



NORTH CAROLINA
Turnpike Authority

Maintenance Rating Program

Triangle Expressway

2017 First Quarter Report

1 S. Wilmington Street
Raleigh, NC 27601



Last Updated:
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CONSULTANT CERTIFICATION OF COMPLETION

April 21, 2017

Dennis Jernigan, P.E.
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1 South Wilmington Street
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NCTA Triangle Expressway Roadway Maintenance Performance Rating Program; Q1, 2017 Rating

This is to certify that I, Ken M. McEntire, PE am an authorized official representative of the company The Kercher Group, Inc., which is a subconsultant 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,

The Kercher Group, 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

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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 2017 First Quarter Assessment of the Triangle Expressway.

The overall 2017 first quarter maintenance rating of the Triangle Expressway is 92.7, 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 2017 First Quarter Assessment		
Element	MRP Rating	Target Rating
Road Surface	97.8	85.0
Unpaved Shoulders and Ditches	95.6	85.0
Drainage	86.7	85.0
Roadside	90.3	85.0
Traffic Control Devices	91.4	85.0
Overall MRP Performance Rating	92.7	90.0

This report also 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 93.7.

Table 2: MRP Rolling Element Results					
Element	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Q1 2017 Rating	Rolling Rating
Road Surface	100	99	98	98	99
Unpaved Shoulders and Ditches	100	100	100	96	99
Drainage	91	88	94	87	90
Roadside	83	90	94	90	89
Traffic Control Devices	96	90	88	91	92
Overall MRP Performance Rating	94.7	93.4	93.9	92.7	93.7

In addition, the report provides findings of the Green Level Historic District signs inspection. Due to construction work during 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.

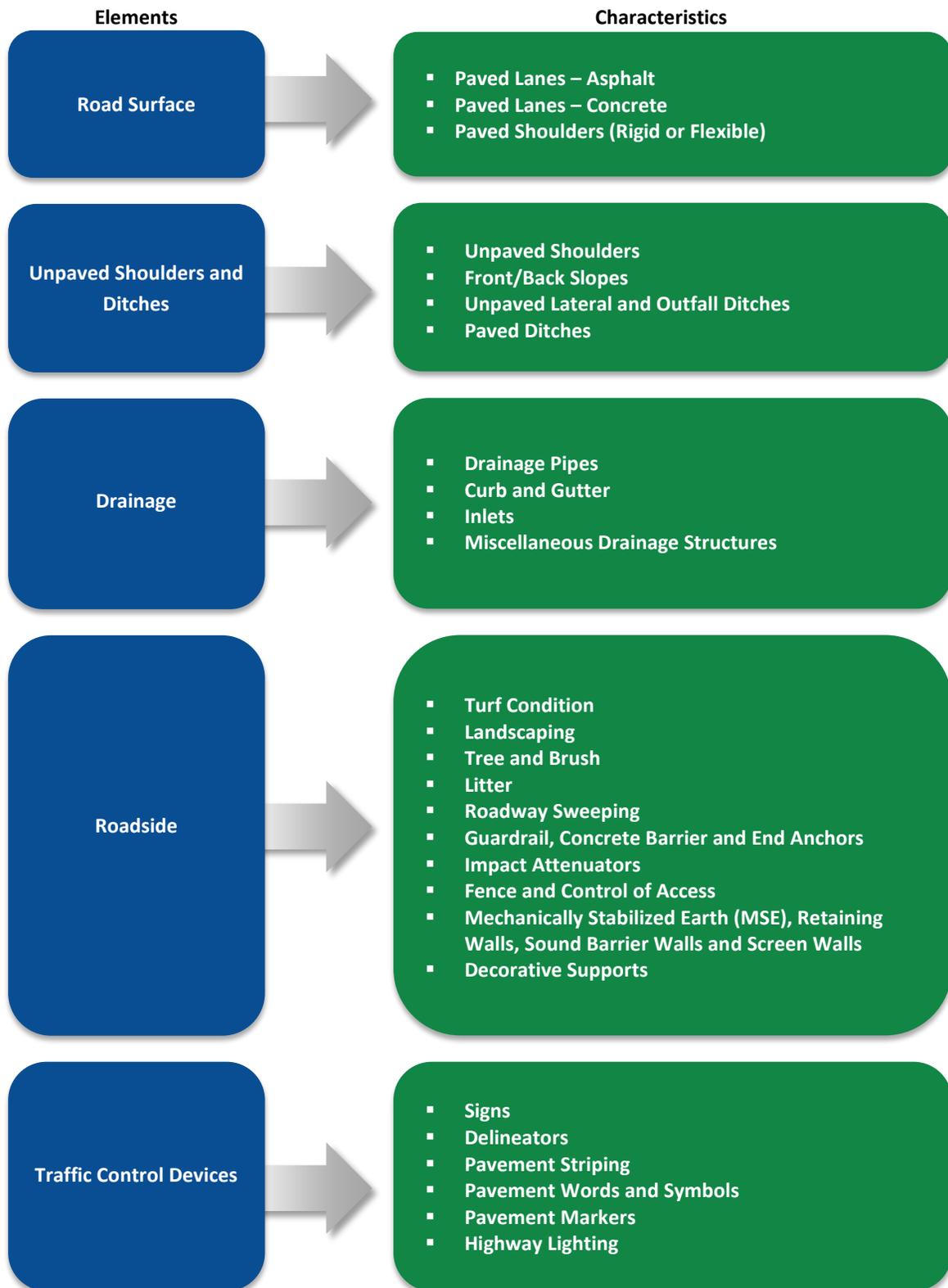
The NCTA performance standards, threshold criteria and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff and consultants.

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:

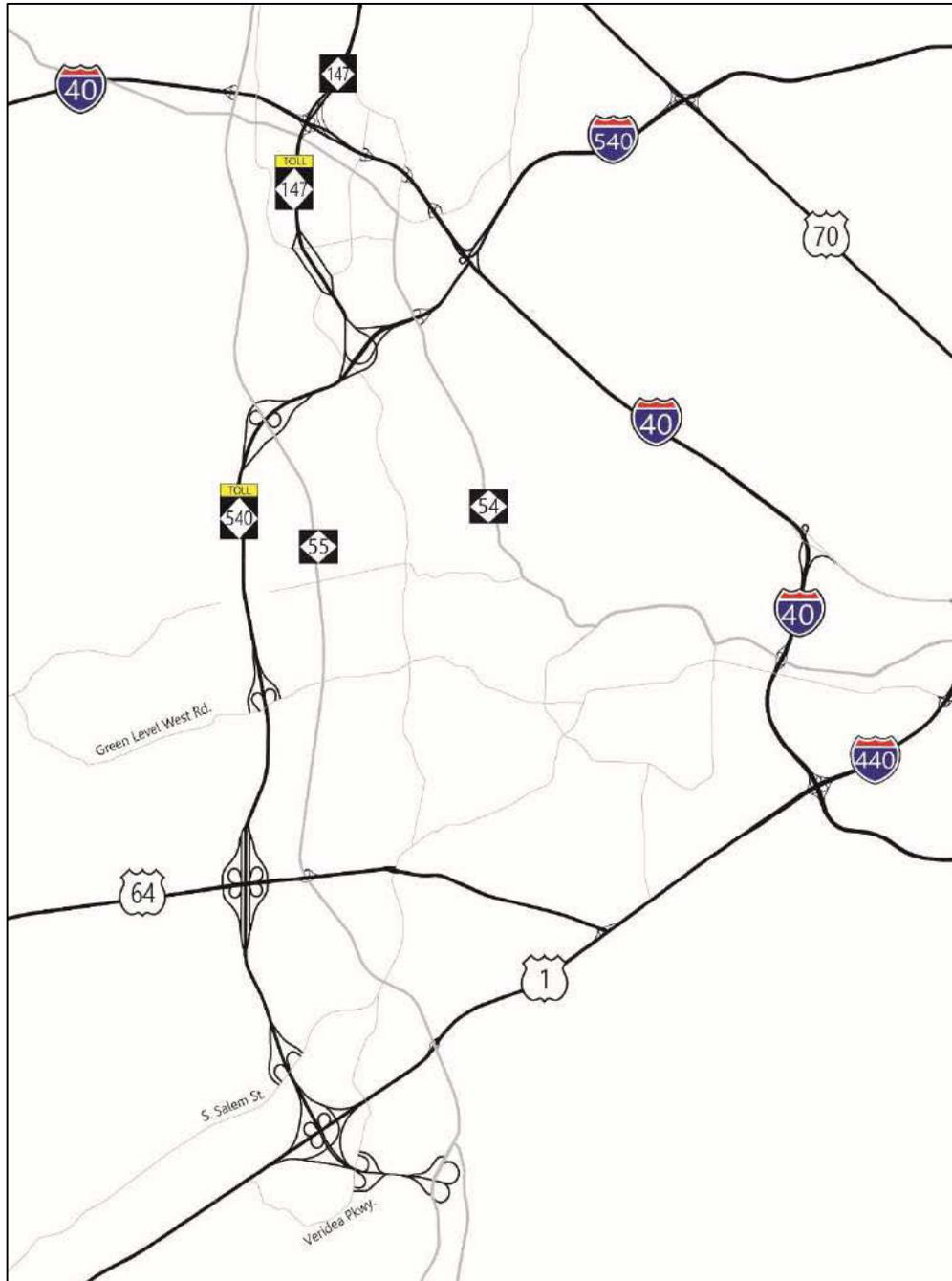
Road Surface =	25%
Unpaved Shoulders =	13%
Drainage =	15%
Roadside =	17%
Traffic Control Devices =	30%
<hr/>	
Total	100%

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 eleven interchanges and twenty 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.

During this quarter, the inventory of barriers and walls was revised to accurately reflect the total number of concrete barriers and sound walls throughout the facility. Also, the total inventory of plant beds was updated to match changes to the facility’s plant bed design completed in 2016. In addition, during this quarter, all assets located on Toll NC-540, south of US-1 and north of NC-55 Bypass, continued to be temporarily removed from the inventory due to the Access 540 Construction Project. **Table 3** presents the updated number of assets that are currently eligible for inspection.

Table 3: Asset Inventory		
Assets	Total Inventory	2017 Eligible Inventory
Barriers	581	531
Curb and Gutter	235	215
Decorative Supports	243	220
Drainage	1135	1045
Misc. Drainage	181	159
Fences	431	376
Highway Lighting	315	291
Impact Attenuators	39	35
Inlets	968	900
Linear Segments	585	522
Plant Beds	267	257
Paved Ditches	2	1
Pavement Symbols	525	493
Signs	968	878
Tree and Brush	565	508
Turf	1010	920
Walls	83	78

6.0 MRP FIRST QUARTER ASSESSMENT

6.1 Quarterly Results

The overall 2017 first quarter maintenance rating of the Triangle Expressway is 92.7, exceeding NCTA's target overall rating of 90. All elements assessed achieved ratings above the target rating of 85. Miscellaneous Drainage (55), Turf Condition (75), Fence/Access Control (79), and Highway Lighting (73) are the characteristics that scored below the target rating of 80. It is important to note that these results are only representative of the first 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 first quarter MRP performance ratings for elements and characteristics are presented in **Table 4** and **Table 5**, respectively.

Table 4: MRP Element Results for Q1 2017	
Element	Q1 2017 MRP Rating
Road Surface	97.8
Unpaved Shoulders and Ditches	95.6
Drainage	86.7
Roadside	90.3
Traffic Control Devices	91.4
Overall MRP Performance Rating	92.7

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Table 5: MRP Characteristic Results for Q1 2017						
Road Surface	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q1 Rating
Paved Lanes Asphalt	12	12	9	108	108	100
Paved Lanes Concrete	20	20	9	180	180	100
Paved Shoulder	30	32	5	150	160	94
Element Total				438	448	97.8
Unpaved Shoulders And Ditches	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q1 Rating
Unpaved Shoulder	30	32	9	270	288	94
Front/Back Slopes	30	32	6	180	192	94
Lateral and Outfall Ditches, Unpaved	32	32	6	192	192	100
Ditches, Paved	1	1	5	5	5	100
Element Total				647	677	95.6
Drainage	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q1 Rating
Drainage Pipes	31	34	7	217	238	91
Curb and Gutter	22	24	6	132	144	92
Inlets	33	34	7	231	238	97
Misc. Drainage Structure	18	33	4	72	132	55
Element Total				652	752	86.7
Roadside	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q1 Rating
Turf Condition	53	71	7	371	497	75
Landscaping	24	25	4	96	100	96
Trees and Brush	31	31	4	124	124	100
Litter	31	32	4	124	128	97
Roadway Sweeping	32	32	5	160	160	100
Guardrail, Concrete Barrier and End Anchors	30	31	9	270	279	97
Impact Attenuators	9	9	9	81	81	100
Fence, Control Access	23	29	7	161	203	79
Retaining Walls and Sound Barrier Walls	15	15	5	75	75	100
Decorative Supports	25	25	5	125	125	100
Graffiti and Stain Removal	32	32	4	128	128	100
Element Total				1715	1900	90.3
Traffic Control Devices	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q1 Rating
Signs	32	36	7	224	252	89
Delineators	26	27	3	78	81	96
Pavement Striping/Marking	31	32	8	248	256	97
Words and Symbols	30	30	7	210	210	100
Pavement Markers	31	32	9	279	288	97
Highway Lighting	30	41	6	180	246	73
Element Total				1219	1333	91.4

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

6.2 Analysis and Recommendations

Elements

During the first quarter, all elements exceeded NCTA's threshold criteria of 85. Road Surface (98) and Unpaved Shoulder/Ditches (96) continued to obtain ratings higher than 95, while Roadside (90) and Traffic Control Devices (91) obtained ratings just above 90. Drainage (87) was the only element that obtained a rating lower than 90.

Traffic Control Devices (91) was the only element that experienced an increase in rating compared to the previous quarter. The rating obtained for this element was 3 points higher than the rating obtained during the fourth quarter of 2016. This increase in the Traffic Control Devices rating is mostly related to higher ratings obtained for Pavement Striping/Markings (97) and Pavement Markers (97), which increased by 6 and 18 points, respectively. However, it should be noted that while this element obtained a higher rating during this quarter, the rating obtained for the Highway Lighting (73) characteristic continued to be low.

In addition, during this quarter the rating obtained for Unpaved Shoulder/Ditches (96) was 4 points lower than the previous quarter due to lower ratings obtained for Shoulders (94) and Slopes (94). Similarly, the rating obtained for Roadside (90) was also 4 points lower than the previous quarter due to significantly lower scores obtained for Turf Condition (75) and Fence/Access Control (79). Also, the rating obtained for Drainage (87) decreased by 7 points from the previous quarter. This decrease was mostly due to the significantly lower ratings that Miscellaneous Drainage Structure (55) continued to obtain. During this quarter, the rating for Miscellaneous Drainage Structure decreased by 23 points.

Recommendations to improve the most critical characteristic ratings and therefore continue to meet or exceed NCTA's threshold criteria are provided in the following sections.

Characteristics

This quarter all but four characteristics, Miscellaneous Drainage Structure (55), Turf Condition (75), Fence/Access Control (79), and Highway Lighting (73) met 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 (55 rating – 15 of the 33 assets failed). All 15 miscellaneous drainage failures, occurred due to obstruction. Two of the failing miscellaneous drainage structures are presented in **Figure 3**.

Figure 3: Miscellaneous Drainage Failures



Some of the 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 the *NCTA Roadway and Facility Maintenance Standards V4* referenced 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

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Turf Condition (75 rating – 18 of the 71 assets failed). All 18 turf area failures were due to bare ground conditions. Two of the failing turf areas are presented in *Figure 4*.

Figure 4: Turf Failures



Improvements in turf condition were not expected in the first quarter rating, since bare ground areas is the dominant failure category in turf condition and warm season grasses were dormant during the winter months. Continued seeding of bare ground areas with warm season grasses is recommended for this summer, as well as continued monitoring of mowing heights during the 2017 mowing cycle pursuant to the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Turf 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:

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- i. Apply pre- and post- emergent broadleaf weed control in accordance with the manufacturer's recommendations in April.
- ii. Bare ground areas shall be scheduled for seeding as necessary.
- c. Fall:
 - i. Apply post-emergence herbicides to select locations in accordance with the manufacturer's recommendations in August.
 - ii. Bare ground areas shall be seeded in the fall as needed.

Turf 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.

During the summer of 2016, NCDOT Division 5 Landscape Unit planted a combination of Fescue, Bermuda, and Centipede grass on bare ground areas throughout 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. Improvements should be anticipated this summer and manifest in better turf scores by the third quarter rating period. Centipede is slow growing and multiple cycles of fertilizing may be needed to fully establish growth. If improvements do not occur this summer, alternative measures may need to be initiated.

Highway Lighting (73 rating – 11 of the 41 assets failed). Out of the 11 highway lights inspected, 8 failed because of functional damage, 2 failed for part damage, and one failed for missing parts. Two of the failing highway lights are presented in *Figure 5*.

Figure 5: Highway Lighting Failures



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In order to avoid future damage, it is recommended that all non-functioning or damaged highway lights noted during the inspections 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.

Highway Lighting 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.
- 3) More than 10% of the poles are damaged or missing.
- 4) Rodent screen protection is not in place.

After investigating circuit-wide failures, the maintenance provider has confirmed that water intrusion in junction boxes and splices is eroding conduit wiring earlier than expected for a normal life-cycle of 10 to 15 years. In order to reduce the number of future circuit-wide failures, it may be necessary to run new properly sealed conduit along with re-wiring the circuit portions that continue to exhibit frequent outages.

Another common problem encountered by the maintenance provider 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.

Fence (79 rating – 6 of the 29 assets failed). Out of the 29 fence segments inspected, 5 failed because of height and 1 failed for having the gate opened. Two of the failing fence segments are presented in **Figure 6**.

Figure 6: Fence Failures



In order to avoid future fence damages, all damaged fences noted by inspectors shall be repaired and/or replaced in accordance with the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below.

Fence Maintenance Program Standards:

- 1) Fence shall be inspected every 4 months.
- 2) All damaged fences that pose a safety hazard shall be mitigated within 2 hours upon notification or observation. Areas where fence is adjacent to livestock or known pedestrian traffic must be secured until fence is fully restored.
- 3) Schedule and repair or replace damaged sections within the annual work program.

Fence Maintenance and Evaluation Standards:

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

- 1) A compression of the fence greater than 1/3 of its original height as measured from the natural ground, to the top of the fence fabric.
- 2) An opening in the fence fabric greater than 2 square feet.
- 3) Any open gate in the limited access fence within the sample area.

7.0 CURRENT ROLLING MRP RATING

The current rolling maintenance rating of the Triangle Expressway is 93.7, exceeding NCTA's target overall rating of 90. All element ratings exceeded the target rating of 85. Also, all but three characteristics' ratings met or exceeded the target rating of 80. Ratings for Miscellaneous Drainage Structure, Turf Condition and Highway Lighting are 64, 66 and 77, respectively.

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

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Table 6: MRP Rolling Characteristic Results					
Road Surface	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Q1 2017 Rating	Rolling Rating
Paved Lanes Asphalt	100	100	95	100	99
Paved Lanes Concrete	100	100	100	100	100
Paved Shoulder	100	98	98	94	97
Element Total	100.0	99.1	97.7	97.8	98.7
Unpaved Shoulders And Ditches	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Q1 2017 Rating	Rolling Rating
Unpaved Shoulder	100	100	100	94	99
Front/Back Slopes	100	100	100	94	99
Lateral and Outfall Ditches, Unpaved	100	100	100	100	100
Ditches, Paved	100	100	100	100	100
Element Total	100.0	100.0	100.0	95.6	99.1
Drainage	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Q1 2017 Rating	Rolling Rating
Drainage Pipes	91	97	100	91	95
Curb and Gutter	96	92	100	92	95
Inlets	100	88	91	97	94
Misc. Drainage Structure	63	64	78	55	64
Element Total	91.0	87.9	93.8	86.7	89.8
Roadside	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Q1 2017 Rating	Rolling Rating
Turf Condition	44	63	83	75	66
Landscaping	96	100	100	96	98
Trees and Brush	100	100	100	100	100
Litter	100	100	100	97	99
Roadway Sweeping	100	100	100	100	100
Guardrail, Concrete Barrier and End Anchors	89	100	100	97	97
Impact Attenuators	100	100	100	100	100
Fence, Control Access	100	96	88	79	91
Retaining Walls and Sound Barrier Walls	94	100	85	100	94
Decorative Supports	95	96	100	100	98
Graffiti and Stain Removal	100	100	100	100	100
Element Total	83.4	90.0	93.7	90.3	89.4
Traffic Control Devices	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Q1 2017 Rating	Rolling Rating
Signs	90	85	91	89	89
Delineators	91	93	97	96	94
Pavement Striping/Marking	100	98	91	97	96
Words and Symbols	100	100	100	100	100
Pavement Markers	100	95	79	97	92
Highway Lighting	88	66	81	73	77
Element Total	96.1	90.5	88.3	91.4	91.5

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Table 7: MRP Rolling Element Results					
Element	Q2 2016 Rating	Q3 2016 Rating	Q4 2016 Rating	Q1 2017 Rating	Rolling Rating
Road Surface	100	99	98	98	99
Unpaved Shoulders and Ditches	100	100	100	96	99
Drainage	91	88	94	87	90
Roadside	83	90	94	90	89
Traffic Control Devices	96	90	88	91	92
Overall MRP Performance Rating	94.7	93.4	93.9	92.7	93.7

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 7**). NCTA is in the process of replacing all signs.

Figure 7: Green Level West Historic District Signs, Landscape Areas



9.0 CONCLUSION

This report presents the 2017 first quarter rating assessment of the Triangle Expressway. The NCTA's target ratings are 90 overall, 85 for elements and 80 for characteristics. The first quarter 2017 overall rating is 92.7 and the current rolling rating is 93.7, both of these ratings are above the target rating of 90.

All first quarter and rolling element ratings are above the target rating of 85. However, during the first quarter assessment all but four characteristics met or exceeded the target rating of 80. These four characteristics are Miscellaneous Drainage Structure (55), Turf Condition (75), Fence/Control Access (79), and Highway Lighting (73). Similarly, based on the cumulative rolling assessment Miscellaneous Drainage Structure (64), Turf Condition (66) and Highway Lighting (77) fell below NCTA's target rating.

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.

Also, it is recommended that the maintenance provider repair and/or replace all damaged highway lights and that a conduit and photo-sensor cells replacement plan is set in place to avoid future highway lighting failures. It is also recommended that all damaged fence segments be repair and/or replace as soon as possible. In addition, mowing heights should continue to be closely monitored during each mowing cycle, and bare areas fertilization efforts should be continued 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 each location were found to be well maintained. NCTA is currently working towards replacing all Green Level Historic District signs that were vandalized.

