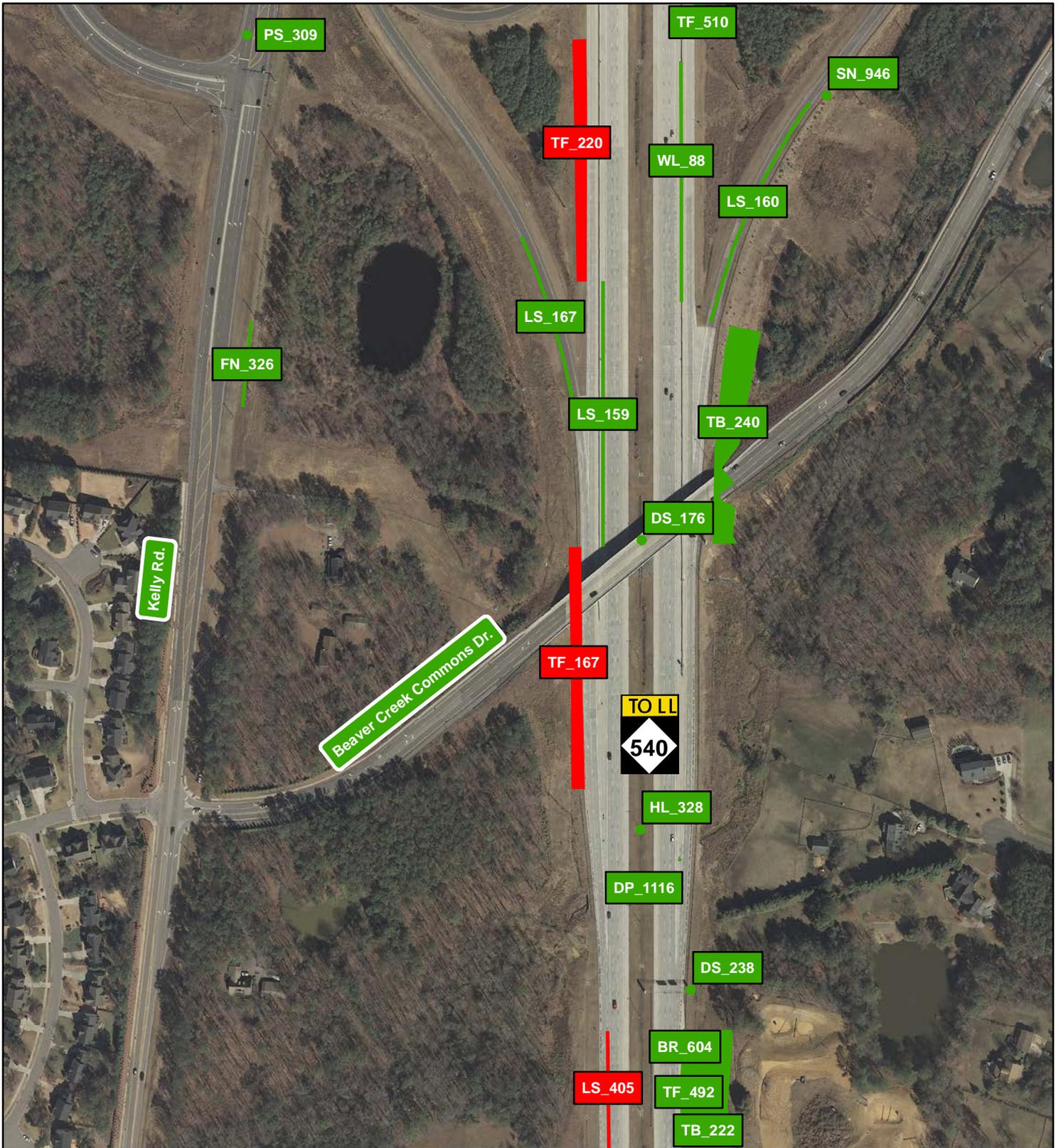


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

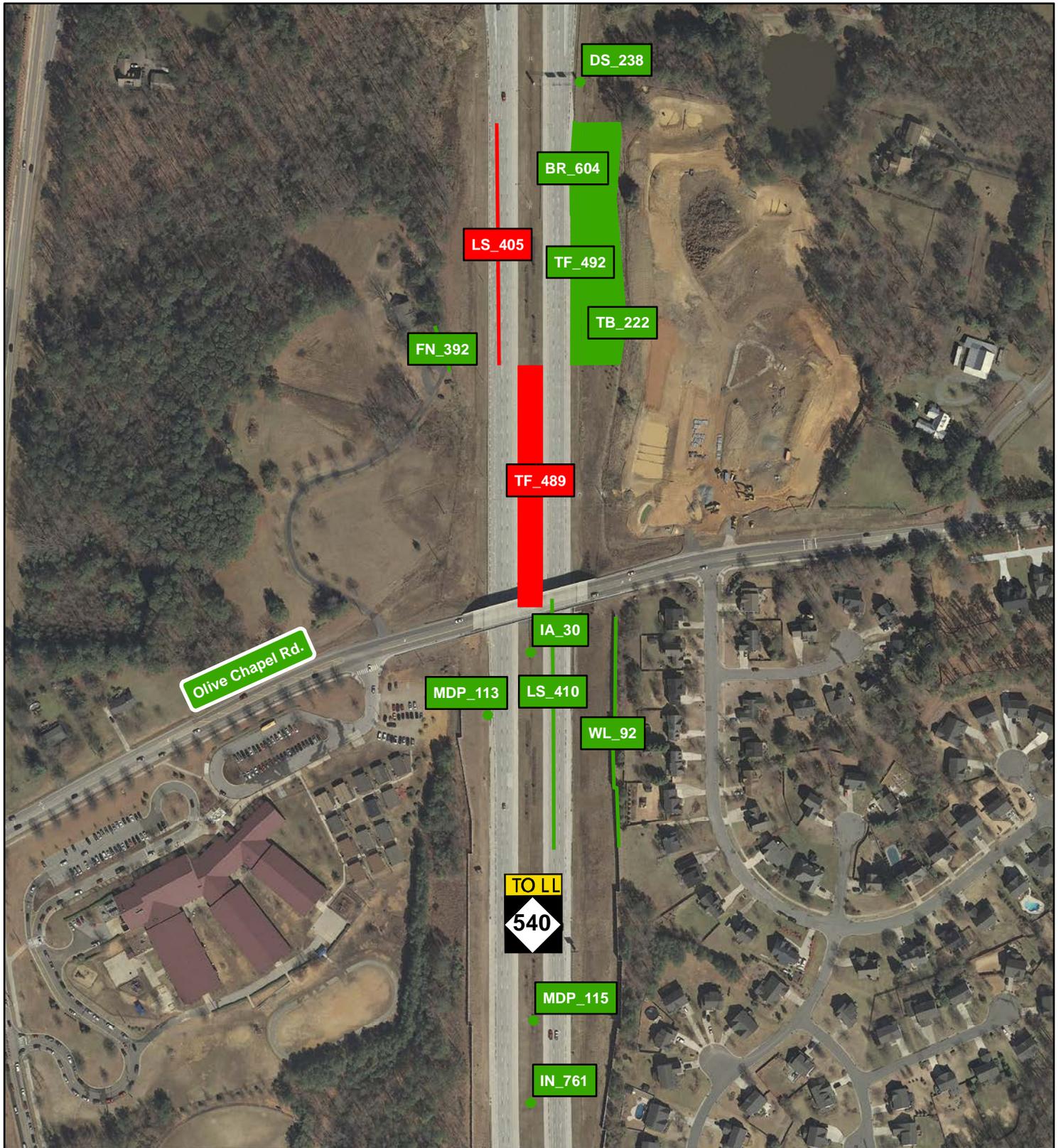


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

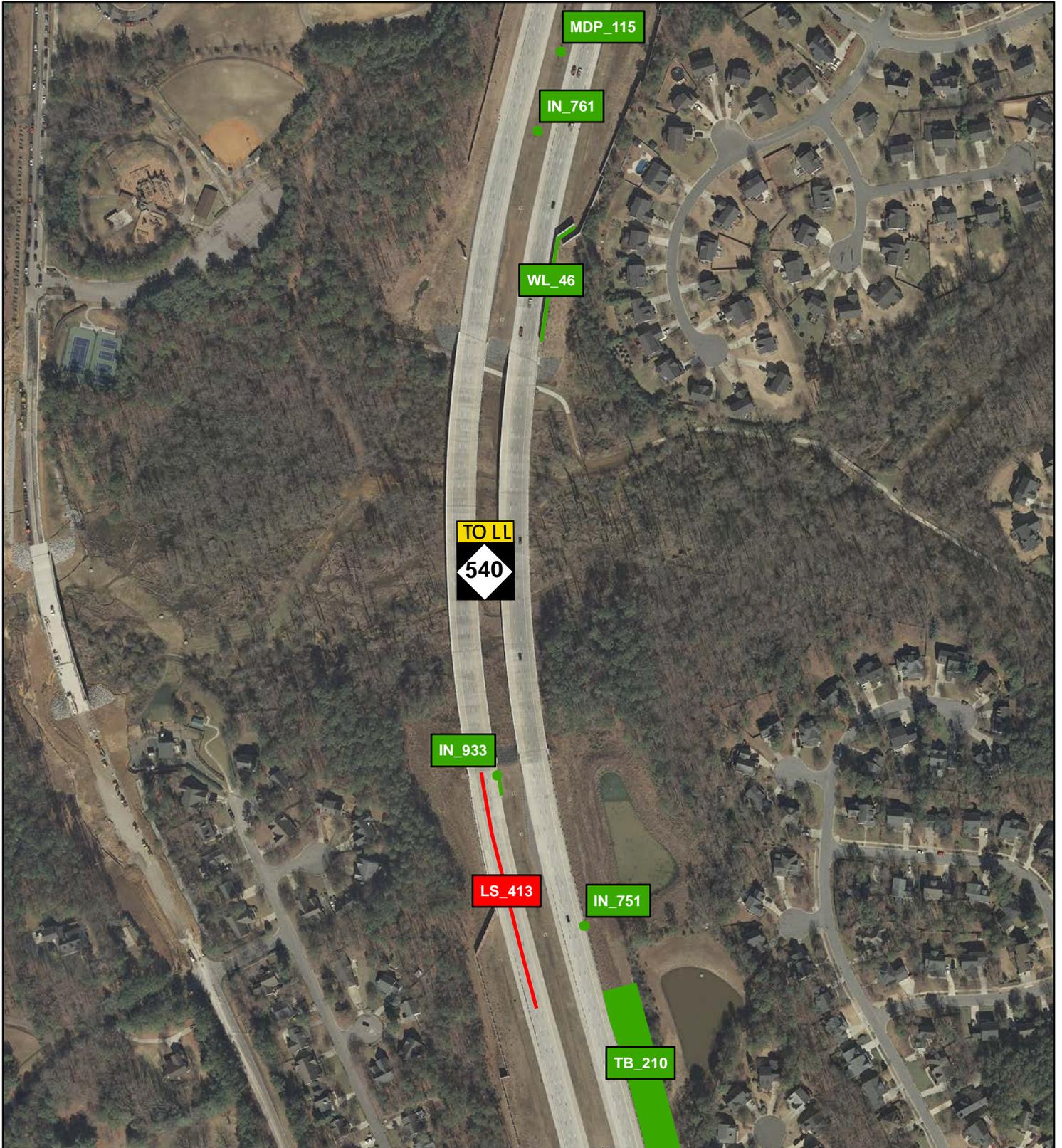


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

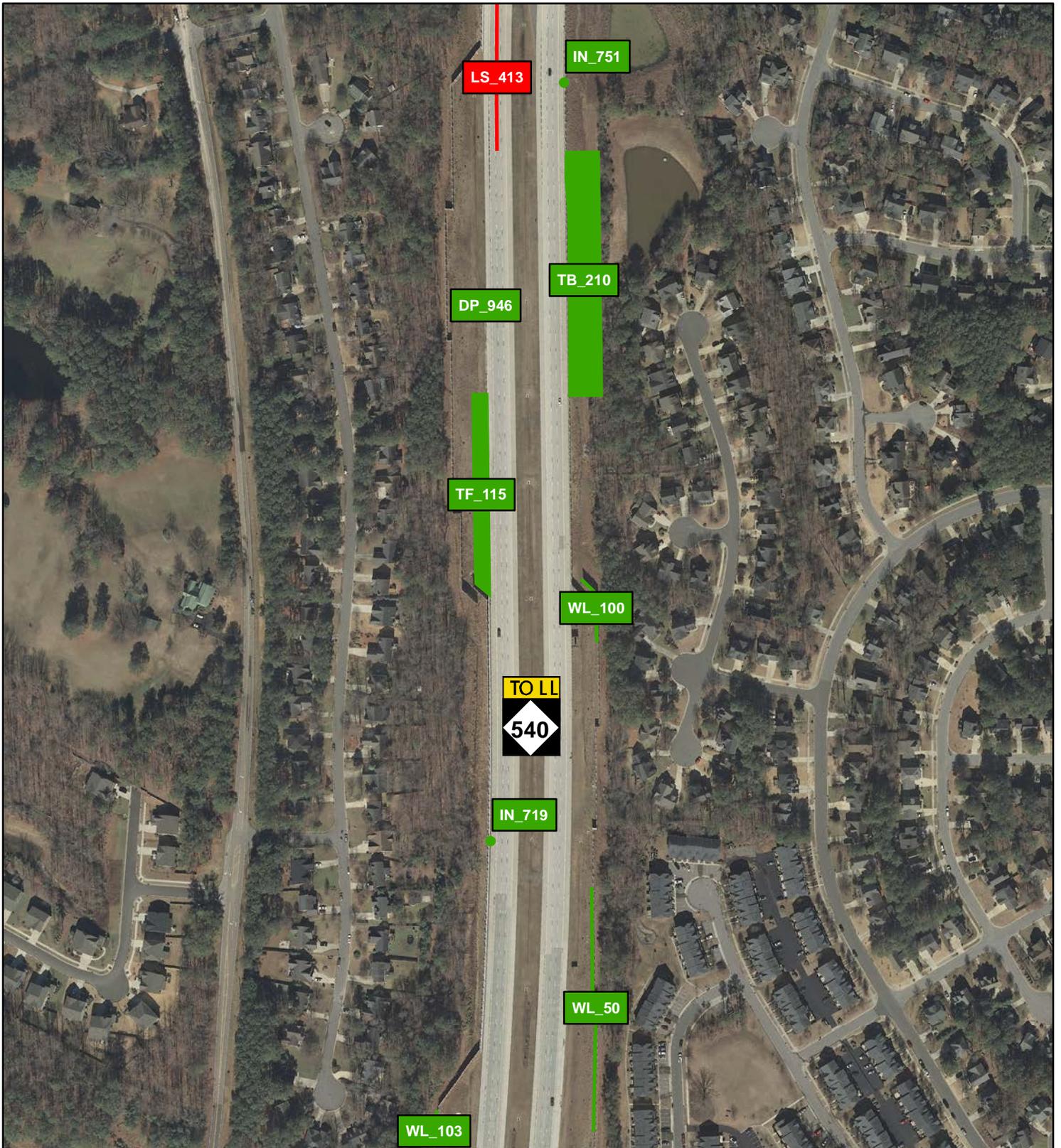


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

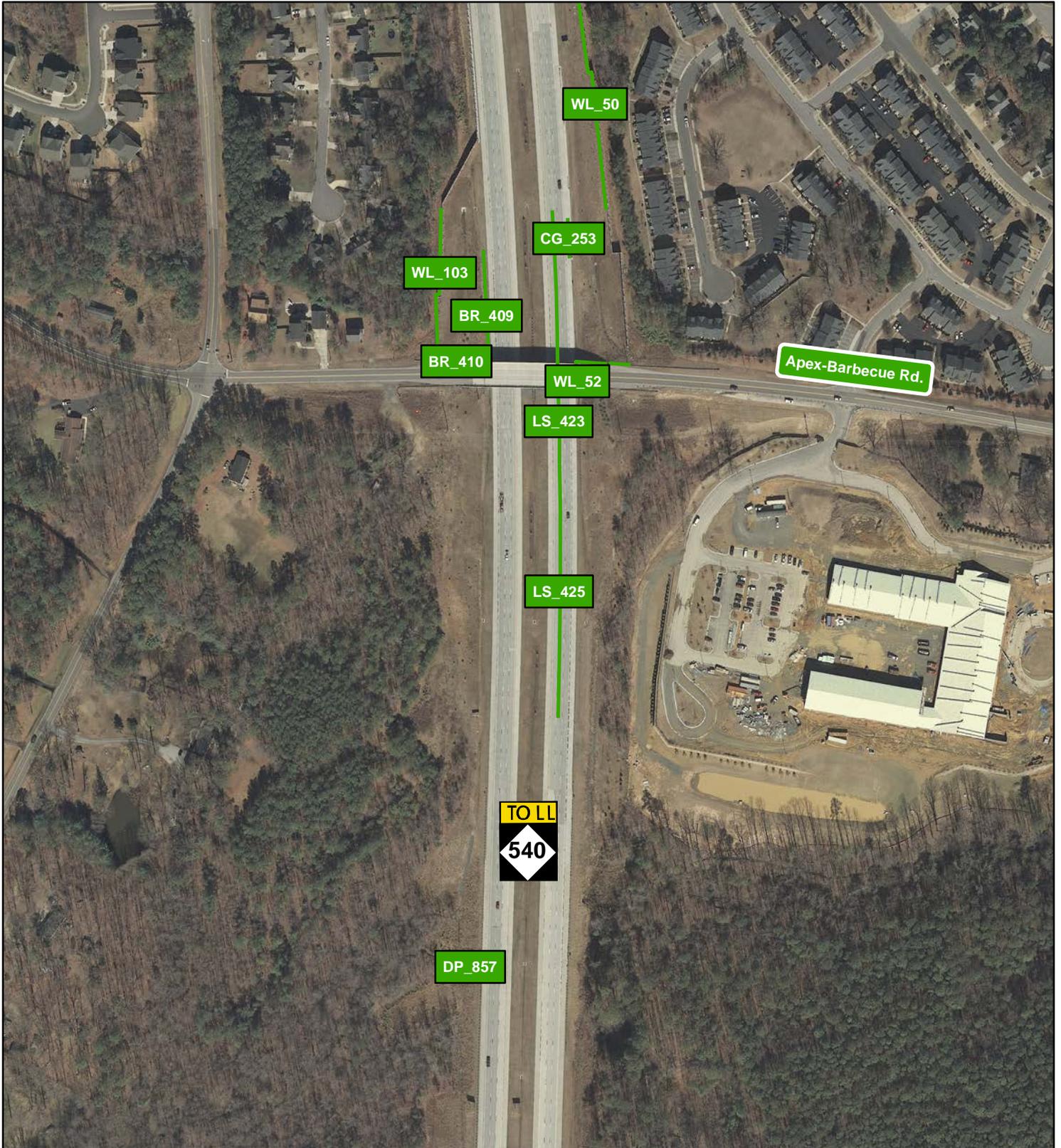


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

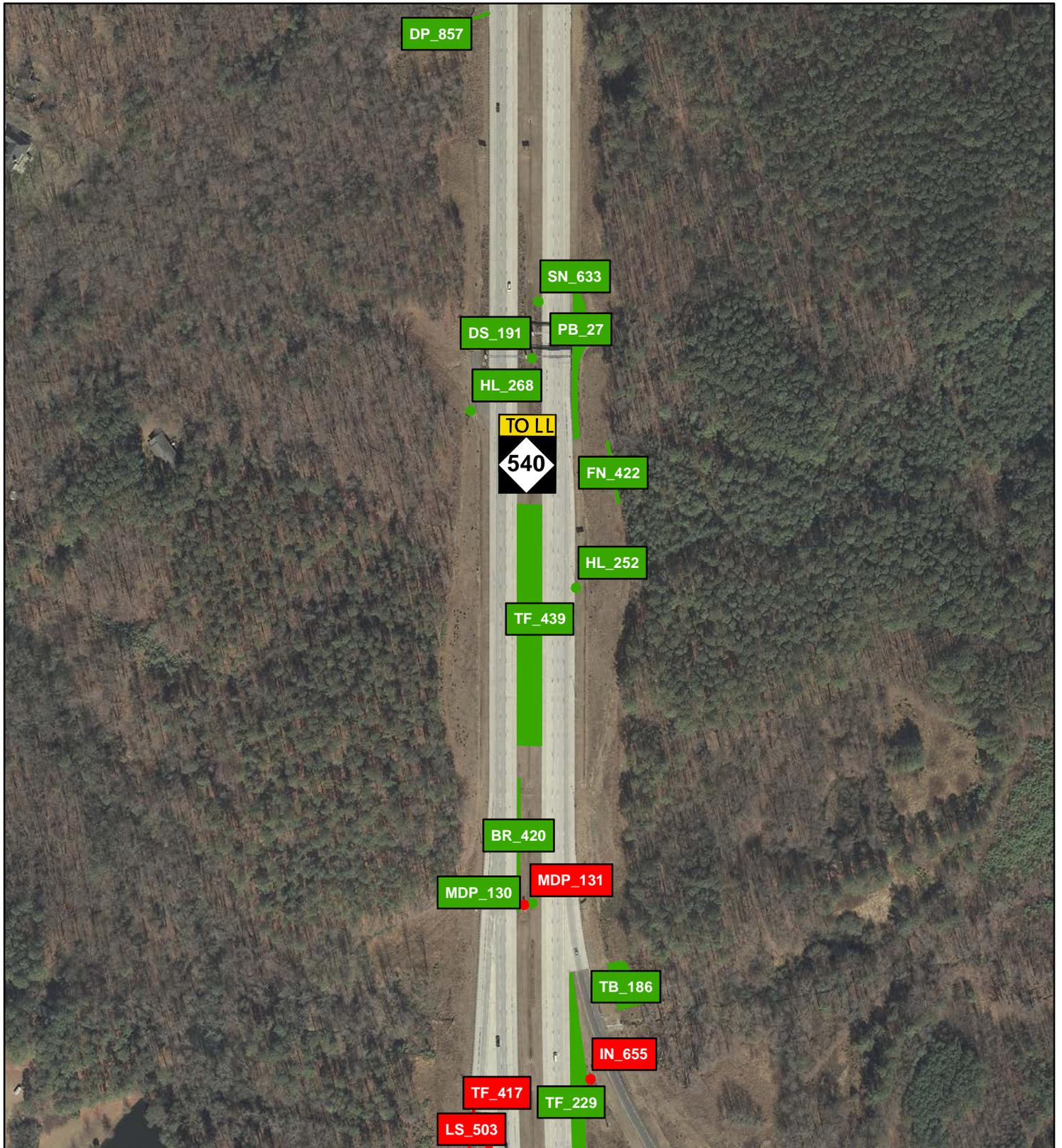


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

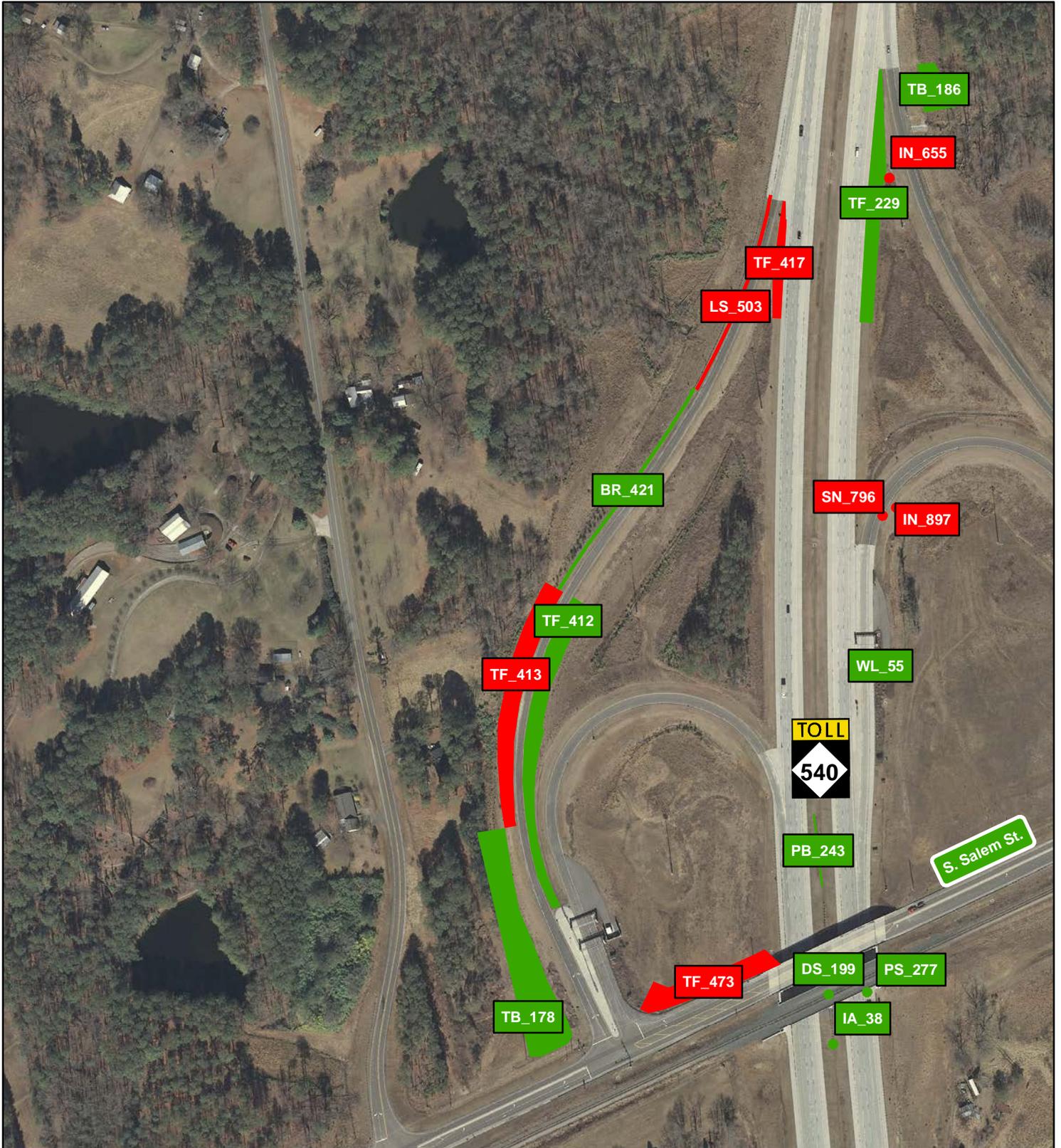


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

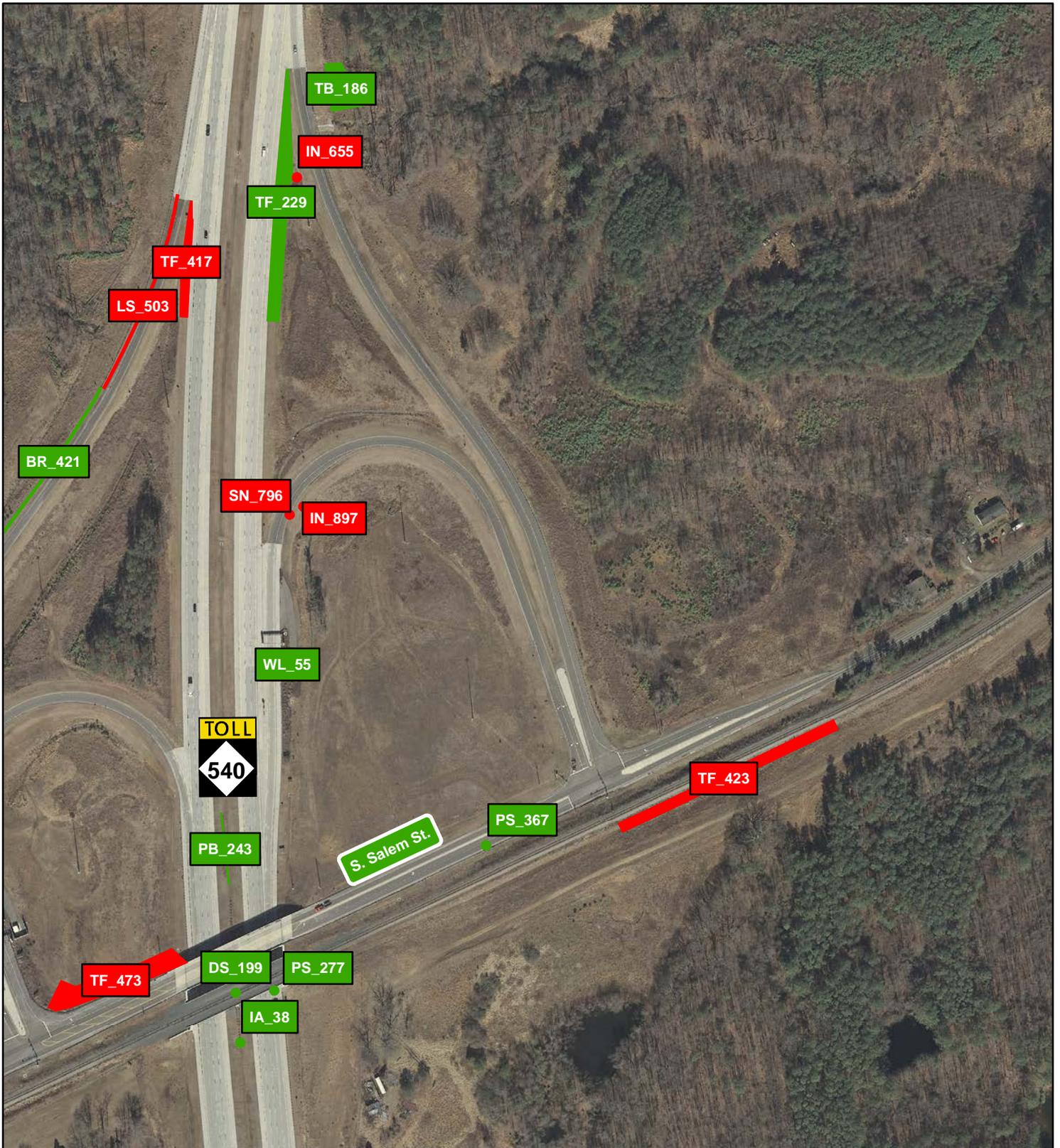


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

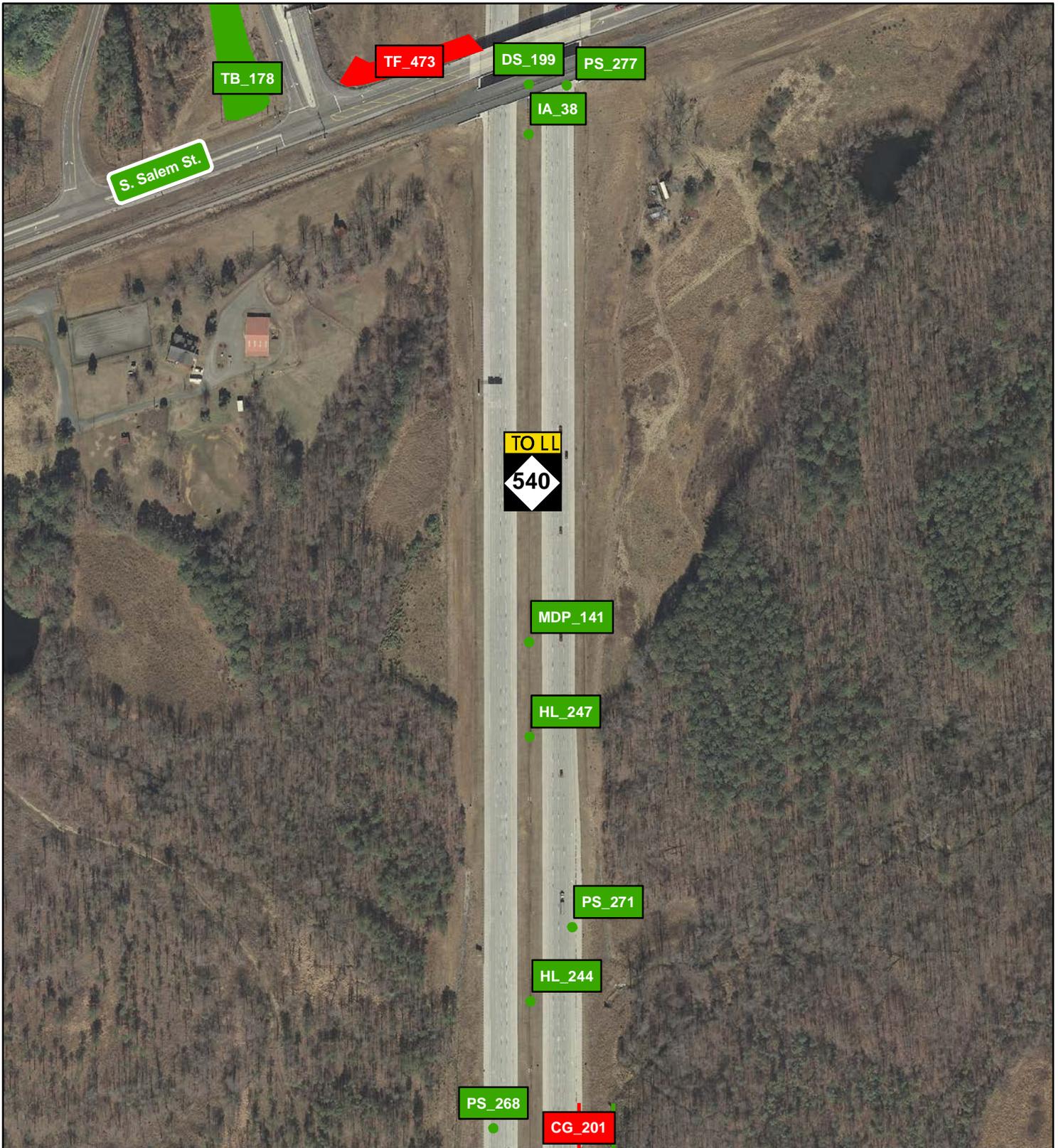


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

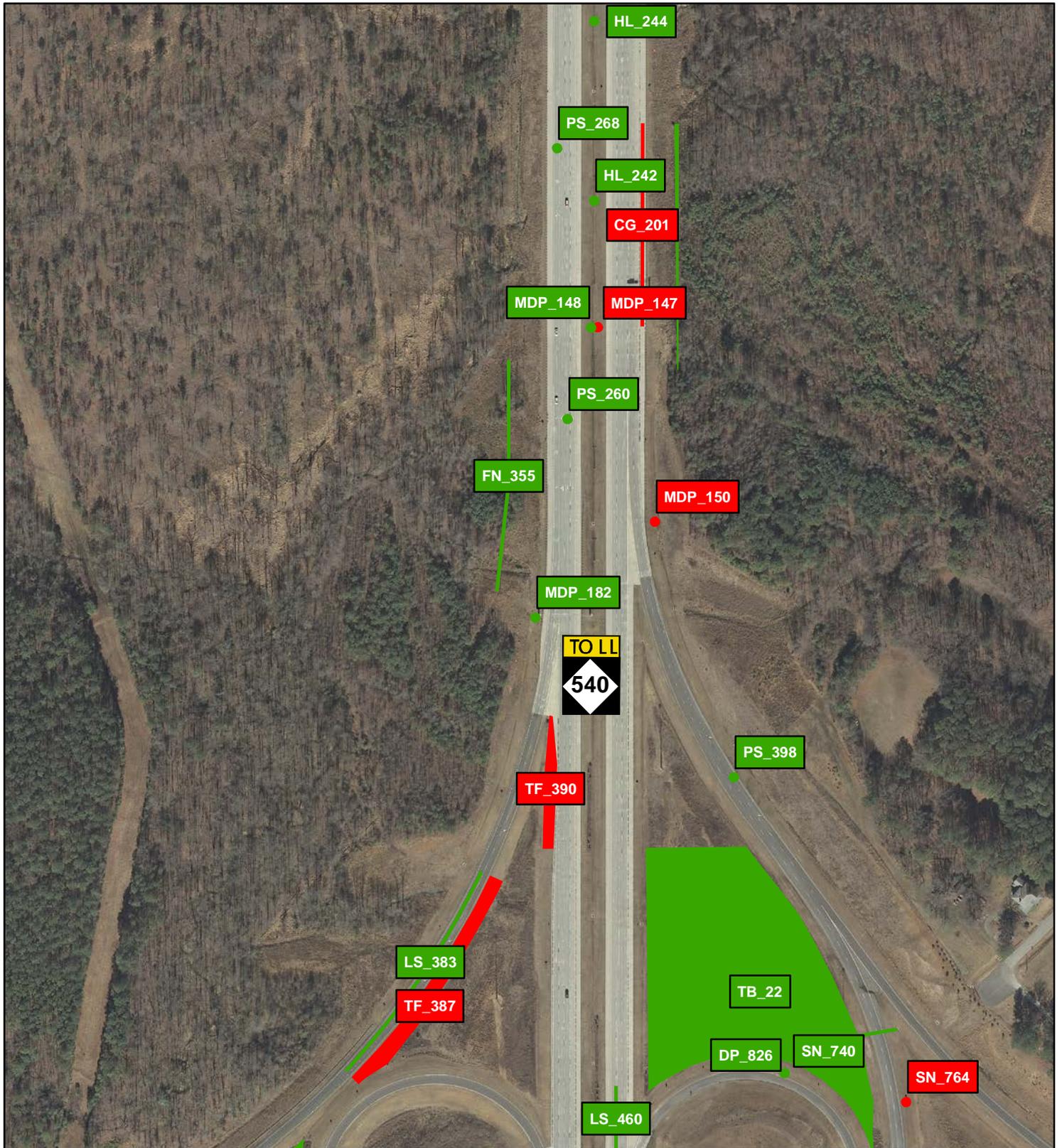


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

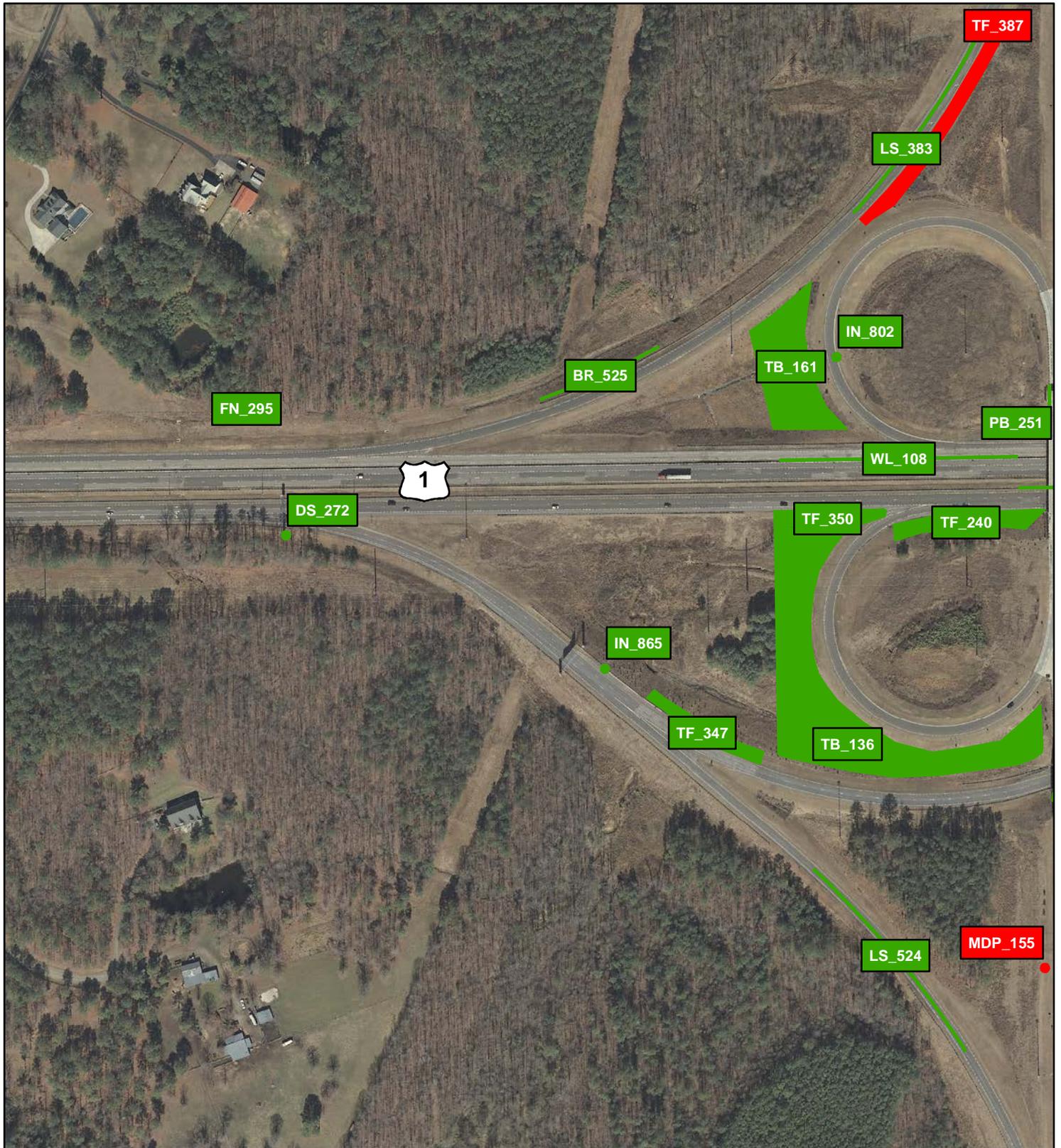


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

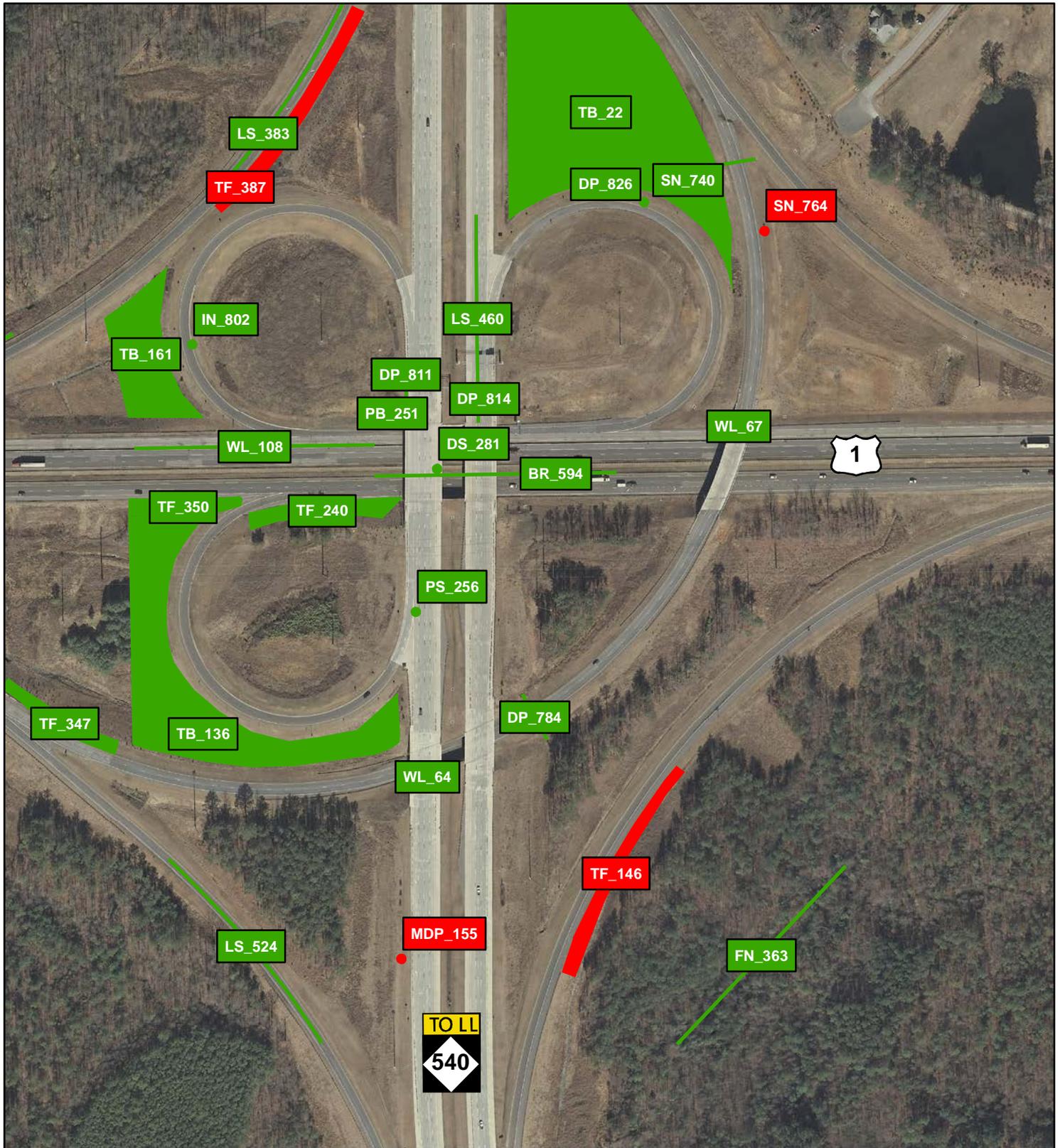


