



NORTH CAROLINA
Turnpike Authority

Maintenance Rating Program

Triangle Expressway

2017 Third Quarter Report

July - September

1 S. Wilmington Street
Raleigh, NC 27601



Last Updated:
November 2, 2017

CONSULTANT CERTIFICATION OF COMPLETION

November 2, 2017

Dennis Jernigan, P.E.
Director of Highway Operations, NCTA
1 South Wilmington Street
Raleigh, NC 27601

NCTA Triangle Expressway Roadway Maintenance Performance Rating Program; Q3, 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 Third Quarter Assessment of the Triangle Expressway.

The overall 2017 third quarter maintenance rating of the Triangle Expressway was 90.9, meeting the NCTA target rating of 90. As shown in **Table 1**, only four of the five elements assessed achieved a rating greater than the target rating of 85.

Table 1: MRP Element Results for the 2017 Third Quarter Assessment		
Element	MRP Rating	Target Rating
Road Surface	98.1	85.0
Unpaved Shoulders and Ditches	100.0	85.0
Drainage	83.2	85.0
Roadside	90.4	85.0
Traffic Control Devices	85.2	85.0
Overall MRP Performance Rating	90.9	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 rolling maintenance rating of the Triangle Expressway was 92.5.

Table 2: MRP Rolling Element Results					
Element	Q4 2016 Rating	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Rolling Rating
Road Surface	97.7	97.8	100.0	98.1	98.2
Unpaved Shoulders and Ditches	100.0	95.6	95.5	100.0	98.2
Drainage	93.8	86.7	92.3	83.2	88.9
Roadside	93.7	90.3	87.4	90.4	90.6
Traffic Control Devices	88.3	91.4	88.5	85.2	88.3
Overall MRP Performance Rating	93.9	92.7	92.7	90.9	92.5

In addition, the report provides findings of the Green Level Historic District signs inspection. This quarter, due to a Town of Cary development project currently taking place near the location of the signs only three of the four signs were available for inspection. All three signs inspected were found to be in good physical condition, and the landscaped areas around the signs were 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 using sampling procedures that capture the level of service being provided for individual assets. The evaluation procedure is based on the establishment of threshold conditions that quantify the maximum defect allowed on assets. Over time, the results can be charted to identify work needs and subsequent necessary actions.

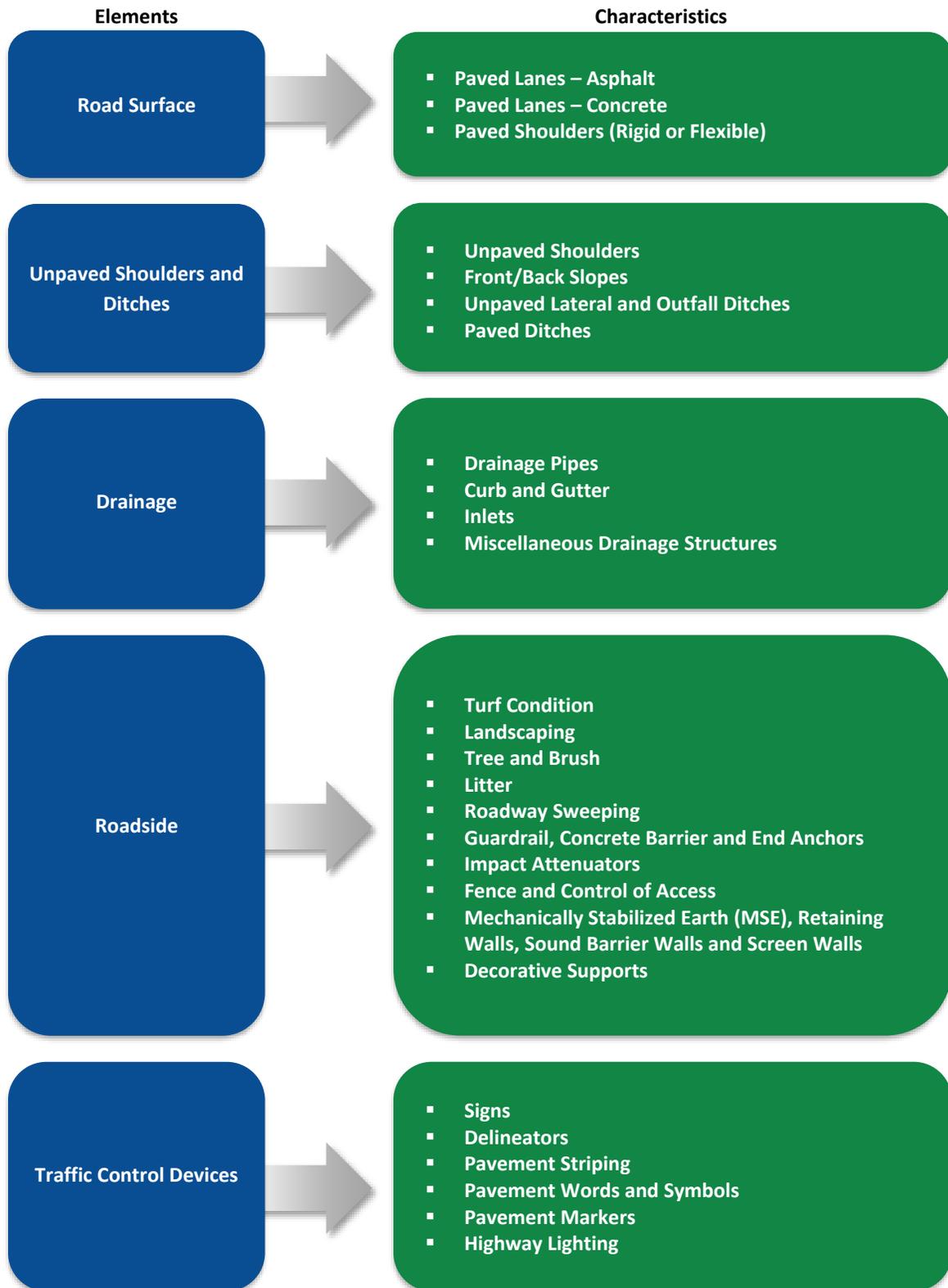
The NCTA performance standards, threshold criteria and maintenance rating program were developed through a collaborative effort by NCTA managers, NCDOT maintenance staff and consultants.

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

3.0 MRP PROCEDURE

Per the *NCTA Roadway and Facility Maintenance Performance Standards 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 using statistically valid, random sampling procedures that capture the level of service for individual characteristics with a 95% confidence level in sampling. The sample characteristics selected are evaluated during quarterly inspections, which are performed during the months of February, May, August, and November to account for dynamic changes in assets during the various seasons. The evaluation process is completed using electronic data collection tablets and is based on established threshold conditions described in the *NCTA Roadway and Facility Maintenance Standards 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, an MRP rating of 83 signifies that 83 percent of the inspected elements/characteristics met the standard.

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

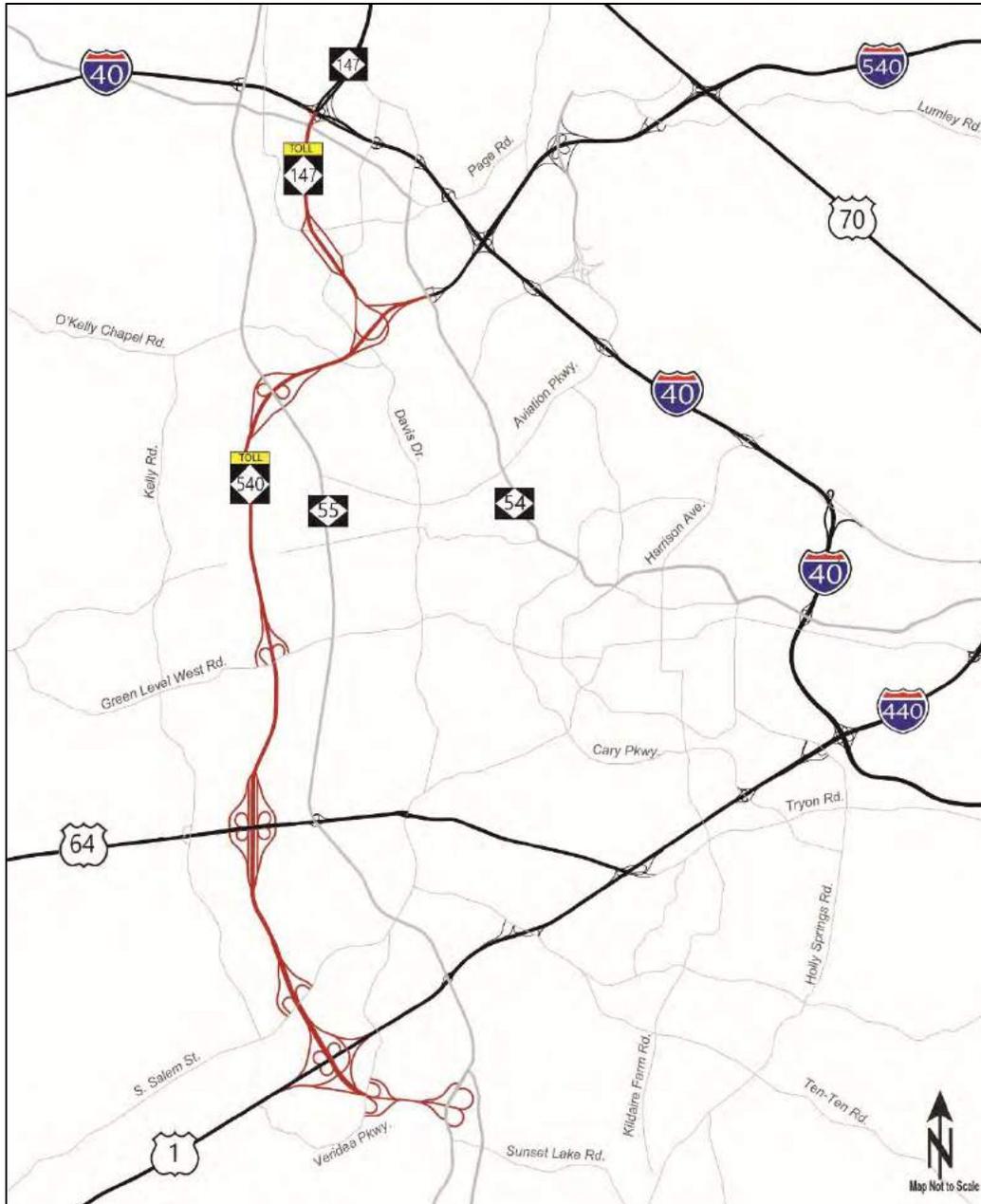
Road Surface =	25%
Unpaved Shoulders =	13%
Drainage =	15%
Roadside =	17%
Traffic Control Devices =	30%
<hr/>	
Total	100%

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

4.0 TRIANGLE EXPRESSWAY DESCRIPTION

The Triangle Expressway extends for approximately 18.8 miles from the interchange of I-40 and 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, all assets located on Toll NC-540, south of US-1 and north of NC-55 Bypass, that were temporarily removed due to the Access 540 Construction Project were added back to the eligible asset inventory. **Table 3** presents the number of assets that were eligible for inspection during this quarter. With the completion of the Access 540 Project, NCTA plans to add to the inventory all new assets located in the Veridea Parkway interchange by January 2018.

Table 3: Asset Inventory		
Assets	Total Inventory	2017 Eligible Inventory
Barriers	581	581
Curb and Gutter	235	235
Decorative Supports	243	243
Drainage	1135	1135
Misc. Drainage	181	181
Fences	431	431
Highway Lighting	315	315
Impact Attenuators	39	39
Inlets	968	968
Linear Segments	585	585
Plant Beds	267	267
Paved Ditches	1	1
Pavement Symbols	525	525
Signs	968	968
Tree and Brush	565	565
Turf	1010	1010
Walls	83	83

6.0 MRP THIRD QUARTER ASSESSMENT

6.1 Quarterly Results

The overall 2017 third quarter maintenance rating of the Triangle Expressway was 90.9, meeting NCTA’s target overall rating of 90. Most elements assessed achieved ratings above the target rating of 85, with the exception of Drainage (83.2). Inlets (74), Miscellaneous Drainage (71), Retaining Walls and Sound Walls (75), and Highway Lighting (60) 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 2017	
Element	Q3 2017 MRP Rating
Road Surface	98.1
Unpaved Shoulders and Ditches	100.0
Drainage	83.2
Roadside	90.4
Traffic Control Devices	85.2
Overall MRP Performance Rating	90.9

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Table 5: MRP Characteristic Results for Q3 2017						
Road Surface	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Paved Lanes Asphalt	13	13	9	117	117	100
Paved Lanes Concrete	25	25	9	225	225	100
Paved Shoulder	36	38	5	180	190	95
Element Total				522	532	98.1
Unpaved Shoulders and Ditches	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Unpaved Shoulder	38	38	9	342	342	100
Front/Back Slopes	38	38	6	228	228	100
Lateral and Outfall Ditches, Unpaved	38	38	6	228	228	100
Ditches, Paved	1	1	5	5	5	100
Element Total				803	803	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	21	24	6	126	144	88
Inlets	25	34	7	175	238	74
Misc. Drainage Structure	25	35	4	100	140	71
Element Total				632	760	83.2
Roadside	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Turf Condition	65	81	7	455	567	80
Landscaping	22	25	4	88	100	88
Trees and Brush	32	32	4	128	128	100
Litter	37	38	4	148	152	97
Roadway Sweeping	38	38	5	190	190	100
Guardrail, Concrete Barrier and End Anchors	29	31	9	261	279	94
Impact Attenuators	10	10	9	90	90	100
Fence, Control Access	26	30	7	182	210	87
Retaining Walls and Sound Barrier Walls	12	16	5	60	80	75
Decorative Supports	25	26	5	125	130	96
Graffiti and Stain Removal	38	38	4	152	152	100
Element Total				1879	2078	90.4
Traffic Control Devices	Sample Passed	Sample Total	Weighted Values	Actual Pts	Available Pts	Q3 Rating
Signs	31	36	7	217	252	86
Delineators	29	31	3	87	93	94
Pavement Striping/Marking	33	38	8	264	304	87
Words and Symbols	28	30	7	196	210	93
Pavement Markers	36	38	9	324	342	95
Highway Lighting	25	42	6	150	252	60
Element Total				1238	1453	85.2

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Additionally, **Appendix A** includes maps that present the location of all assets assessed during the third 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 third quarter, most elements exceeded NCTA's threshold criteria of 85 except for Drainage (83.2). Road Surface (98.1) and Unpaved Shoulder/Ditches (100) continued to obtain ratings higher than 95, while Roadside (90.4) and Traffic Control Devices (85.2) obtained ratings just above 90 and 85, respectively.

Drainage was the element that experienced the most significant decrease in rating compared to the previous quarter. The rating obtained for this element was 9.1 points lower than the rating obtained during the second quarter of 2017. This decrease in rating is attributed to lower ratings attained for Miscellaneous Drainage Structures (71) and Inlets (74). Similarly, the rating for Traffic Control Devices decreased slightly by 3.3 points. This decrease in rating is associated to a low Highway Lighting (60) rating.

During this quarter, Roadside (90.4) and Unpaved Shoulders and Ditches (100.0) were two elements that experienced an increase in rating compared to the previous quarter. The rating obtained for Roadside was 3 points higher than the previous quarter due to a higher Turf (80) rating. Also, Unpaved Shoulders and Ditches was 4.5 points higher than the previous quarter due to higher ratings obtained for Paved Ditches (100).

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

Characteristics

This quarter all but four characteristics, Inlets (74), Miscellaneous Drainage Structure (71), Retaining Walls and Sound Barrier Walls (75), and Highway Lighting (60) met the NCTA target threshold criteria of 80. A description of the characteristics' conditions and future work planning recommendations are provided below. Pictures of all characteristic failures are included in **Appendix B**.

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Inlets (74 rating – 9 of the 34 asset failed): Out of the 9 miscellaneous drainage failures, 6 occurred due to obstruction, 2 occurred due to erosion, and 1 occurred due to surface damage. Two of the failing inlet structures are presented in **Figure 3**.

Figure 3: Inlet Failures



To improve inlet performance throughout the facility, it is recommended that the maintenance provider inspect inlets pursuant to the *NCTA Roadway and Facility Maintenance Standards V4*, referenced below. During inspections, it is also recommended that the maintenance provider remove any debris accumulation upon observation.

Inlets Maintenance Program Standards:

- 1) Emergency response time shall be two (2) hours regardless of the day or time of the notification unless otherwise specified.
- 2) Inlets shall be inspected during routine daily patrols for evidence of blockage and obstructions.
- 3) Any damaged inlet shall be evaluated and scheduled for repair within the annual work plan.

Inlets Maintenance and Evaluation Standards:

Inlets 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) Inlets are damaged or have missing or broken grates.
- 3) Eroded area within 1 foot of the structure that is greater than 6 inches deep or below the base elevation of the concrete apron.
- 4) Surface damage greater than 0.5 SF.

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Miscellaneous Drainage (71 rating – 10 of the 35 assets failed): Out of the 10 miscellaneous drainage failures, 7 occurred due to obstruction and 3 occurred due to erosion at the outlet to freeway edge drains. Two of the failing miscellaneous drainage structures (edge drains) are presented in **Figure 4**.

Figure 4: Miscellaneous Drainage Failures



In accordance with *NCTA Roadway and Facility Maintenance Standards V4*, referenced below, the maintenance provider shall plan annual cleaning of these drainage features to remove any debris or overgrown vegetation. It is also recommended that the maintenance provider continue to follow the routine patrol schedule and repair any erosion or soil buildup problems along the ditch line near the outlets. Edge drains are a critical component of extending the life cycle of pavements as they provide a means for water to drain away from the subgrade and base.

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.

It should be noted that some of the obstruction failures are a result of inadequate gradient flow away from the edge drain outlets. To avoid affecting the natural flow of water near the drainage features and potential pavement failures, 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.

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Retaining Walls and Sound Barrier Walls (75 rating – 4 of the 16 assets failed): All 4 of the wall failures occurred due to paint scaling. Two of the failing wall segments are presented in **Figure 5**.

Figure 5: Retaining and Sound Barrier Walls Failures



In accordance with *NCTA Roadway and Facility Maintenance Standards V4*, referenced below, it is recommended that the maintenance provider plan for and schedule paint repairs within the annual work program.

Retaining Walls and Sound Barrier Walls Maintenance Program Standards:

- 1) Walls shall be inspected during daily patrols.
- 2) Unwanted vegetation and graffiti (see graffiti standard) shall be scheduled for removal.
- 3) Minor wall or column damage shall be scheduled for repair within the annual work program.
- 4) Staining damage shall be scheduled for repair within the annual work program.
- 5) Any structural damage that poses a safety risk shall be scheduled immediately upon observation. Mitigate any safety hazard upon observation.