Appendix A

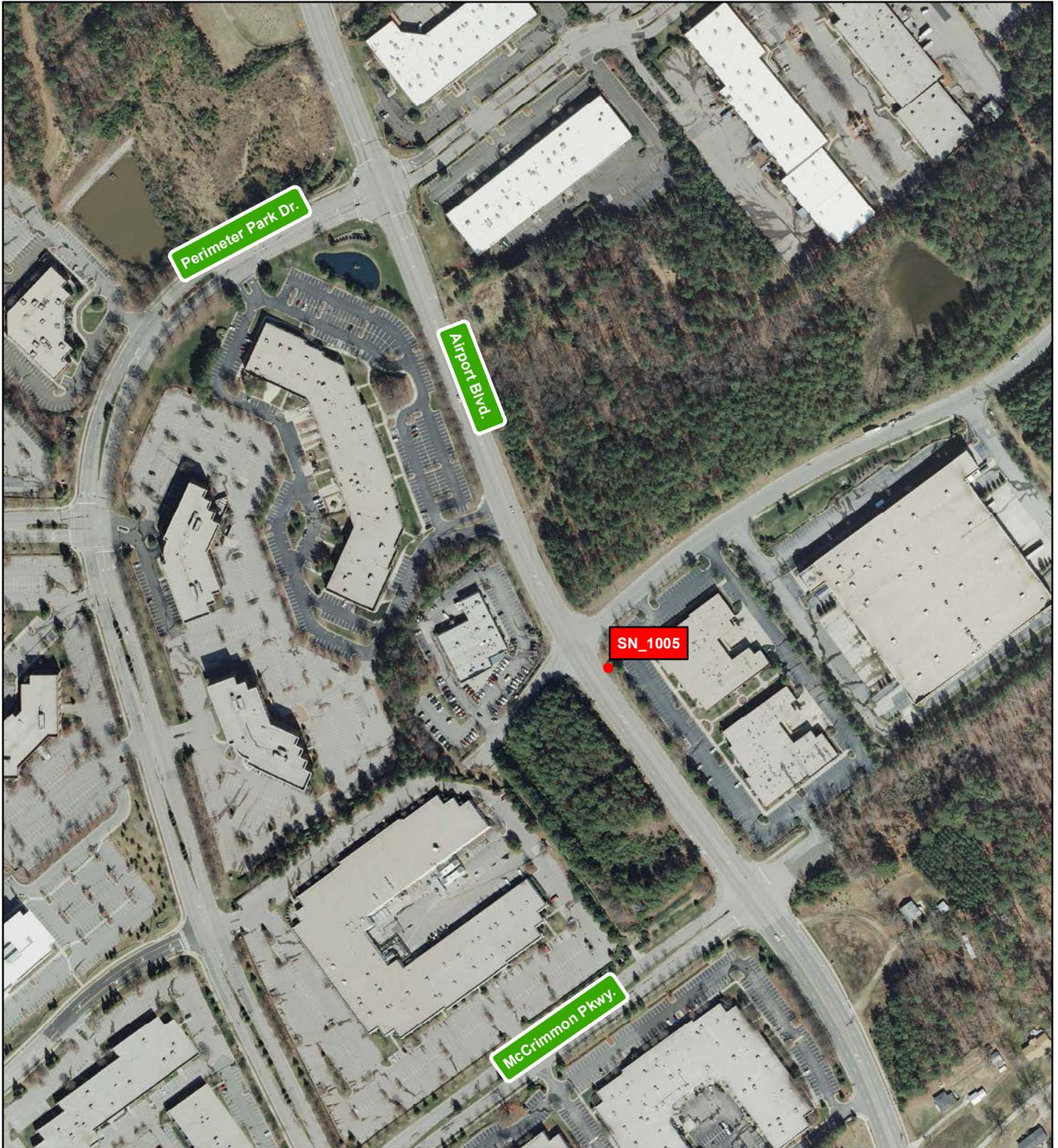
Triangle Expressway 2017 First Quarter Asset Assessment Locations

Appendix A: Triangle Expressway 2017 First 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:

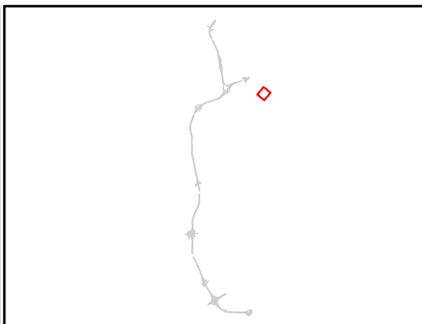
- Guardrail, Concrete Barrier and End Anchors – BR
- Curb and Gutter – CG
- Decorative Supports – DS
- Drainage Pipes – DP
- Misc. Drainage Structures – MDP
- Fence and Control of Access – FN
- Graffiti - GF
- Highway Lighting – HL
- Impact Attenuators – IA
- Inlets – IN
- Landscaping – PB
- Linear Samples – 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 2017 First Quarter Asset Assessment Locations