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

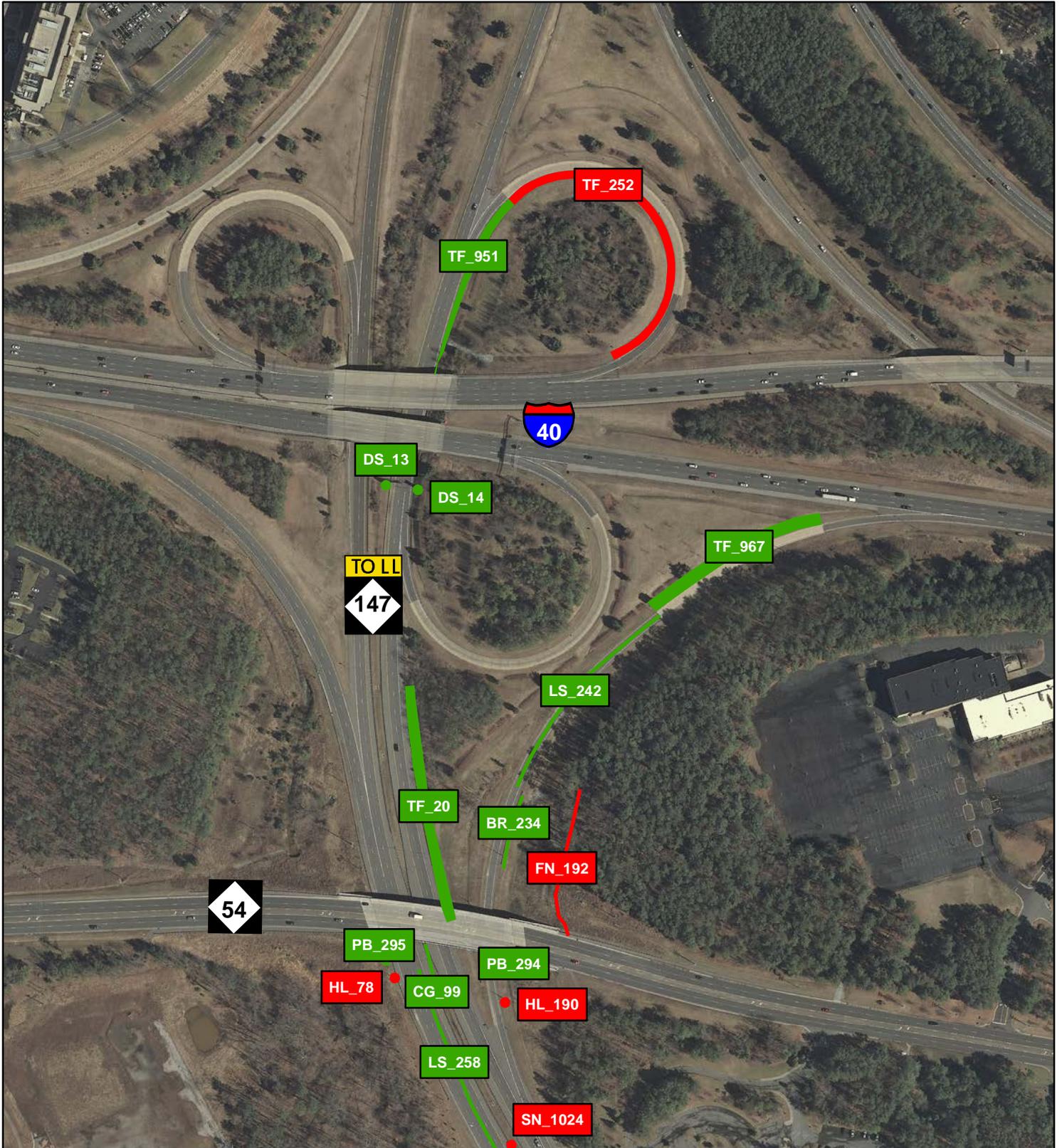


Legend

-  Failing Asset
-  Passing Asset

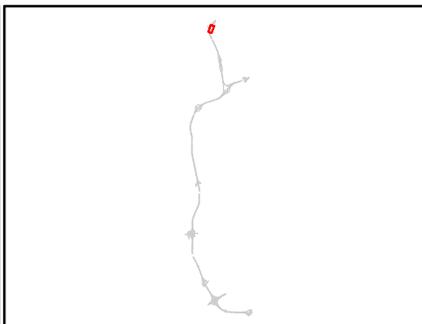


Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

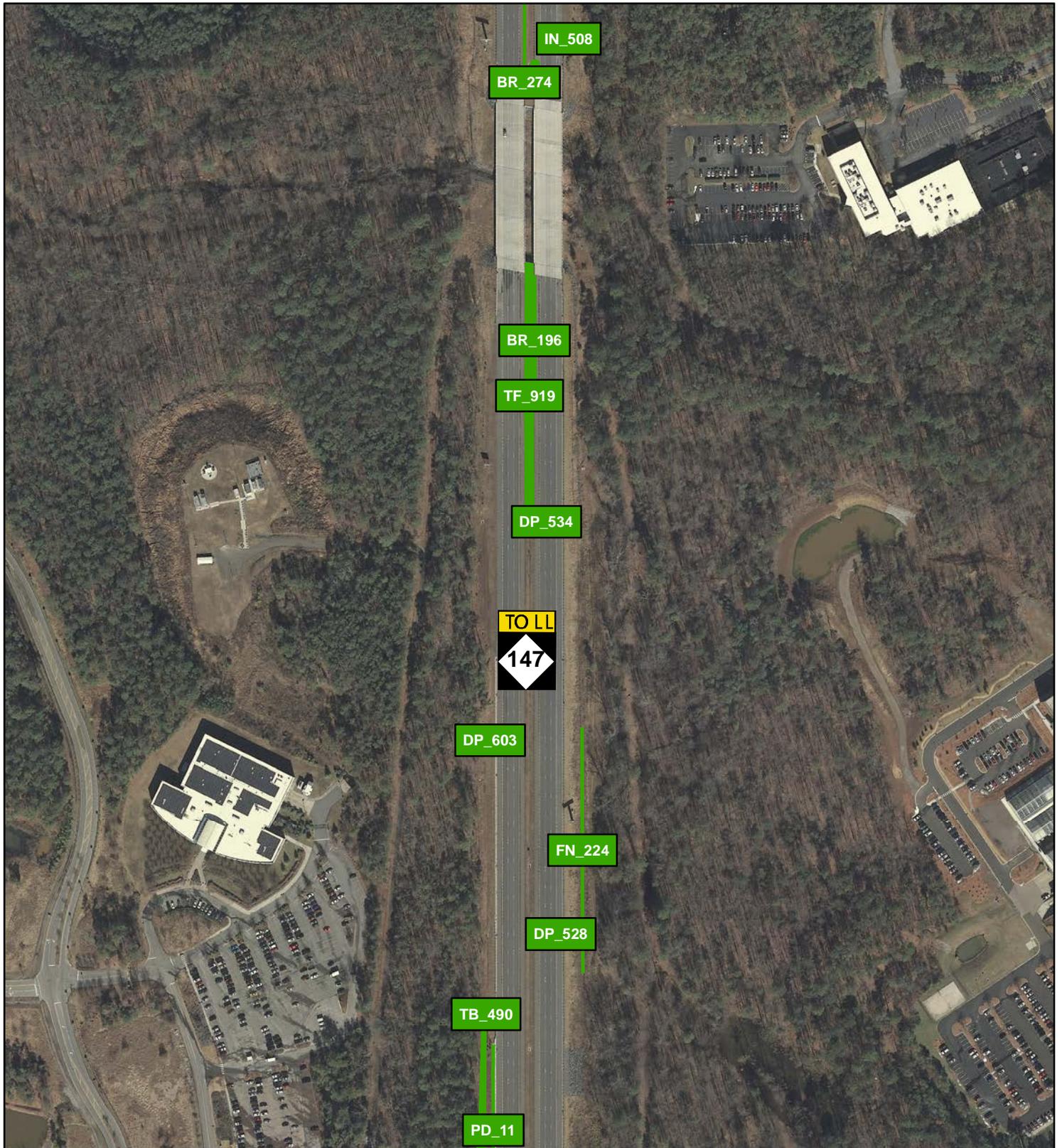


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

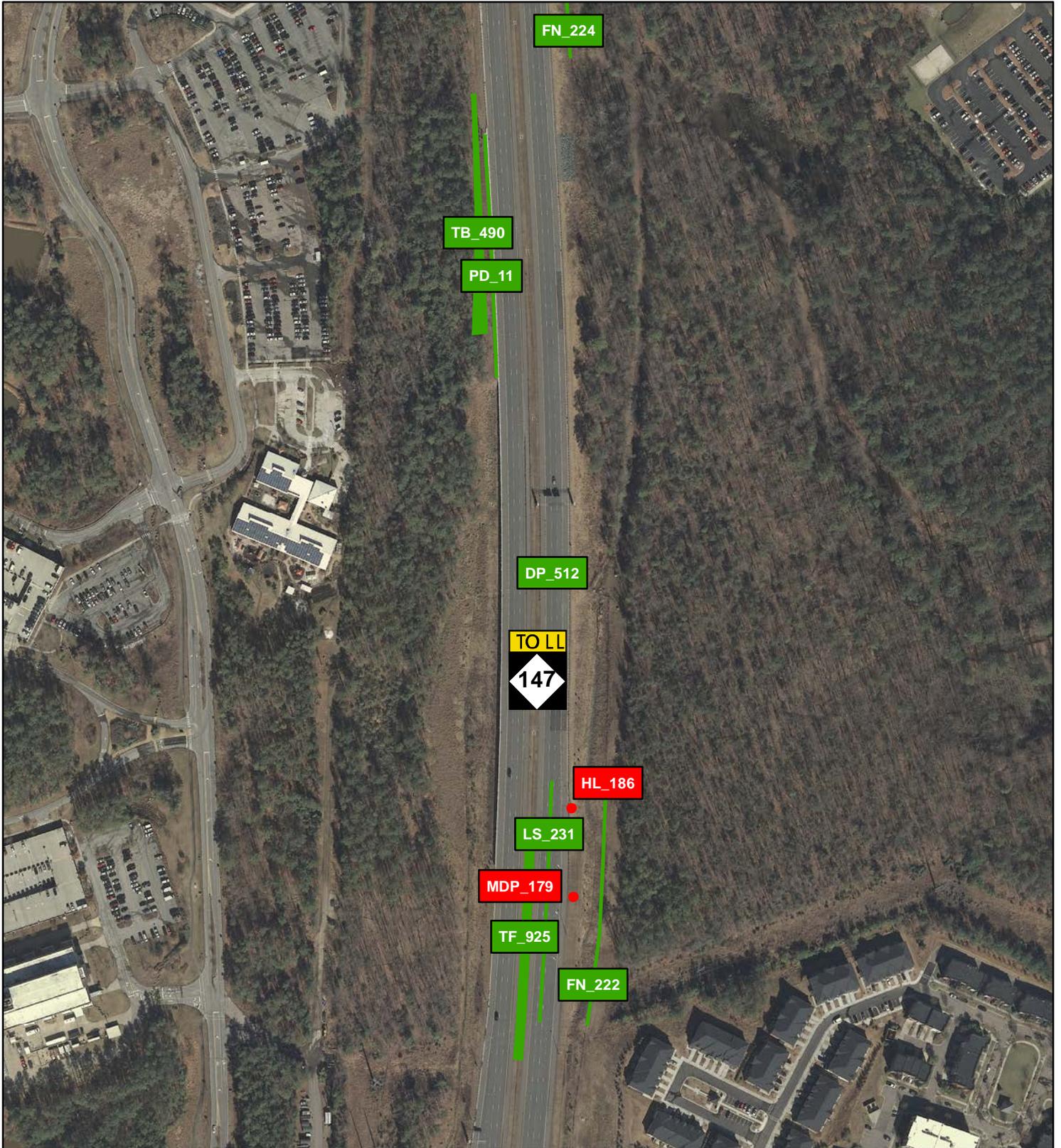


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

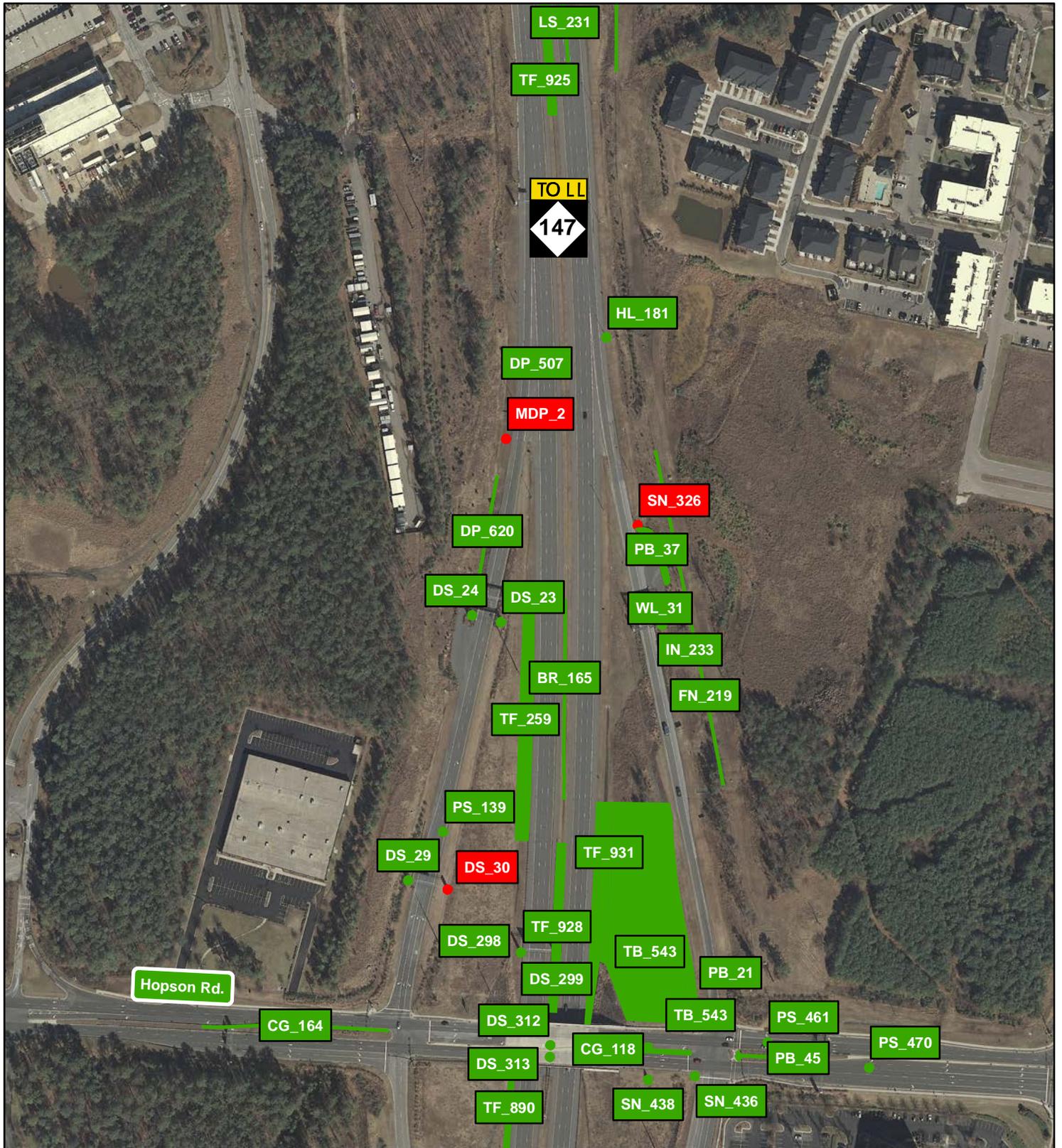


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

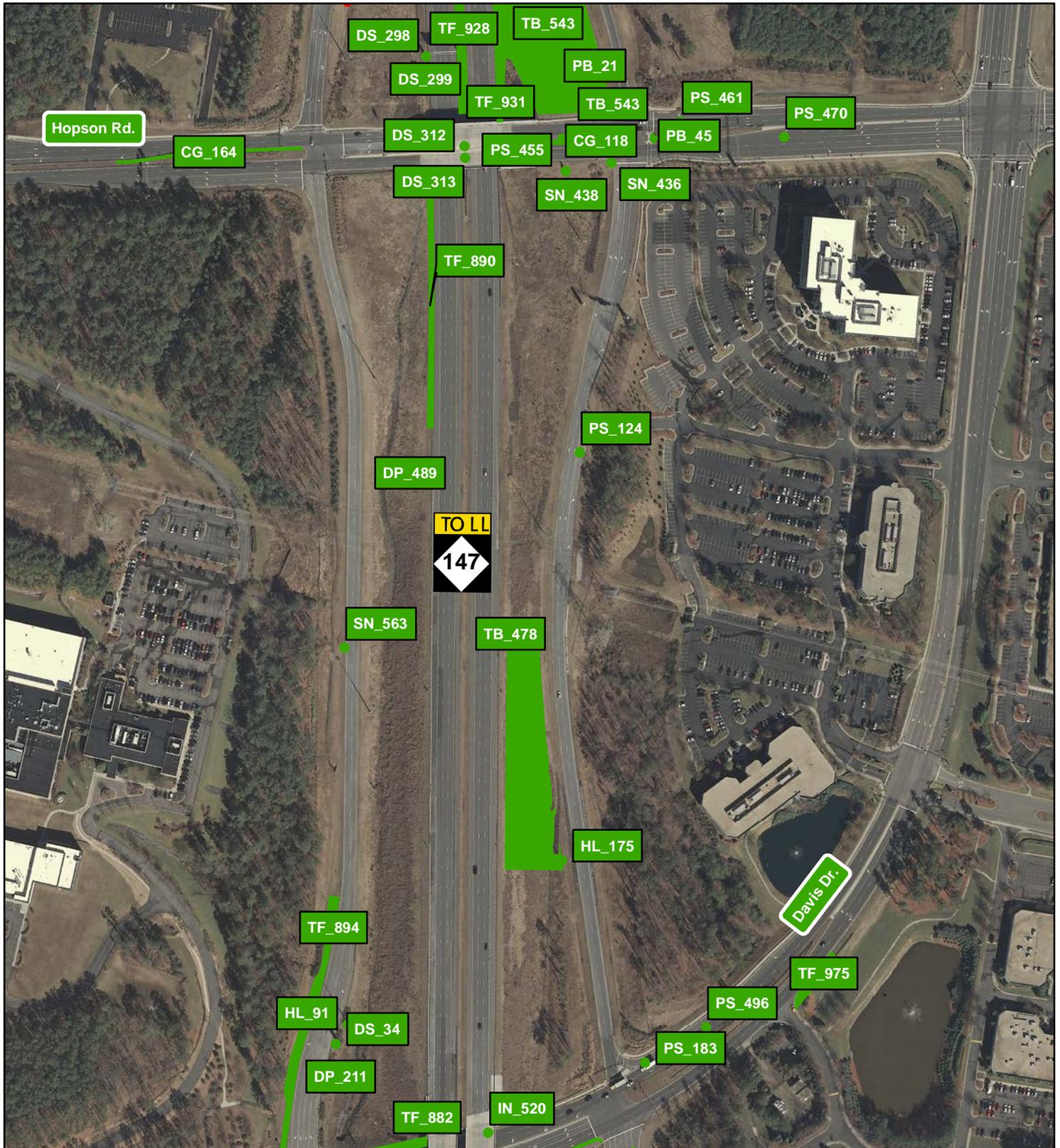


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

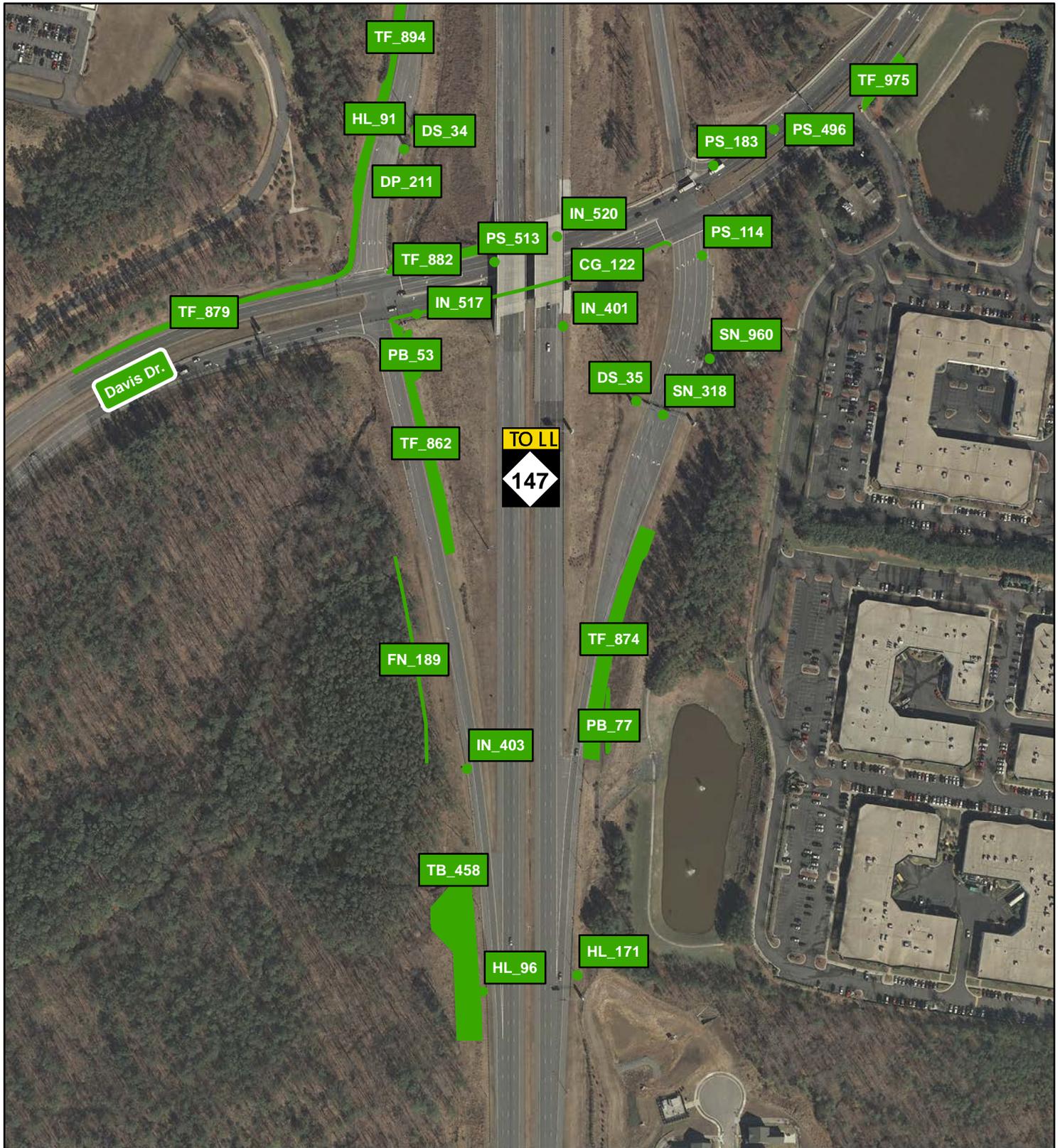


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

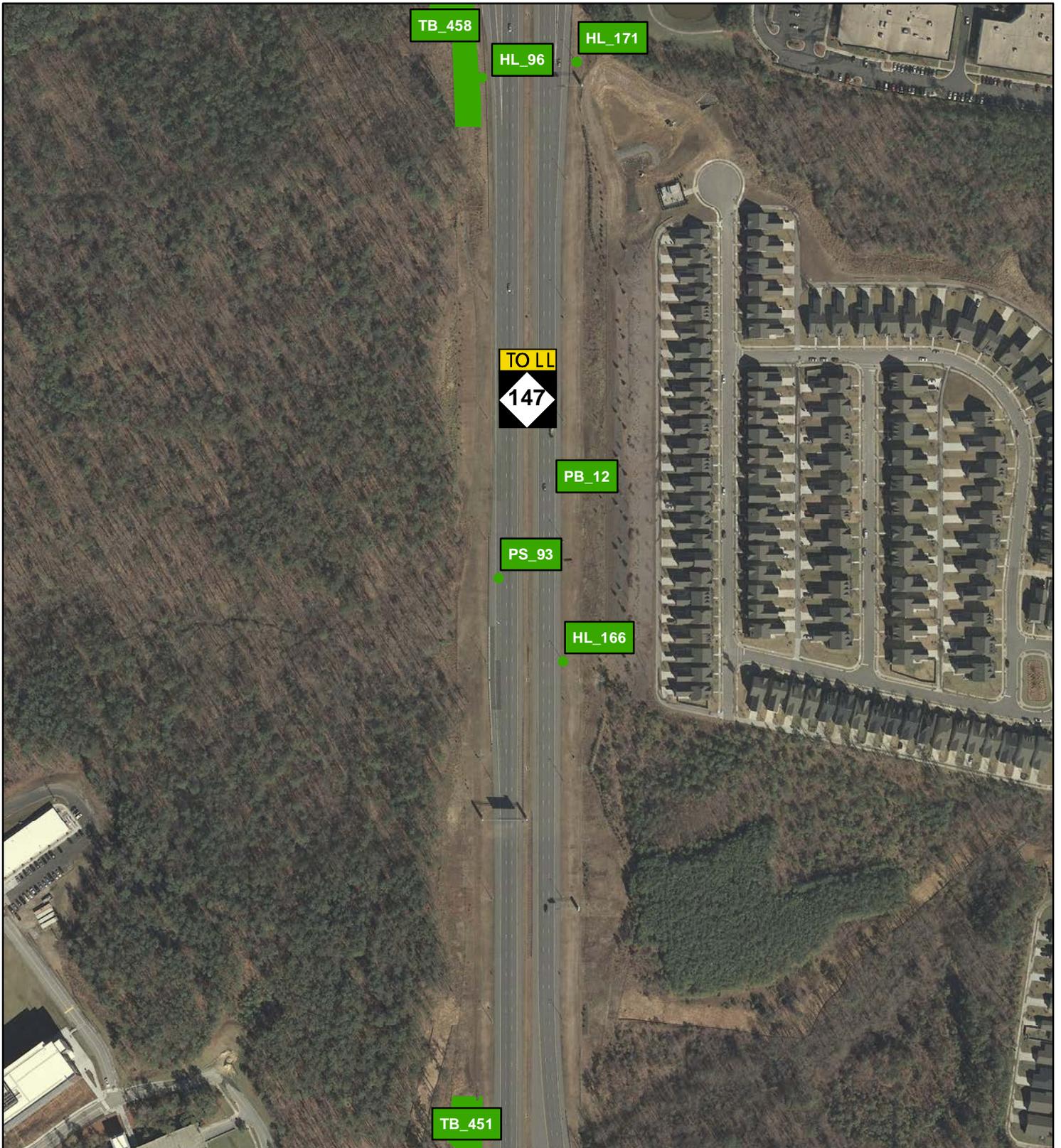


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations

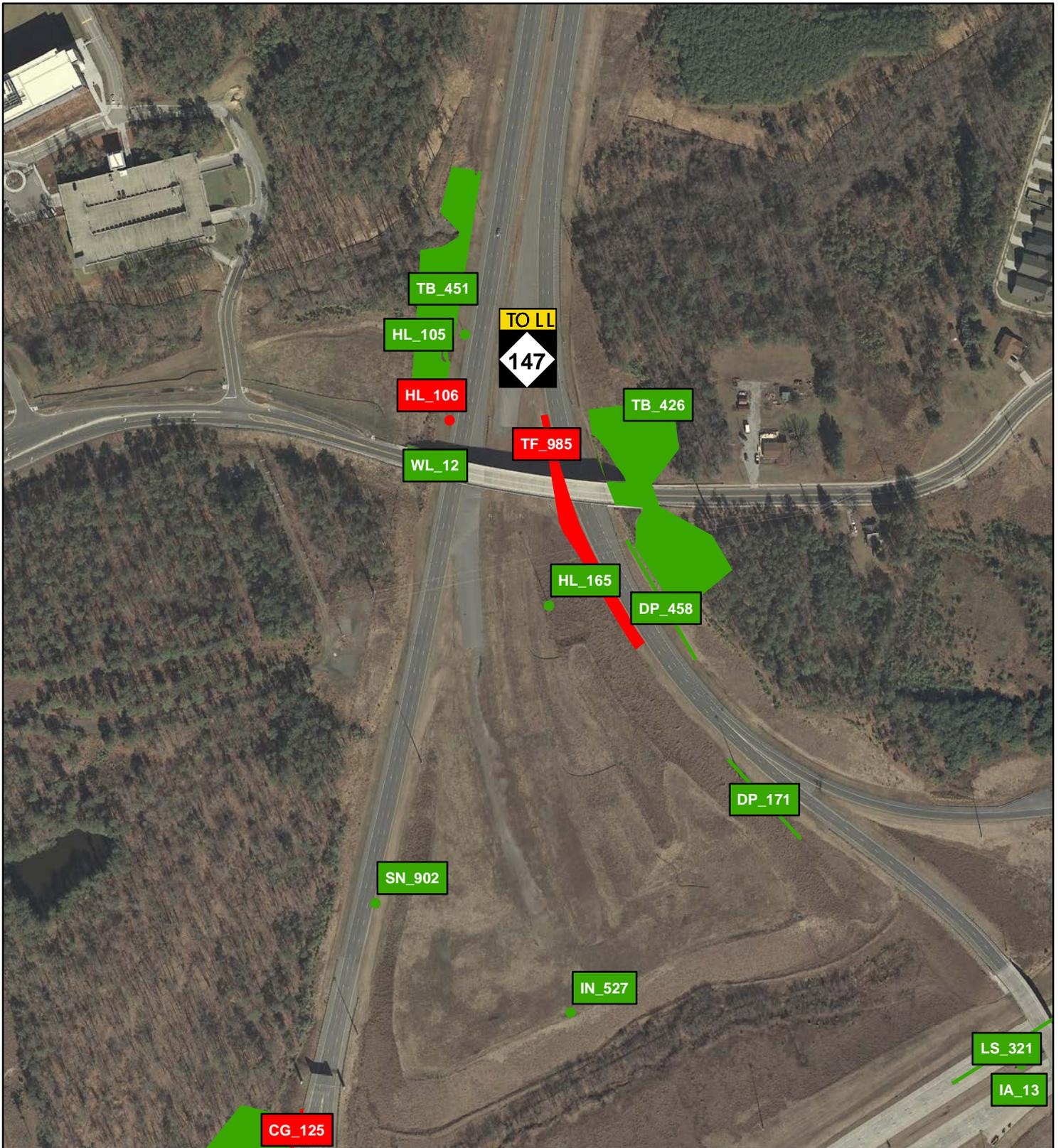


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2016 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix B

Triangle Expressway 2016 Third Quarter Table Results of Assets Failing MRP