Standards Maintenance and Evaluation Standards:

MSE/retaining walls, sound barrier walls, and screen walls do not meet the maintenance standards when any of the following criteria is observed:

- 1) More than 10% of exposed surface is covered with unwanted vegetation.
- 2) Any single spall 1 inch deep or greater or cumulative spalls in excess of 1 inch deep over 5 SF.
- 3) More than 25% of weep holes within the sample section are not functioning properly.
- 4) Unsealed cracks or joints greater than 0.25 inches in width.
- 5) Stained areas exhibit cumulative scaling in excess of 1 SF.

Highway Lighting (60 rating – 17 of the 42 assets failed): Out of the 42 highway lights inspected, 8 failed due to functional damage, 5 failed due to damaged parts, and 4 failed due to missing parts. Two of the failing highway lights are presented in **Figure 6**.

Figure 6: Highway Lighting Failures



To increase this asset’s rating, it is recommended that all non-functioning or damaged highway lights noted during the inspection 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.

7.0 CURRENT ROLLING MRP RATING

The rolling maintenance rating of the Triangle Expressway was 92.5, exceeding NCTA’s target overall rating of 90. All element ratings exceeded the target rating of 85. Also, all but four characteristics’ ratings met or exceeded the target rating of 80. Ratings for Paved Ditches, Miscellaneous Drainage Structure, Turf Condition, and Highway Lighting were 75, 69, 75, and 72, 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.

Table 6: MRP Rolling Element Results					
Element	Q4 2016 Rating	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Rolling Rating
Road Surface	97.7	97.8	100.0	98.1	98.2
Unpaved Shoulders and Ditches	100.0	95.6	95.5	100.0	98.2
Drainage	93.8	86.7	92.3	83.2	88.9
Roadside	93.7	90.3	87.4	90.4	90.6
Traffic Control Devices	88.3	91.4	88.5	85.2	88.3
Overall MRP Performance Rating	93.9	92.7	92.7	90.9	92.5

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Table 7: MRP Rolling Element Results					
Road Surface	Q4 2016 Rating	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Rolling Rating
Paved Lanes Asphalt	95	100	100	100	98
Paved Lanes Concrete	100	100	100	100	100
Paved Shoulder	98	94	100	95	96
Element Total	97.7	97.8	100.0	98.1	98.2
Unpaved Shoulders and Ditches	Q4 2016 Rating	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Rolling Rating
Unpaved Shoulder	100	94	92	100	97
Front/Back Slopes	100	94	100	100	99
Lateral and Outfall Ditches, Unpaved	100	100	100	100	100
Ditches, Paved	100	100	0	100	75
Element Total	100.0	95.6	95.5	100.0	98.2
Drainage	Q4 2016 Rating	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Rolling Rating
Drainage Pipes	100	91	100	97	97
Curb and Gutter	100	92	88	88	92
Inlets	91	97	97	74	90
Misc. Drainage Structure	78	55	72	71	69
Element Total	93.8	86.7	92.3	83.2	88.9
Roadside	Q4 2016 Rating	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Rolling Rating
Turf Condition	83	75	54	80	75
Landscaping	100	96	100	88	96
Trees and Brush	100	100	100	100	100
Litter	100	97	100	97	99
Roadway Sweeping	100	100	100	100	100
Guardrail, Concrete Barrier and End Anchors	100	97	97	94	97
Impact Attenuators	100	100	100	100	100
Fence, Control Access	88	79	93	87	87
Retaining Walls and Sound Barrier Walls	85	100	100	75	89
Decorative Supports	100	100	92	96	97
Graffiti and Stain Removal	100	100	96	100	99
Element Total	93.7	90.3	87.4	90.4	90.6
Traffic Control Devices	Q4 2016 Rating	Q1 2017 Rating	Q2 2017 Rating	Q3 2017 Rating	Rolling Rating
Signs	91	89	92	86	89
Delineators	97	96	100	94	96
Pavement Striping/Marking	91	97	88	87	91
Words and Symbols	100	100	97	93	98
Pavement Markers	79	97	88	95	89
Highway Lighting	81	73	78	60	72
Element Total	88.3	91.4	88.5	85.2	88.3

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 at the intersection of Green Level Church Road and Green Level West Road was excluded from the inspection inventory due to its removal during the completion of a Town of Cary development project near the intersection. The three signs included in the inspection inventory were found to be in good condition, with the landscaped areas being well maintained. **Figure 7** shows two of these signs.

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



9.0 CONCLUSION

This report presents the 2017 third quarter rating assessment of the Triangle Expressway. The NCTA's target ratings are 90 overall, 85 for elements, and 80 for characteristics. The third quarter 2017 overall rating was **90.9** and the rolling rating was **92.5**, both ratings met the target rating of 90.

All element ratings were above the target ratings for the cumulative rolling assessment. However, only four of the five elements met the target rating for the quarterly assessment. During the third quarter, Drainage (83.2) obtained a rating lower than the required elements rating of 85. This rating is attributed to lower ratings obtained for Miscellaneous Drainage (71) and Inlets (74). Out of the four elements that met the required rating, Traffic Control Devices (85.2) experienced a decrease in rating compared to the previous quarter, while Roadside (90.4) and Unpaved Shoulders and Ditches (100) experienced an increase in ratings compared to the previous quarter. The Traffic Control Devices rating decreased by 3.3 points, the Roadside element rating increased by 3 points, and the Unpaved Shoulders and Ditches rating increased by 4.5 points.

During the third quarter assessment, all but four characteristics met or exceeded the target rating of 80. These four characteristics are: Inlets (74), Miscellaneous Drainage Structure (71), Retaining Walls and Sound Barrier Walls (75), and Highway Lighting (60). Similarly, during the cumulative rolling assessment four characteristics did not meet the target rating of 80. These characteristics are: Paved Ditches (75), Miscellaneous Drainage Structure (69), Turf Condition (75), and Highway Lighting (72).

To improve the quarterly and rolling ratings, it is recommended that the maintenance provider conduct routine patrols of inlets and miscellaneous drainage structures, in addition to periodically remove any debris or overgrown vegetation that may impair the flow of water. It is also recommended that any erosion soil buildup problems identified along the ditch line near and adjacent to the outlets be corrected. 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 to provide positive flow.

Also, it is recommended that the maintenance provider repair and/or replace all defects in highway lights. Wall paint scaling issues should be scheduled for repair within the annual work plan to alleviate further deterioration and maintain the facility's intended aesthetics. Turf condition is expected to improve as mowing heights continue to be closely monitored during each mowing cycle, and bare areas seeding/fertilization program efforts continue to promote new growth.

This quarter, only three of the four Green Level Historic District sign locations were inspected due to the removal of one of the signs as part a Town of Cary development project near Green Level West Road. The three signs inspected were found to be in good standing condition. Additionally, the landscaped areas surrounding the signs were found to be well maintained.

Appendix A

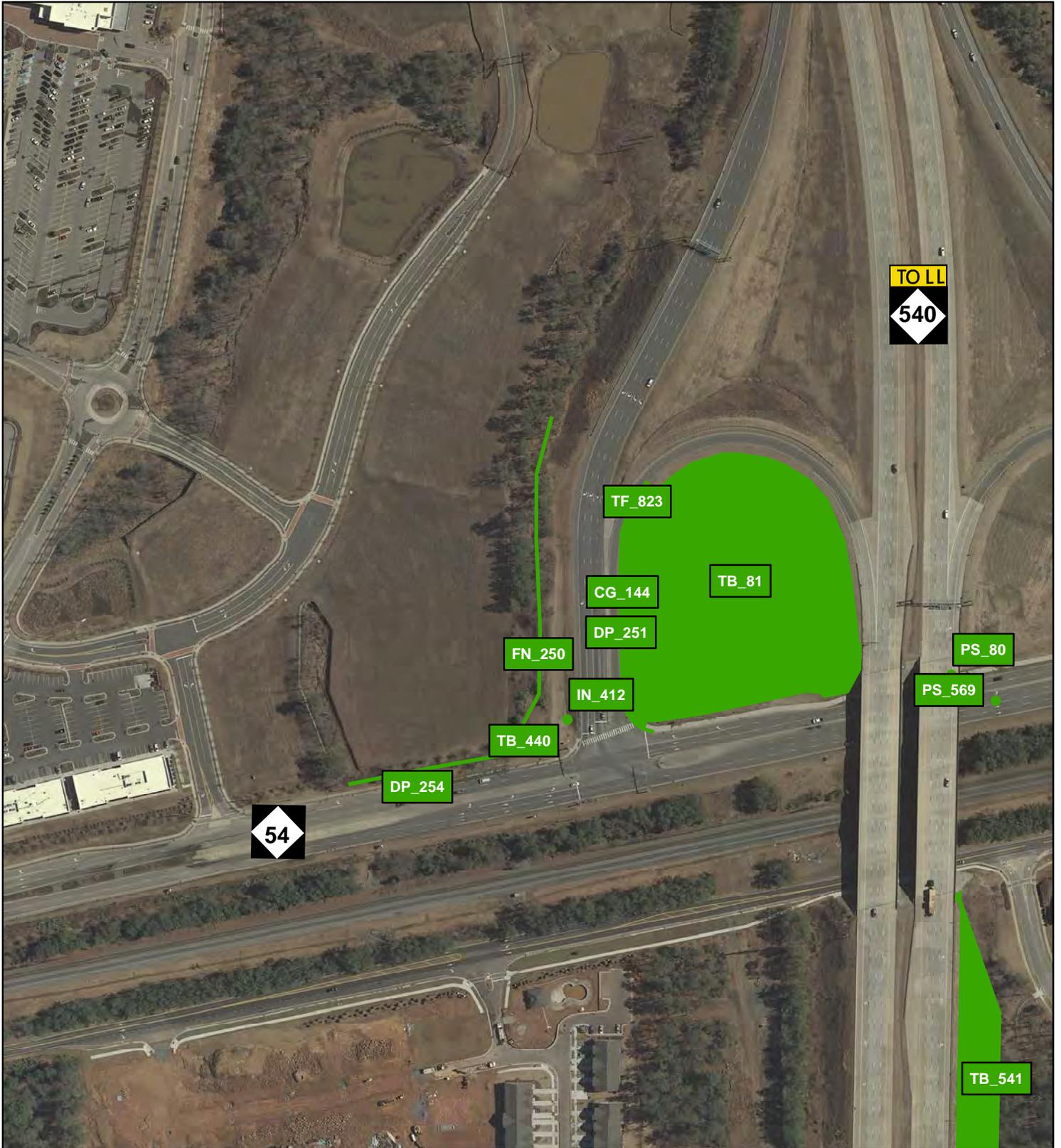
Triangle Expressway 2017 Third Quarter Asset Assessment Locations

Appendix A: Triangle Expressway 2017 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 2017 Third Quarter Asset Assessment Locations