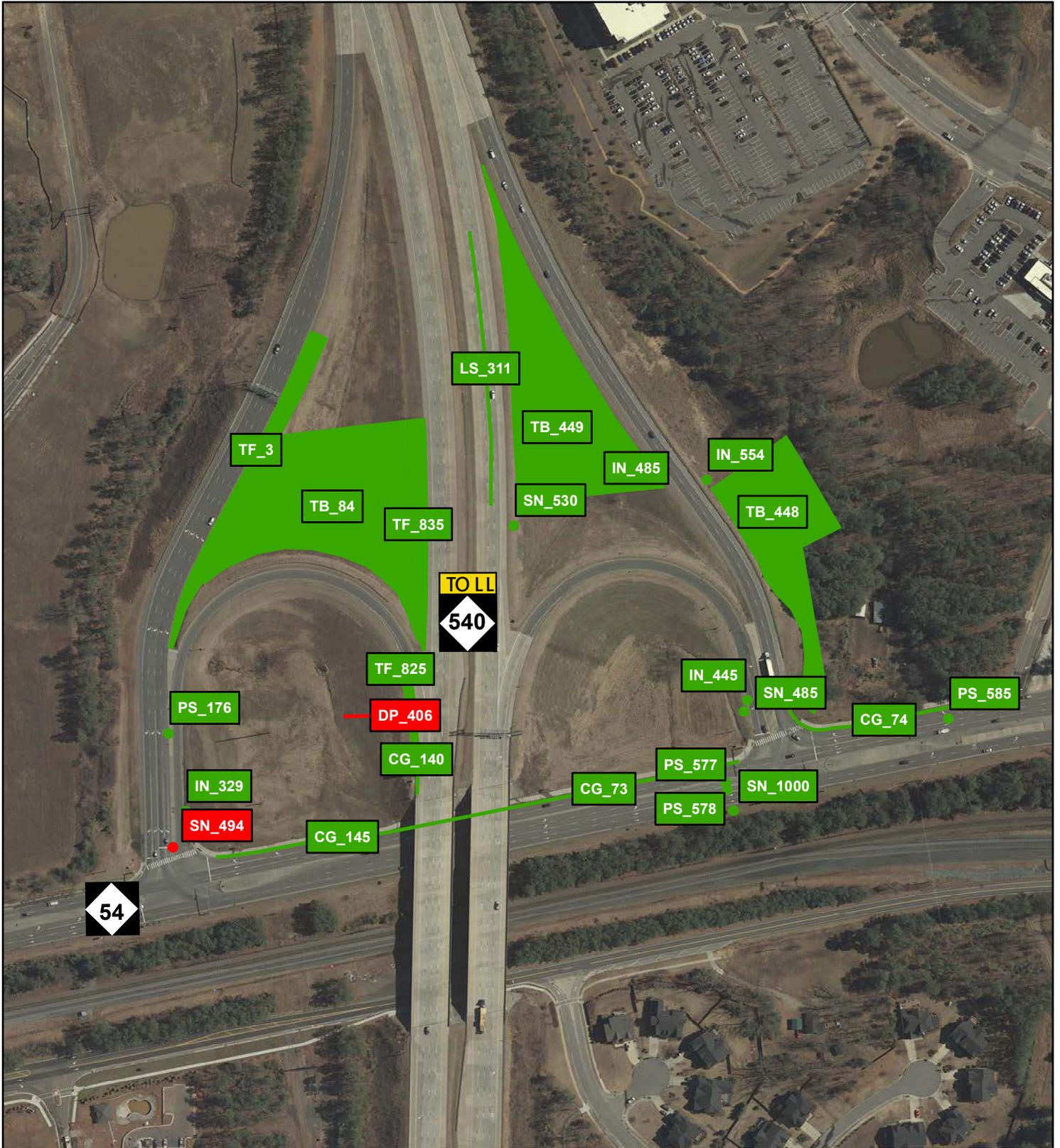


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

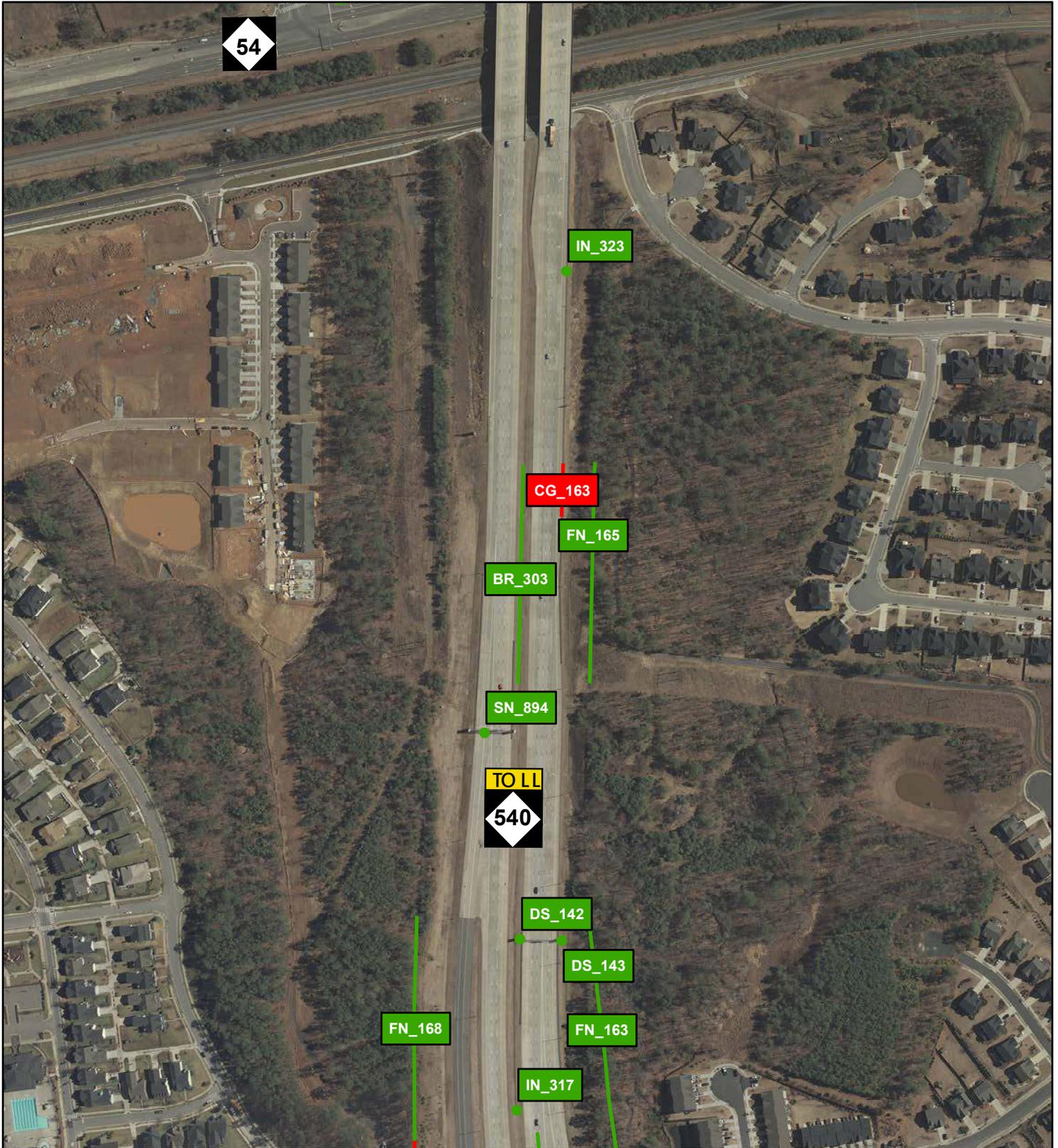


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

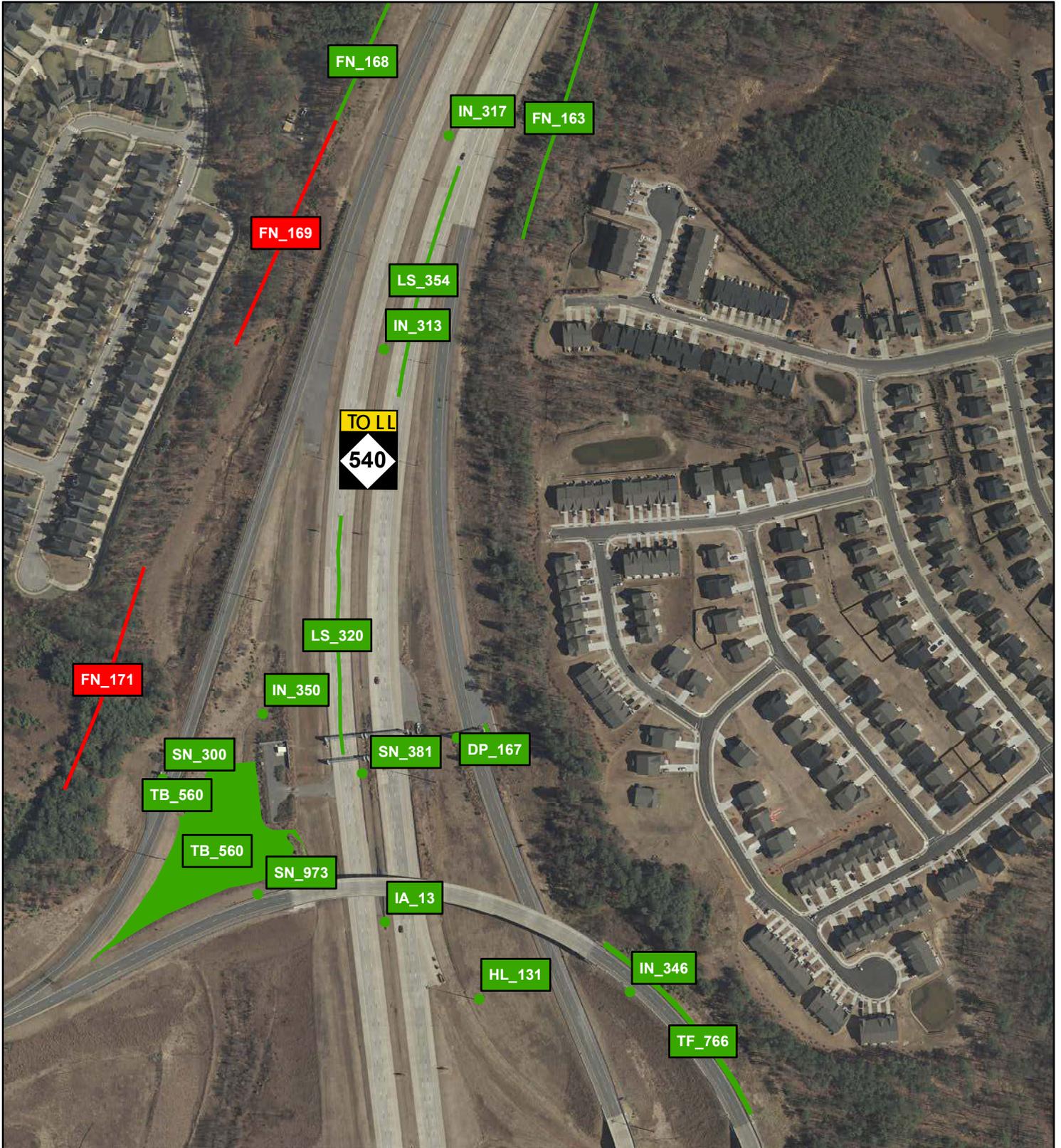


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

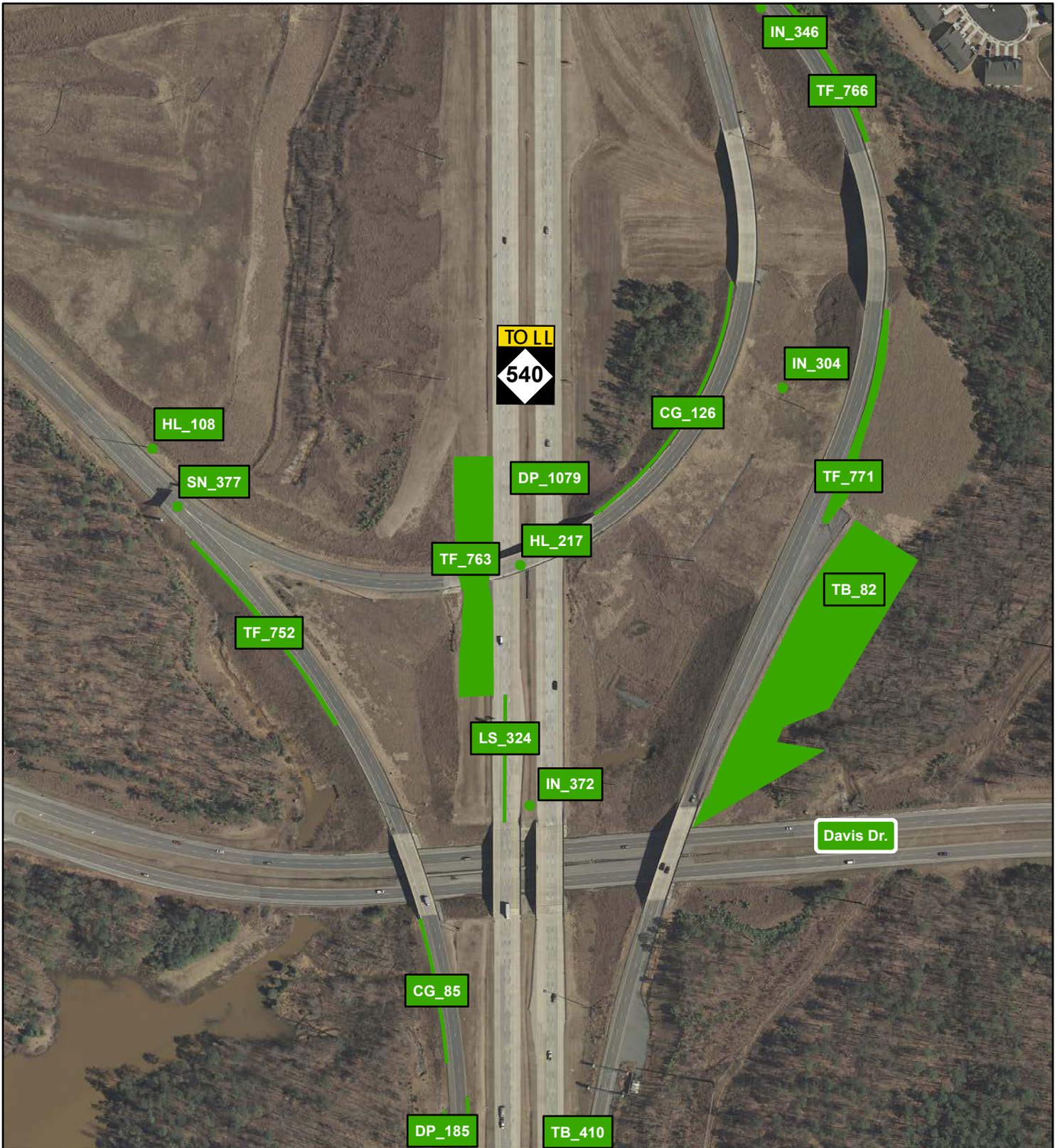


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

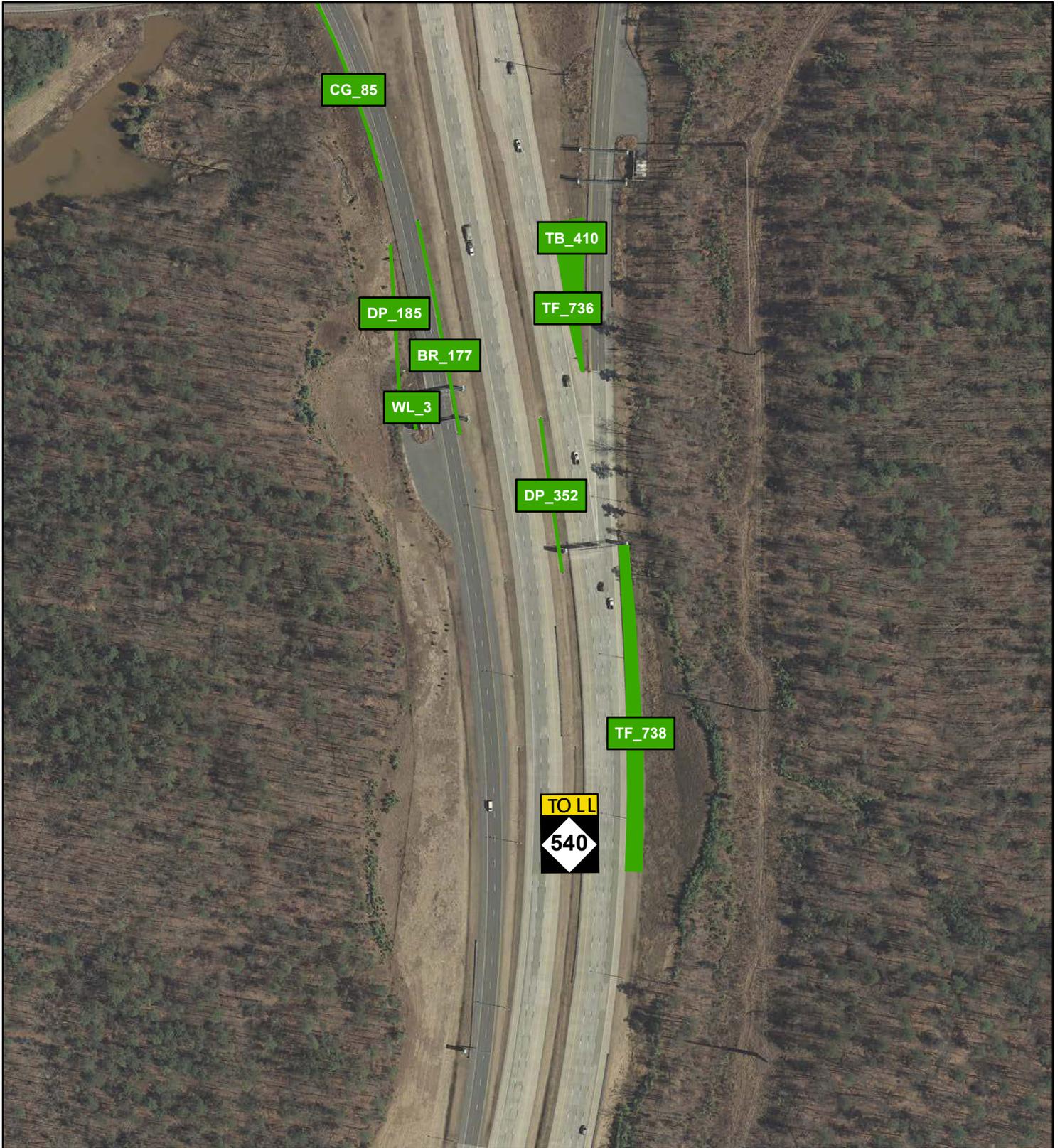


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

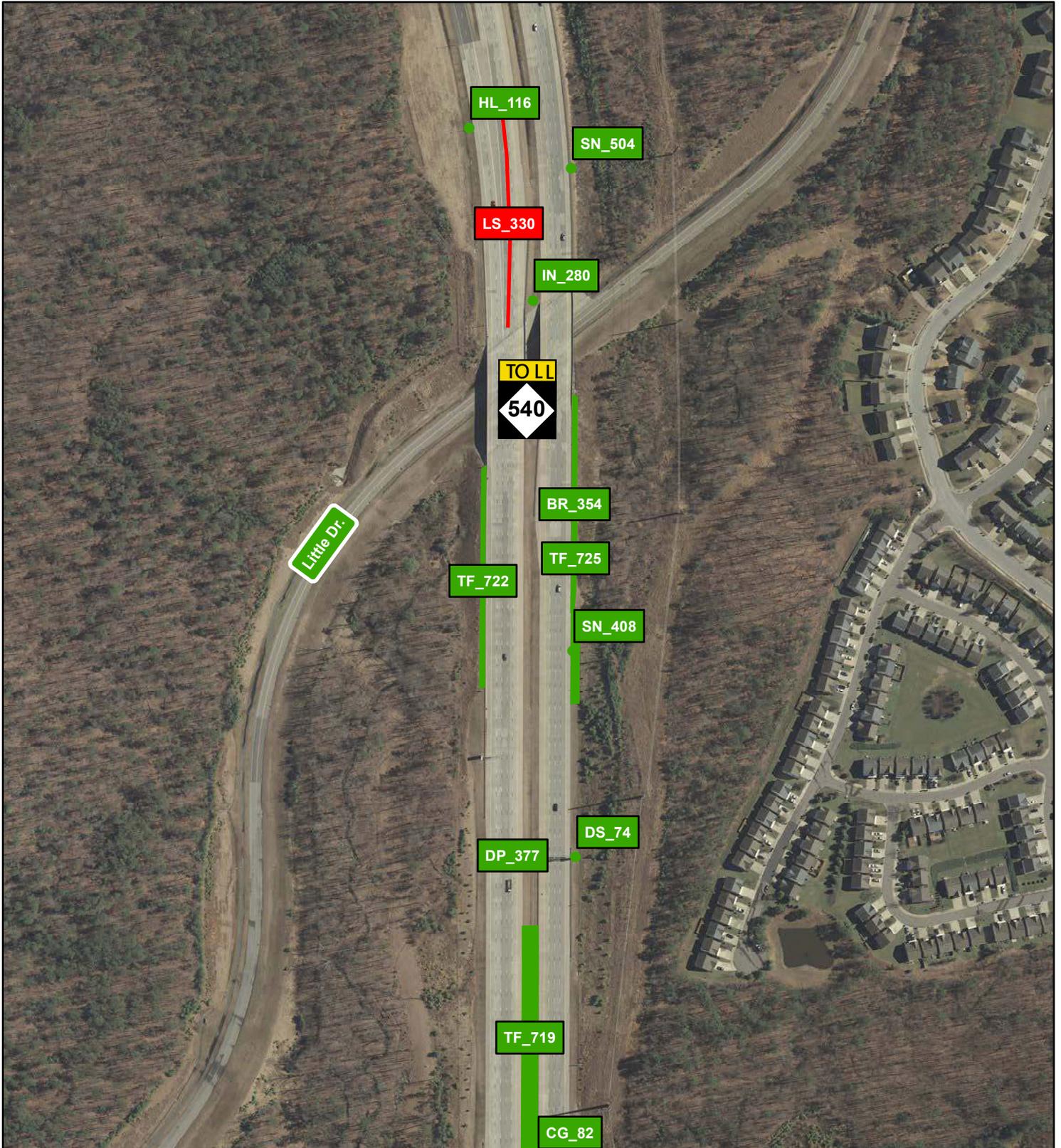


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

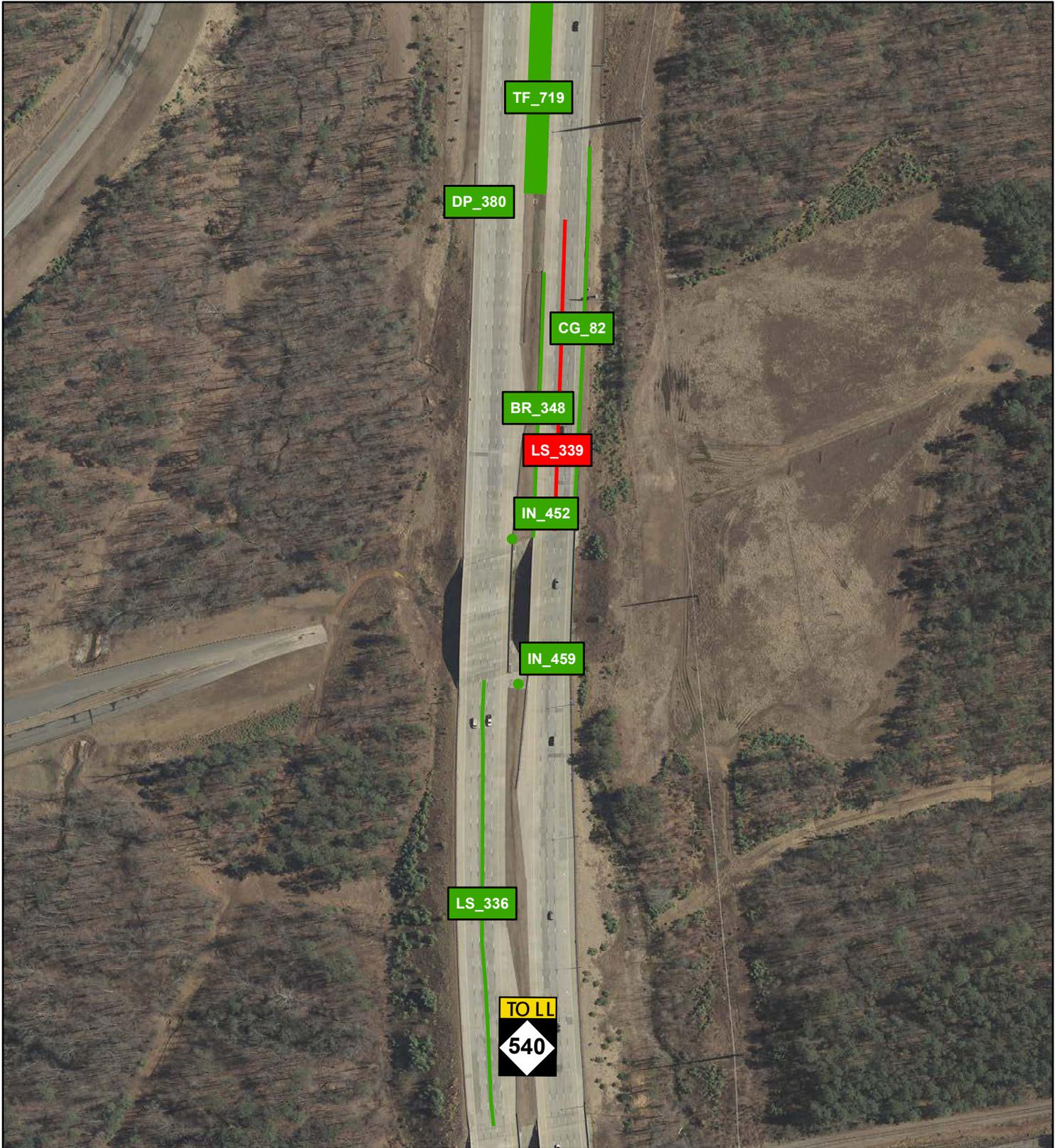


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

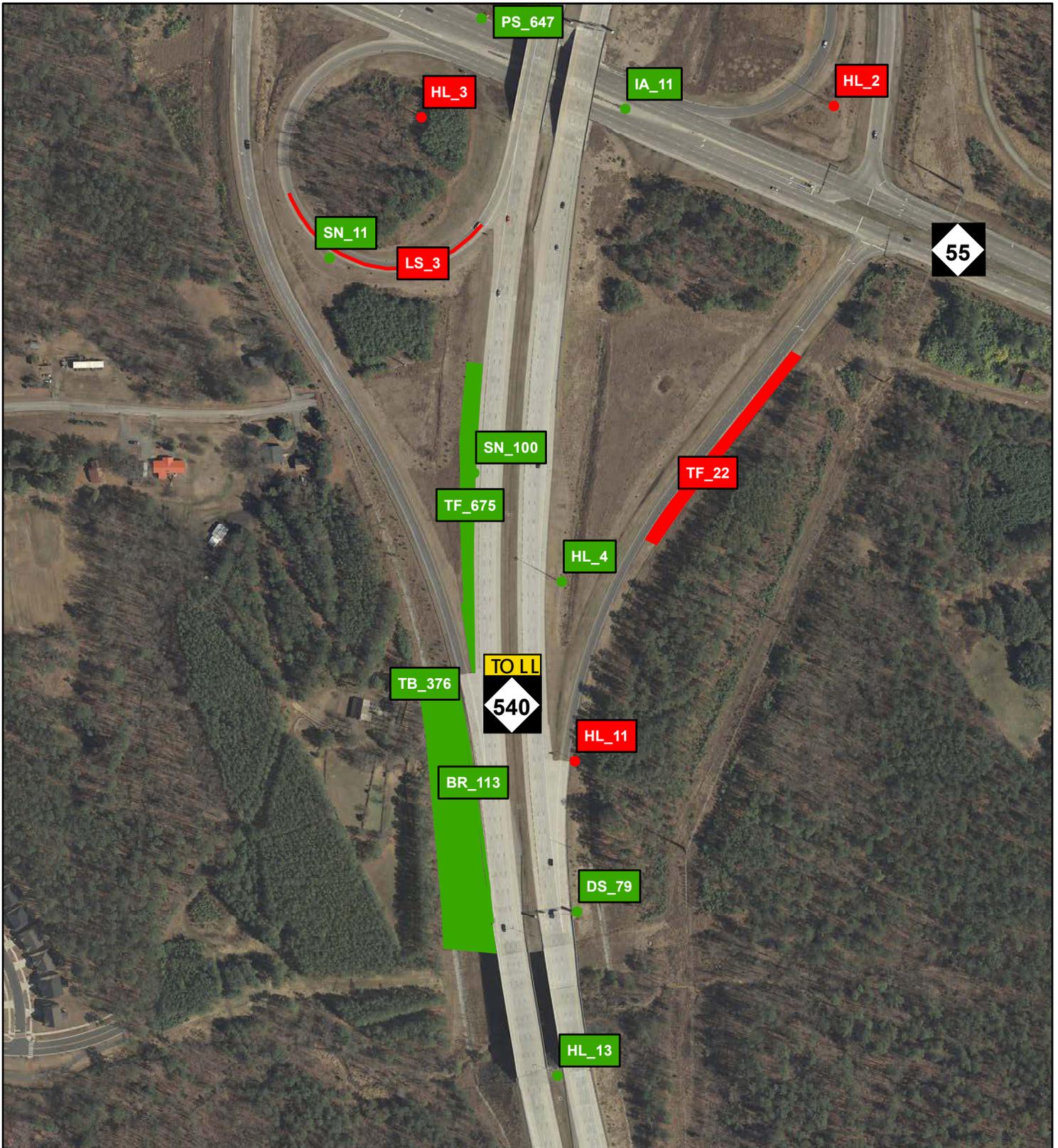


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

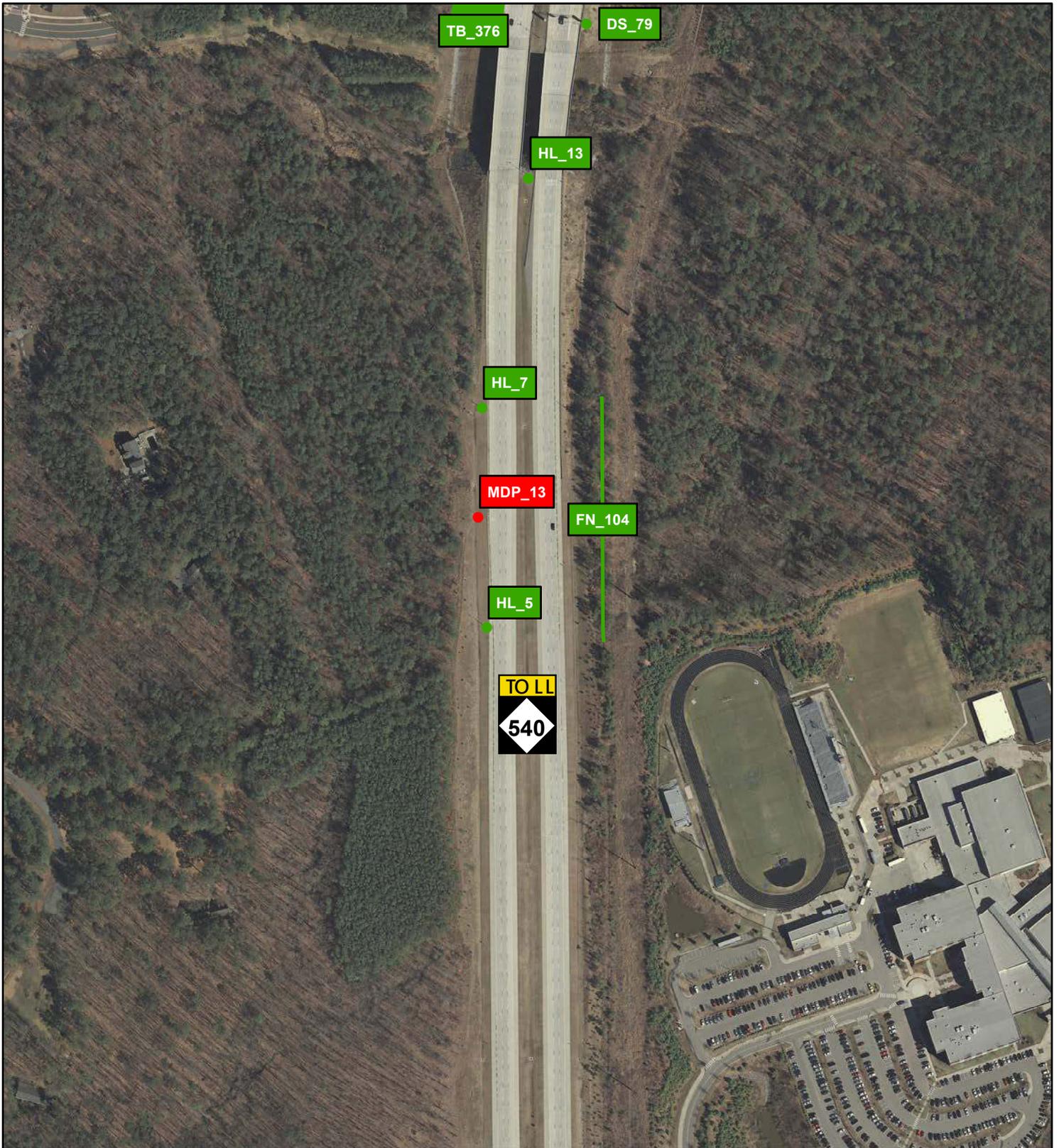


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

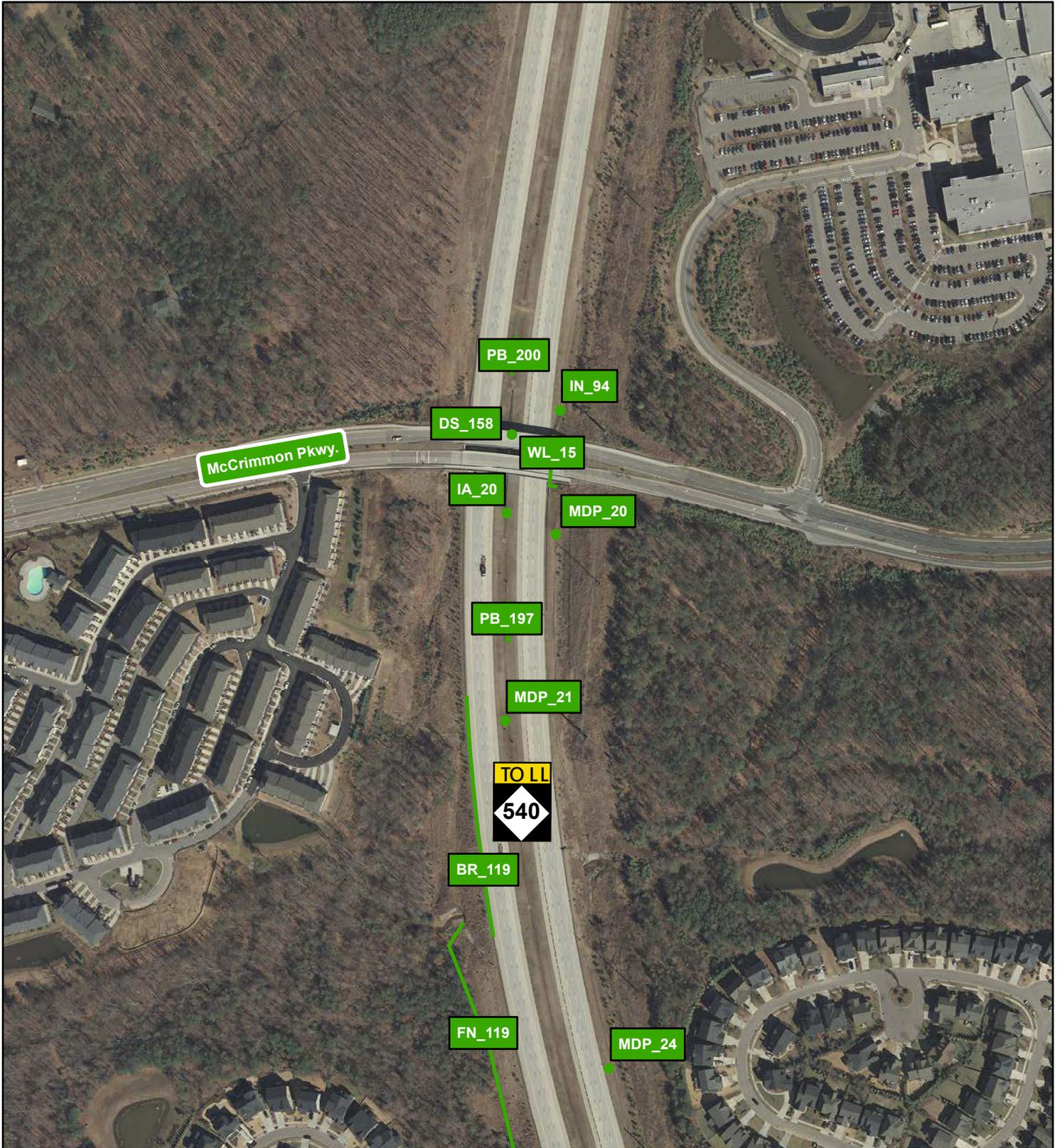


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

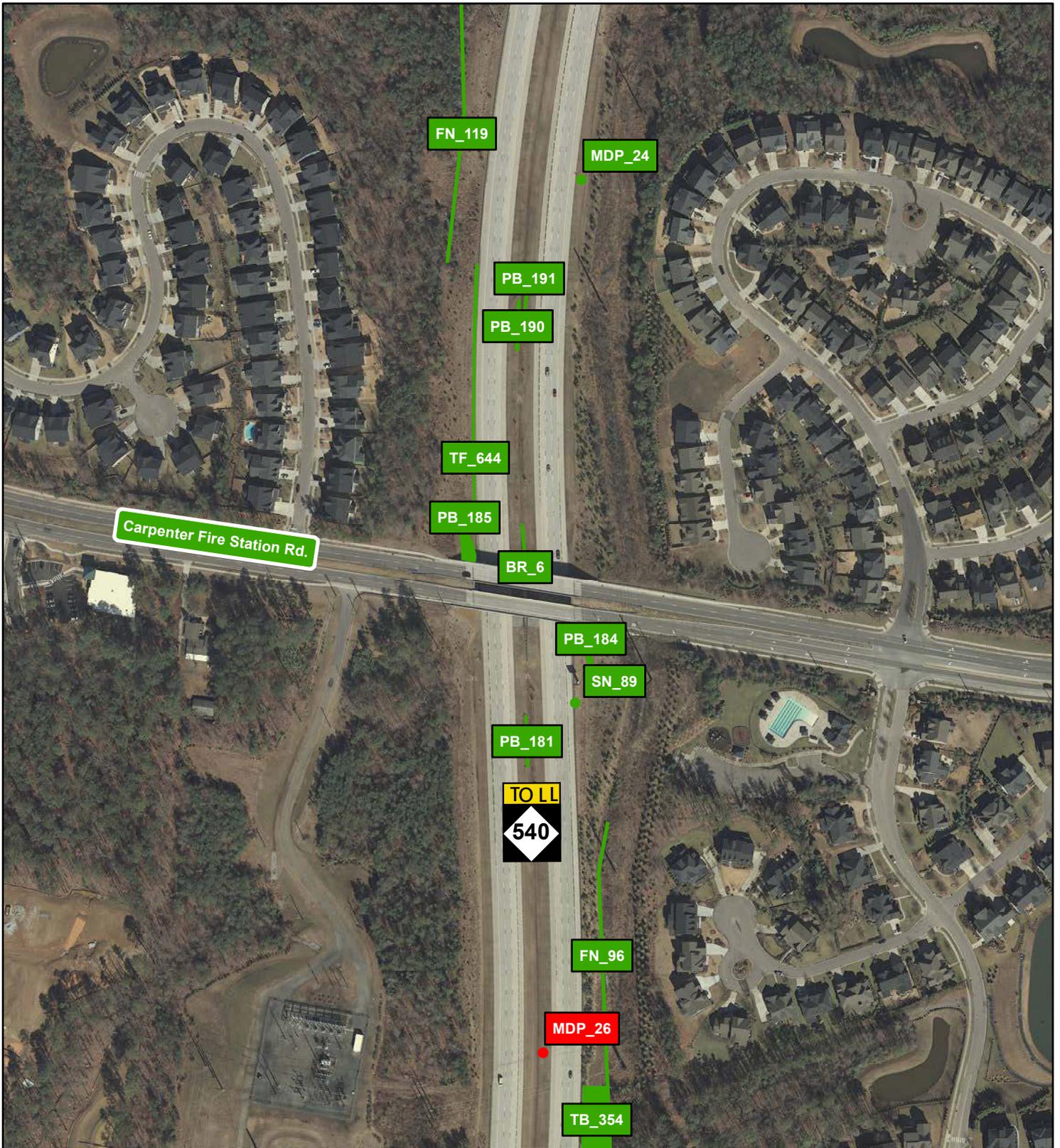


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

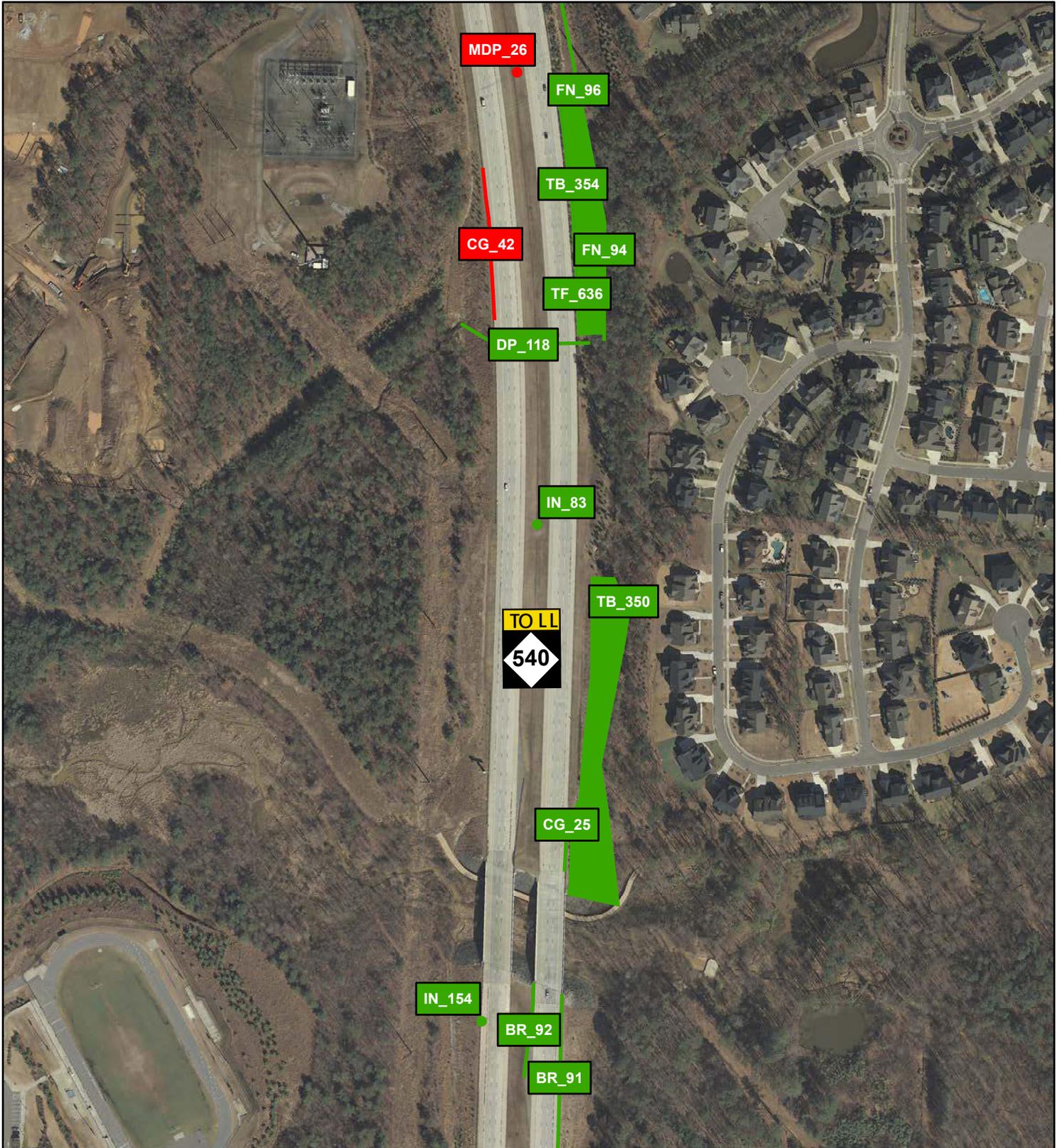


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

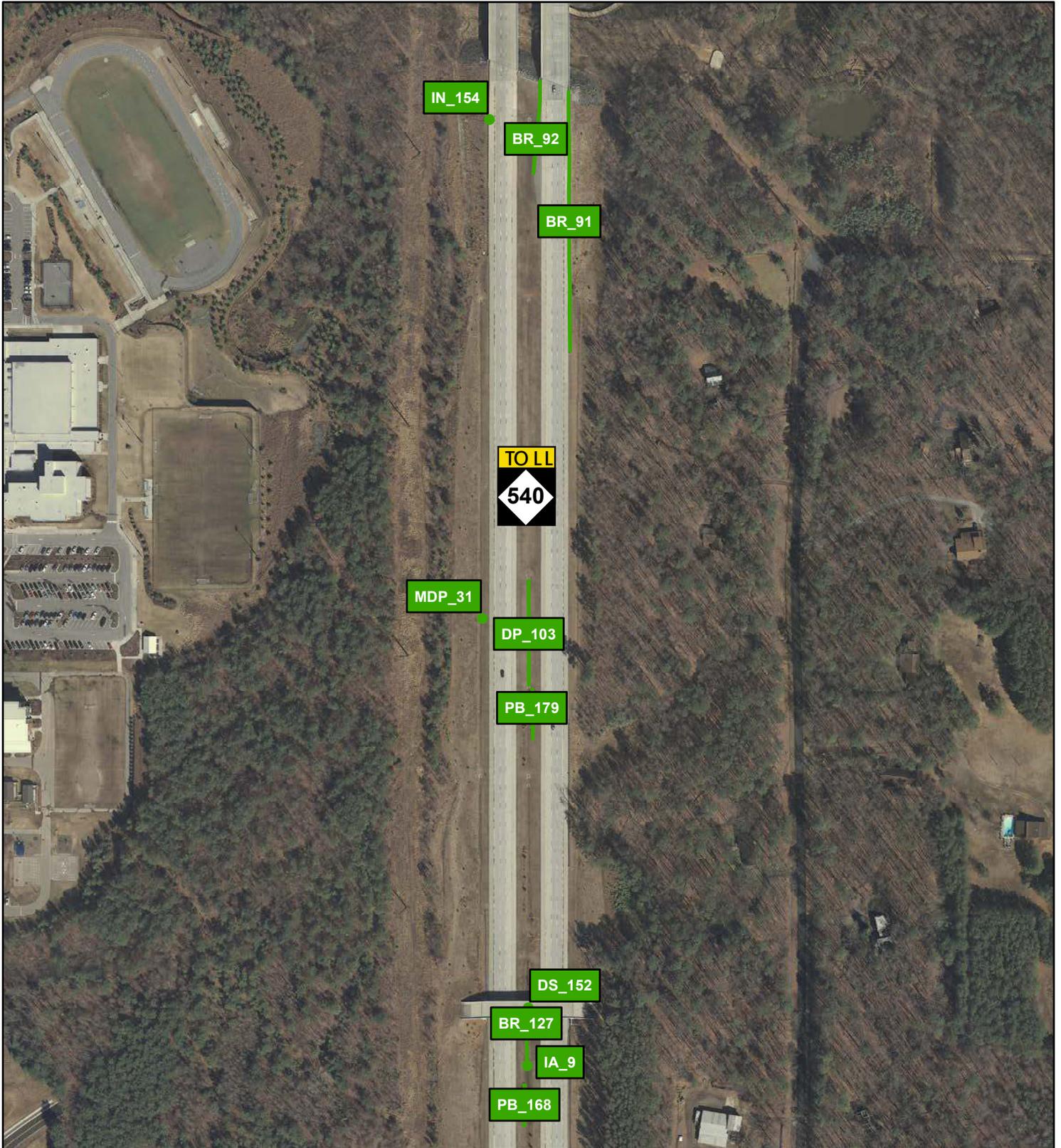


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

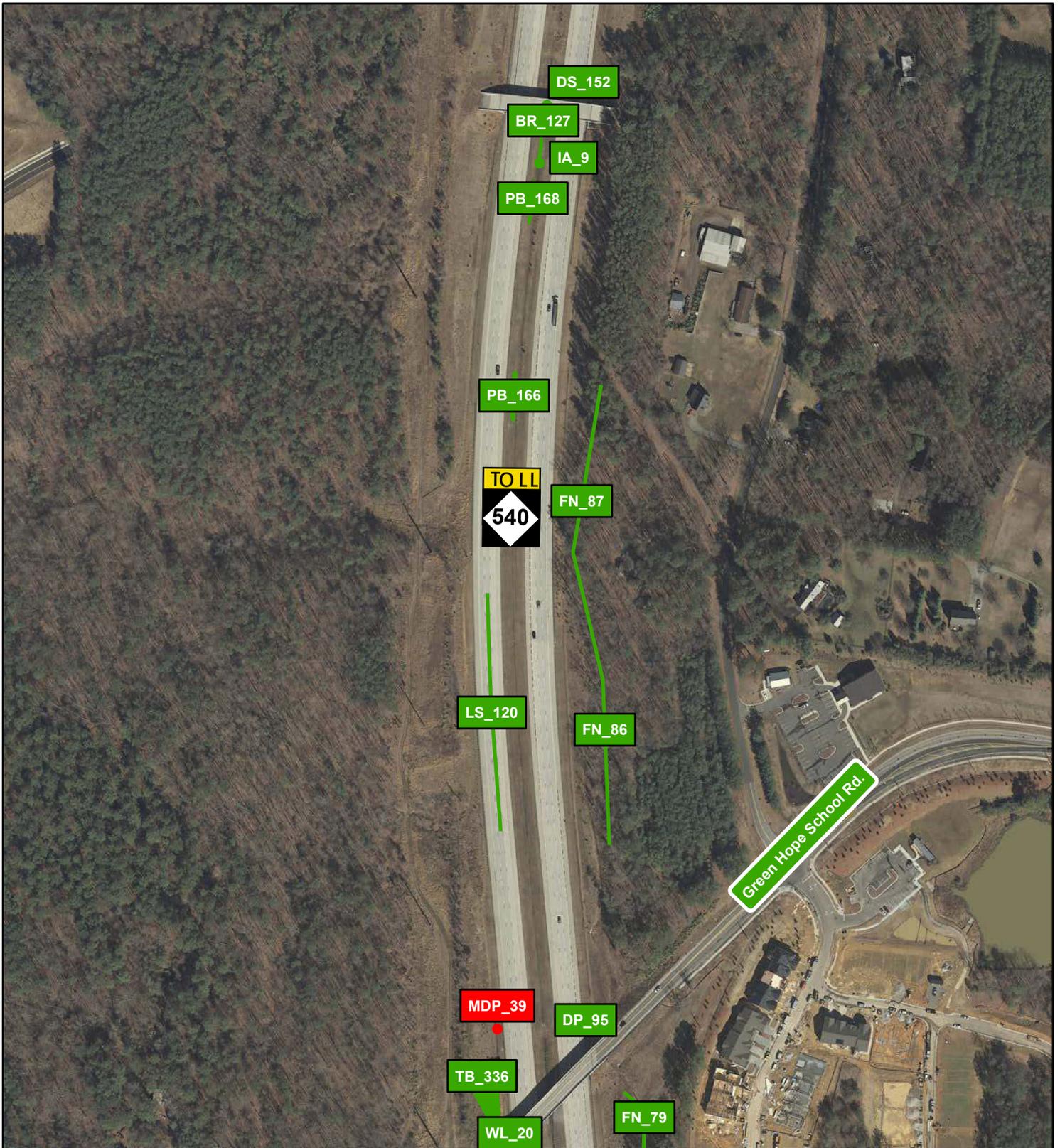


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

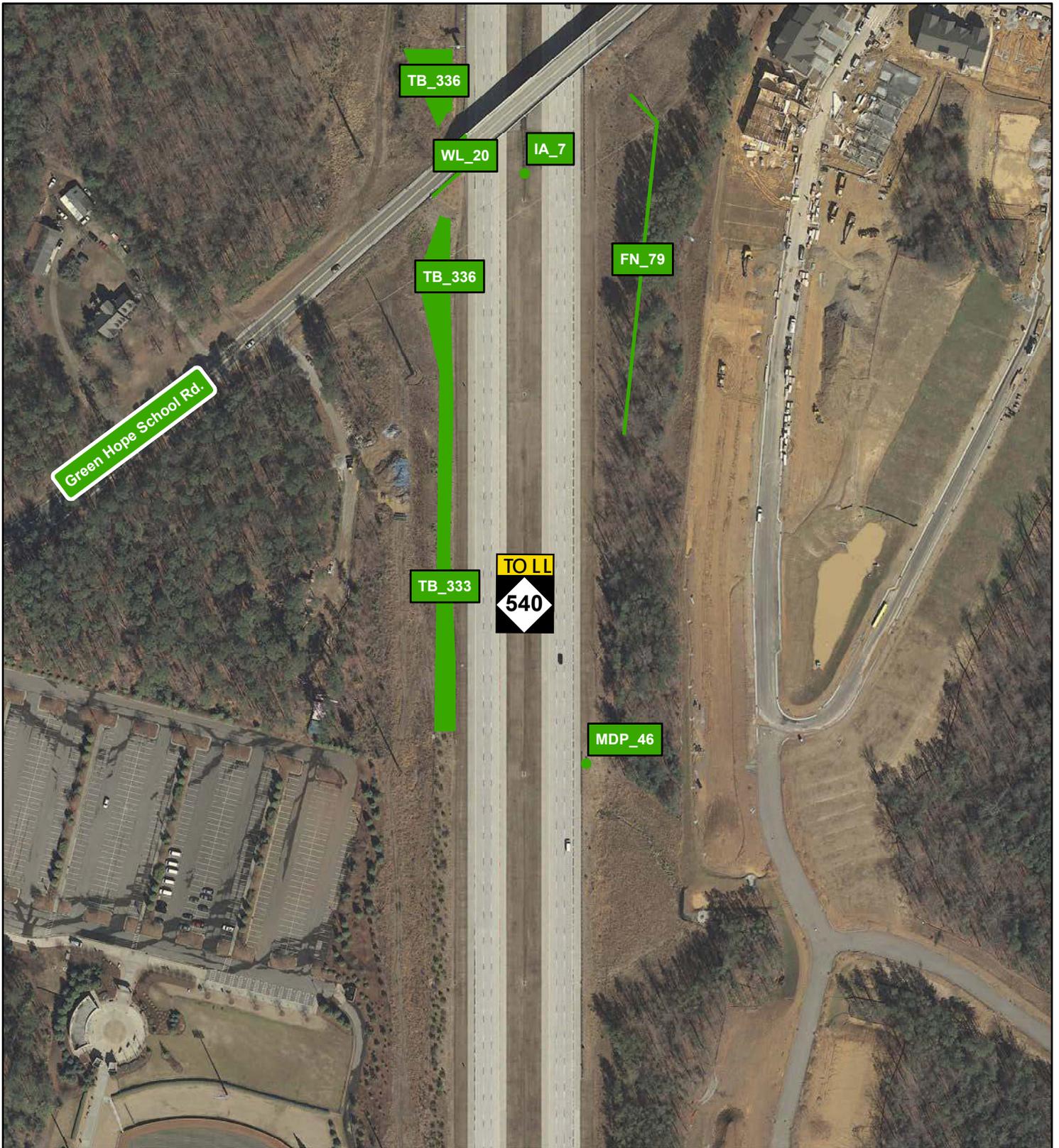


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

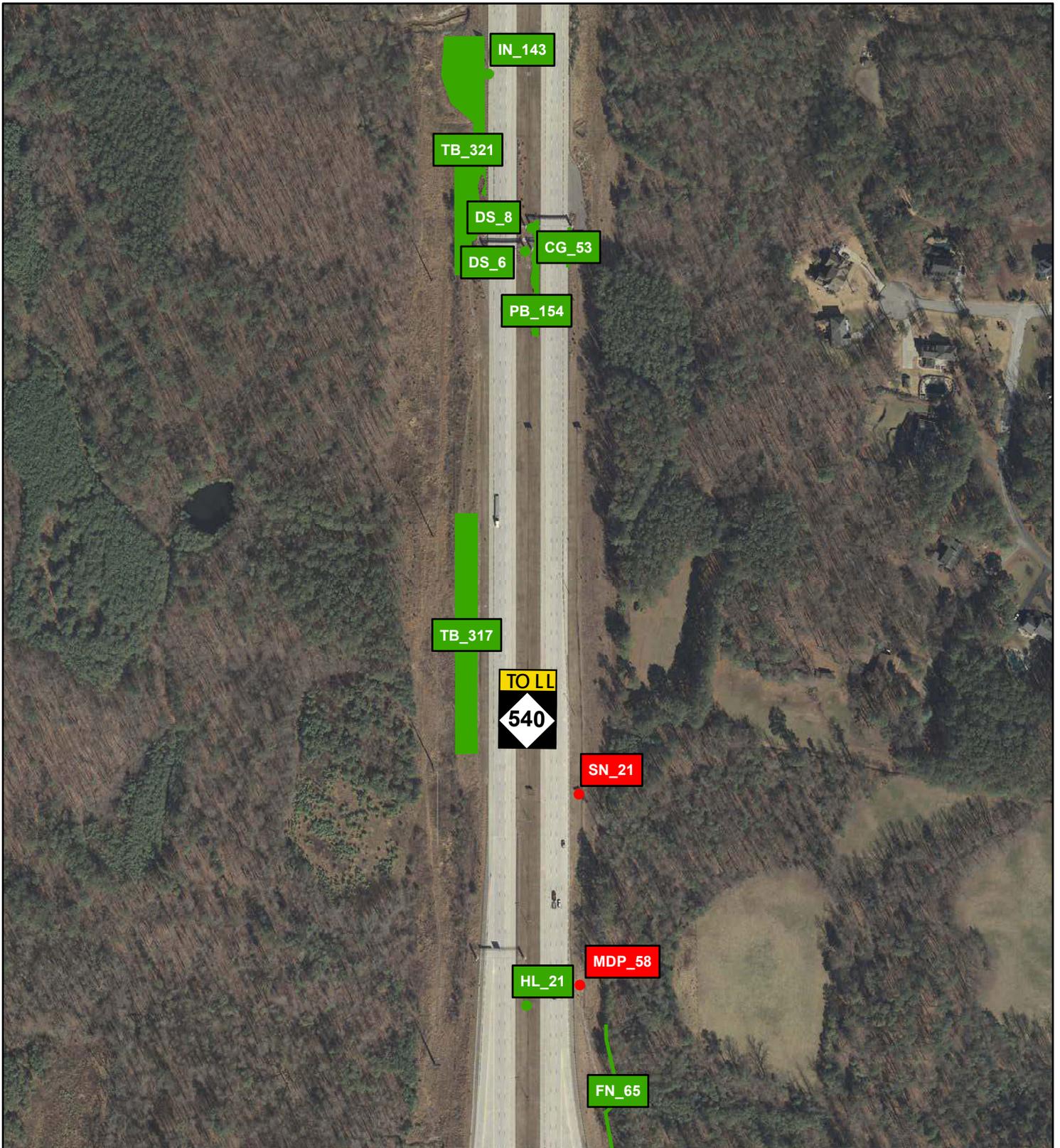


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

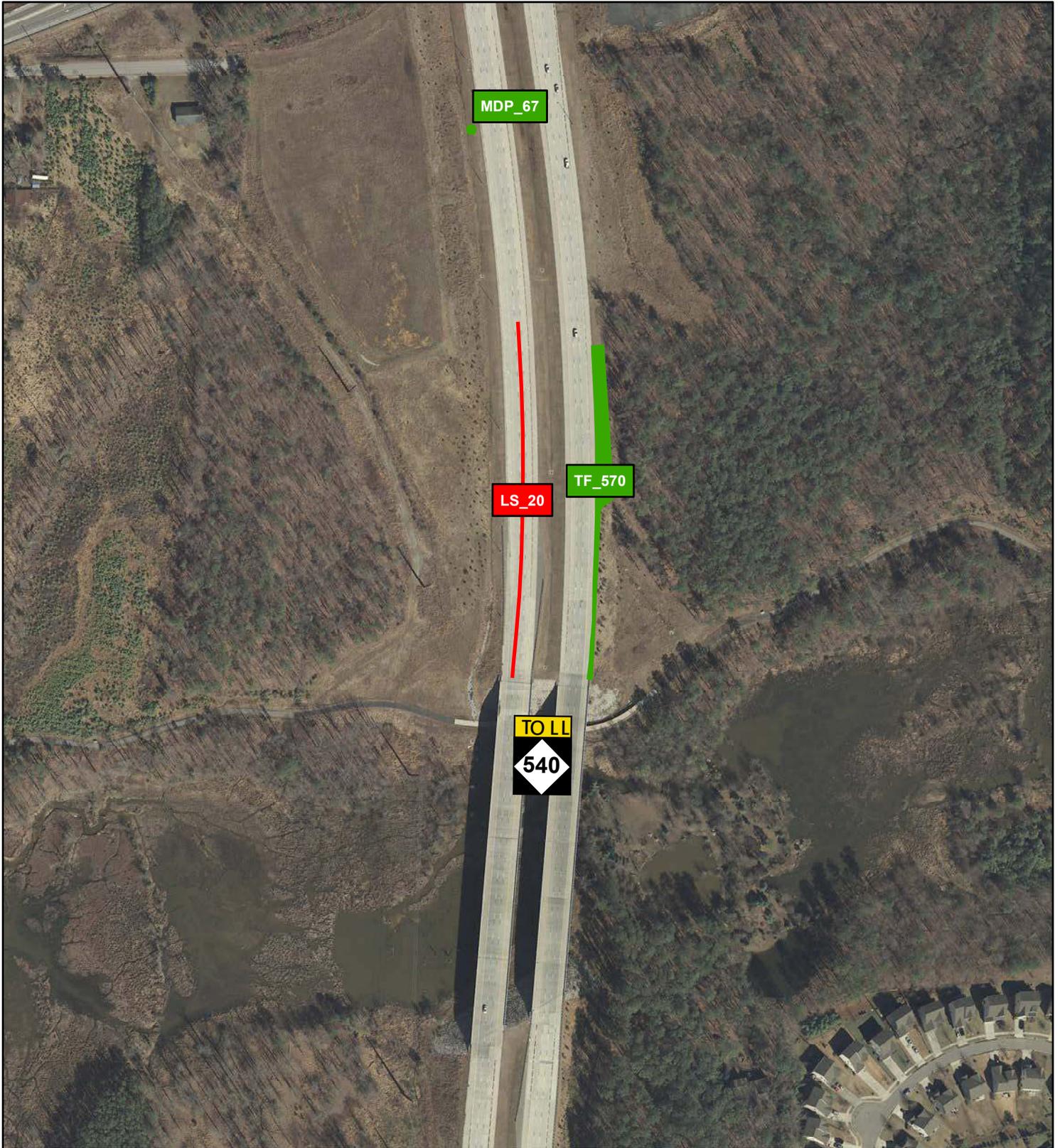


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

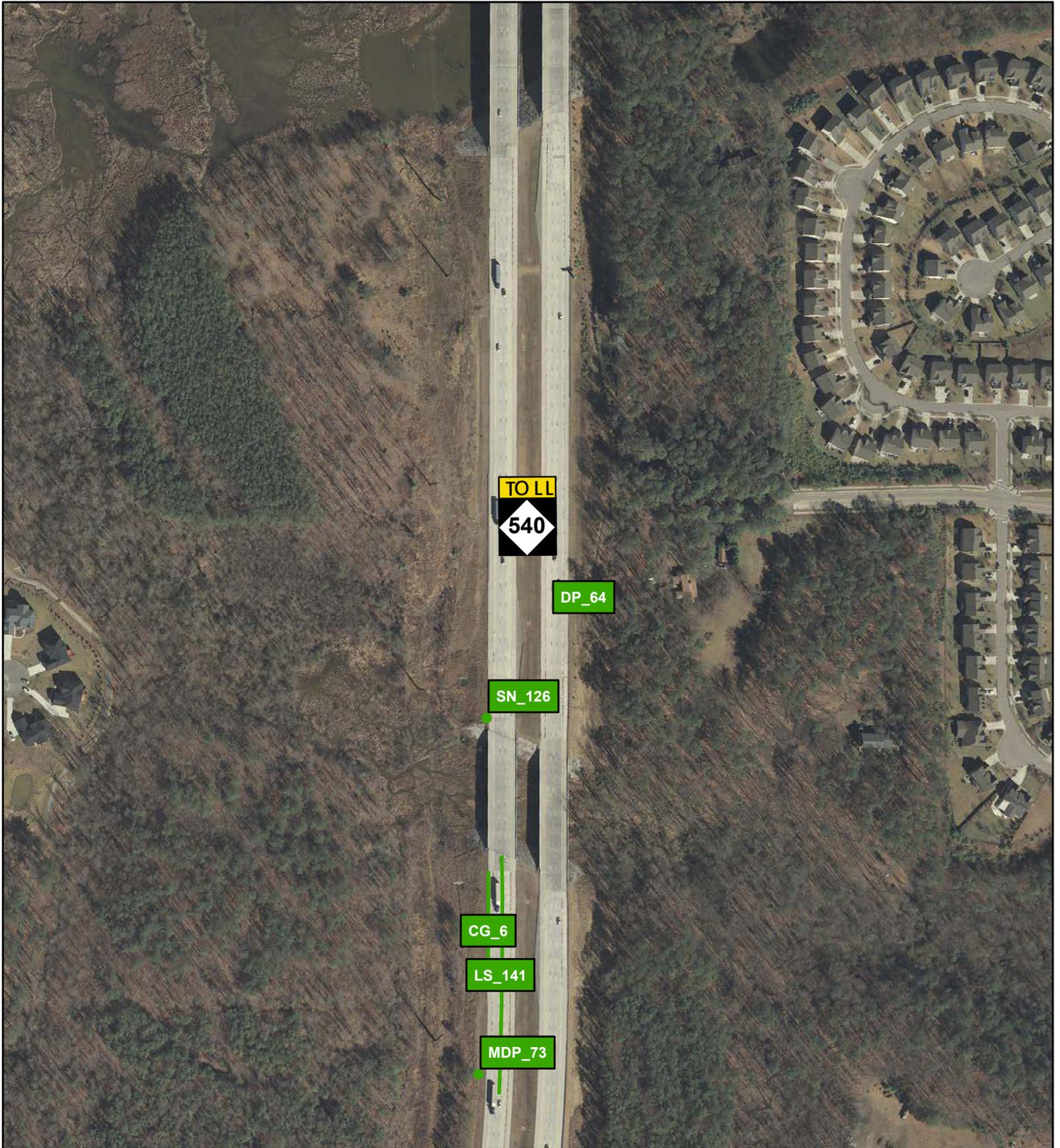


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