Appendix B: Triangle Expressway 2016 Third 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. All assets and their respective prefixes are listed below:

Guardrail, Concrete Barrier and End Anchors (BR)..... 3
Curb and Gutter (CG) 4
Decorative Supports (DS)..... 5
Drainage Pipes (DP)..... 6
Misc. Drainage Structures (MDP)..... 7
Fence and Control of Access (FN) 10
Graffiti (GR) 11
Highway Lighting (HL) 12
Impact Attenuators (IA) 13
Inlets (IN)..... 14
Landscaping (PB) 15
Paved Lanes – Asphalt (LS)..... 16
Paved Lanes – Concrete (LS) 17
Paved Shoulders (LS)..... 18
Unpaved Shoulders (LS) 19
Front/Back Slopes (LS) 20
Unpaved Lateral and Outfall Ditches (LS) 21
Litter (LS) 22
Roadway Sweeping (LS) 23
Pavement Striping (LS)..... 24
Delineators (LS) 26
Paved Ditches (PD)..... 27
Pavement Words and Symbols (PS)..... 28
Signs (SN) 29
Tree and Brush (TB)..... 31
Turf Condition (TF) 32
MSE/Retaining Walls, Sound Barrier Walls and Screen Walls (WL)..... 39

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.

Guardrail, Concrete Barrier and End Anchors (BR)

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