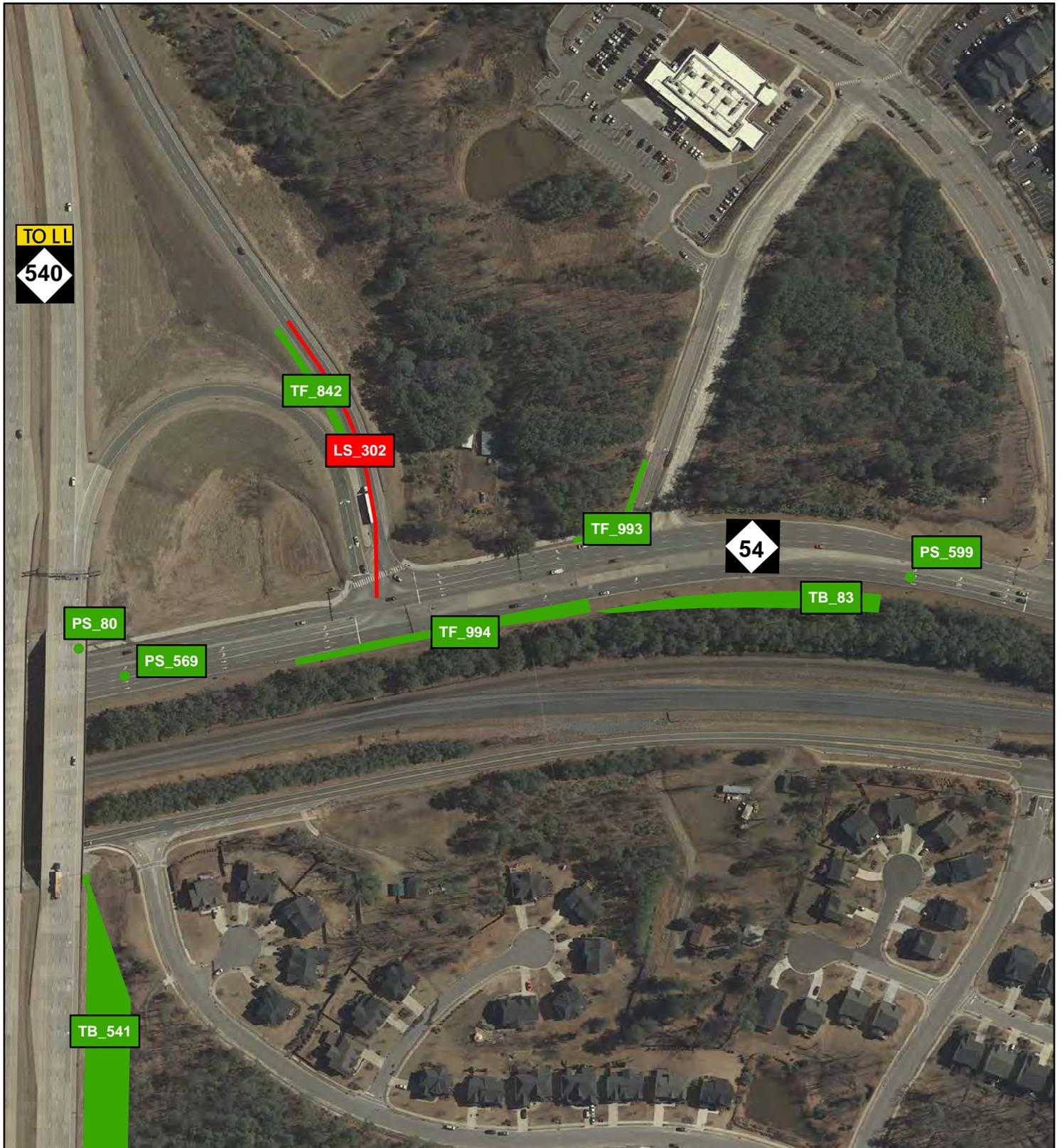


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

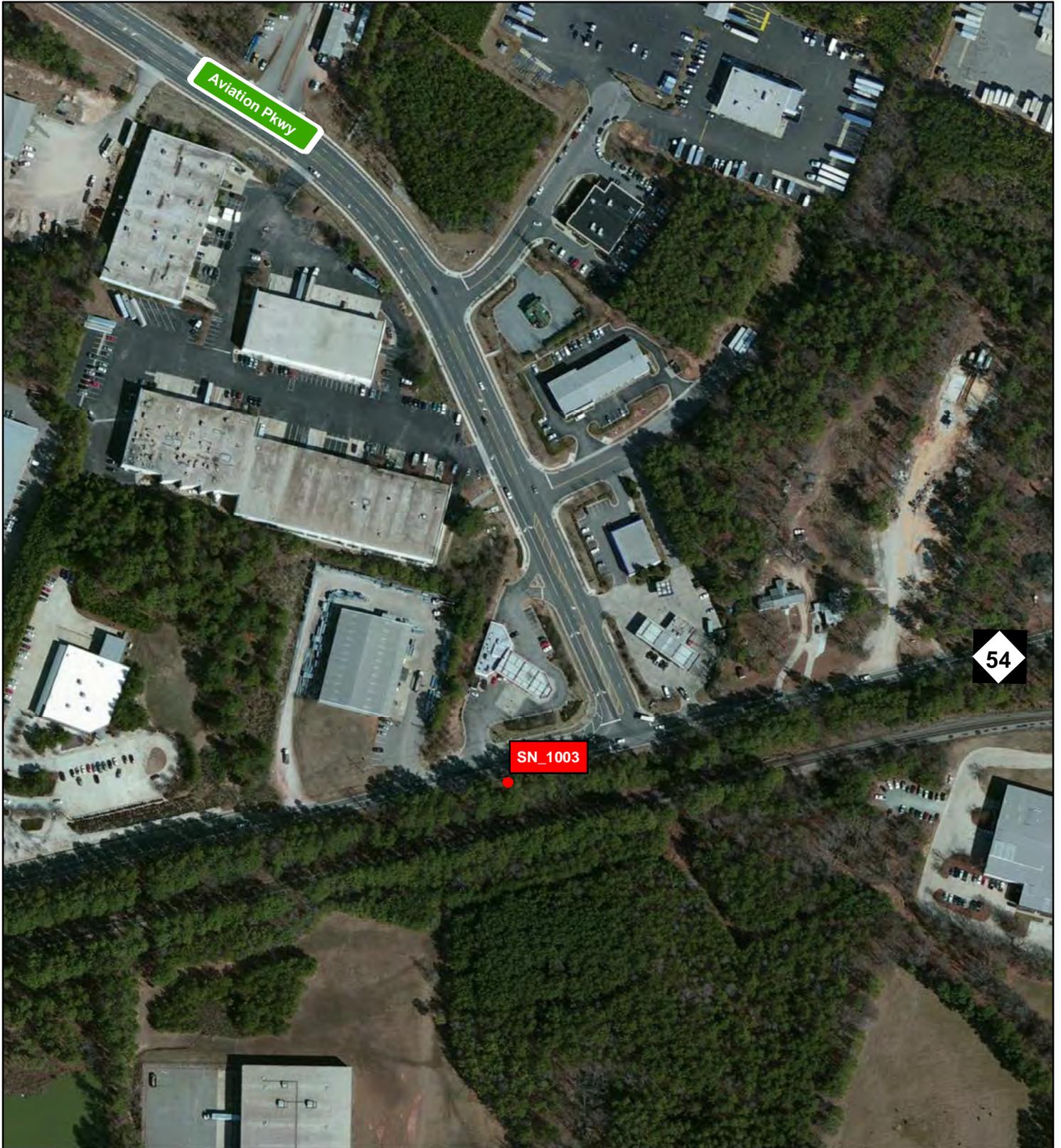


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

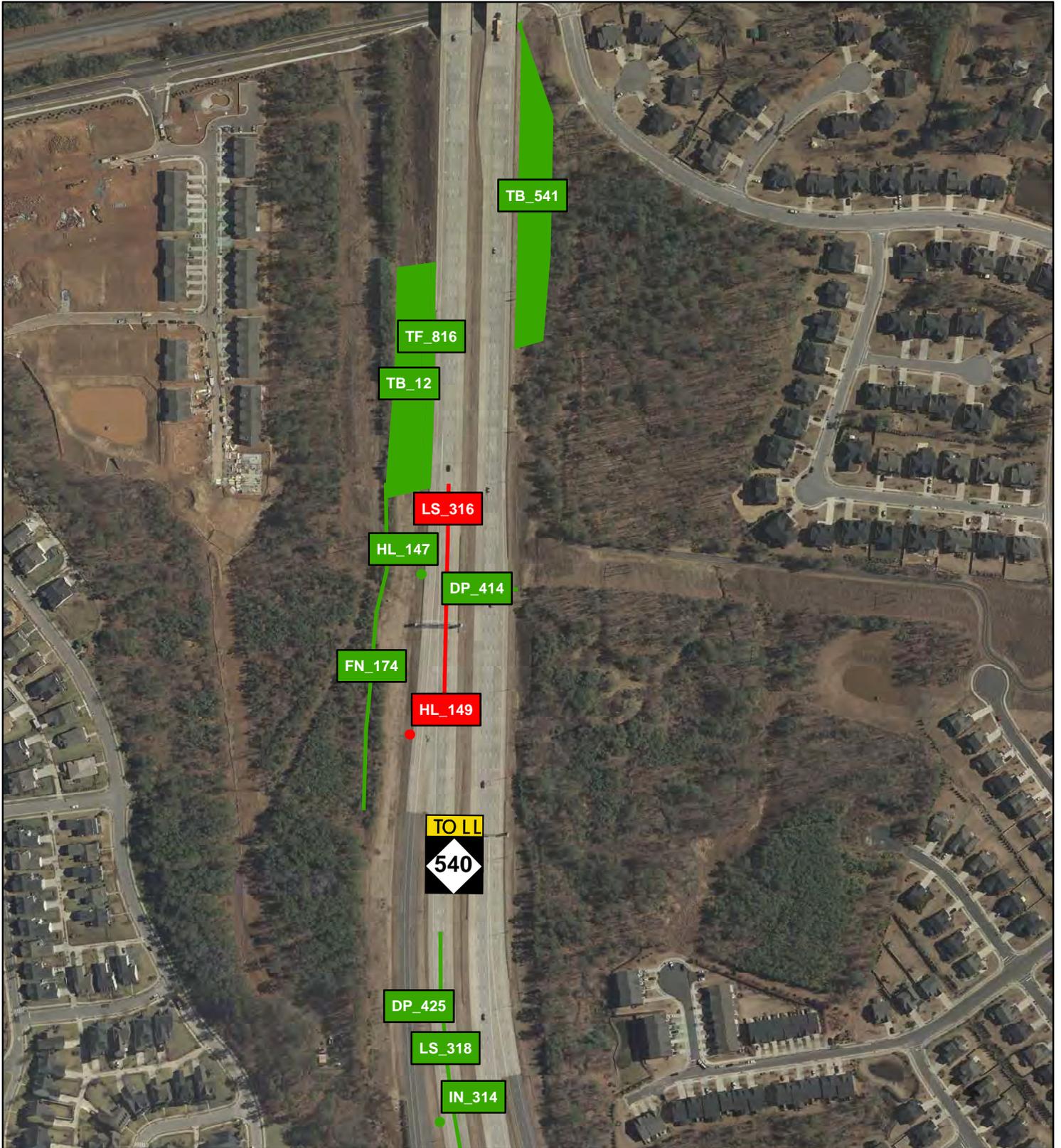


Legend

-  Failing Asset
-  Passing Asset

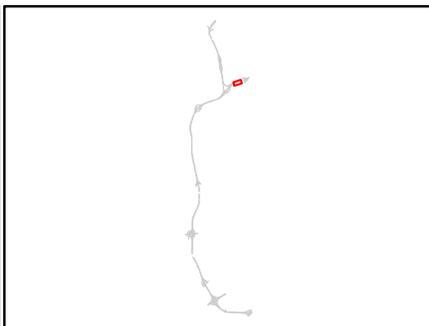


Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

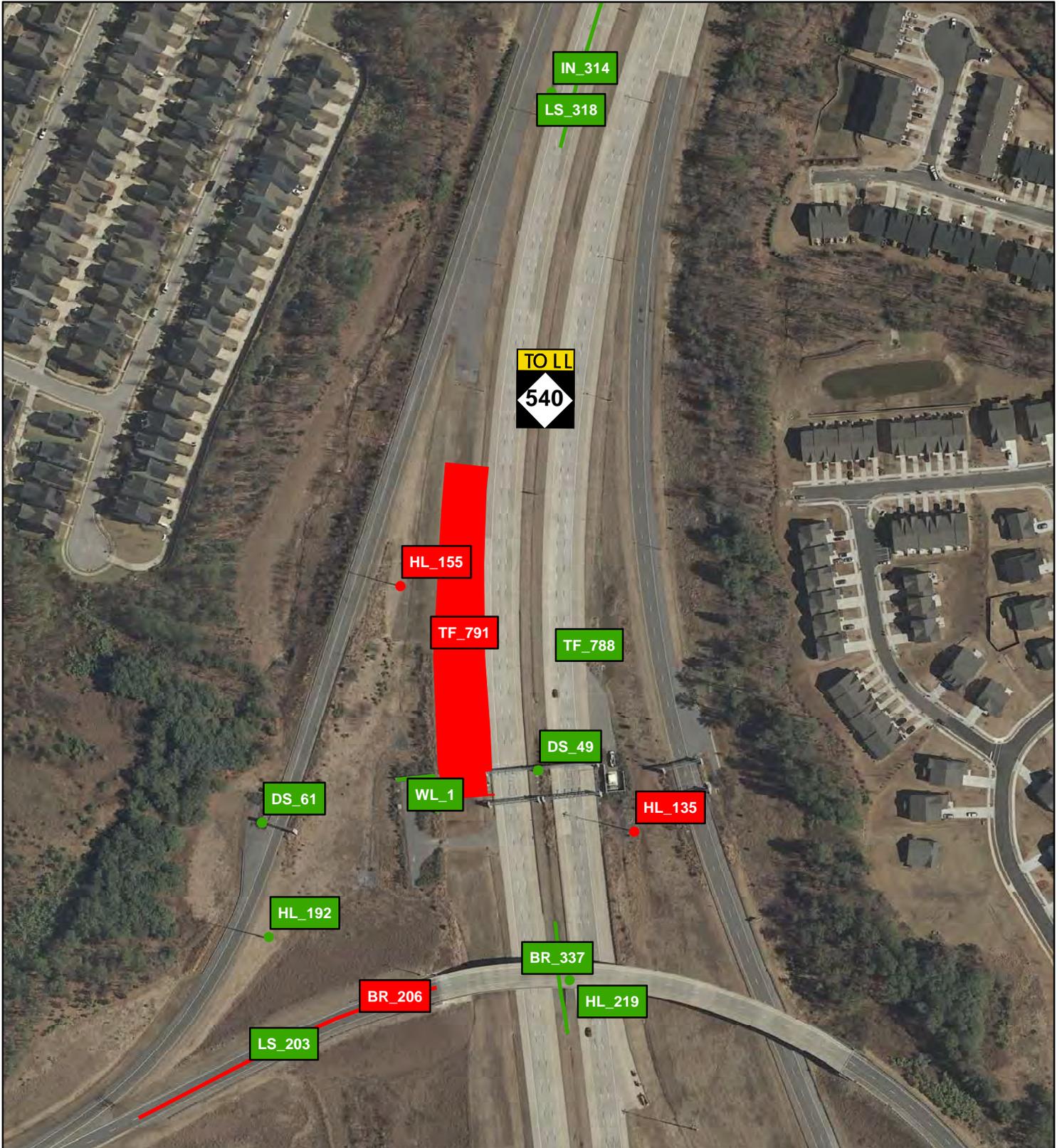


Legend

- Failing Asset
- Passing Asset

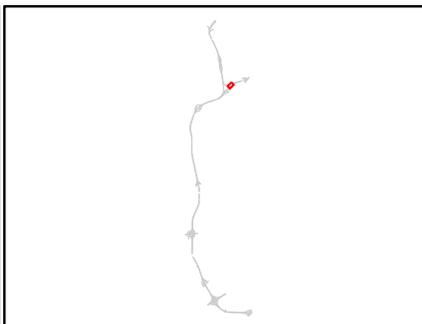


Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