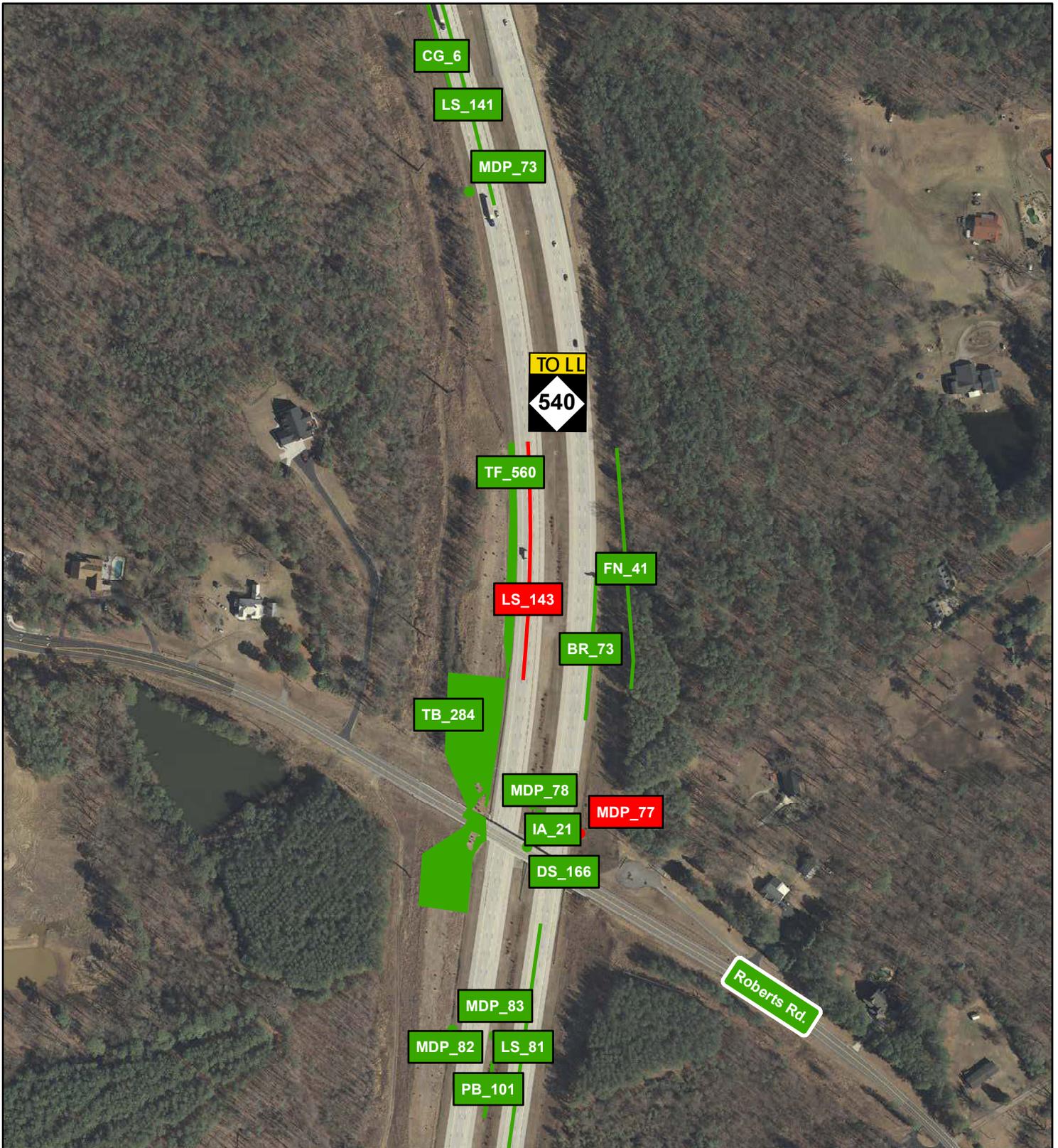


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

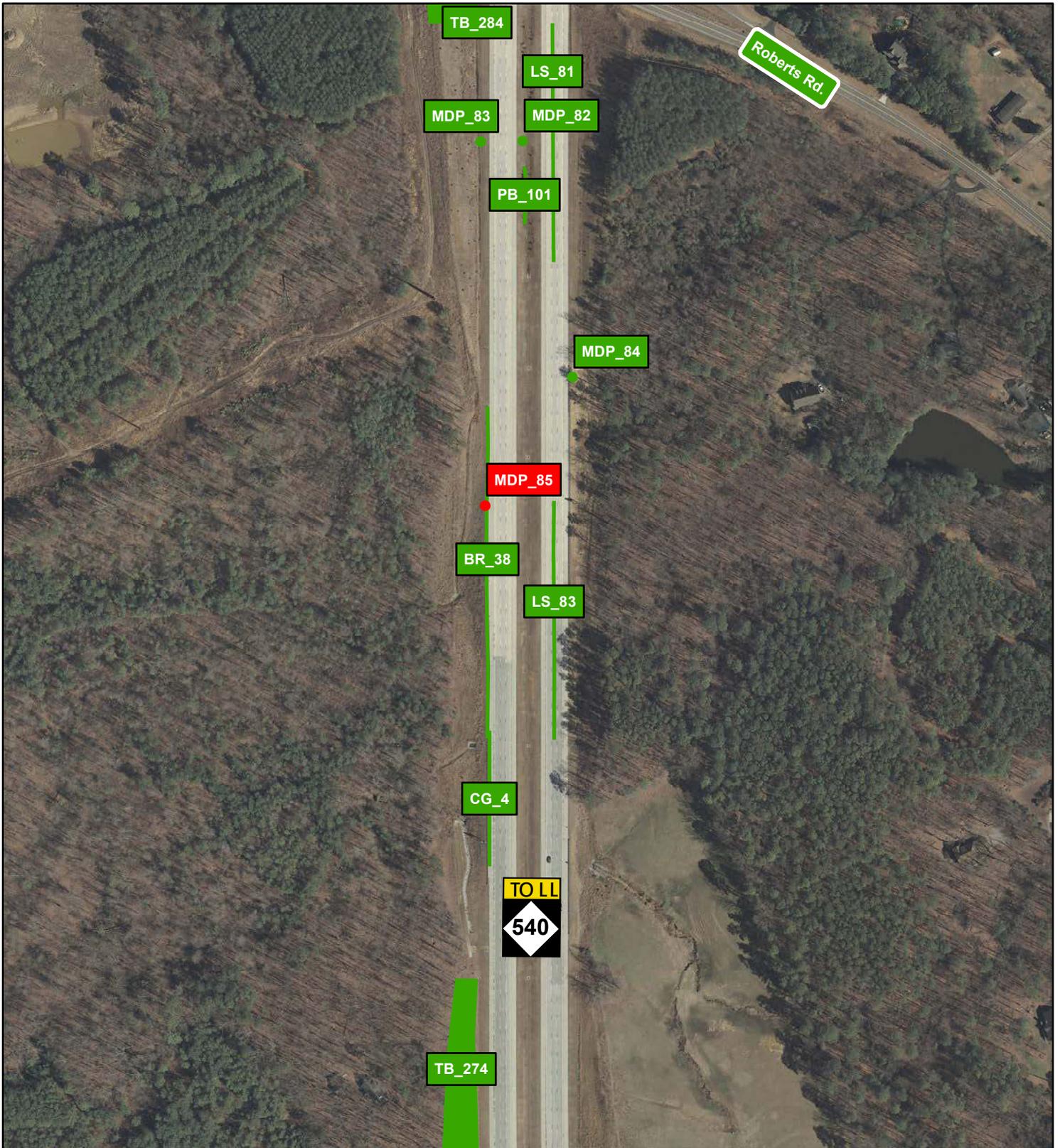


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

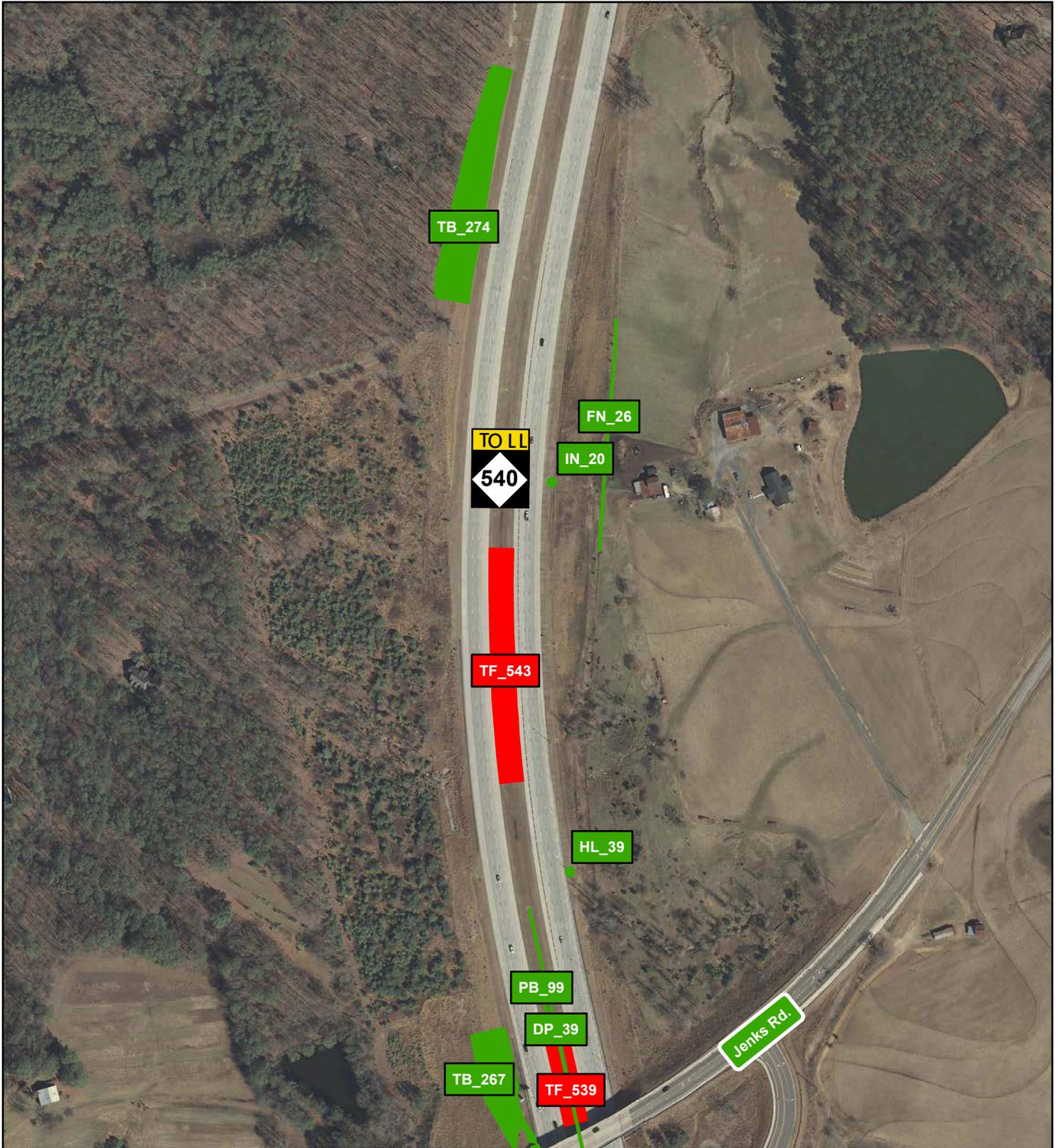


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

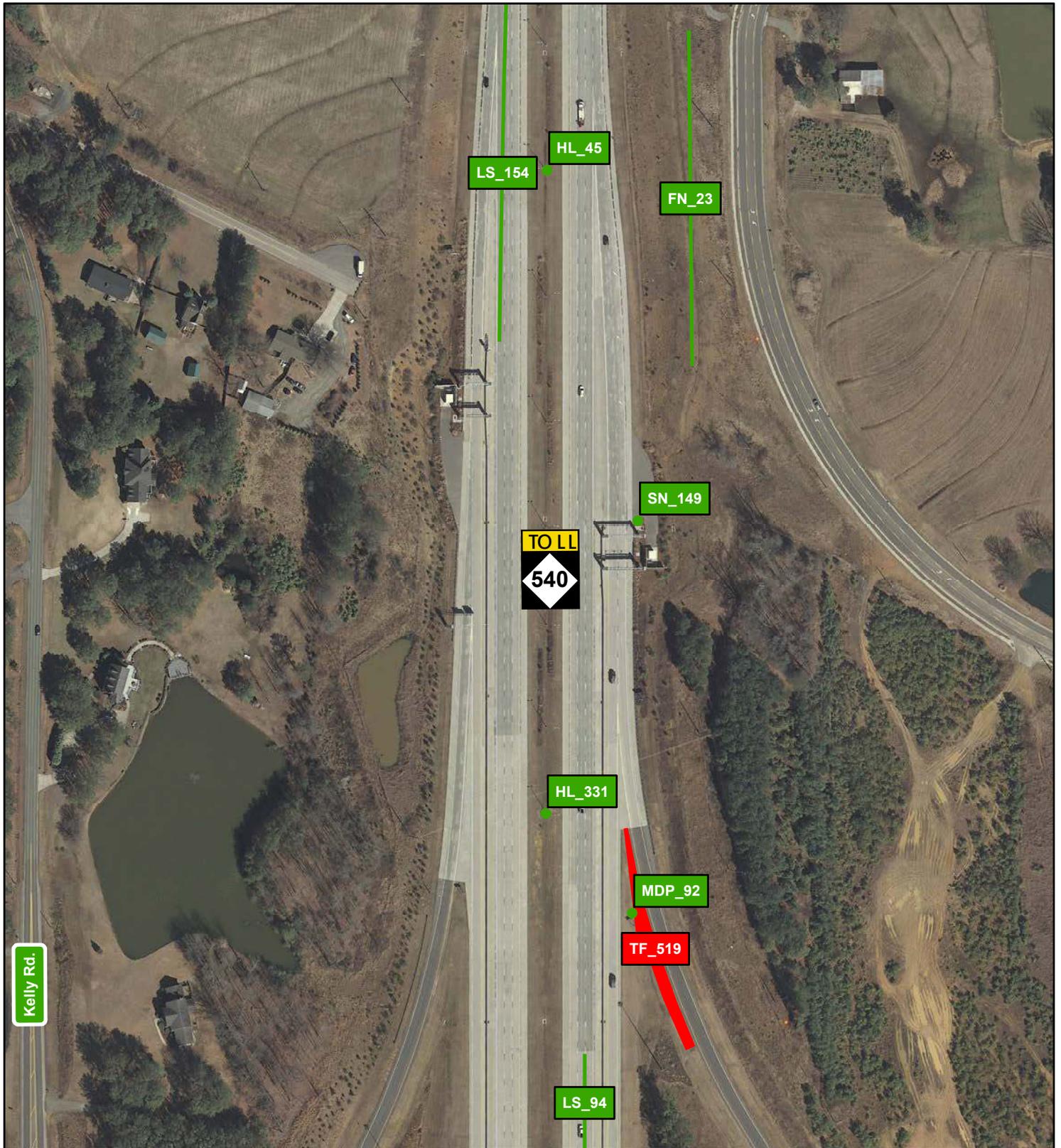


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

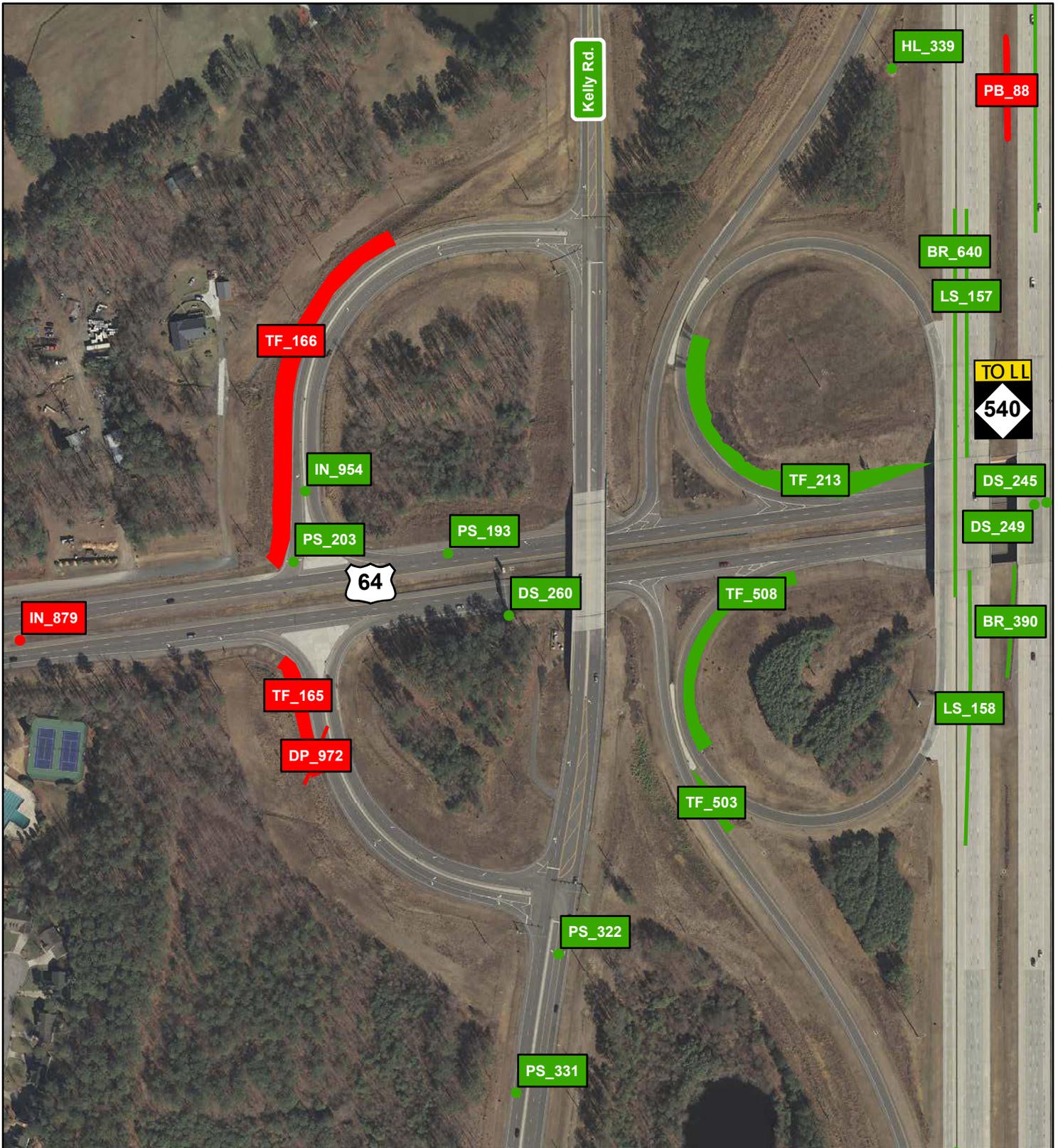


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

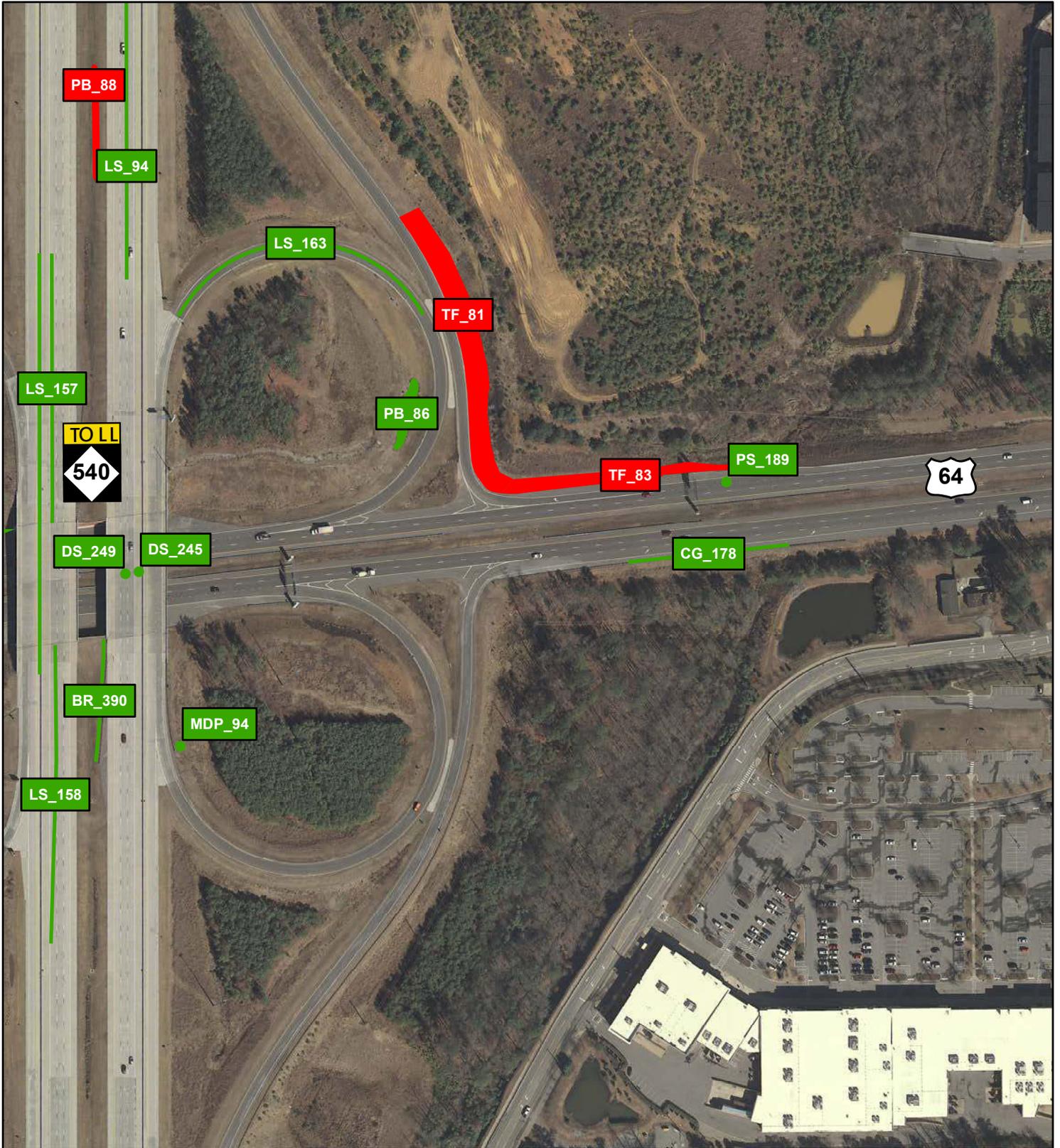


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

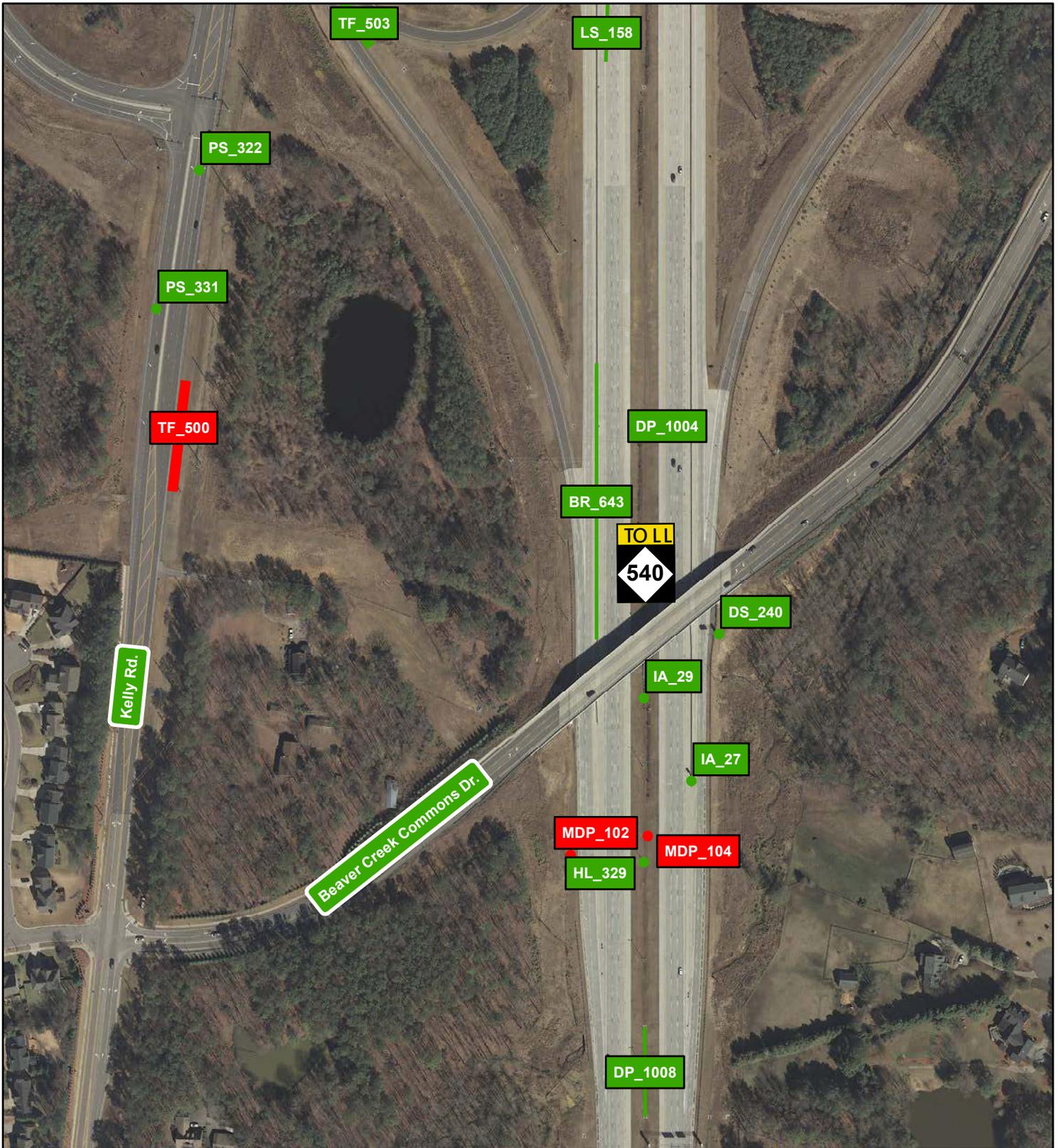


Legend

- Failing Asset
- Passing Asset

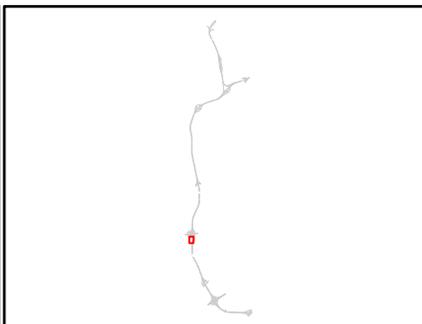


Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

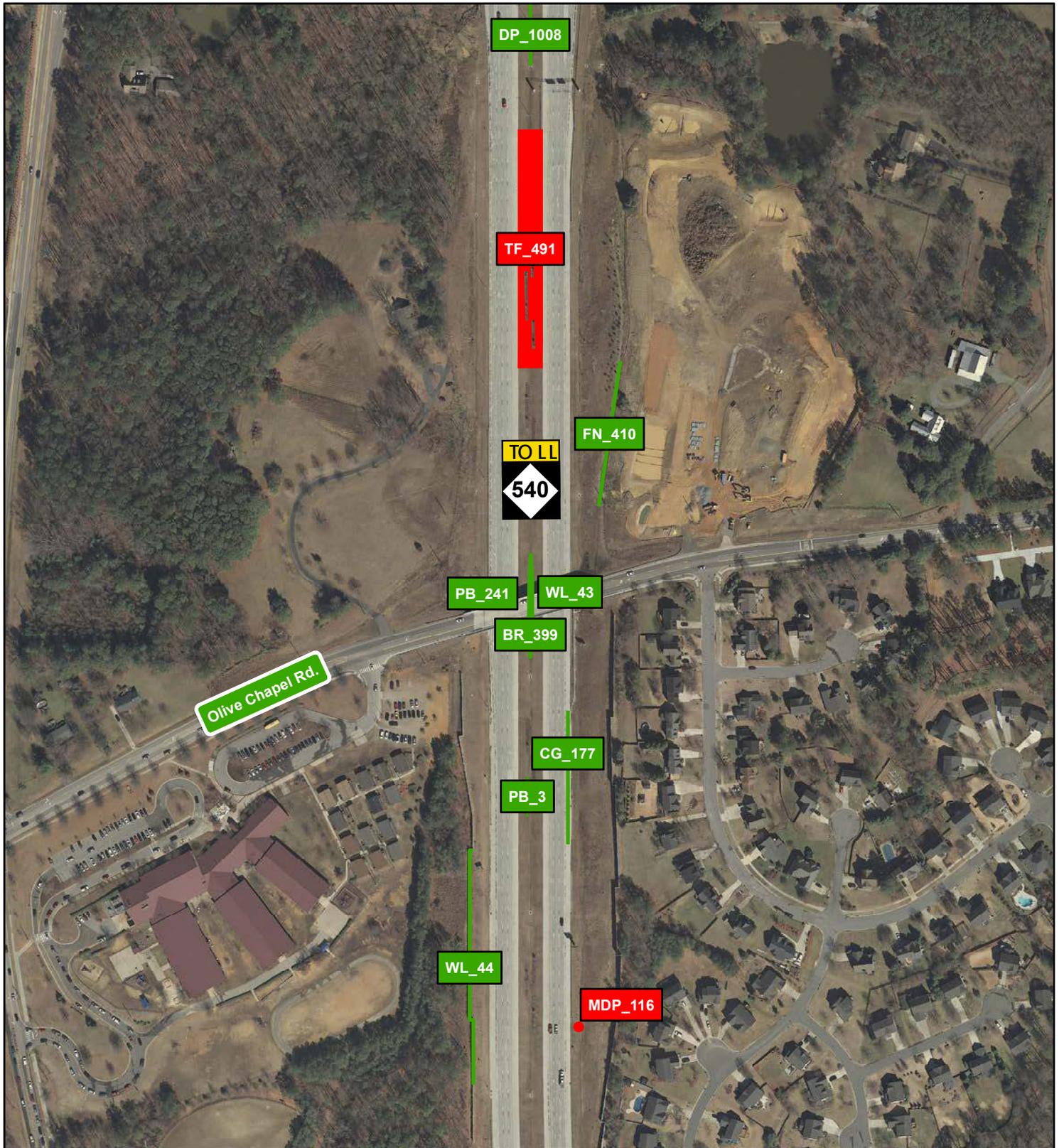


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

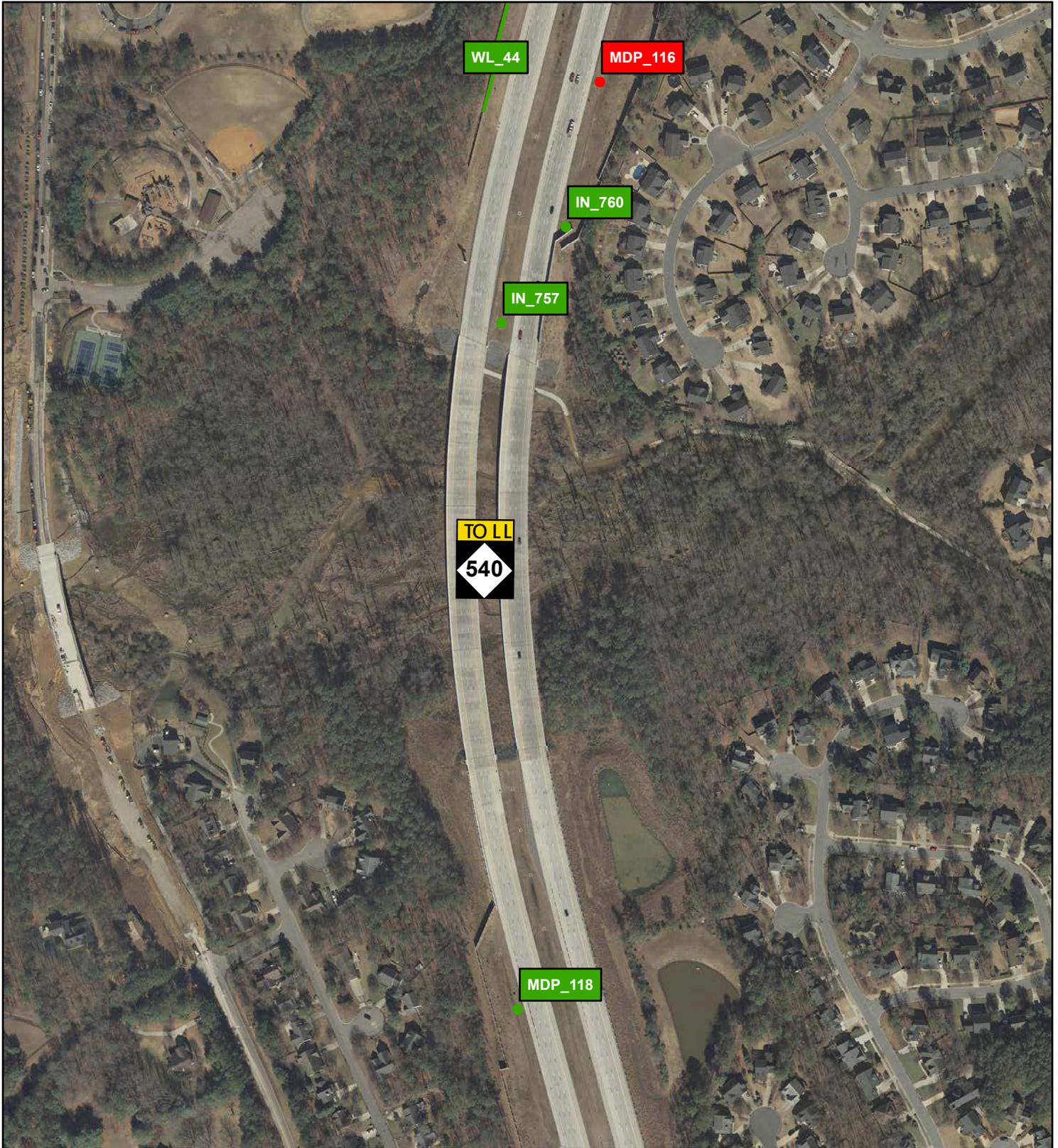


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

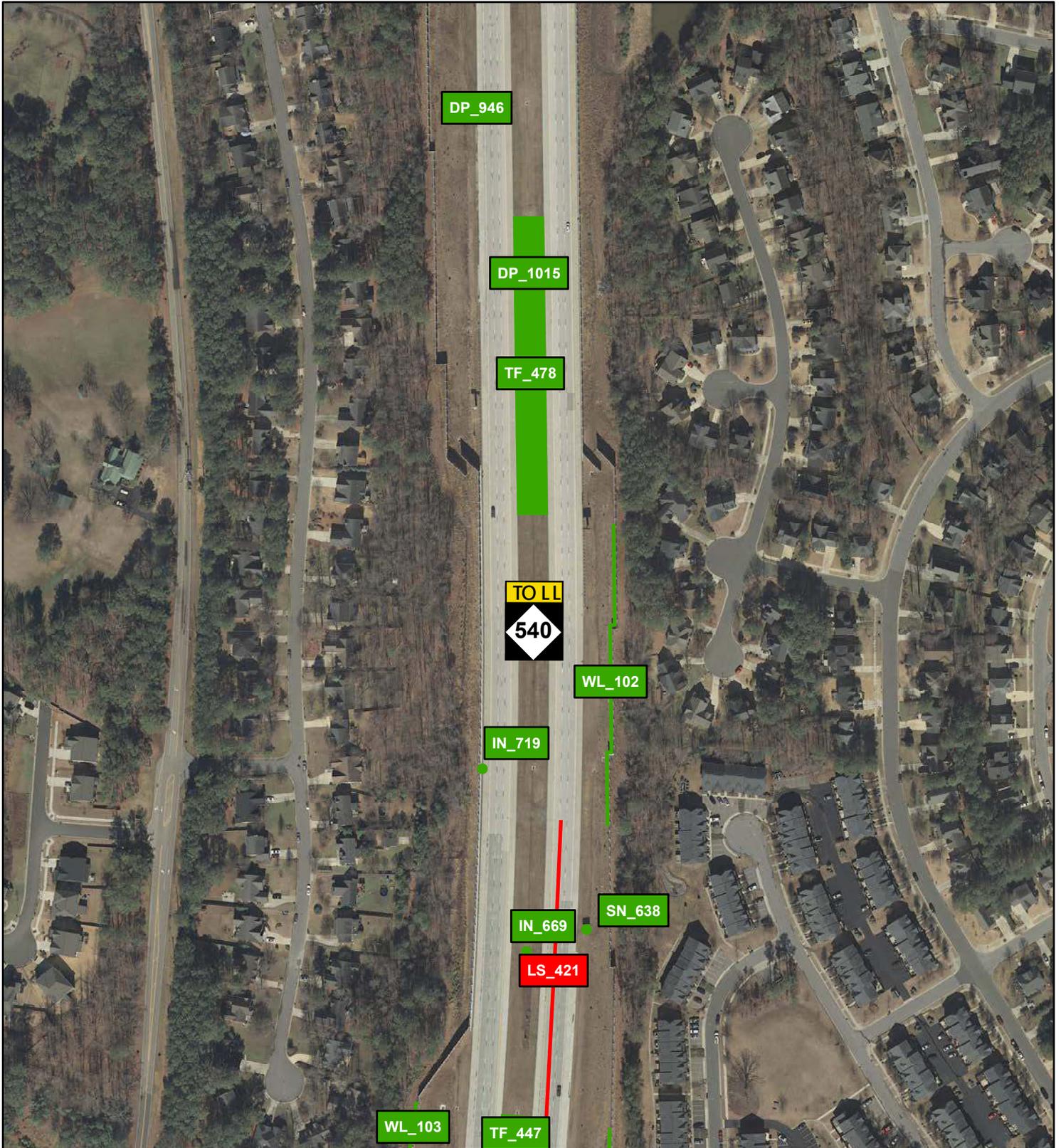


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

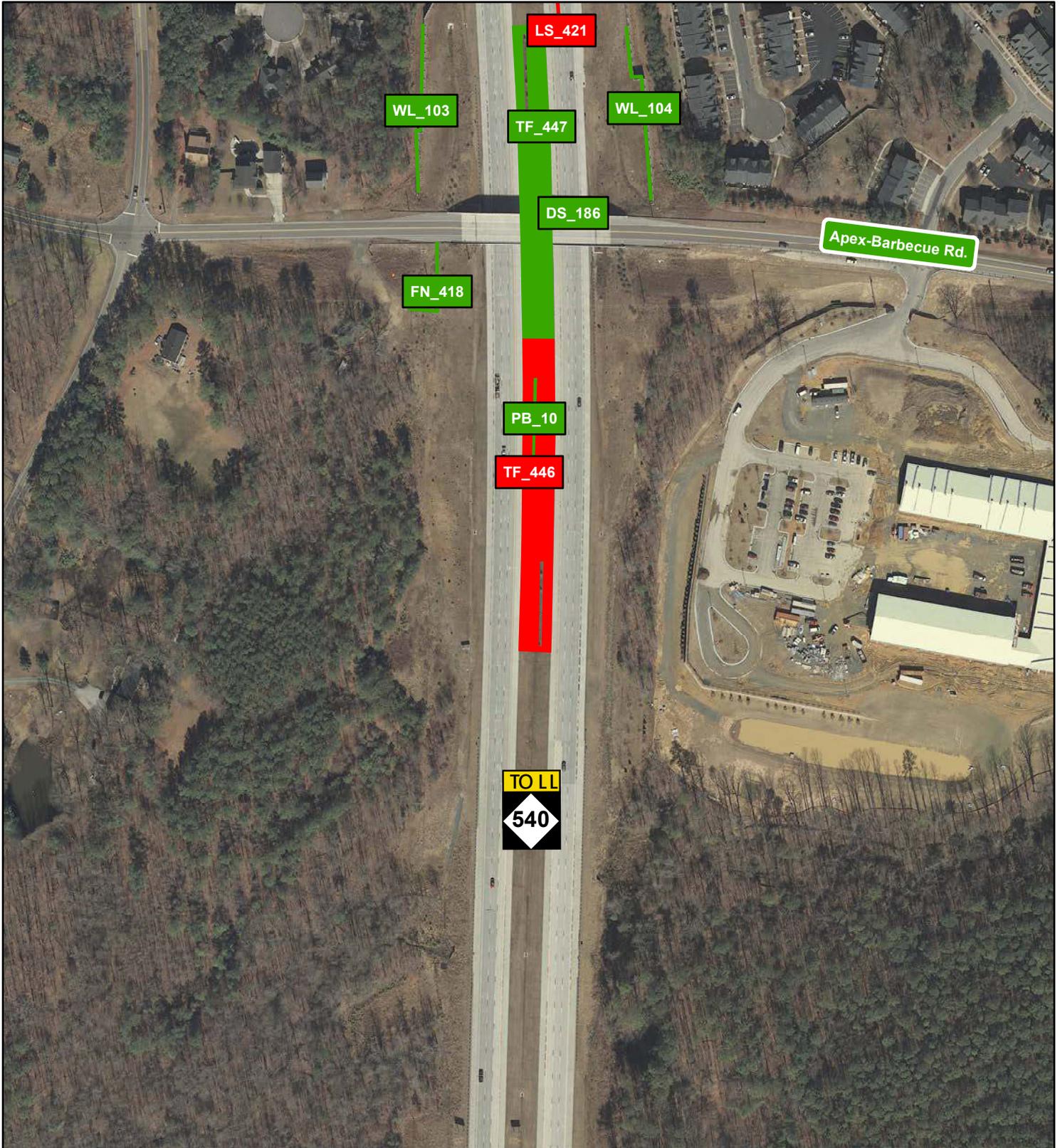


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

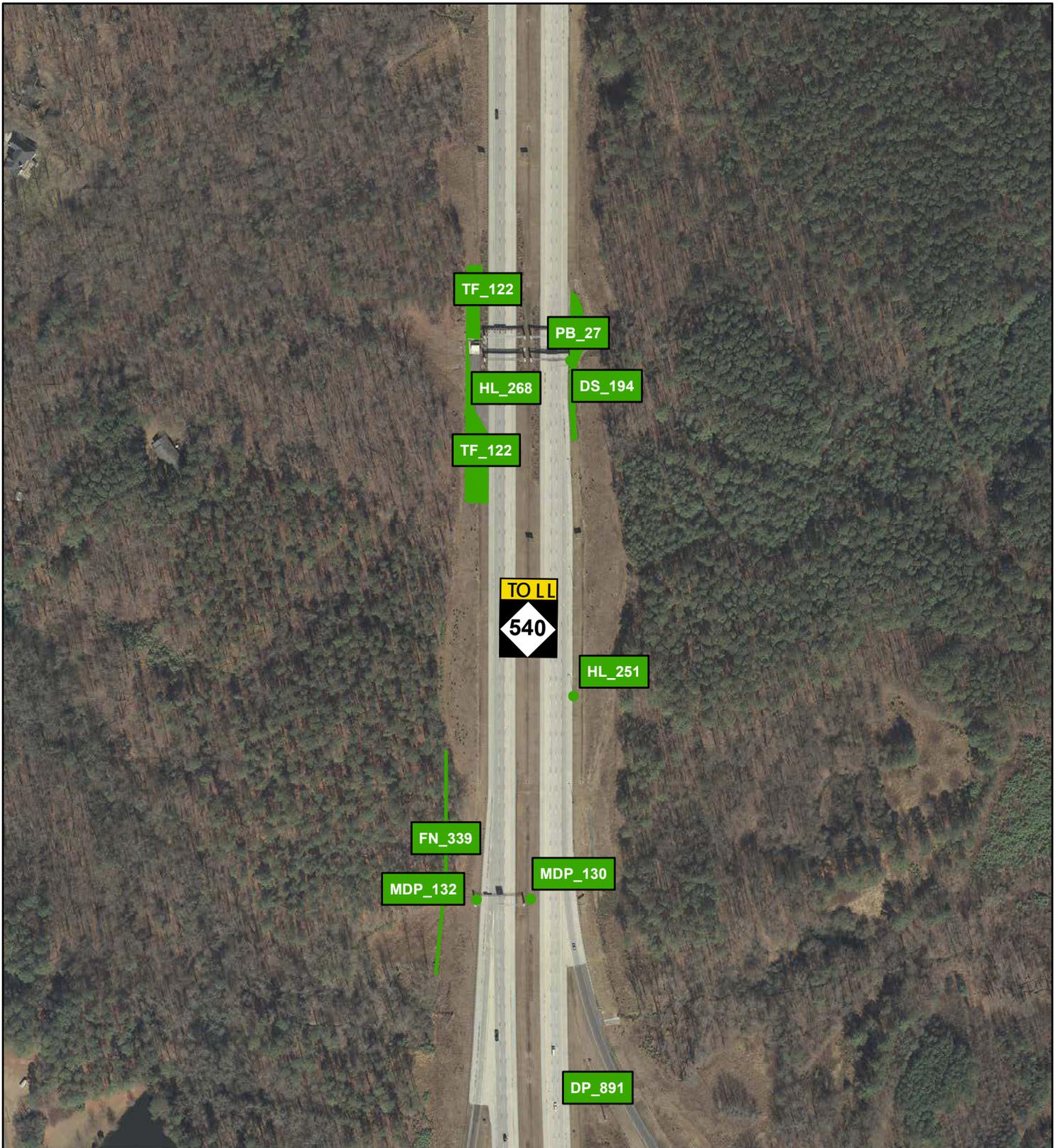


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

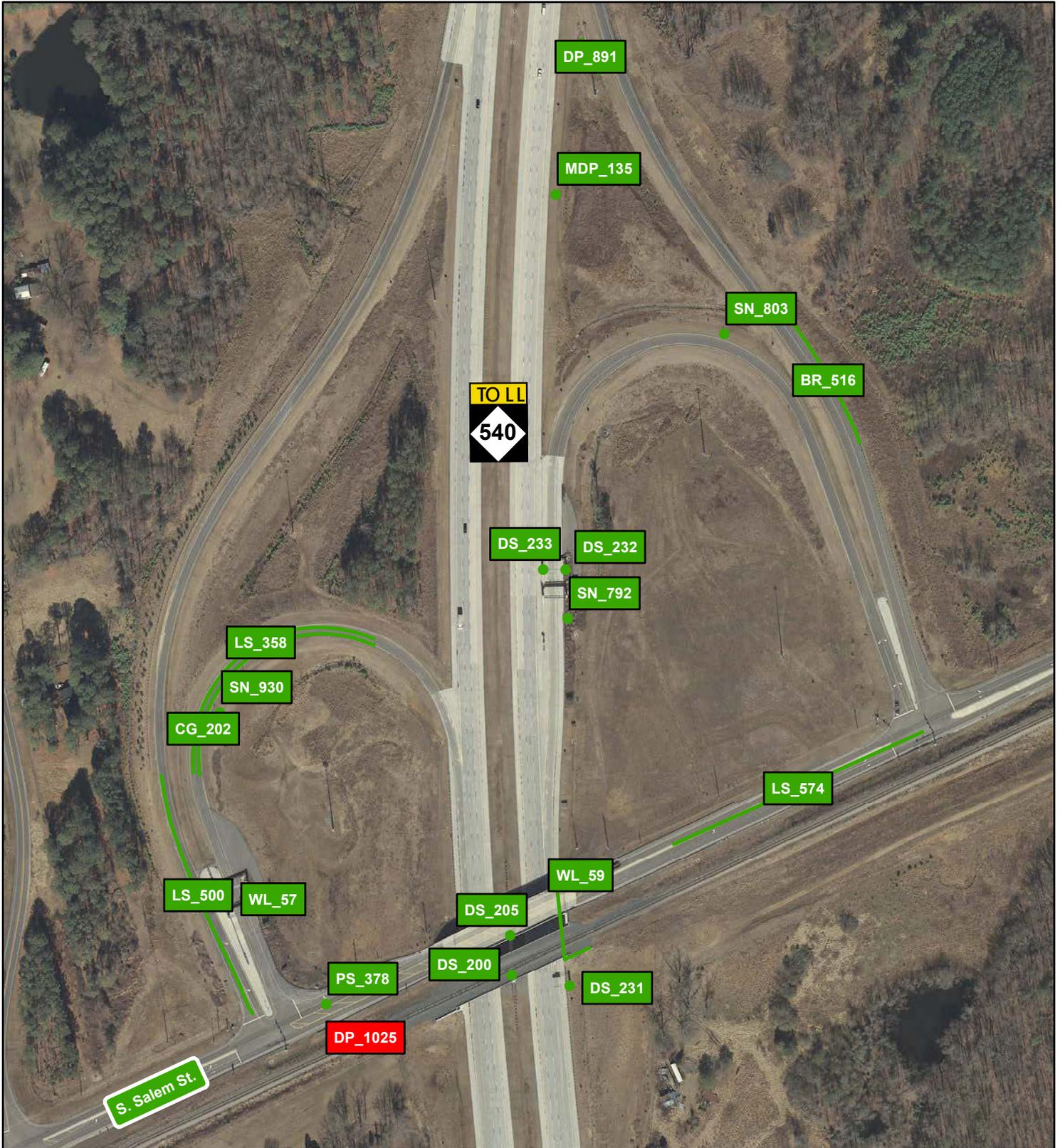


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

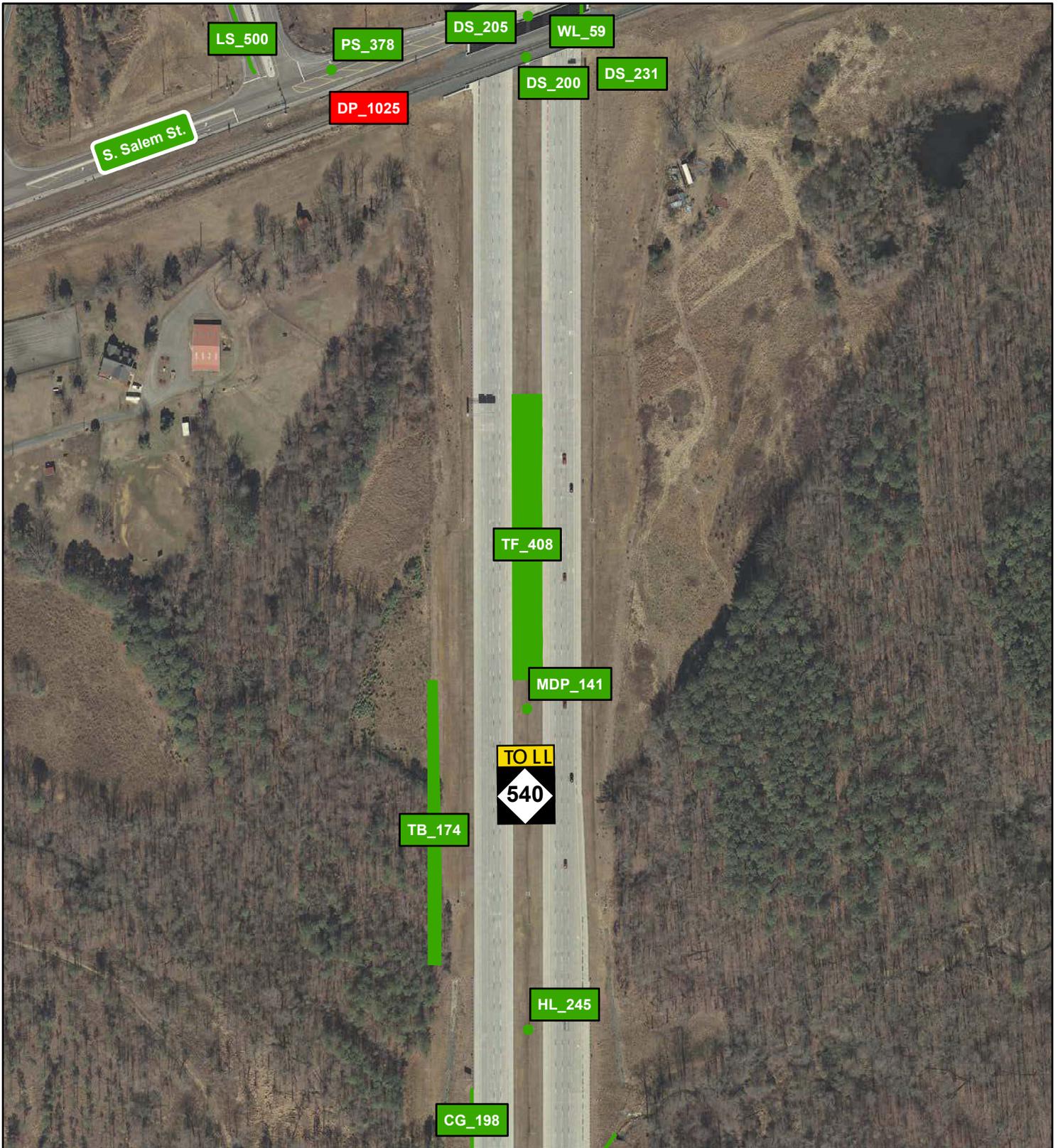


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

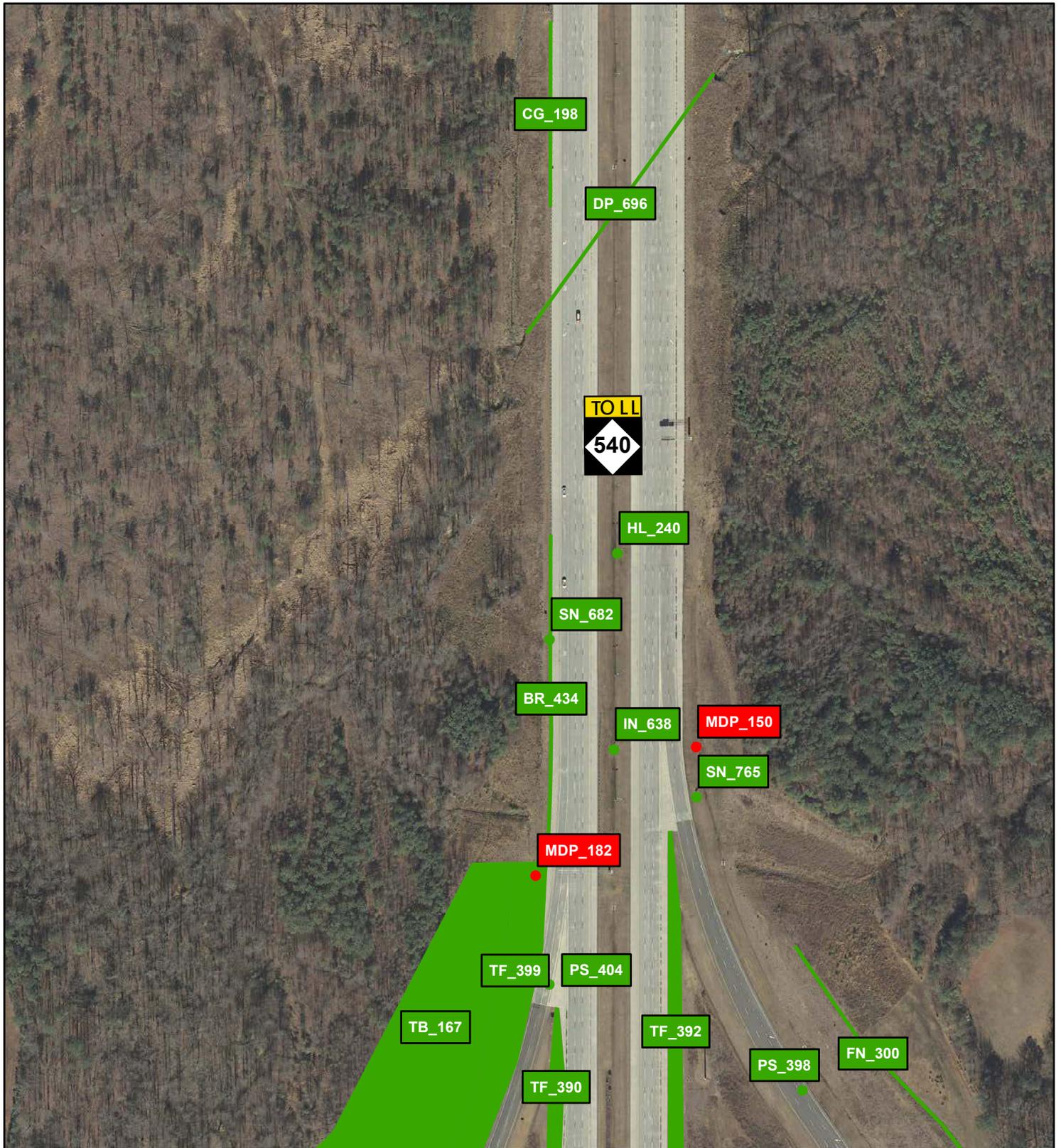


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

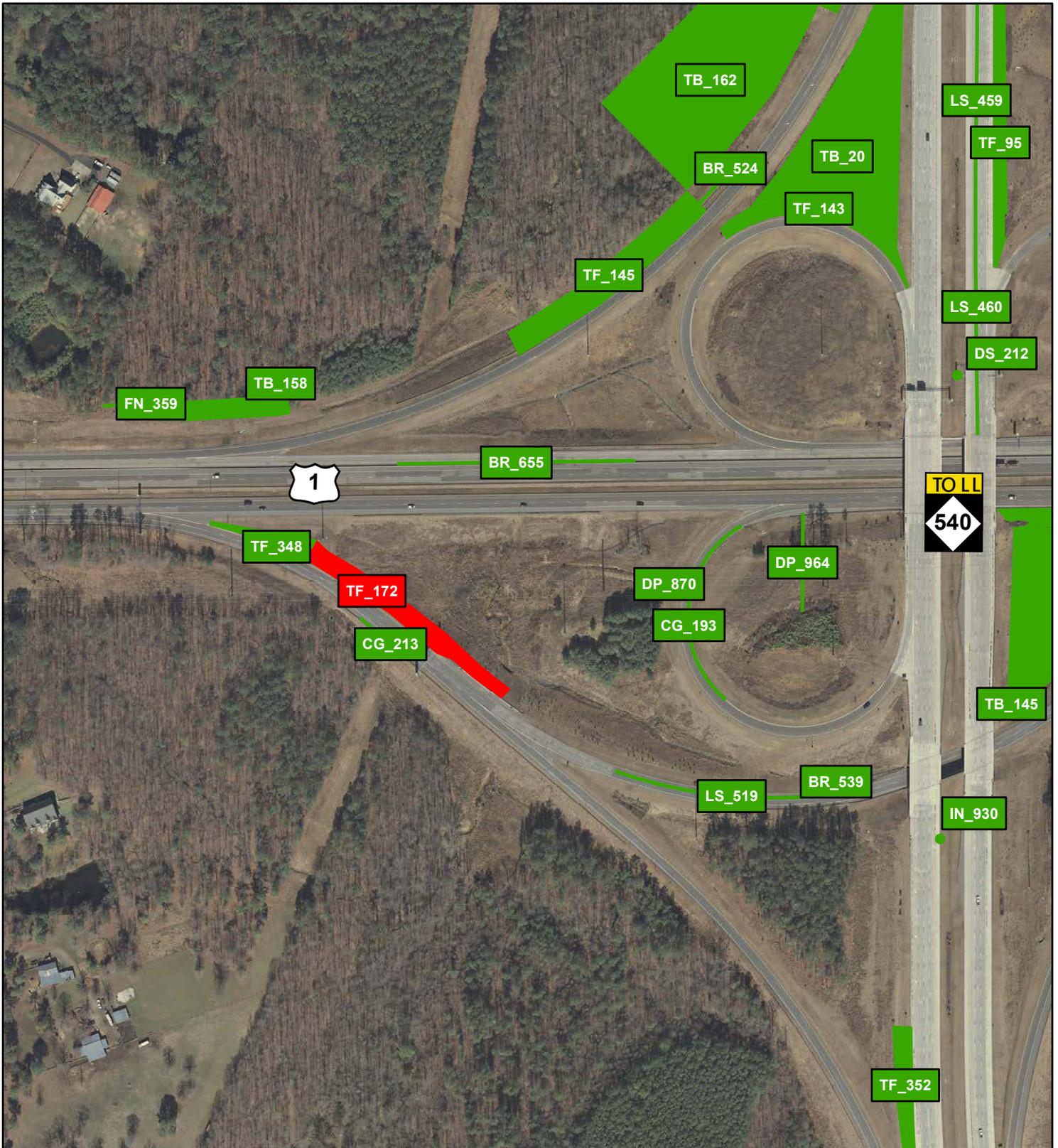


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

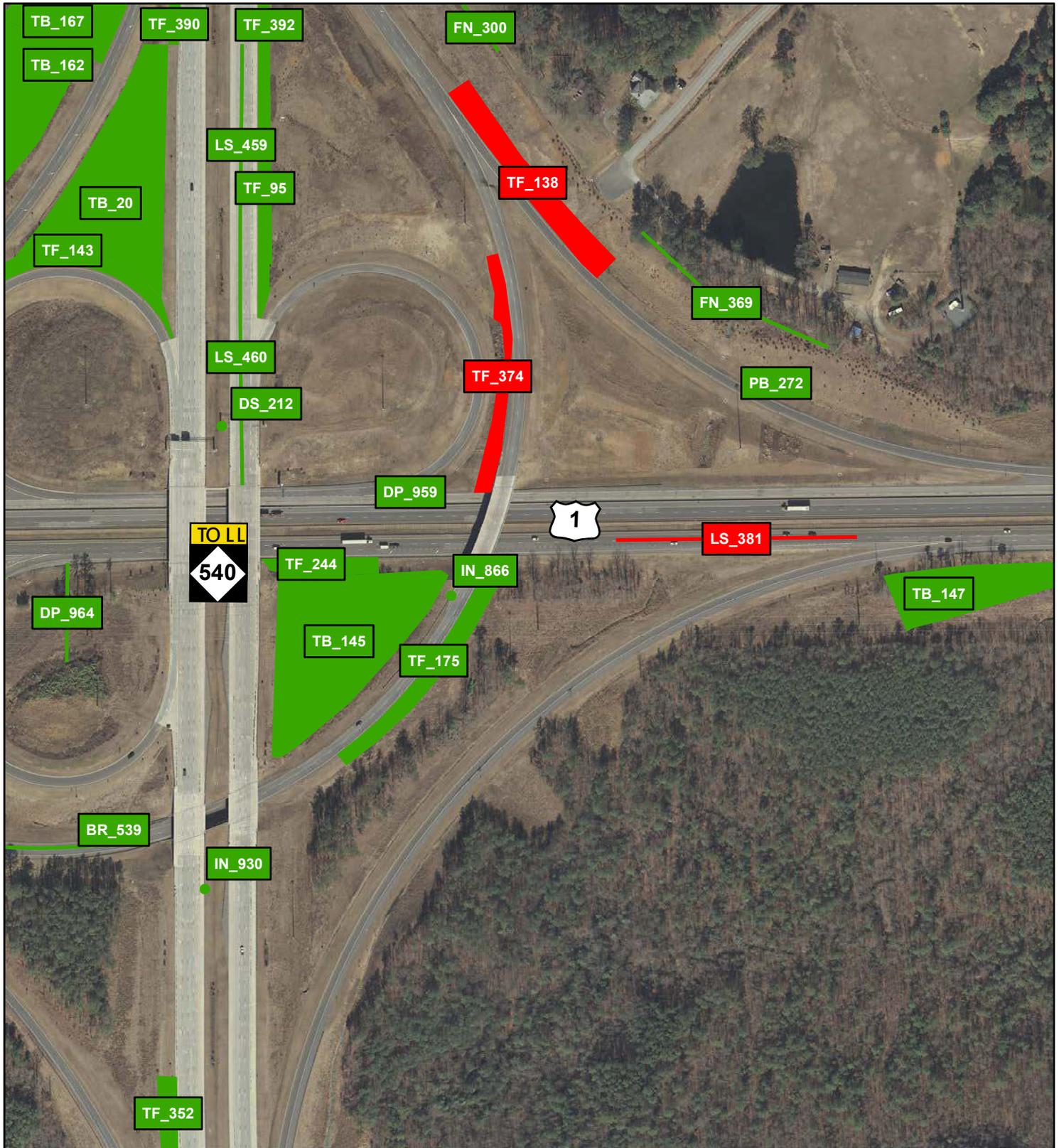