Curb and Gutter (CG)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Valley	CG_125	Obstruction		A6, A53
2	Valley	CG_201	Obstruction		A40, A41

Decorative Supports (DS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Overhead Sign Support	DS_30	Spalls		A49

Drainage Pipes (DP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Drain	DP_11	Obstruction		A22, A23

Misc. Drainage Structures (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Shoulder Drain	MDP_2	Obstruction		A49
2	Shoulder Drain	MDP_34	Obstruction		A17
3	Shoulder Drain	MDP_56	Obstruction		A21
4	Shoulder Drain	MDP_63	Obstruction		A22, A23

Misc. Drainage Structures (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Shoulder Drain	MDP_89	Obstruction		A28
6	Shoulder Drain	MDP_131	Obstruction		A37
7	Shoulder Drain	MDP_147	Obstruction		A41
8	Shoulder Drain	MDP_150	Obstruction		A41

Misc. Drainage Structures (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Shoulder Drain	MDP_155	Erosion		A42, A43
10	Shoulder Drain	MDP_179	Obstruction		A48

Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Woven	FN_192	Fence Height		A45, A46

Graffiti (GR)

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

Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Single Roadway	HL_78	Functional Damage	Not Available for Nighttime Failure	A45, A46
2	Single Roadway	HL_106	Functional Damage	Not Available for Nighttime Failure	A53
3	Single Roadway	HL_120	Functional Damage	Not Available for Nighttime Failure	A9, A10, A11
4	Single Roadway	HL_149	Functional Damage	Not Available for Nighttime Failure	A4
5	Single Roadway	HL_151	Part Damage		A4
6	Single Roadway	HL_186	Functional Damage	Not Available for Nighttime Failure	A48
7	Single Roadway	HL_189	Functional Damage	Not Available for Nighttime Failure	A46
8	Single Roadway	HL_190	Functional Damage	Not Available for Nighttime Failure	A45, A46
9	Single Roadway	HL_211	Functional Damage	Not Available for Nighttime Failure	A9, A10, A11
10	Single Roadway	HL_212	Functional Damage	Not Available for Nighttime Failure	A10, A11
11	Single Roadway	HL_314	Functional Damage	Not Available for Nighttime Failure	A44
12	High Mast	HL_345	Part Damage		A29, A30, A31

Impact Attenuators (IA)

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