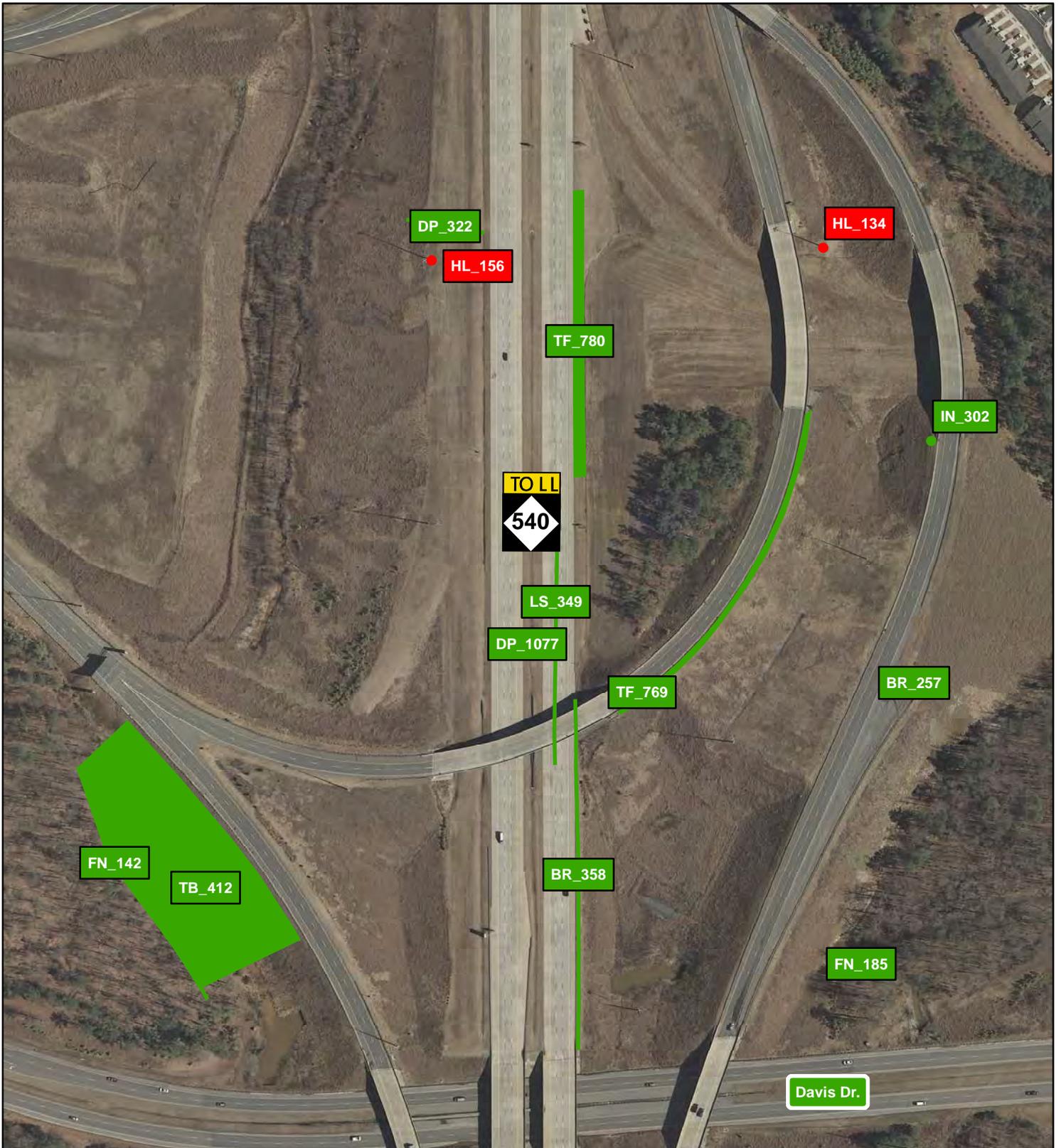


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

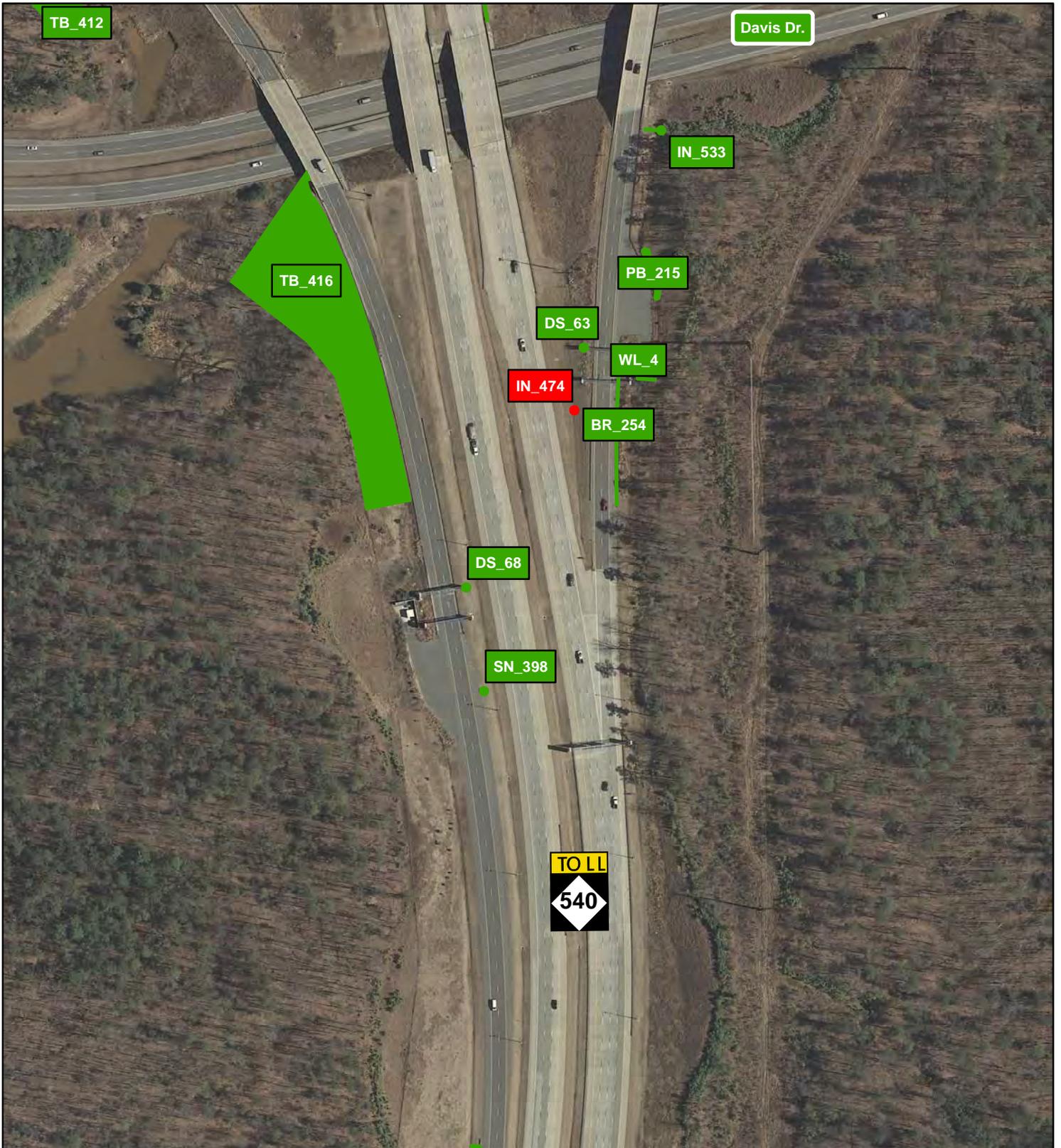


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

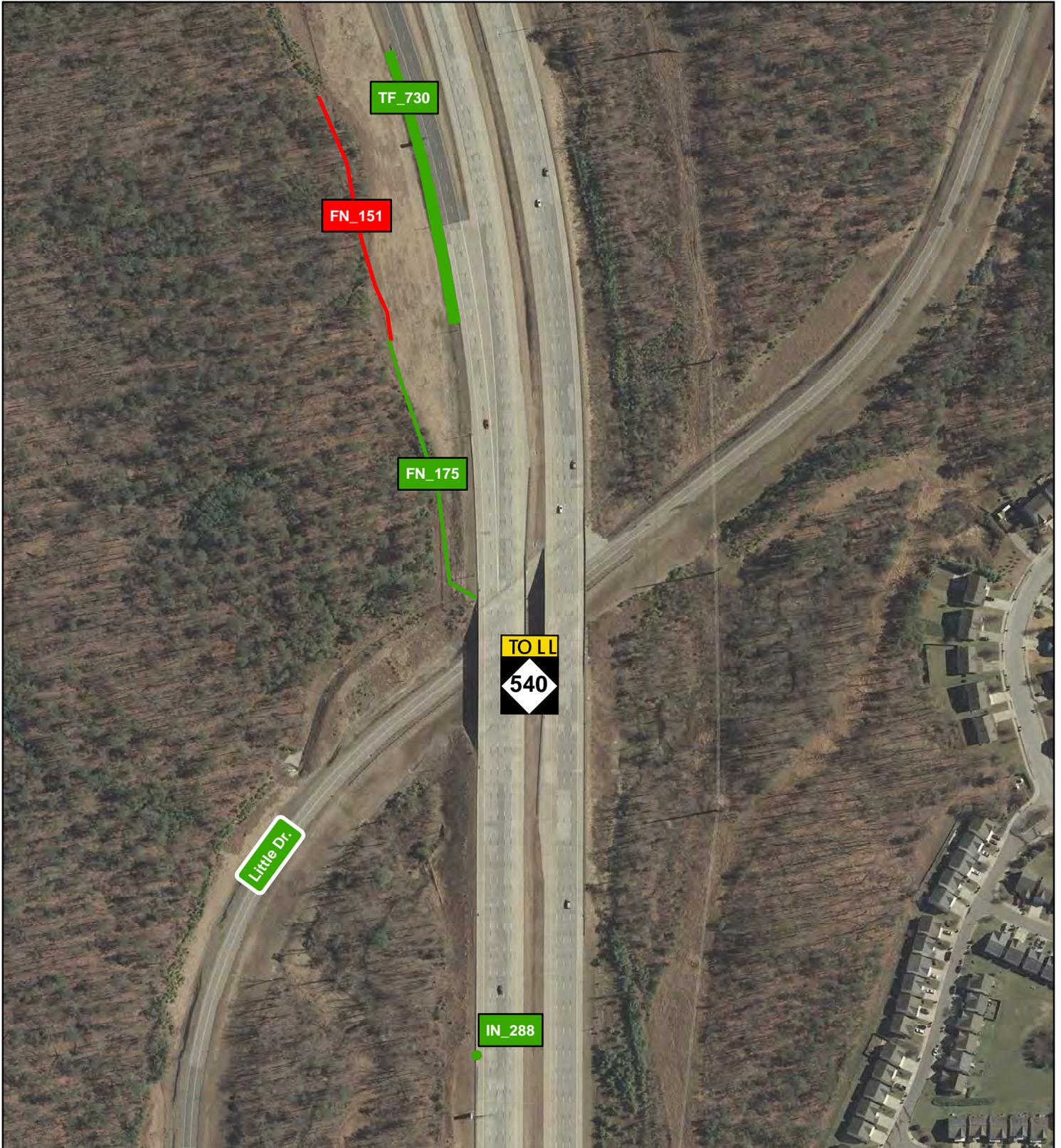


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

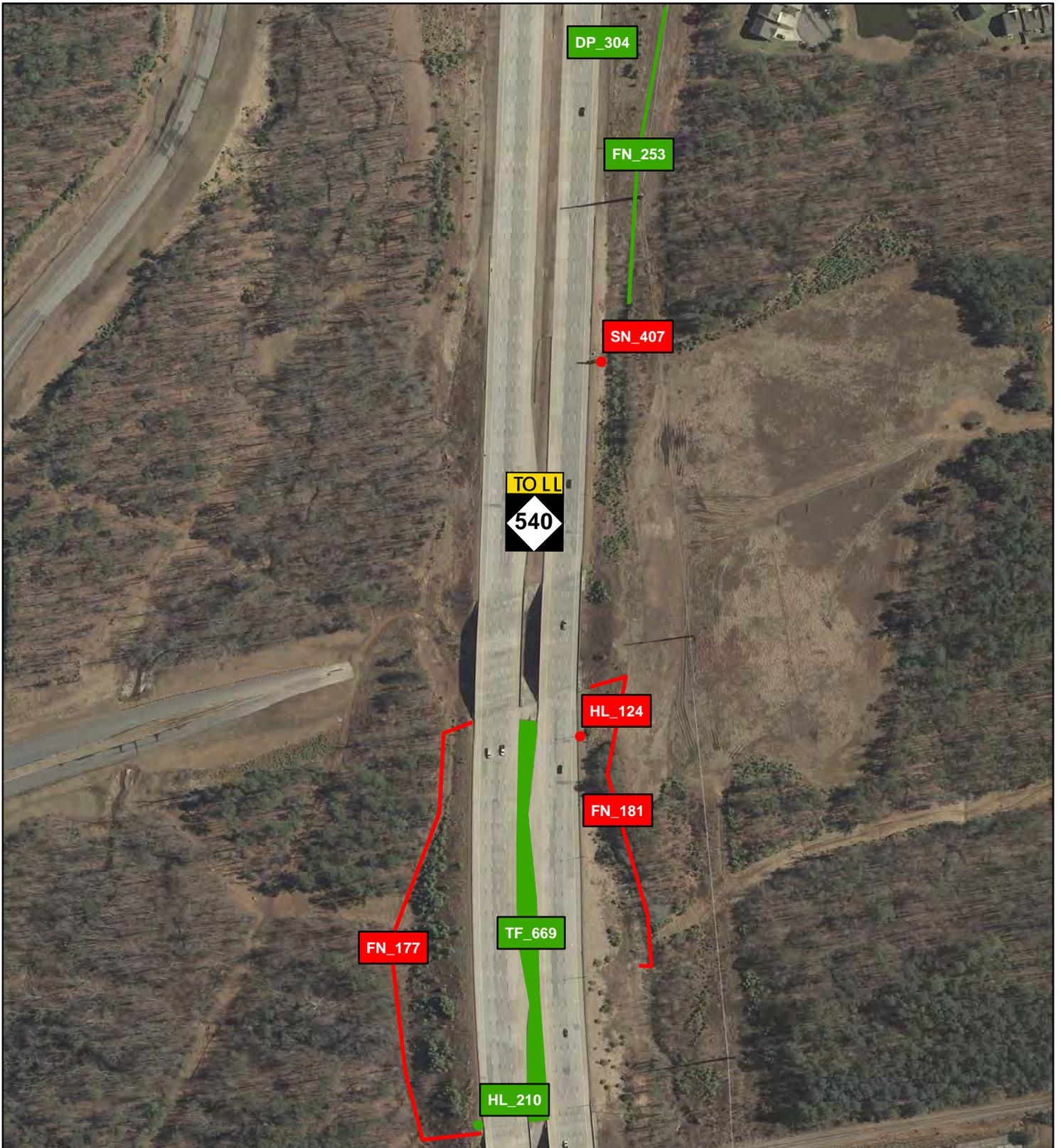


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

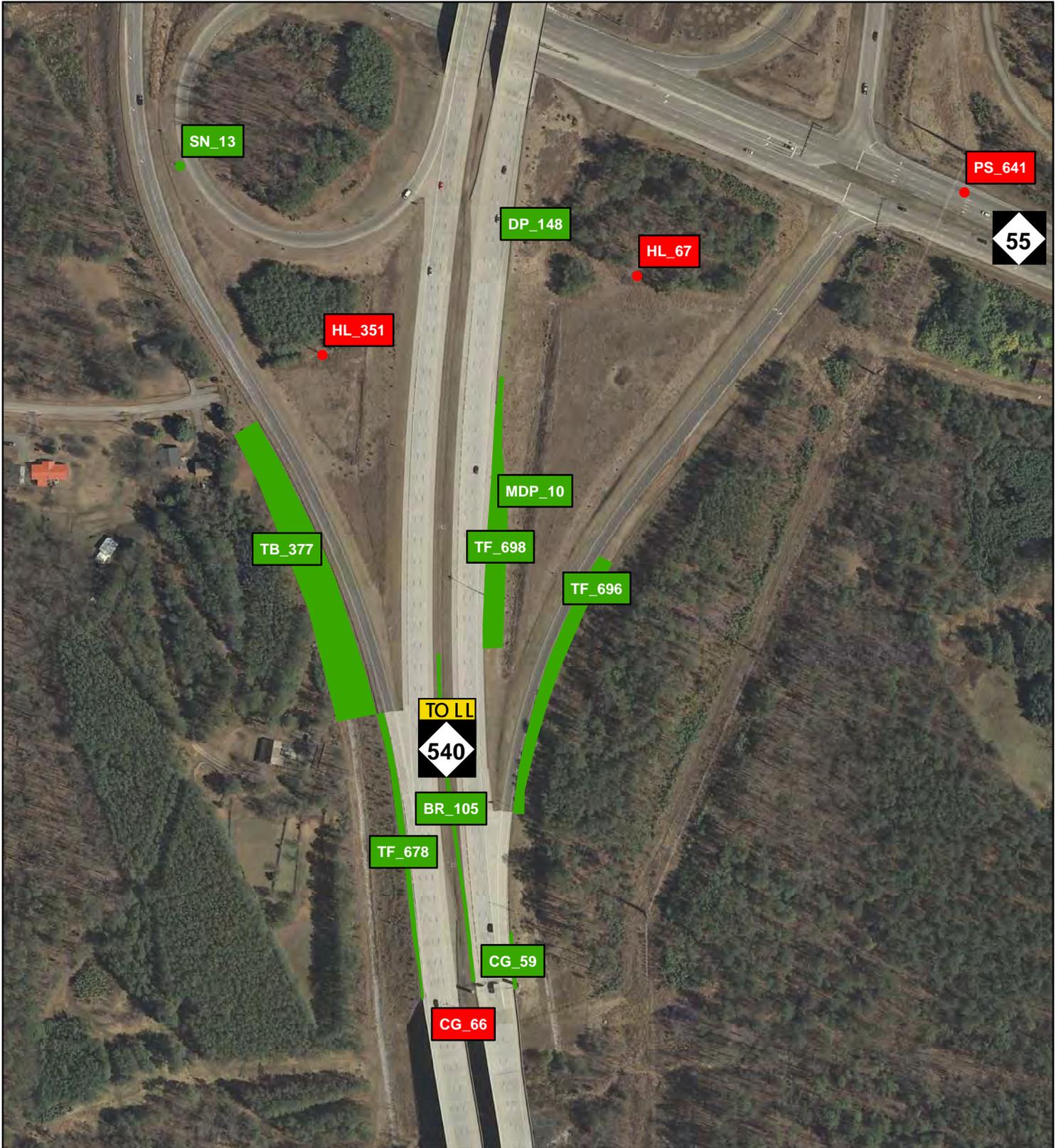


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

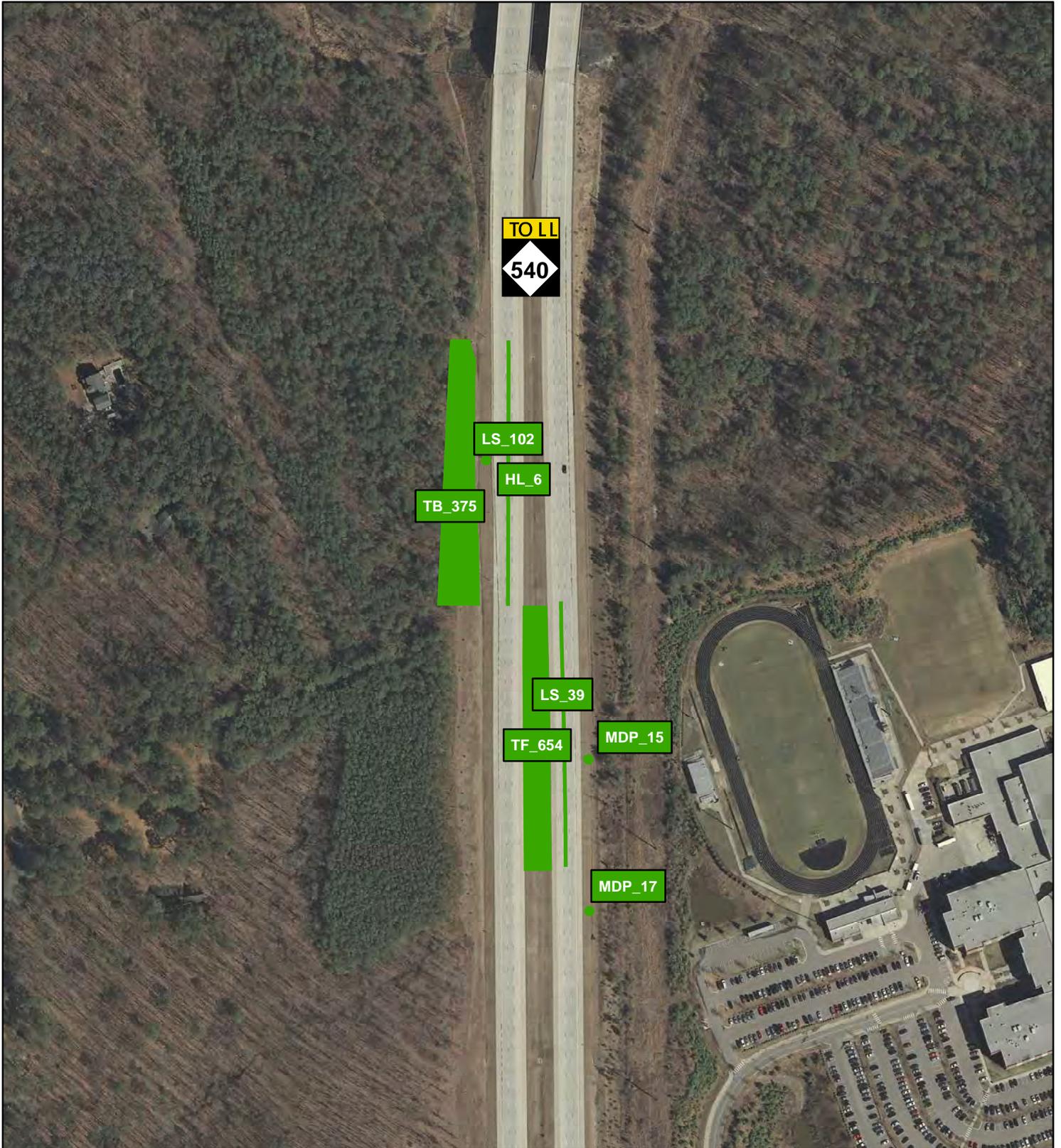


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