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

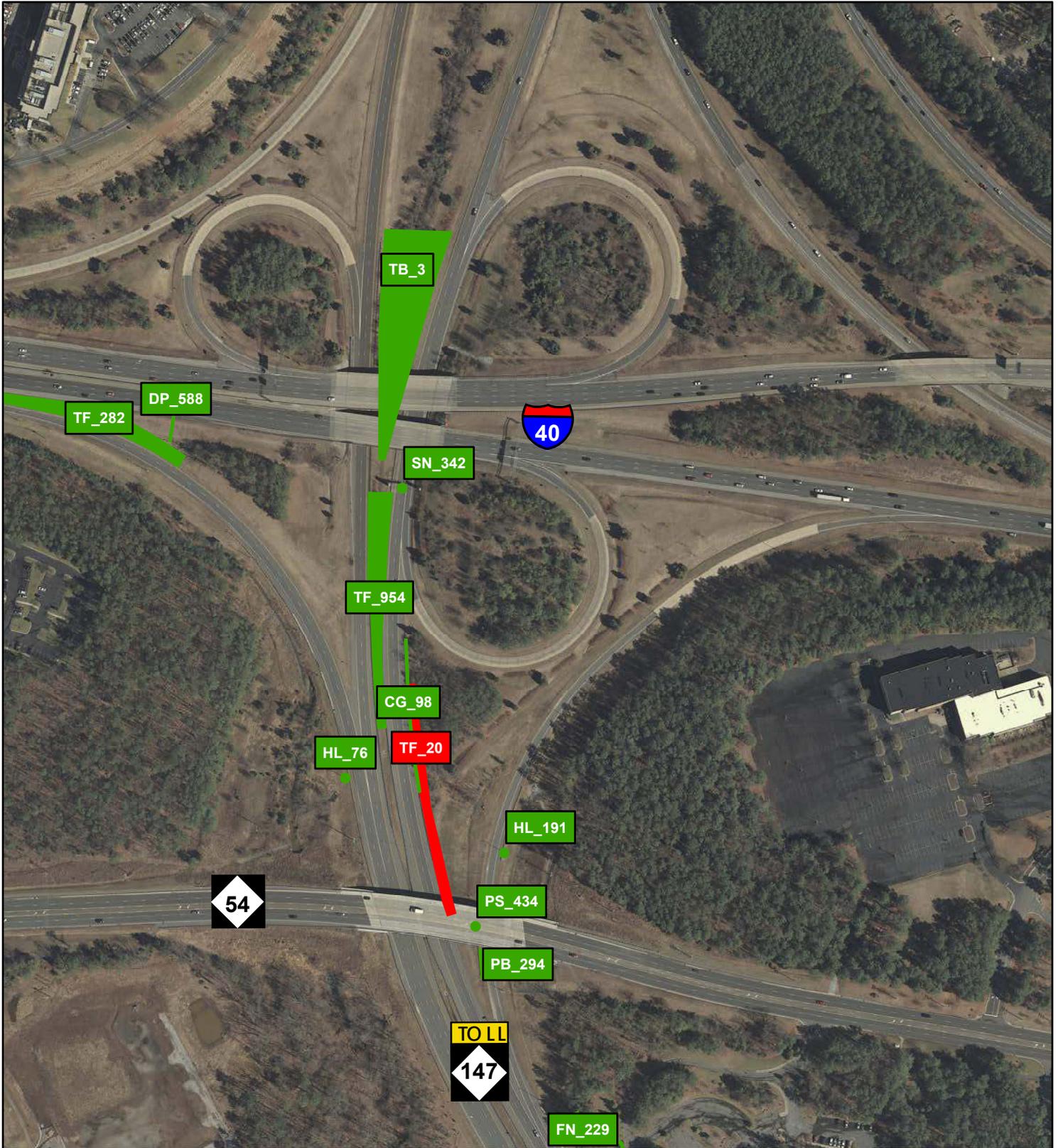


Legend

- Failing Asset
- Passing Asset

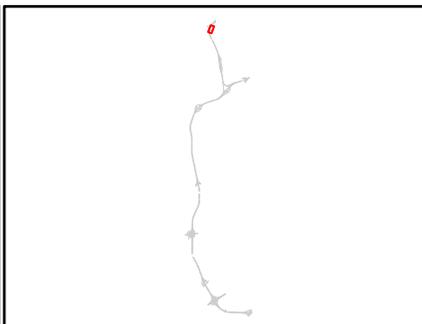


Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

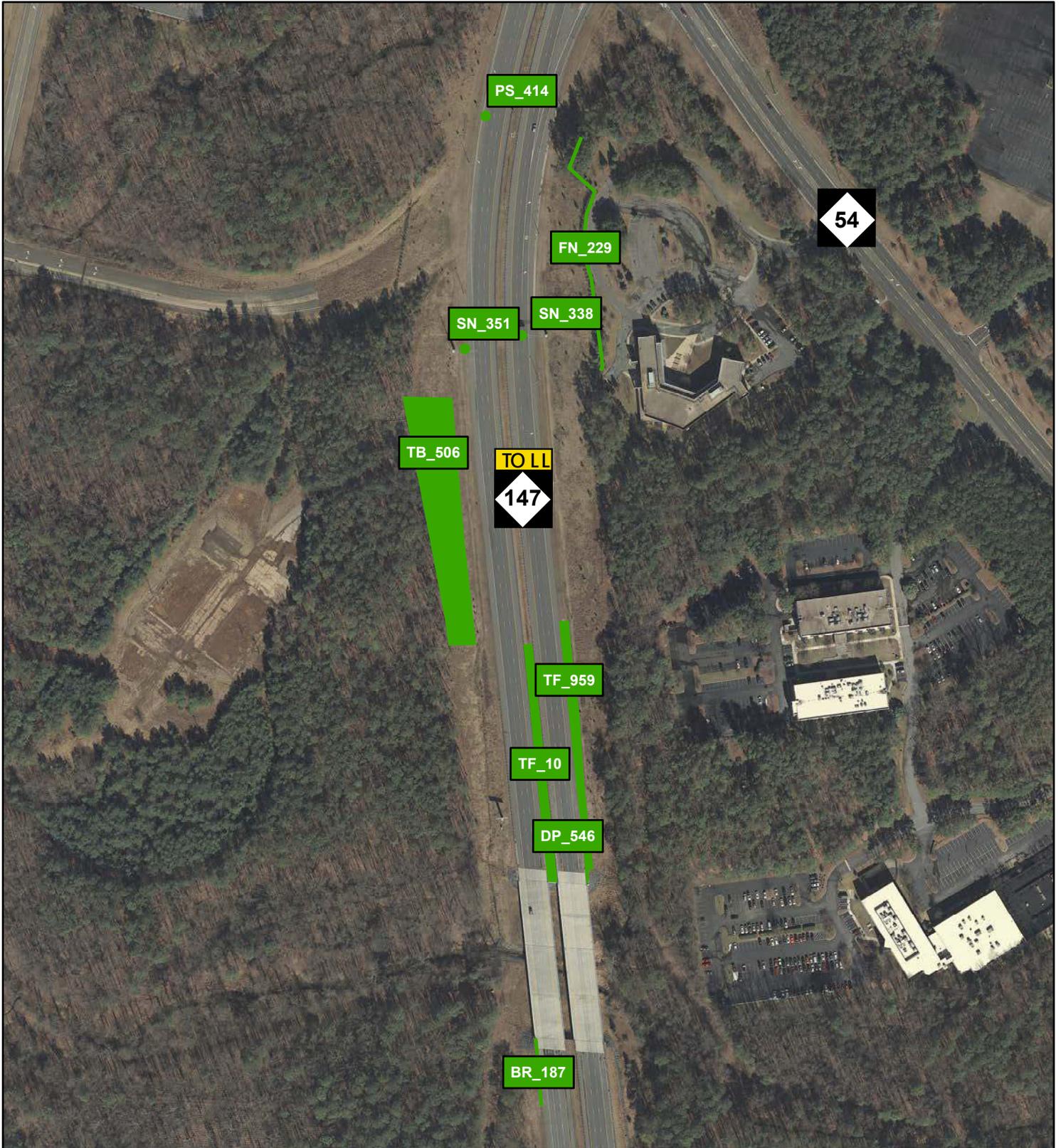


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

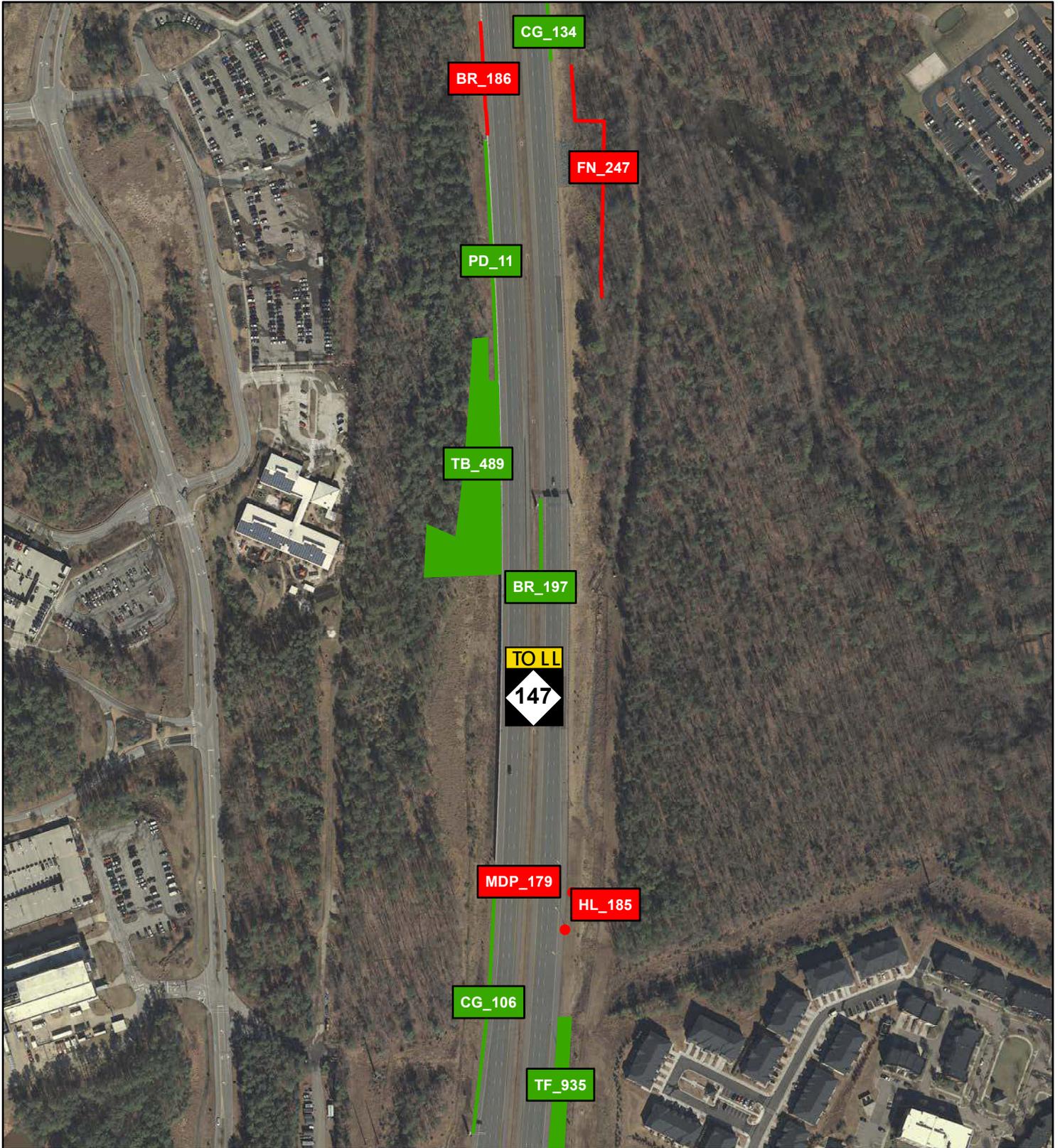


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

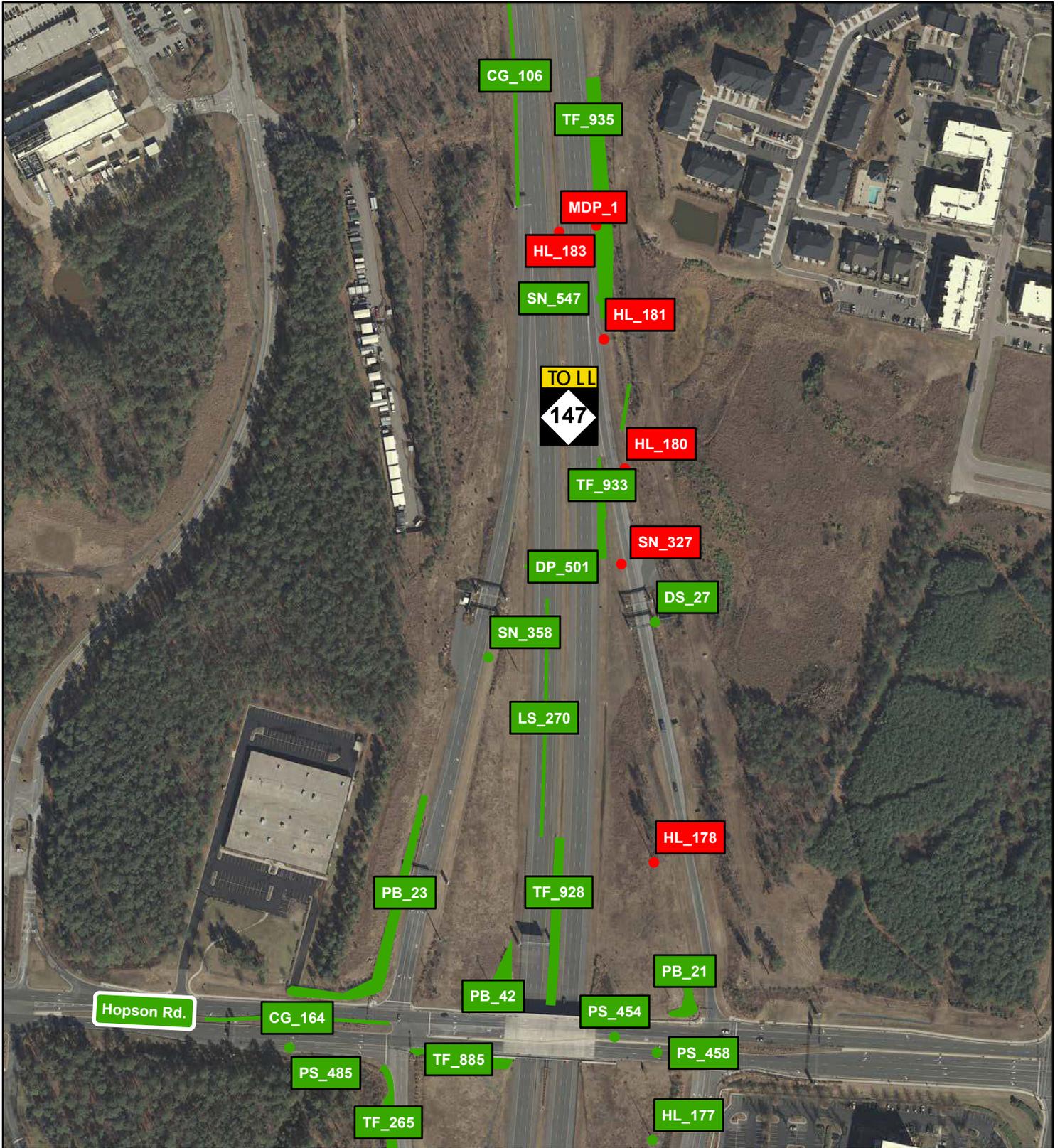


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

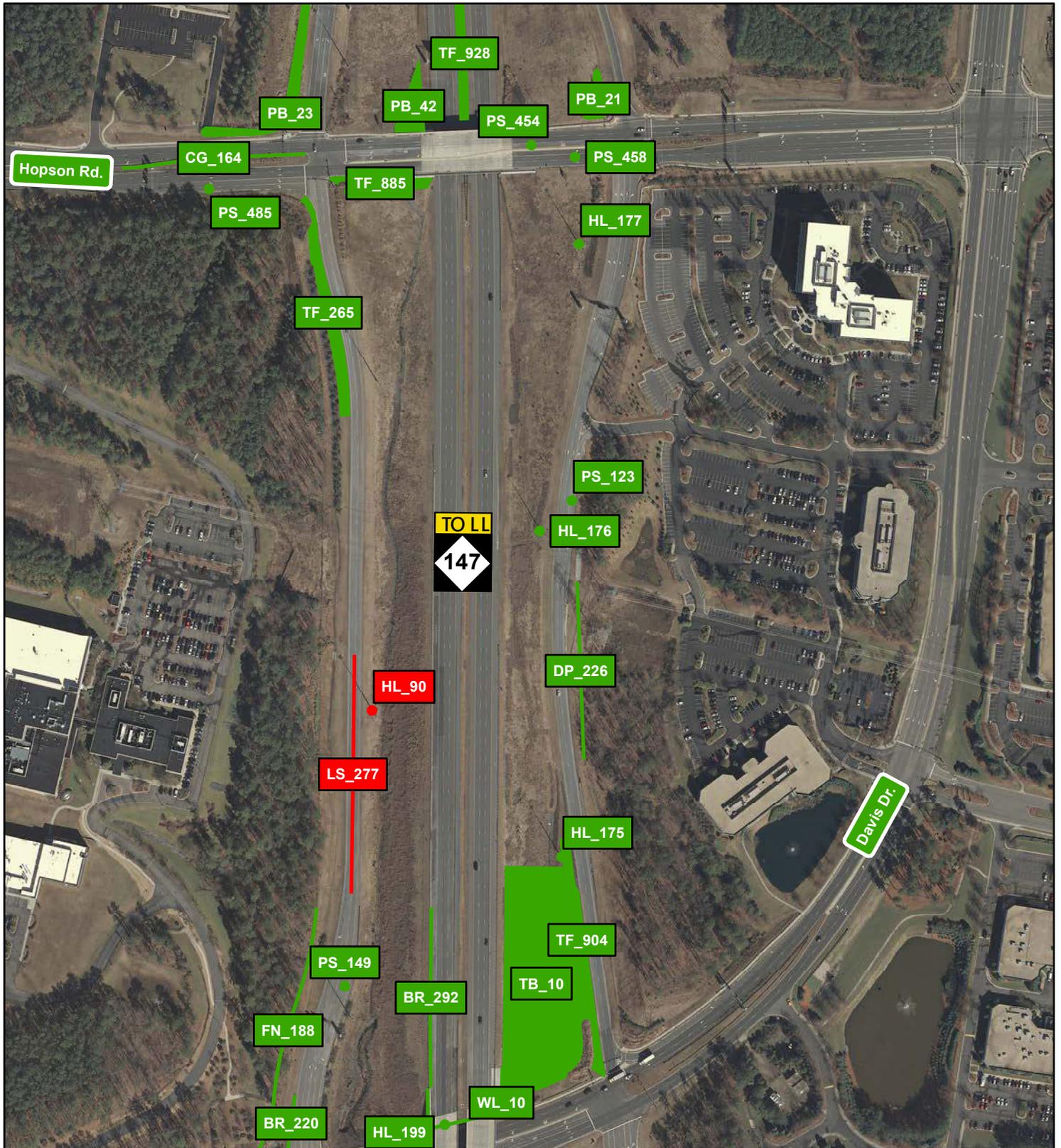


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

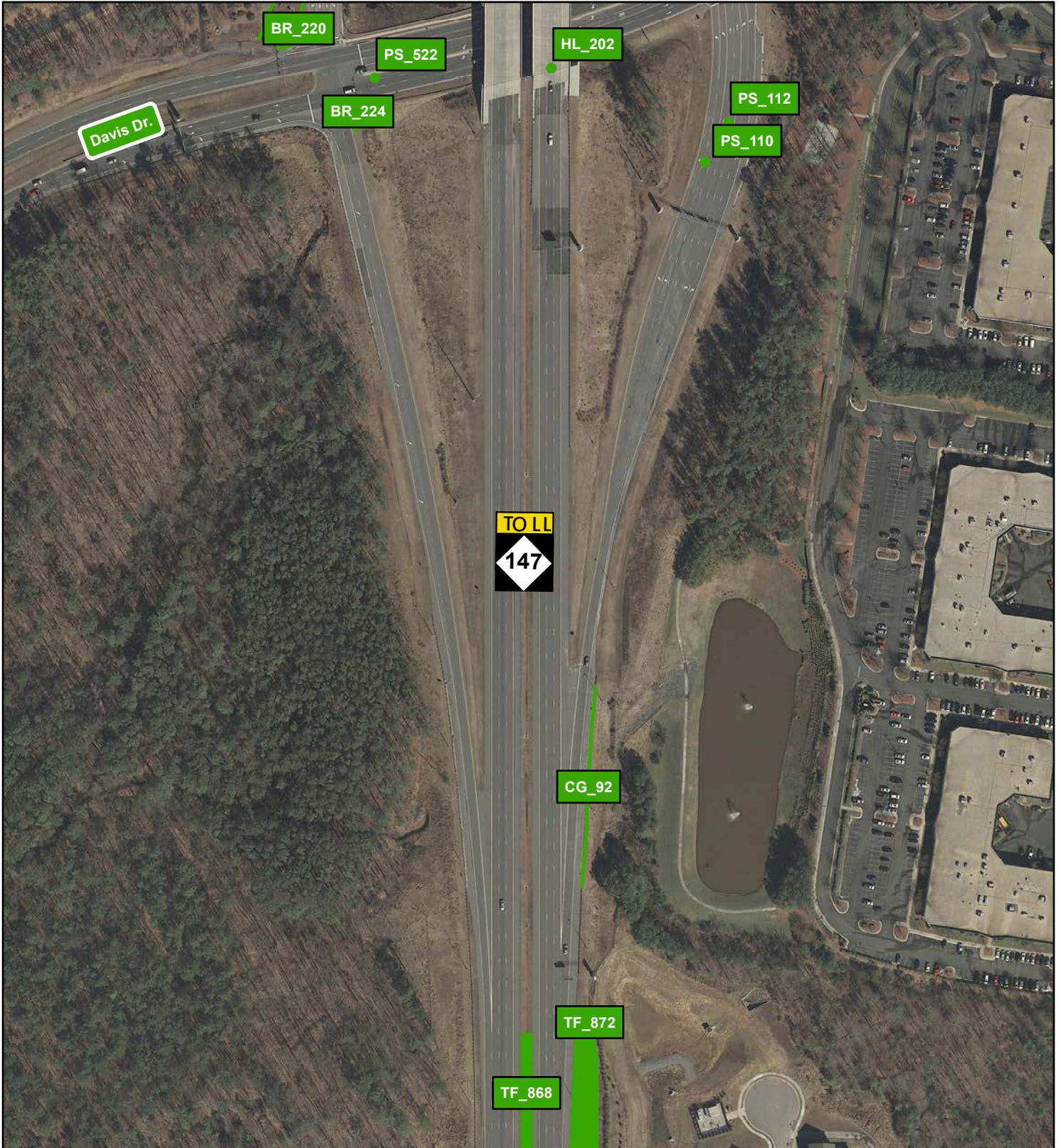


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

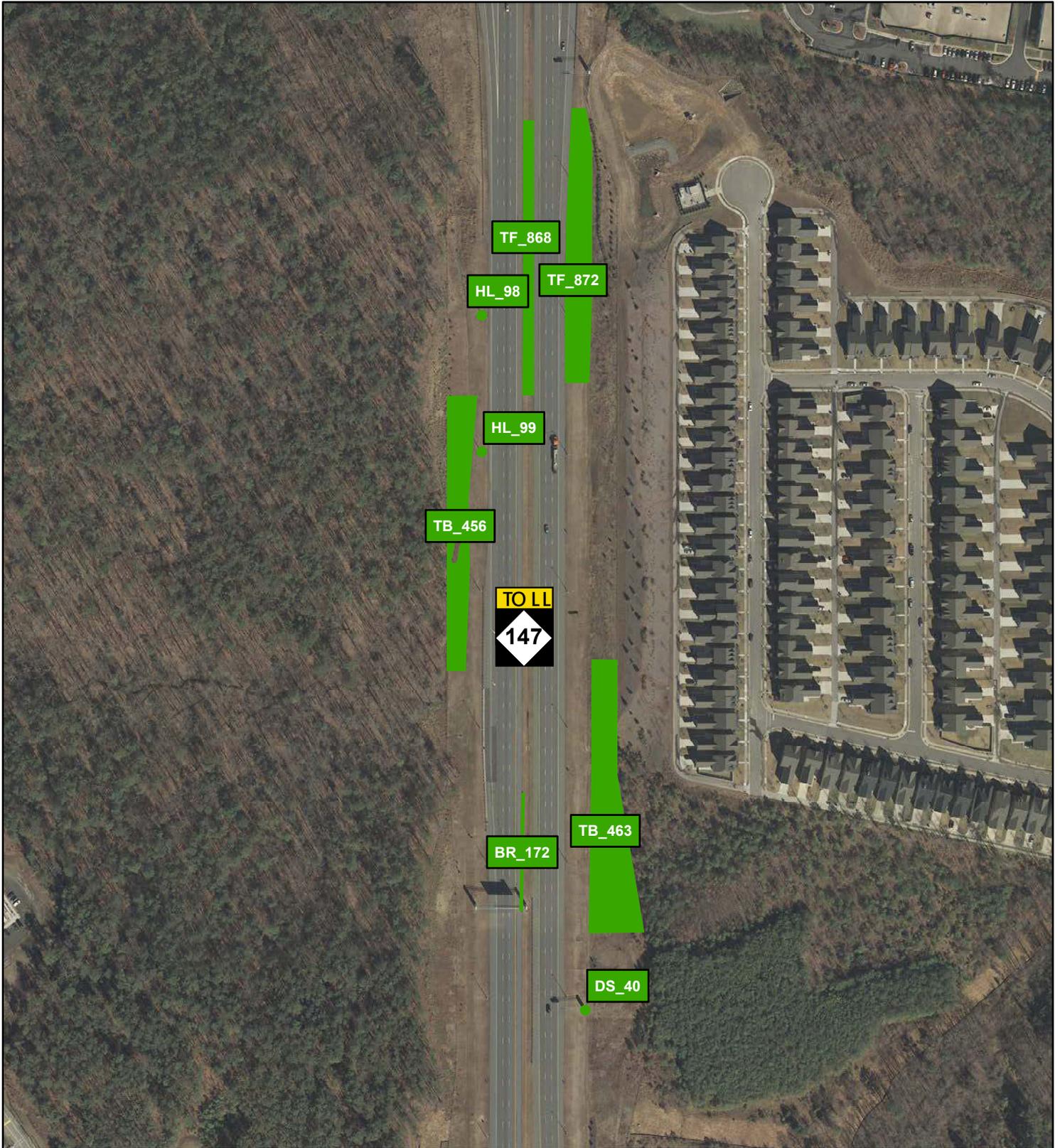


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations

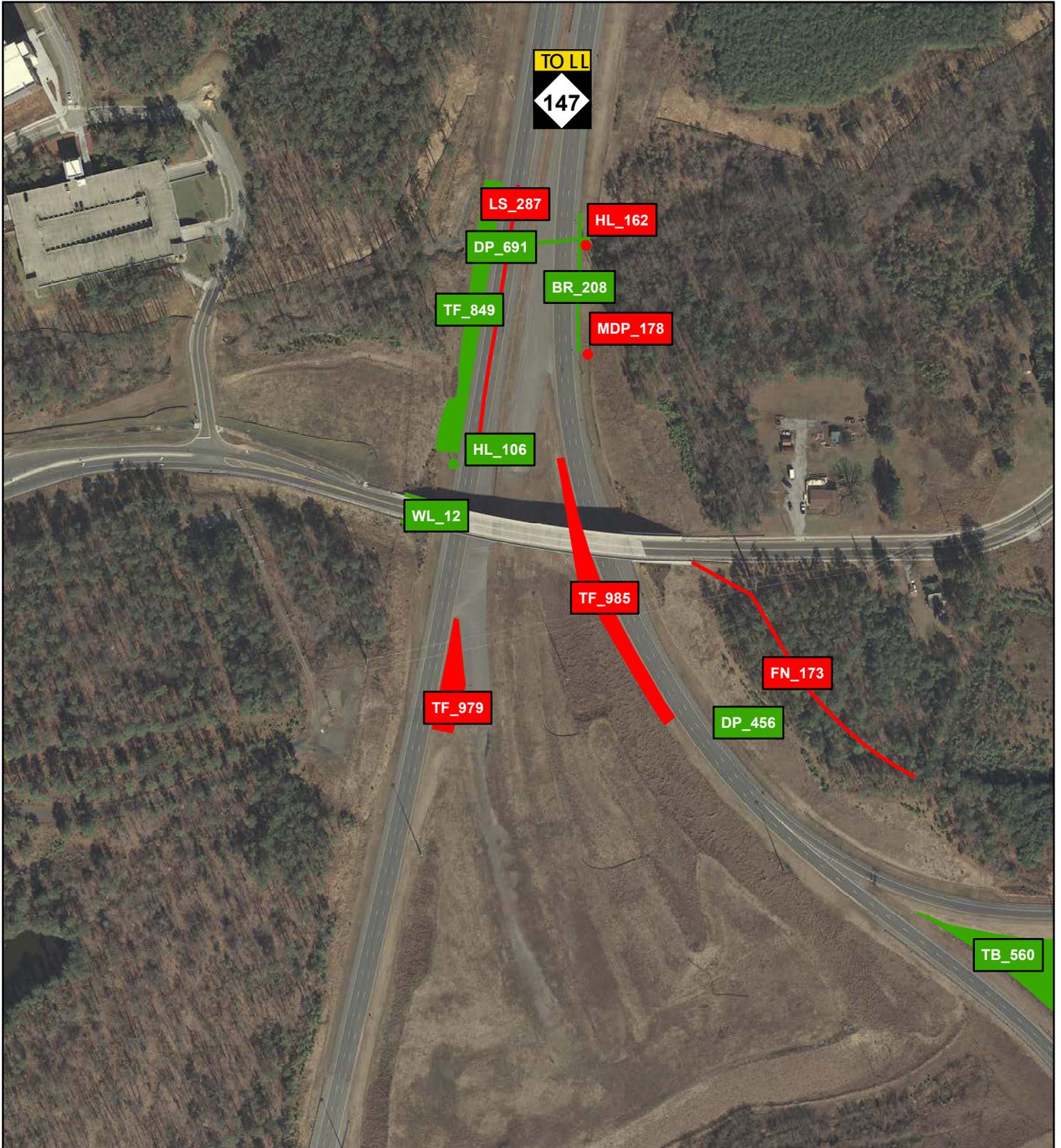


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 First Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix B

Triangle Expressway 2017 First Quarter Table Results of Assets Failing MRP

Appendix B: Triangle Expressway 2017 First 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 Structure (MDP) 7
Fence and Control of Access (FN) 11
Graffiti (GR) 13
Highway Lighting (HL) 14
Impact Attenuators (IA) 15
Inlets (IN)..... 16
Landscaping (PB) 17
Paved Lanes – Asphalt (LS)..... 18
Paved Lanes – Concrete (LS) 19
Paved Shoulders (LS)..... 20
Unpaved Shoulders (LS) 21
Front/Back Slopes (LS) 22
Unpaved Lateral and Outfall Ditches (LS) 23
Litter (LS) 24
Roadway Sweeping (LS) 25
Pavement Striping (LS)..... 26
Pavement Markers (LS)..... 27
Delineators (LS) 28
Paved Ditches (PD)..... 29
Pavement Words and Symbols (PS)..... 30
Signs (SN) 31
Tree and Brush (TB)..... 32
Turf Condition (TF) 33