Inlets (IN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Inlet	IN_273	Obstruction		A7
2	Inlet	IN_274	Obstruction		A7
3	Inlet	IN_655	Obstruction		A37, A38, A39
4	Inlet	IN_897	Obstruction		A38, A39

Landscaping (PB)

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

Paved Lanes – Asphalt (LS)

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

Paved Lanes – Concrete (LS)

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

Paved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_293	Paved Shoulder Joint		A6, A7

Unpaved Shoulders (LS)

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

Front/Back Slopes (LS)

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

Unpaved Lateral and Outfall Ditches (LS)

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

Litter (LS)

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

Roadway Sweeping (LS)

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

Pavement Striping (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_405	Missing Line		A32, A33

Pavement Markers (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_76	Marker Reflectivity	Not Available for Nighttime Failure	A25
2	Concrete	LS_413	Marker Reflectivity	Not Available for Nighttime Failure	A34, A35

Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_359	Missing Markers		A44
2	Asphalt	LS_503	Missing Markers		A37, A38, A39

Paved Ditches (PD)

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

Pavement Words and Symbols (PS)

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

Signs (SN)

#	Sign Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Destination	SN_192	Height Requirement		A22, A24
2	Authorized Vehicles	SN_326	Height Requirement		A49
3	Merge	SN_764	Height Requirement		A41, A43
4	Speed Limit Ramp	SN_796	Leaning		A38, A39

Signs (SN)

#	Sign Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Speed Limit	SN_1024	Height Requirement		A45, A46

Tree and Brush (TB)

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

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Turf	TF_5	Height		A9, A10
2	Turf	TF_45	Bareground		A22, A23, A24
3	Turf	TF_53	Bareground		A20, A21
4	Turf	TF_146	Height		A43

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_167	Bareground		A32
6	Turf	TF_187	Height		A44
7	Turf	TF_205	Bareground		A30, A31
8	Turf	TF_220	Bareground		A30, A31, A32

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Turf	TF_222	Bareground		A30
10	Turf	TF_252	Height		A45
11	Turf	TF_367	Height		A44
12	Turf	TF_387	Bareground		A41, A42, A43

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Turf	TF_390	Bareground		A41
14	Turf	TF_413	Bareground		A38
15	Turf	TF_417	Bareground		A37, A38, A39
16	Turf	TF_423	Height		A39

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
17	Turf	TF_473	Height, Bareground		A38, A39, A40
18	Turf	TF_489	Bareground		A33
19	Turf	TF_506	Bareground		A30, A31
20	Turf	TF_515	Height		A31

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
21	Turf	TF_519	Bareground		A29, A30, A31
22	Turf	TF_587	Bareground		A21, A22, A23
23	Turf	TF_591	Bareground		A21
24	Turf	TF_691	Bareground		A11, A12

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
25	Turf	TF_740	Bareground		A6, A7
26	Turf	TF_750	Height		A6
27	Turf	TF_832	Height		A2, A3
28	Turf	TF_985	Bareground		A53

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

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