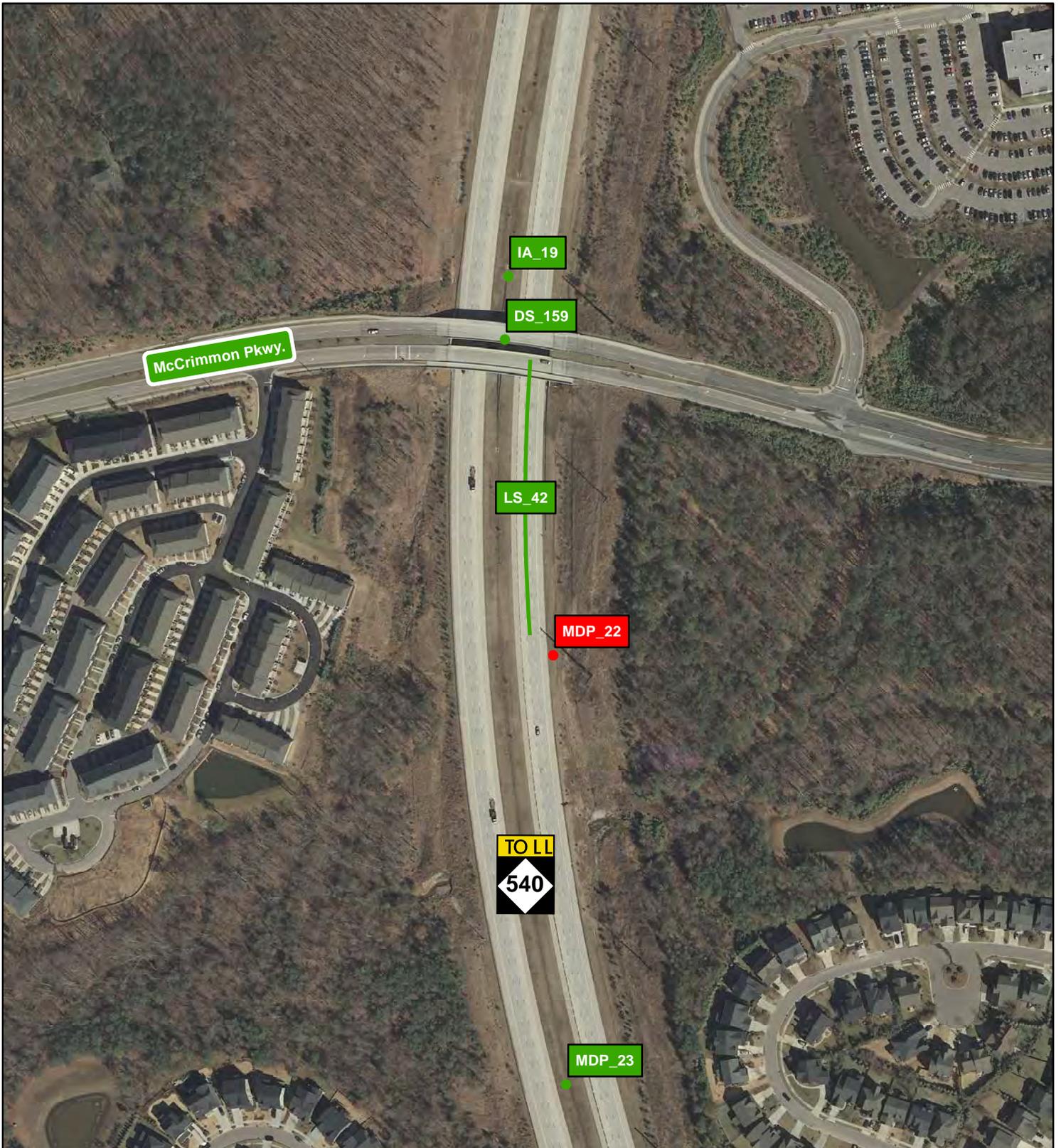


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

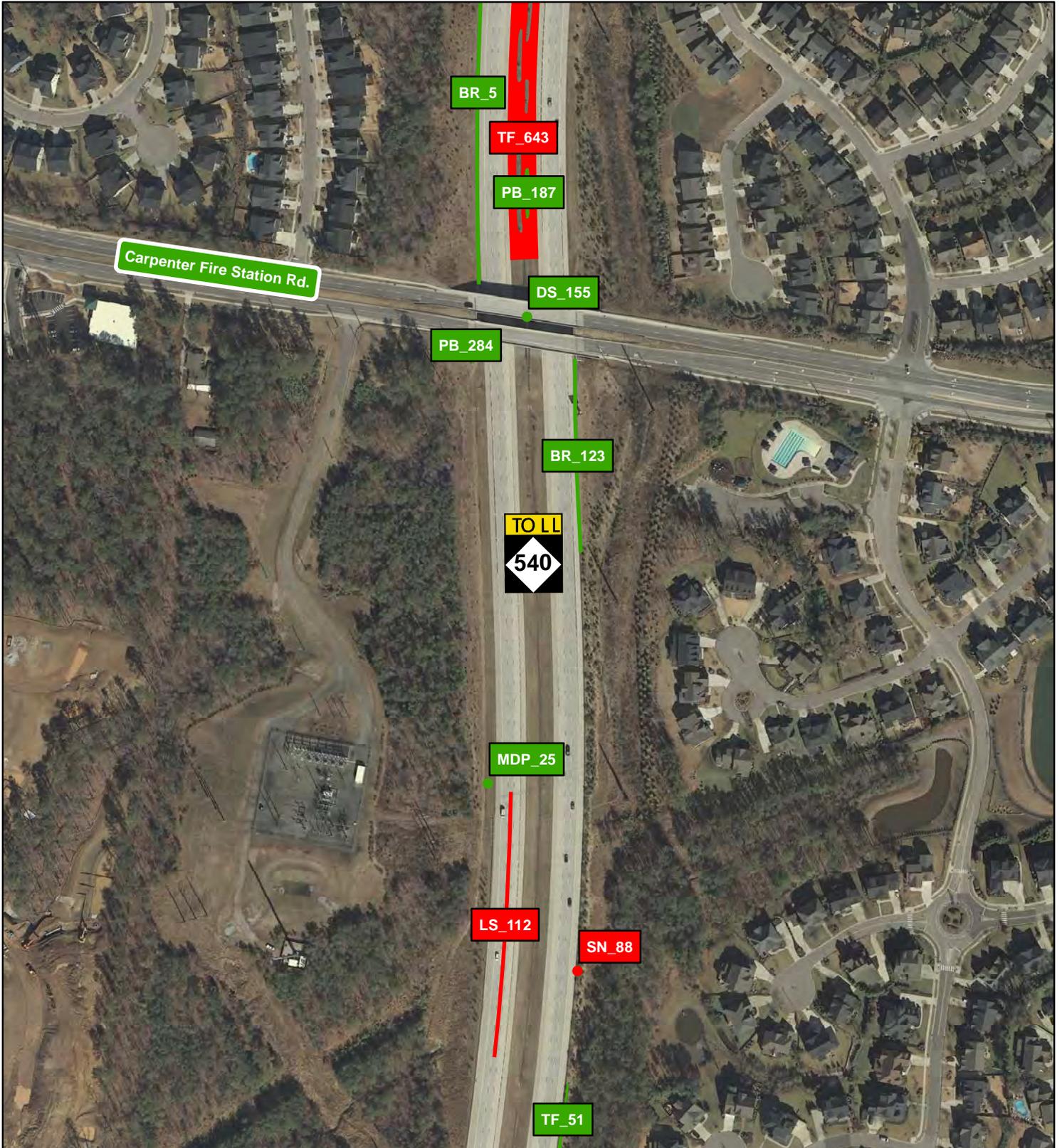


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

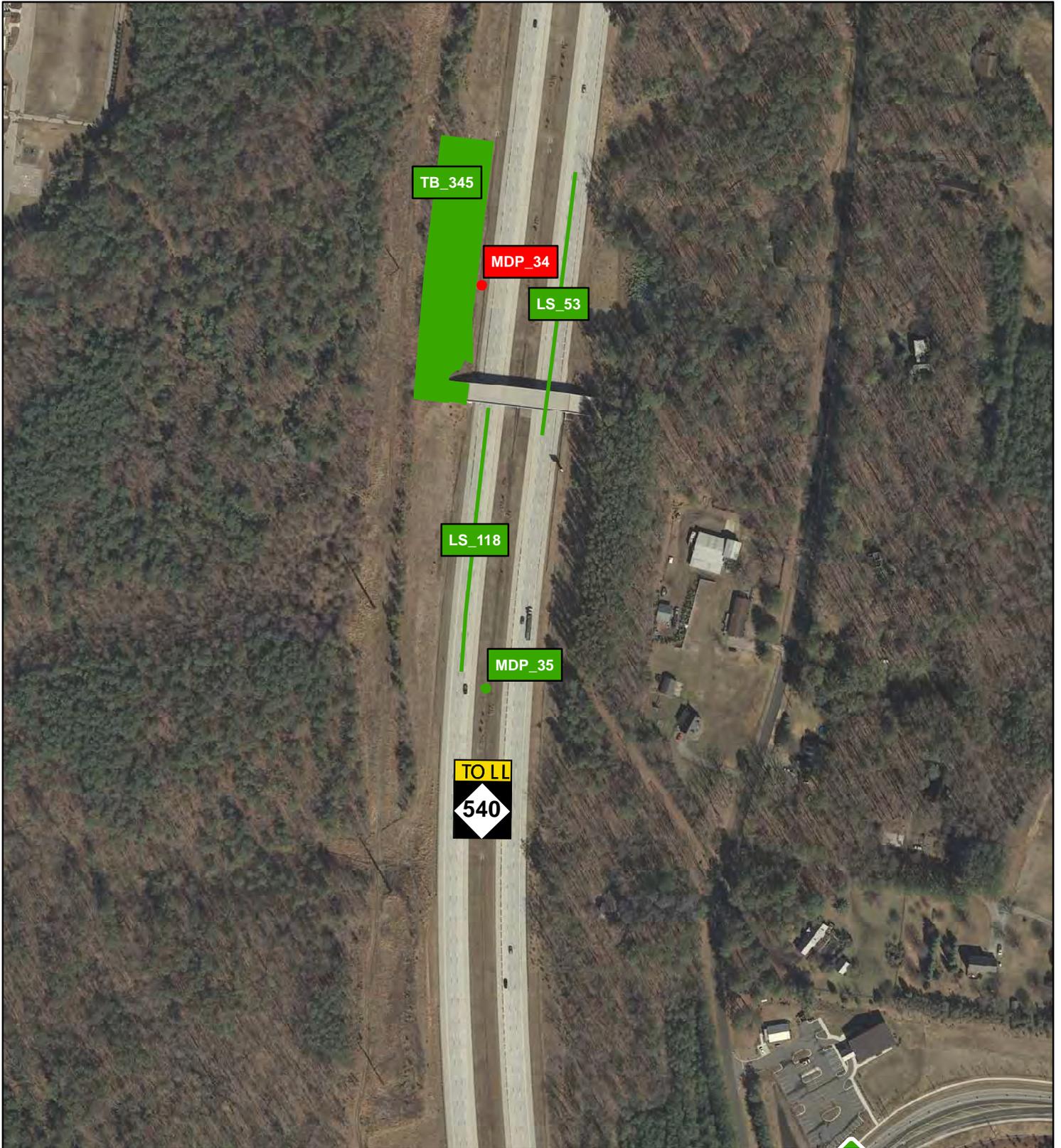


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

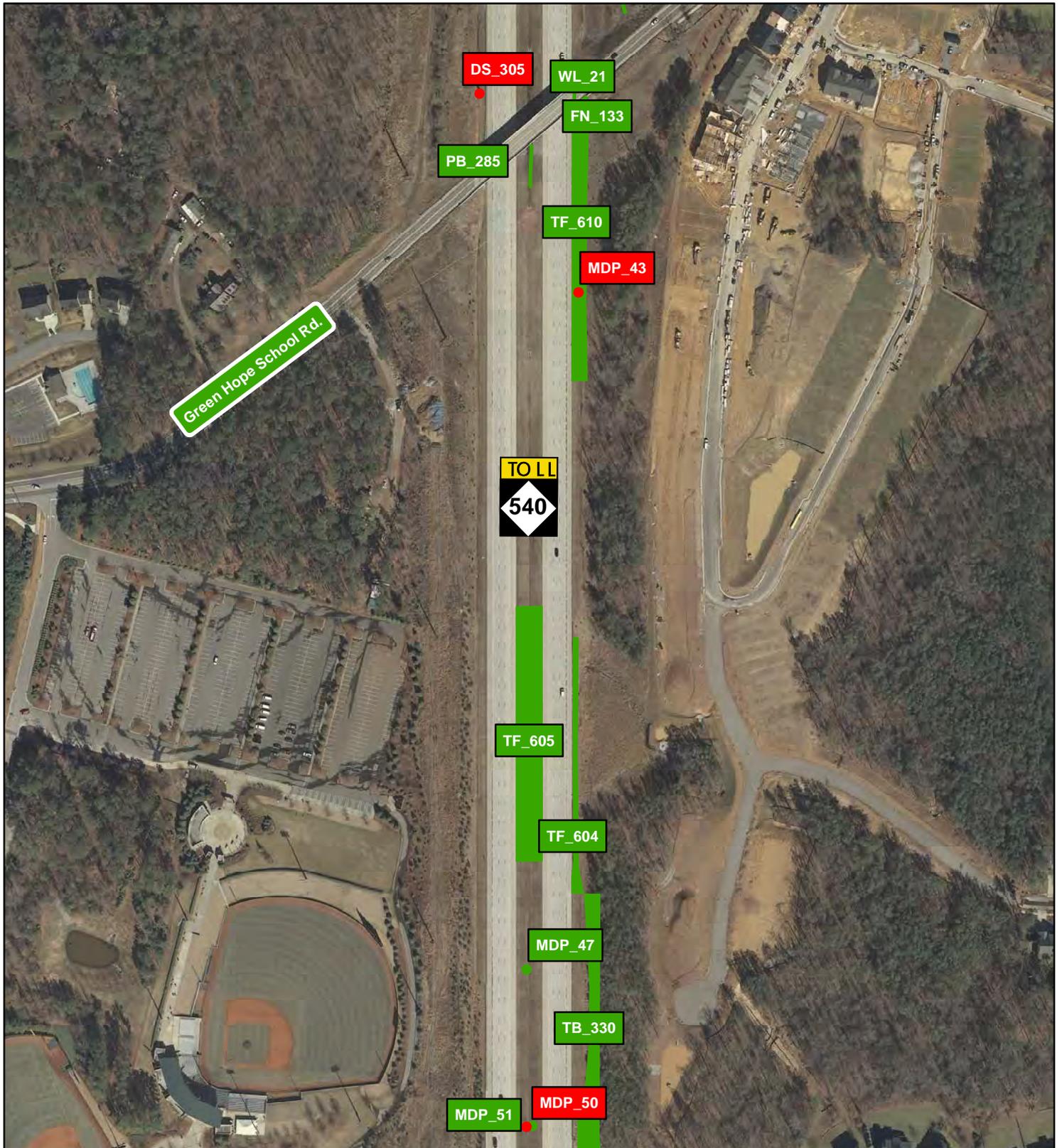


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

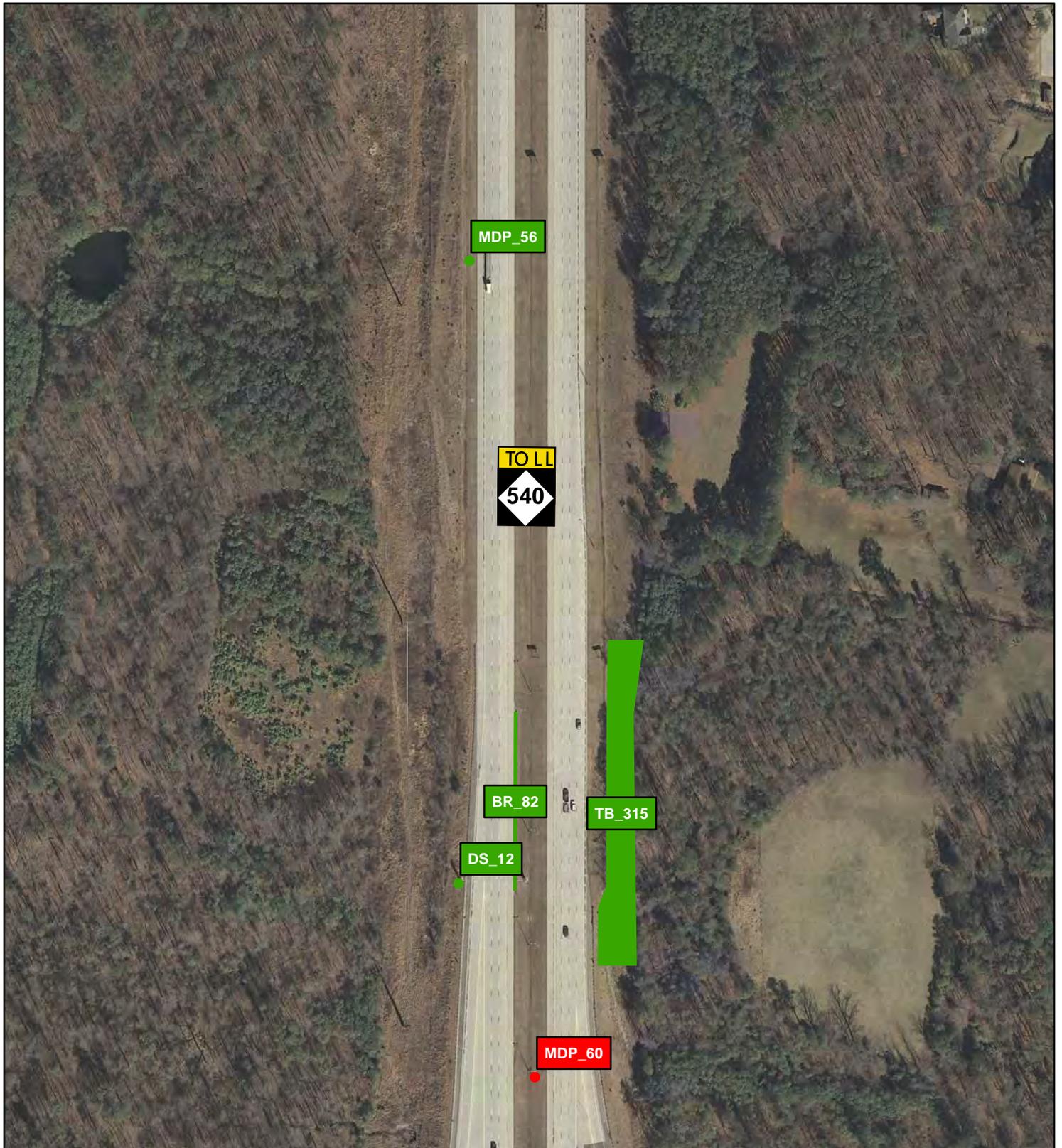


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

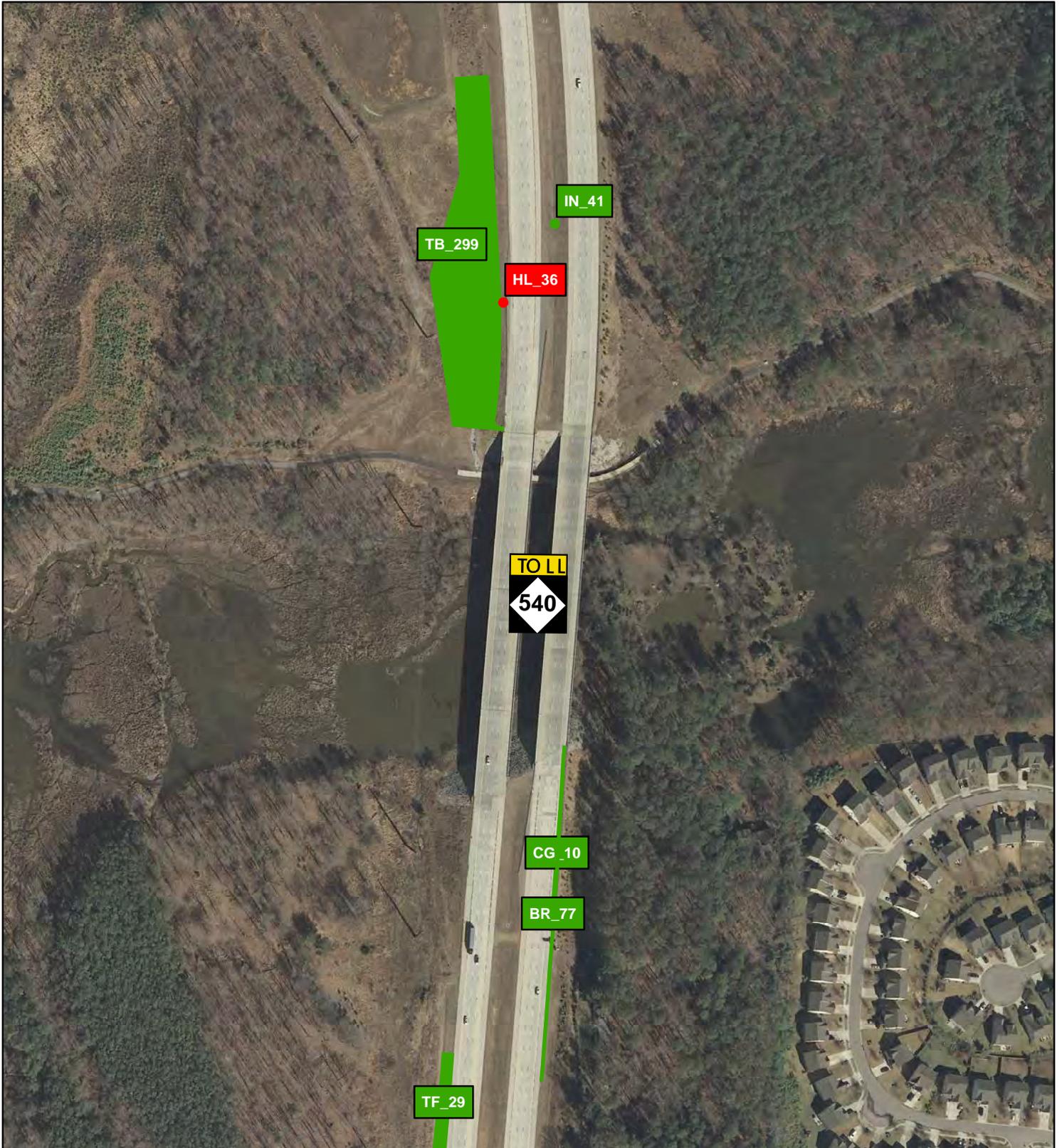