MSE/Retaining Walls, Sound Barrier Walls and Screen Walls (WL)..... 38

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
1	Guardrail	BR_186	Missing Parts		A43

Curb and Gutter (CG)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	CG_42	Misalignment		A15
2	Valley	CG_163	Misalignment		A4

Decorative Supports (DS)

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

Drainage Pipes (DP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Drain	DP_406	Obstruction, End Treatment Damage		A3
2	Drain	DP_972	End Treatment Damage		A28
3	Culvert	DP_1025	Obstruction		A36, A37

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Shoulder Drain	MDP_1	Obstruction		A44
2	Shoulder Drain	MDP_13	Obstruction, Grate Damage		A12
3	Shoulder Drain	MDP_26	Obstruction		A14, A15
4	Shoulder Drain	MDP_39	Obstruction		A17

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Shoulder Drain	MDP_58	Obstruction		A20, A21
6	Shoulder Drain	MDP_63	Obstruction		A21
7	Shoulder Drain	MDP_77	Obstruction		A24
8	Shoulder Drain	MDP_85	Obstruction		A25

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Shoulder Drain	MDP_102	Grate Damage		A30
10	Shoulder Drain	MDP_104	Erosion		A30
11	Shoulder Drain	MDP_116	Obstruction		A31, A32
12	Shoulder Drain	MDP_150	Obstruction		A38

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Shoulder Drain	MDP_178	Obstruction		A48
14	Shoulder Drain	MDP_179	Obstruction		A43
15	Shoulder Drain	MDP_182	Obstruction		A38

Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Woven	FN_1	Fence Height, Hole Height		A10
2	Woven	FN_7	Fence Height, Hole Height		A10
3	Woven	FN_169	Fence Height		A5
4	Woven	FN_171	Fence Height		A5

Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Woven	FN_173	Fence Height		A48