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

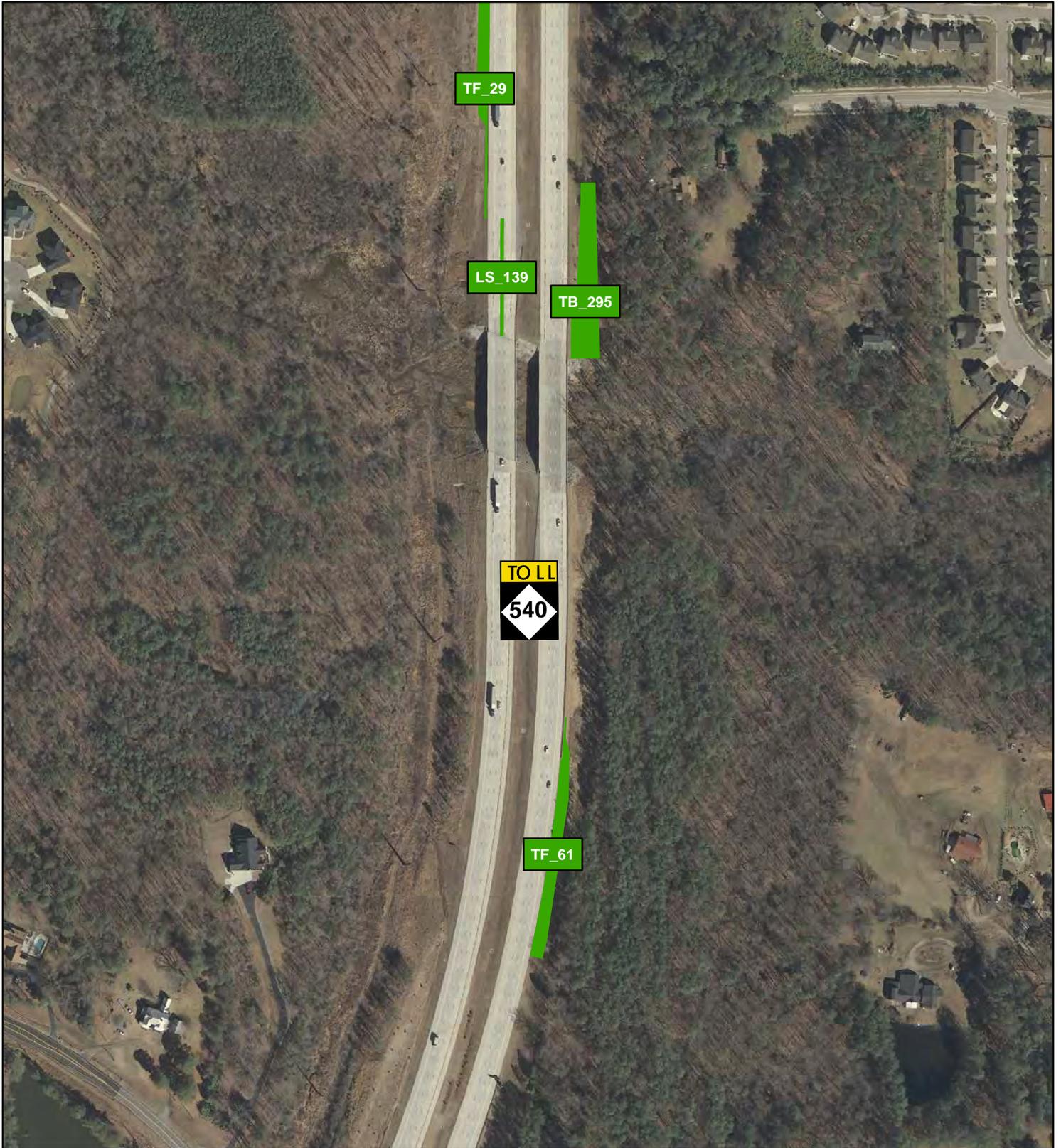


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

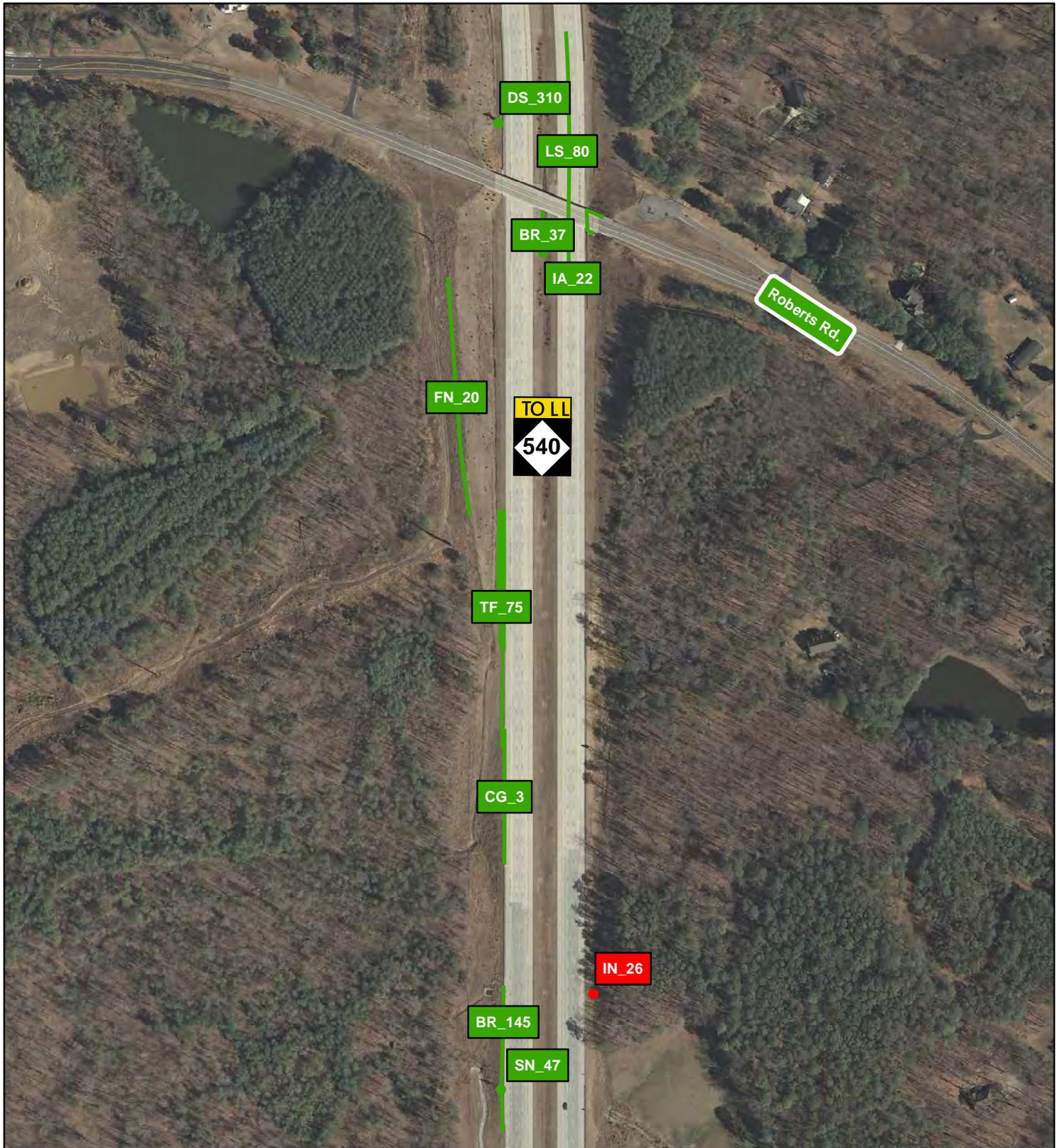


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

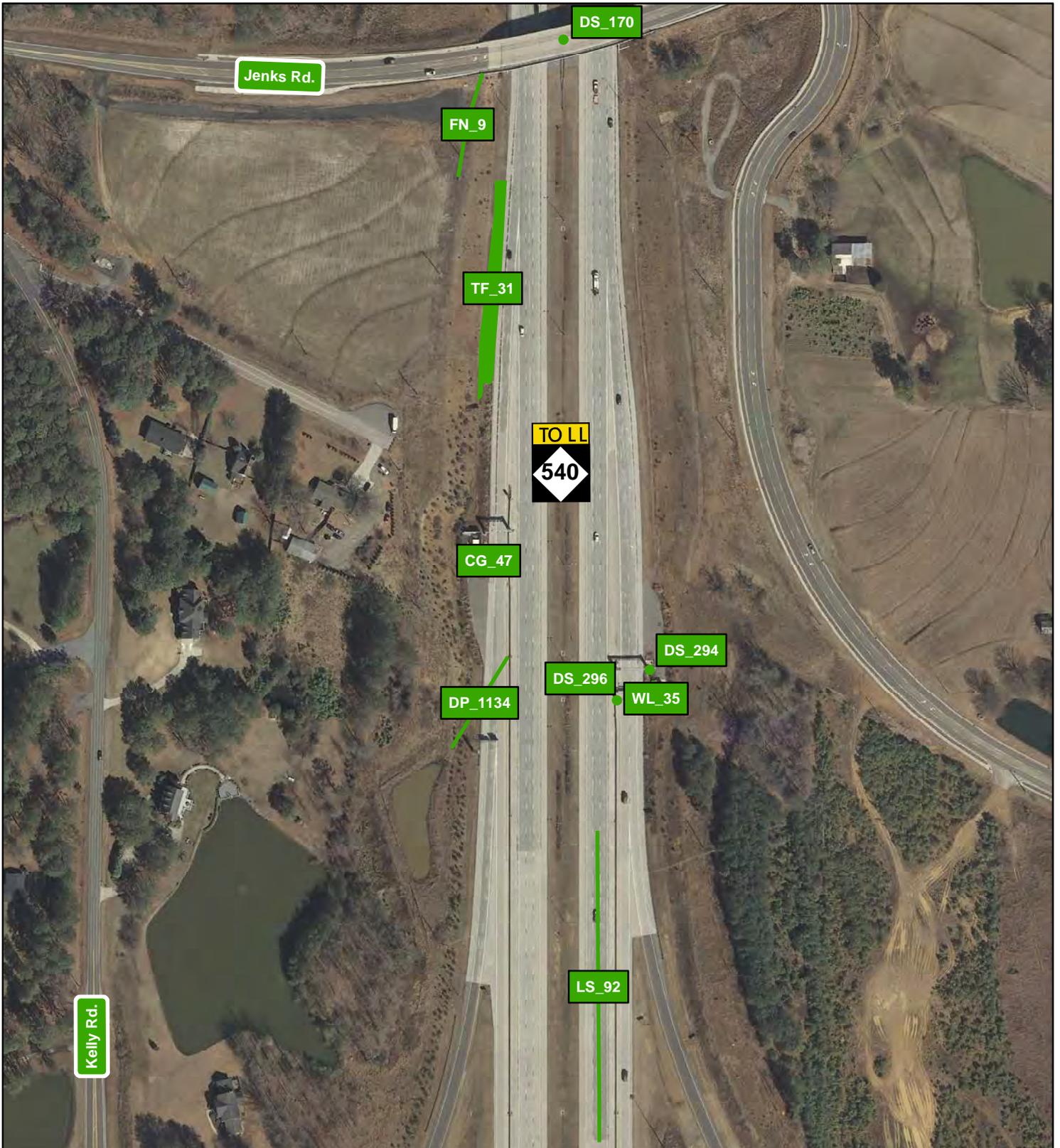


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

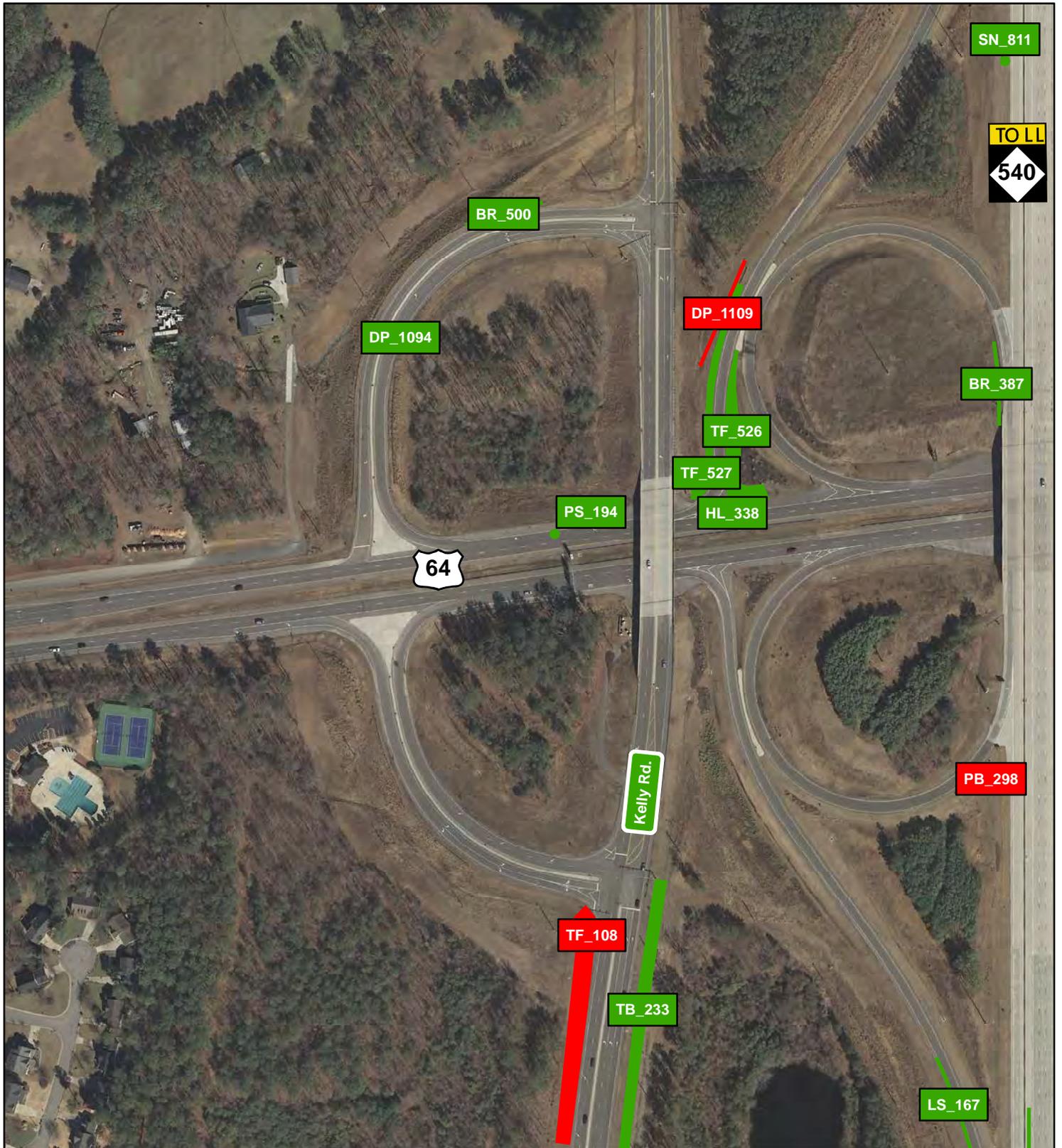


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

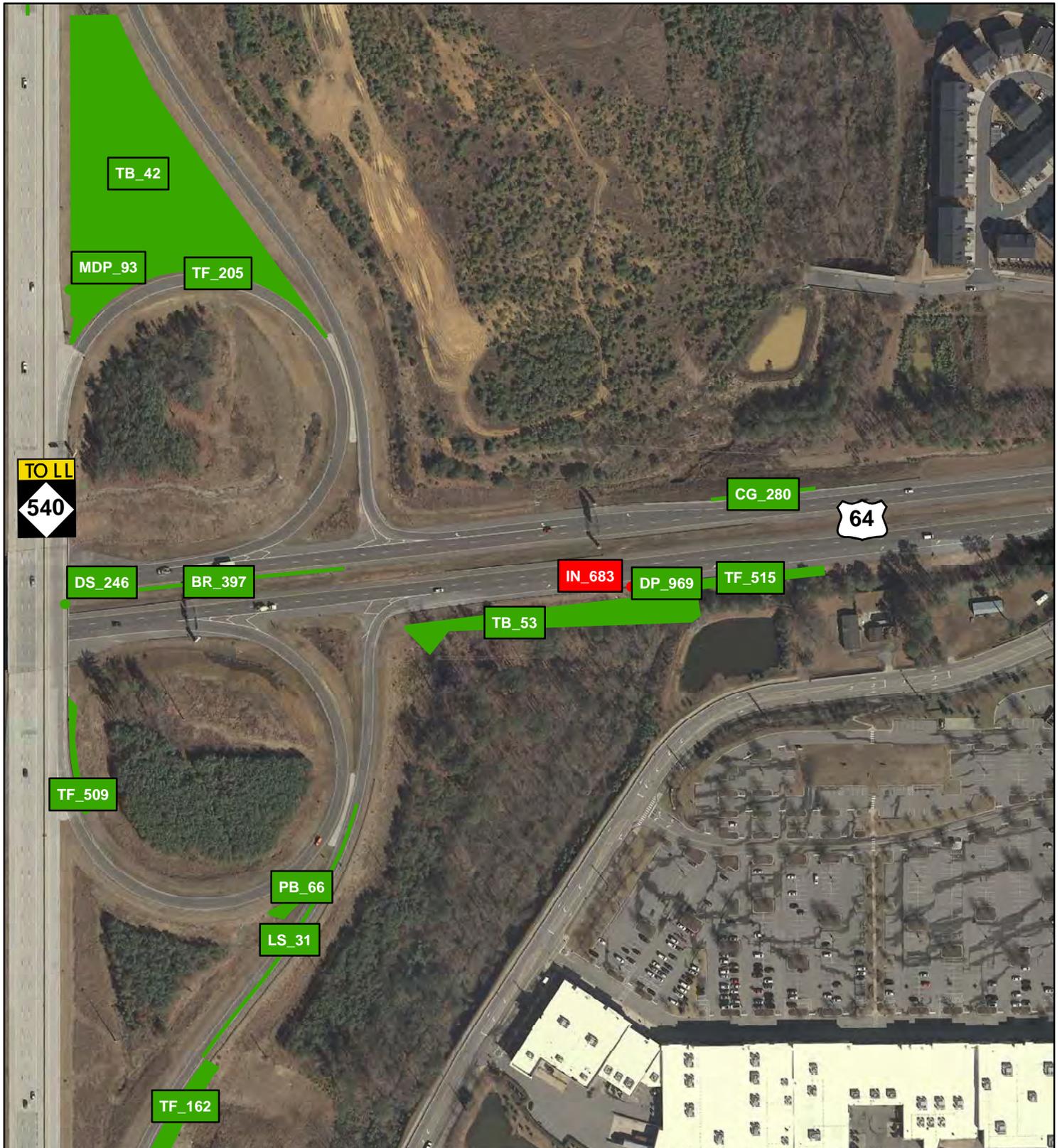


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

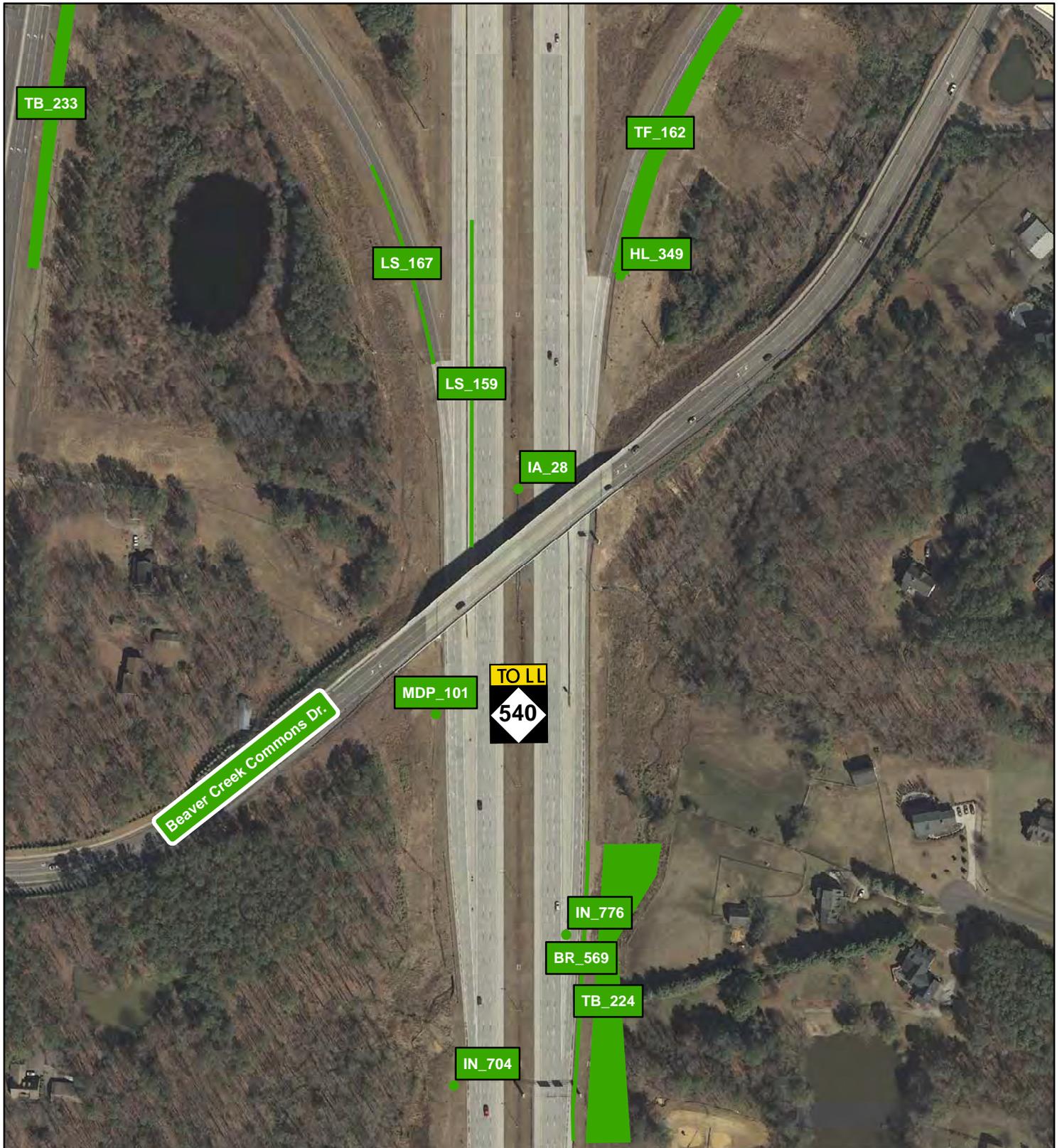