6	Chain Link	FN_247	Opened Gate		A43

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	High Mast	HL_2	Functional Damage	Not Available for Nighttime Failure.	A10, A11
2	High Mast	HL_3	Functional Damage	Not Available for Nighttime Failure.	A10, A11
3	Single Roadway	HL_11	Functional Damage	Not Available for Nighttime Failure.	A11
4	High Mast	HL_26	Part Damage		A21
5	High Mast	HL_90	Part Damage		A45
6	Single Roadway	HL_162	Part Damage		A48
7	High Mast	HL_178	Functional Damage	Not Available for Nighttime Failure.	A44
8	Single Roadway	HL_180	Functional Damage	Not Available for Nighttime Failure.	A44
9	Single Roadway	HL_181	Functional Damage	Not Available for Nighttime Failure.	A44
10	Single Roadway	HL_183	Functional Damage	Not Available for Nighttime Failure.	A44
11	Single Roadway	HL_185	Functional Damage	Not Available for Nighttime Failure.	A43

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	Inlets	IN_879	Obstruction		A28

Landscaping (PB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Plant Bed	PB_88	Weeds		A28, A29

Paved Lanes – Asphalt (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_3	Unsealed Crack		A11

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_287	Rumble Strips		A48
2	Concrete	LS_339	Rumble Strips		A9

Unpaved Shoulders (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_20	Shoulder Drop Off		A22
2	Asphalt	LS_381	Shoulder Drop Off		A40

Front/Back Slopes (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_143	Slope Failure		A24
2	Asphalt	LS_277	Slope Failure		A45

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
1	Concrete	LS_421	Litter	 A photograph showing a concrete road shoulder. A red circle highlights a small, dark object (litter) on the concrete surface. The background shows a road, trees, and a utility pole.	A33, A34

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	Asphalt	LS_3	Nighttime Line Visibility, Line width, Missing Line		A11

Pavement Markers (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_330	Missing Markers	 A photograph showing a concrete pavement surface. A red circle is drawn around a small, dark, rectangular area on the pavement, which is identified as a missing marker. The background shows a road with some trees and a cloudy sky.	A8

Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_339	Nighttime Reflectivity	Not Available for Nighttime Failure.	A9

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	Toll Payments	SN_21	Sign Support		A20
2	One Way	SN_327	Surface Damage		A44
3	Keep Right of Median	SN_494	Height Requirement		A3
4	Trailblazer	SN_1005	Leaning		A2

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_20	Bare Ground		A41
2	Turf	TF_22	Bare Ground		A11
3	Turf	TF_26	Bare Ground		A21
4	Turf	TF_81	Bare Ground		A29

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_83	Bare Ground		A29
6	Turf	TF_138	Bare Ground		A40
7	Turf	TF_165	Bare Ground		A28
8	Turf	TF_166	Bare Ground		A28

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
8	Turf	TF_166	Height		A28
9	Turf	TF_172	Bare Ground		A39
10	Turf	TF_374	Bare Ground		A40
11	Turf	TF_446	Bare Ground		A34

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
12	Turf	TF_491	Bare Ground		A31
13	Turf	TF_500	Bare Ground		A30
14	Turf	TF_519	Bare Ground		A27
15	Turf	TF_539	Bare Ground		A26

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
16	Turf	TF_543	Bare Ground		A26
17	Turf	TF_979	Bare Ground		A48
18	Turf	TF_985	Bare Ground		A48

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.					