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

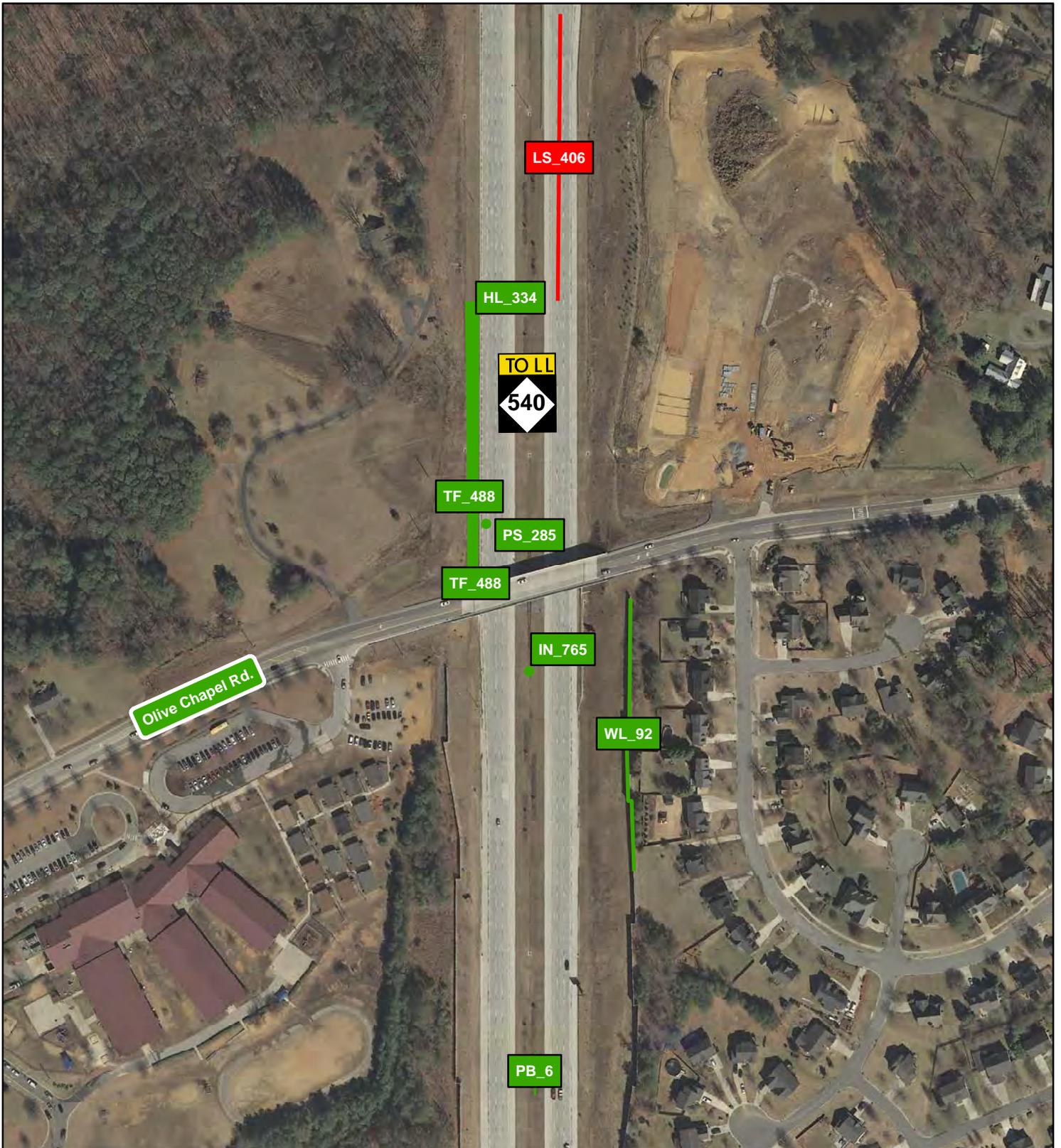


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

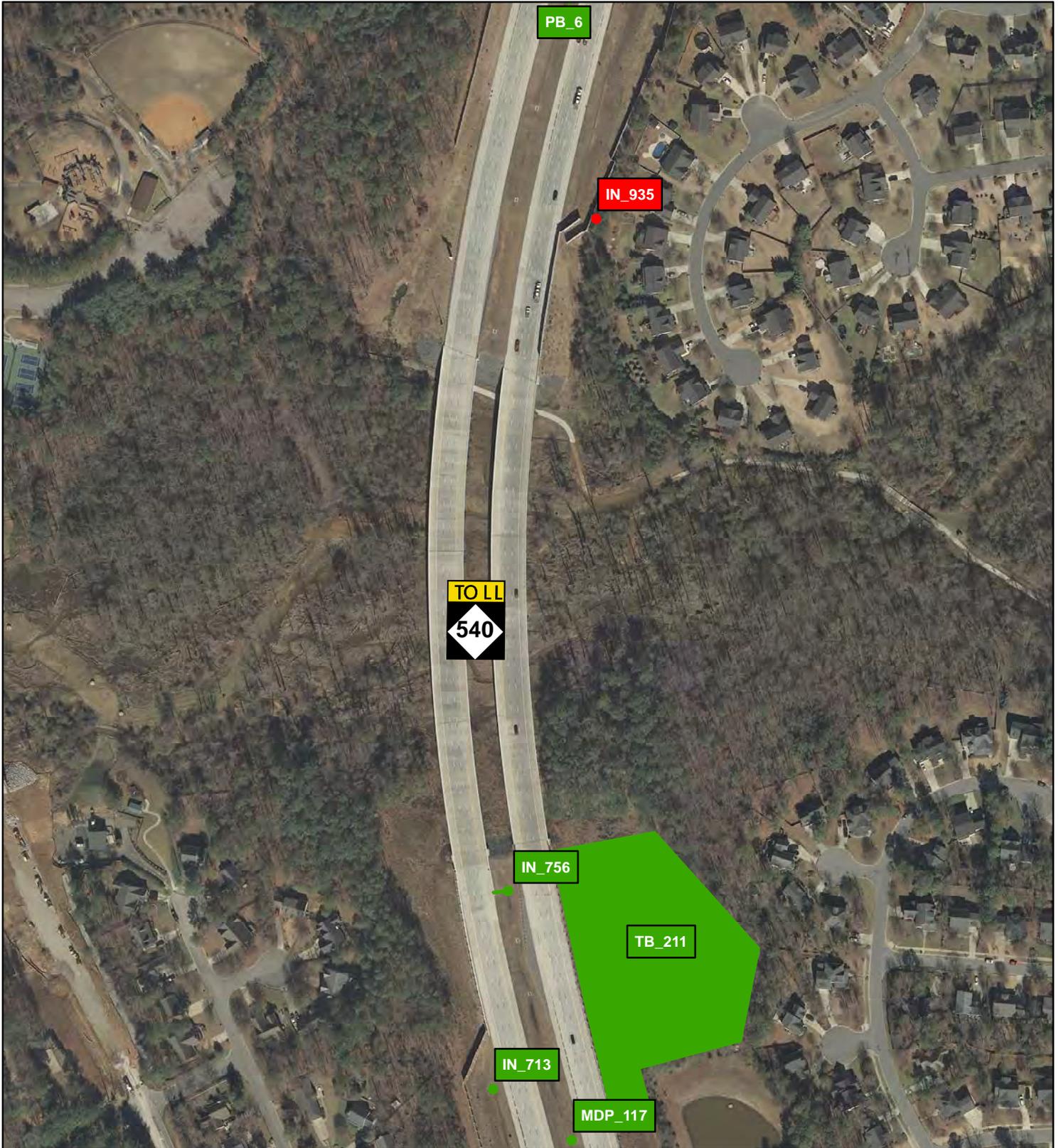


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

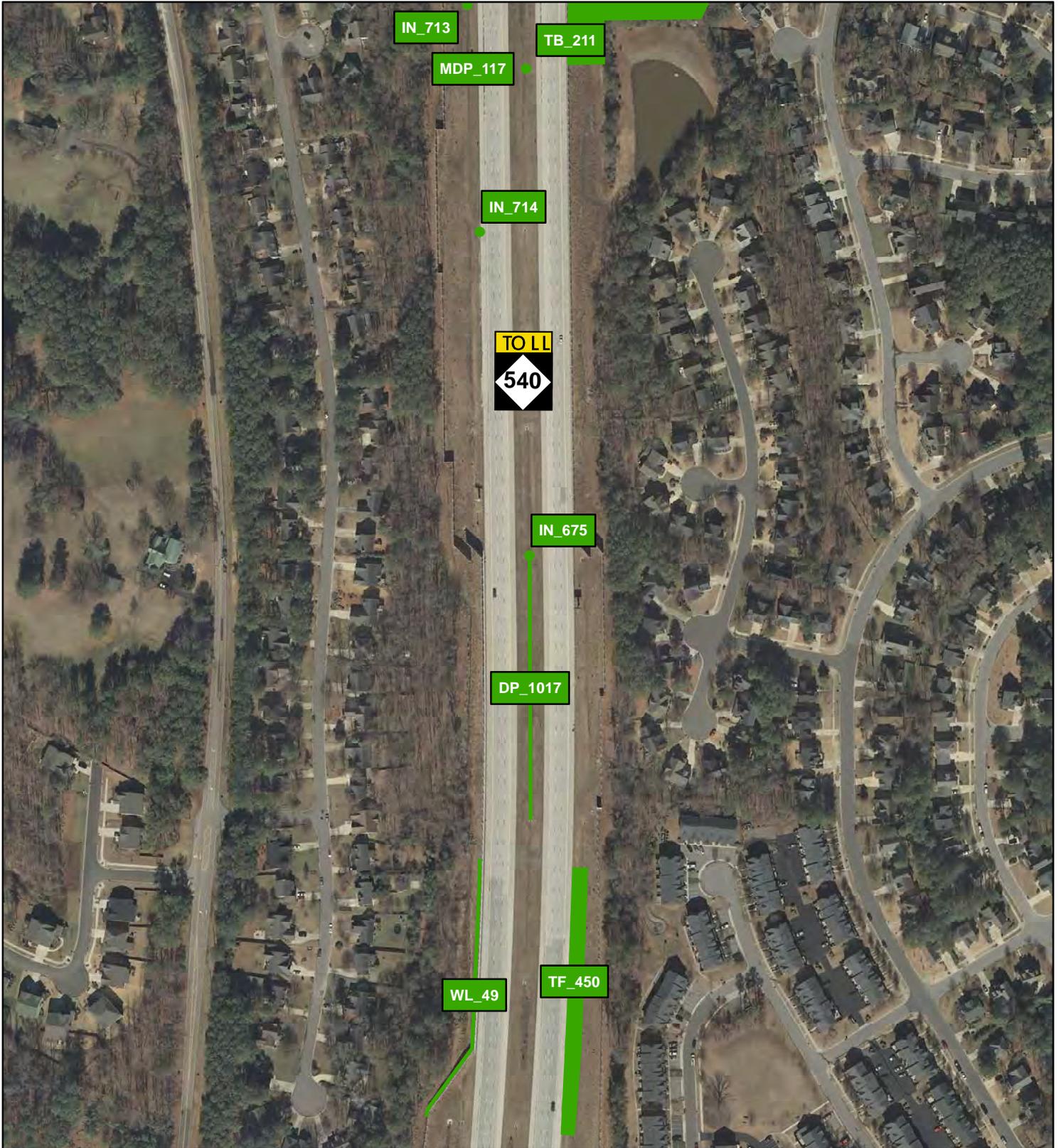


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

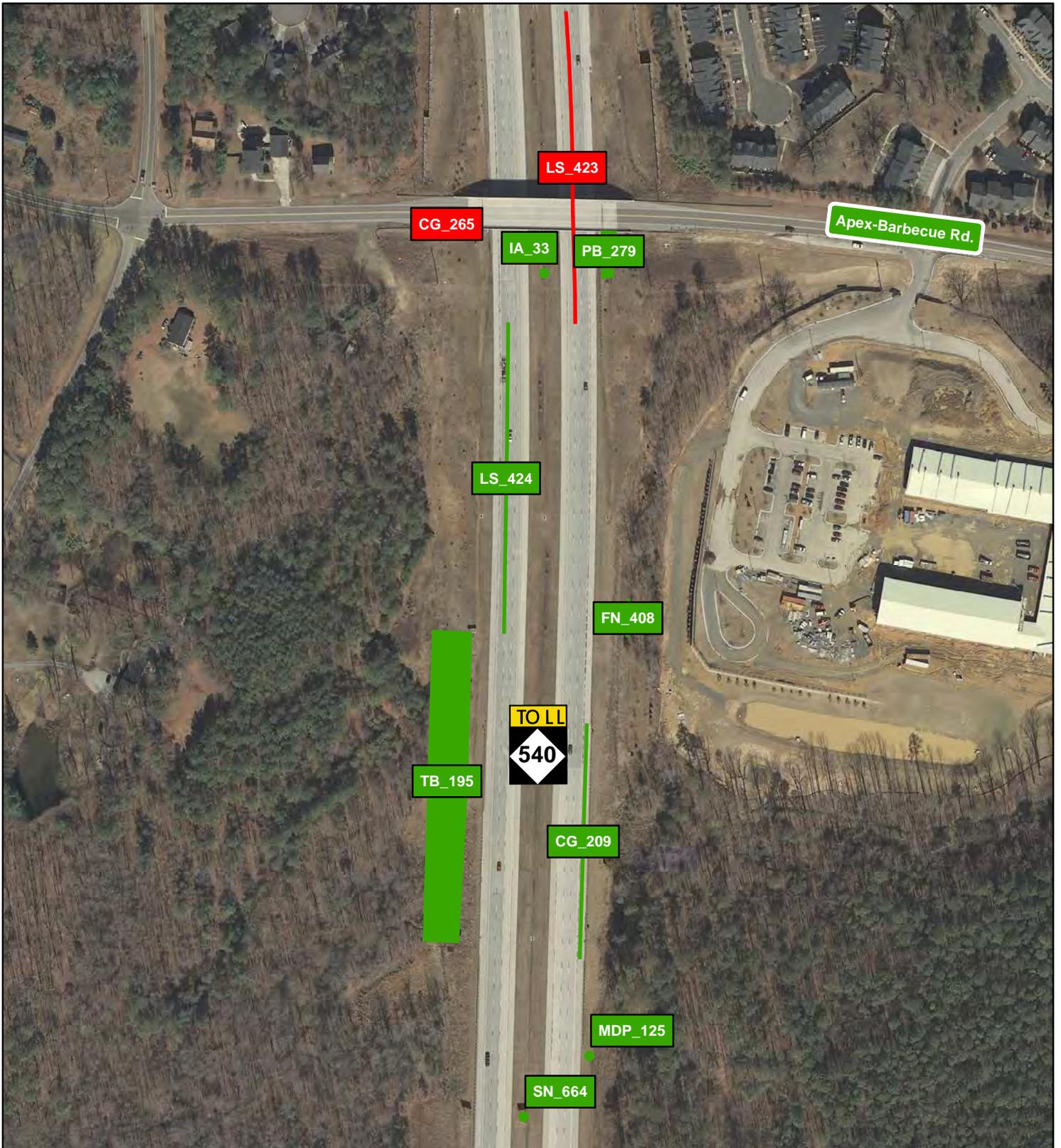


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



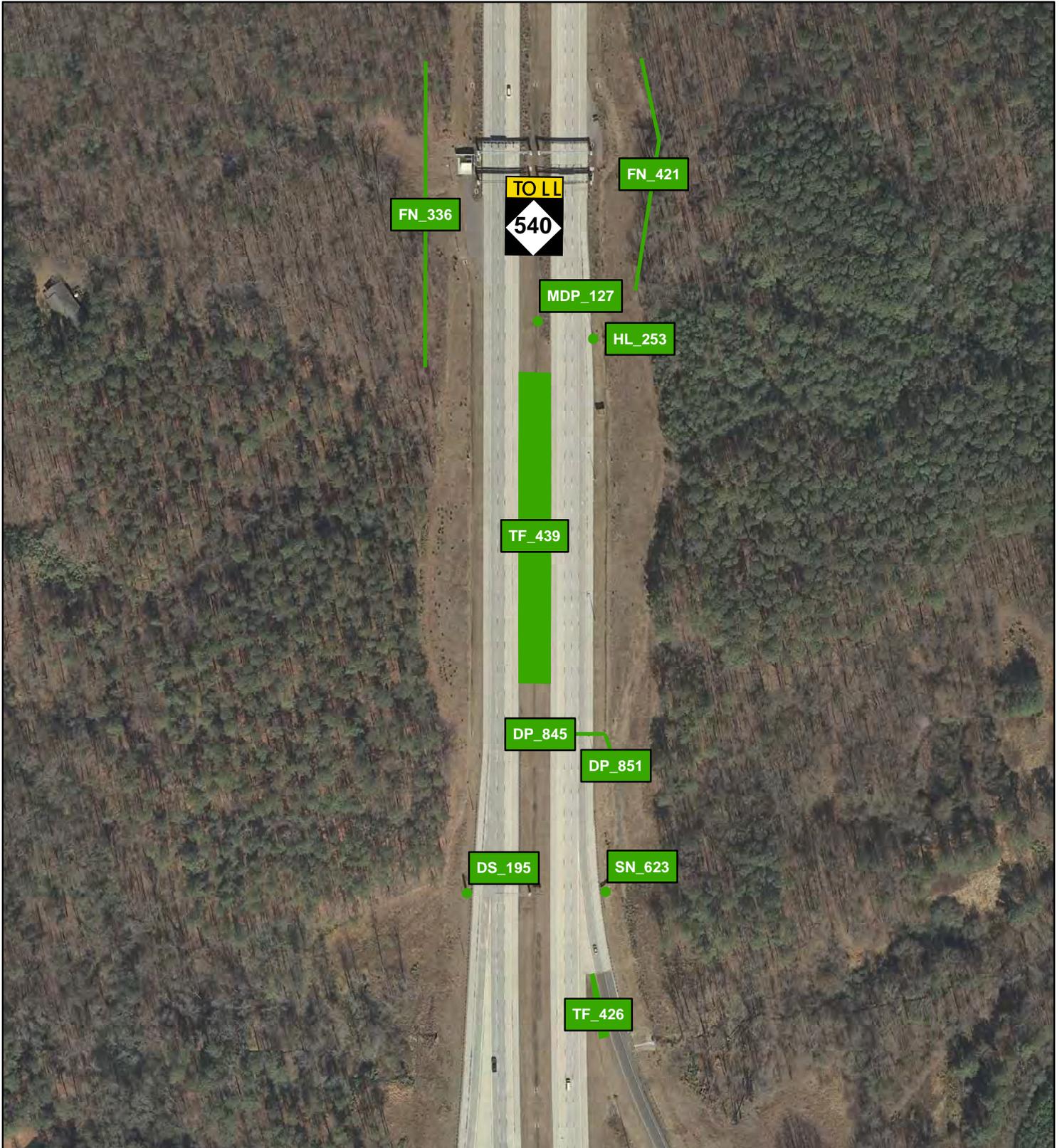
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 Failing Asset

 Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

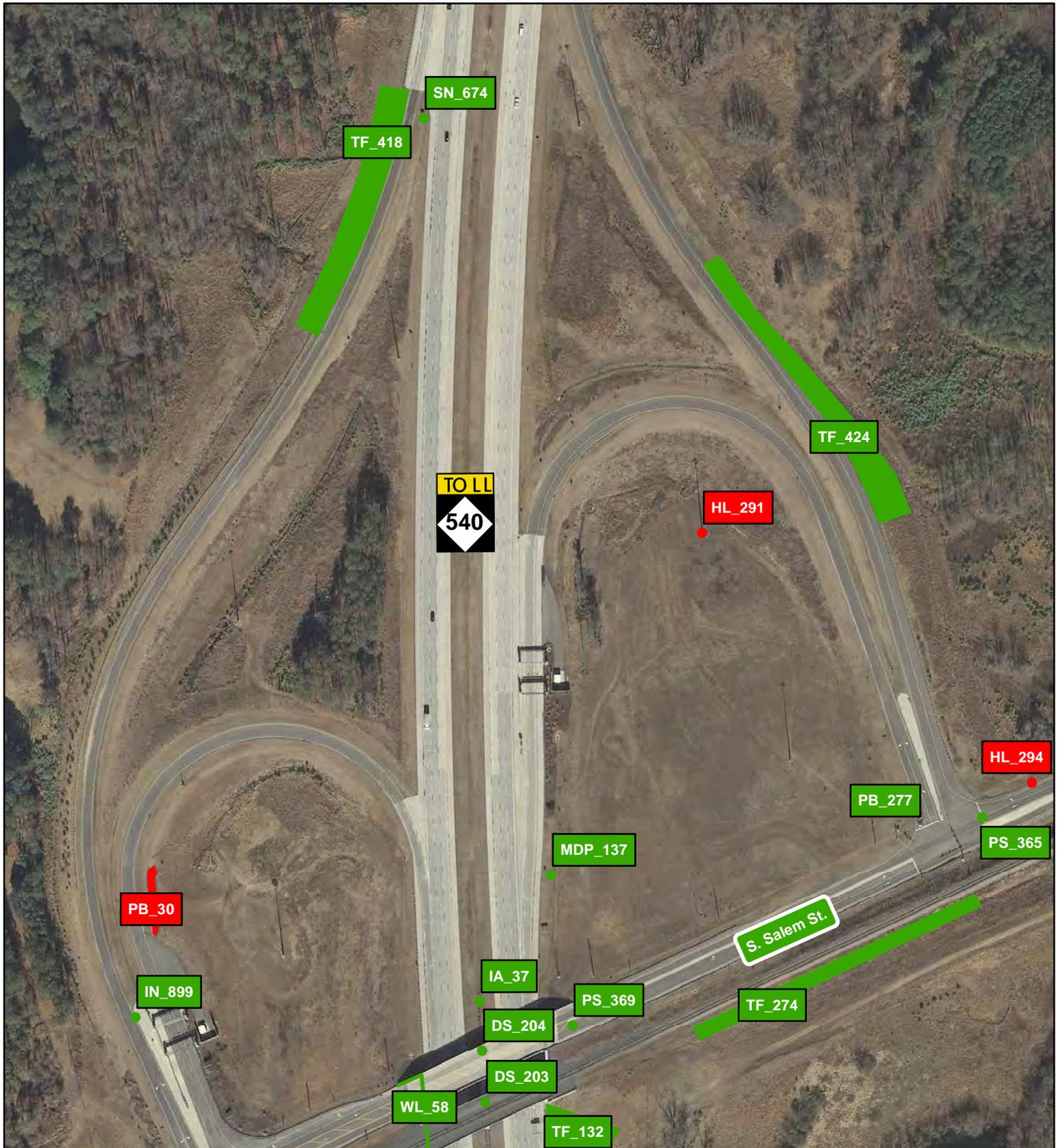


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

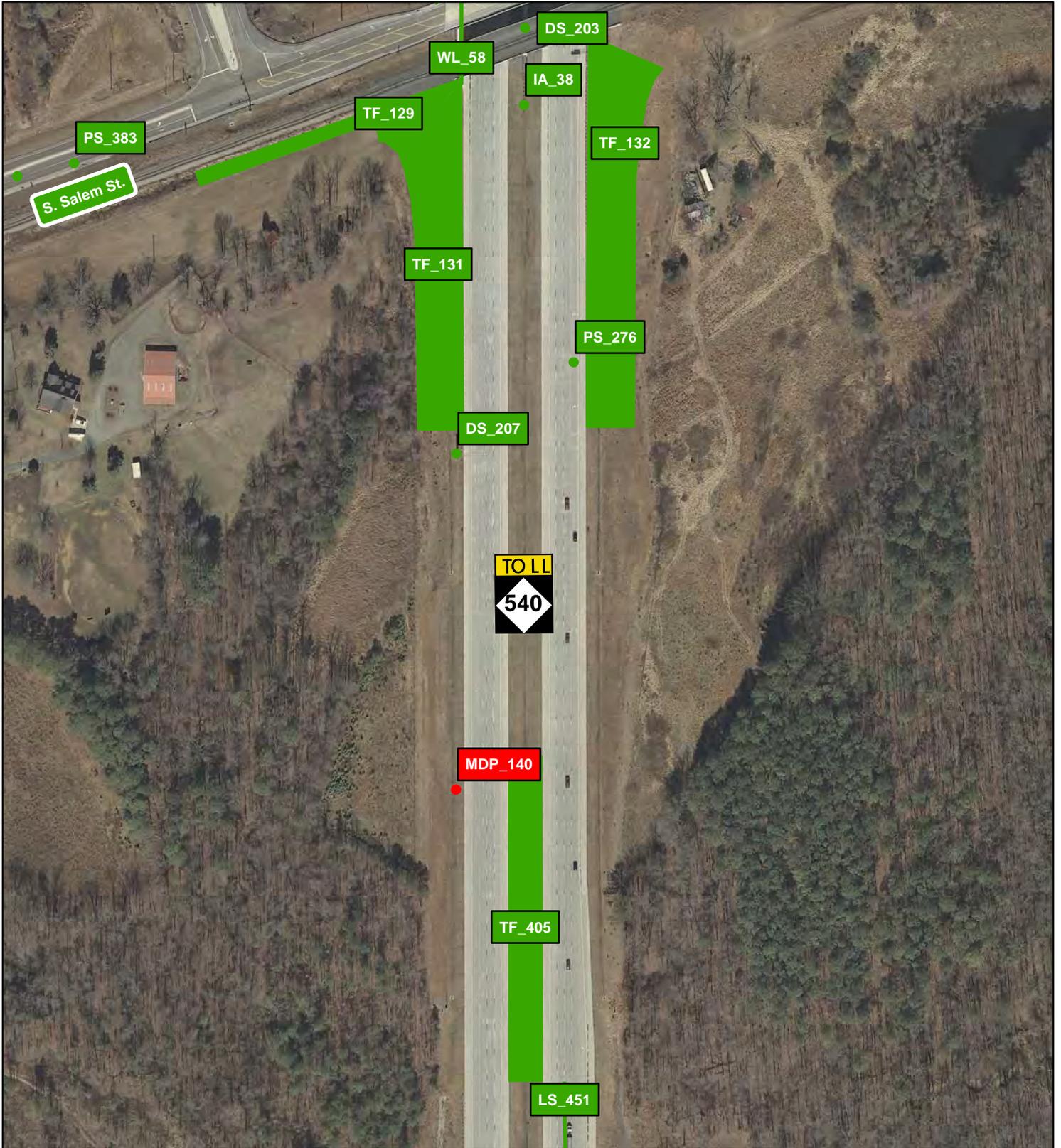


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

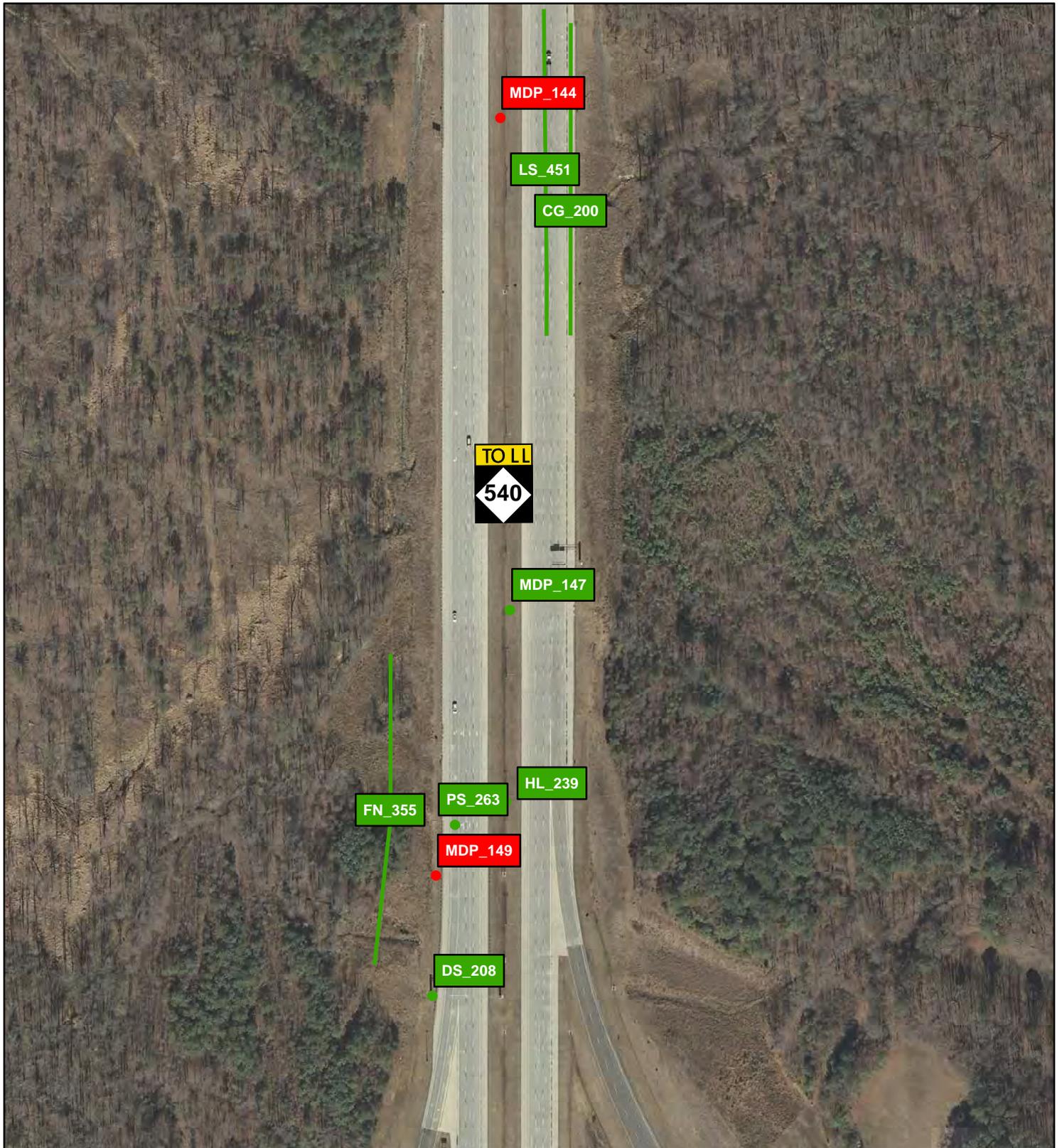


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



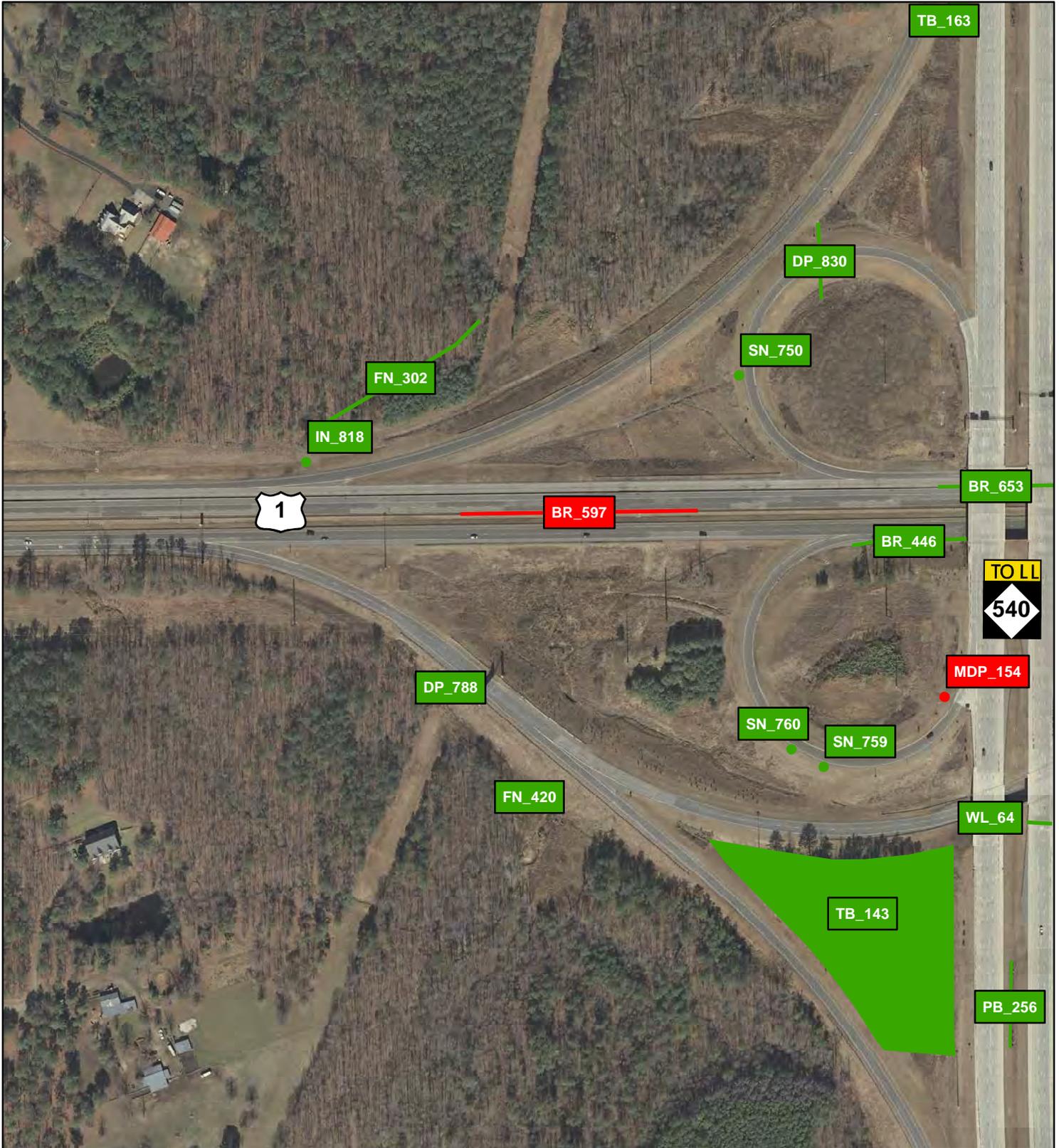
Legend

 Failing Asset

 Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

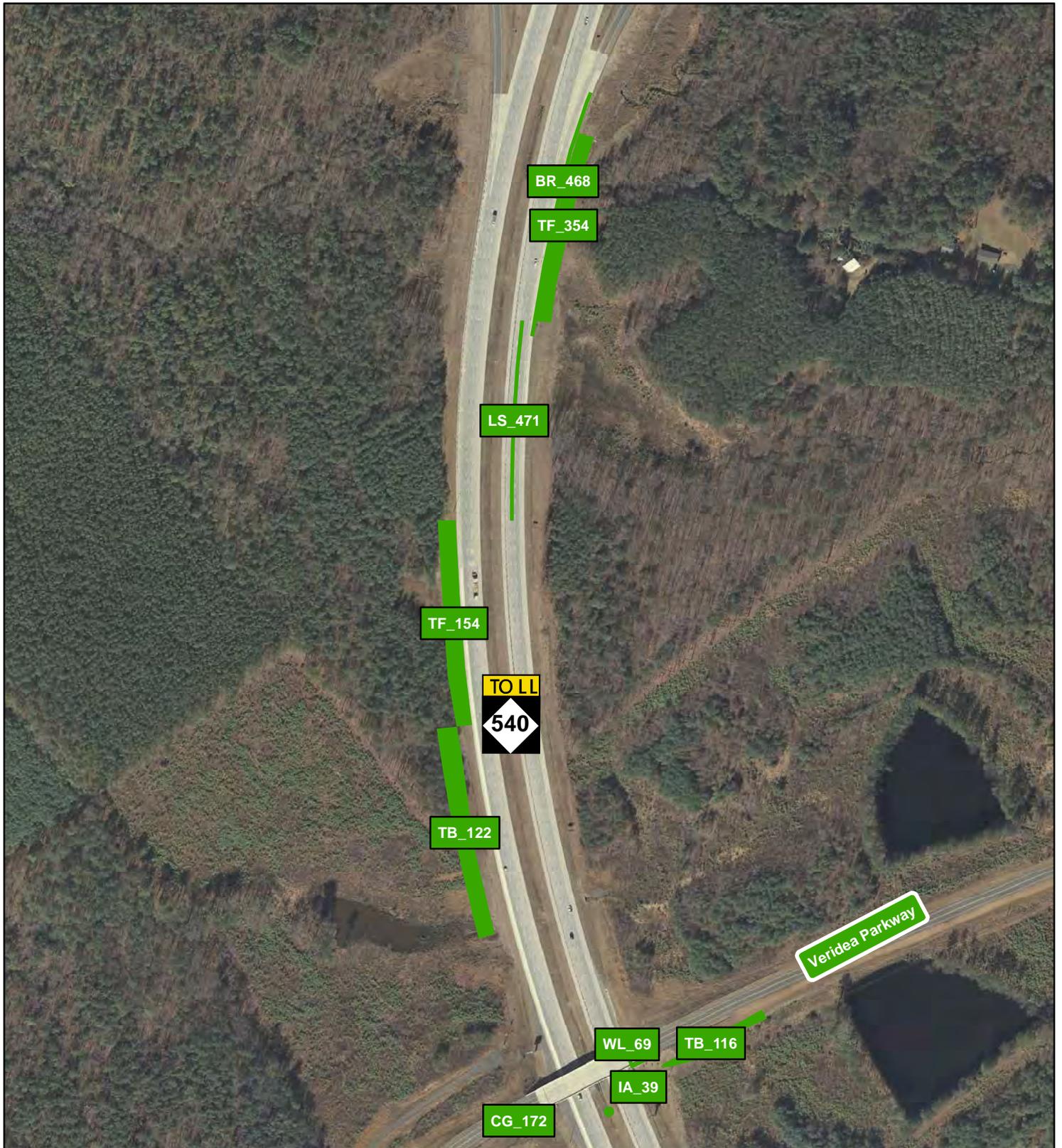


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

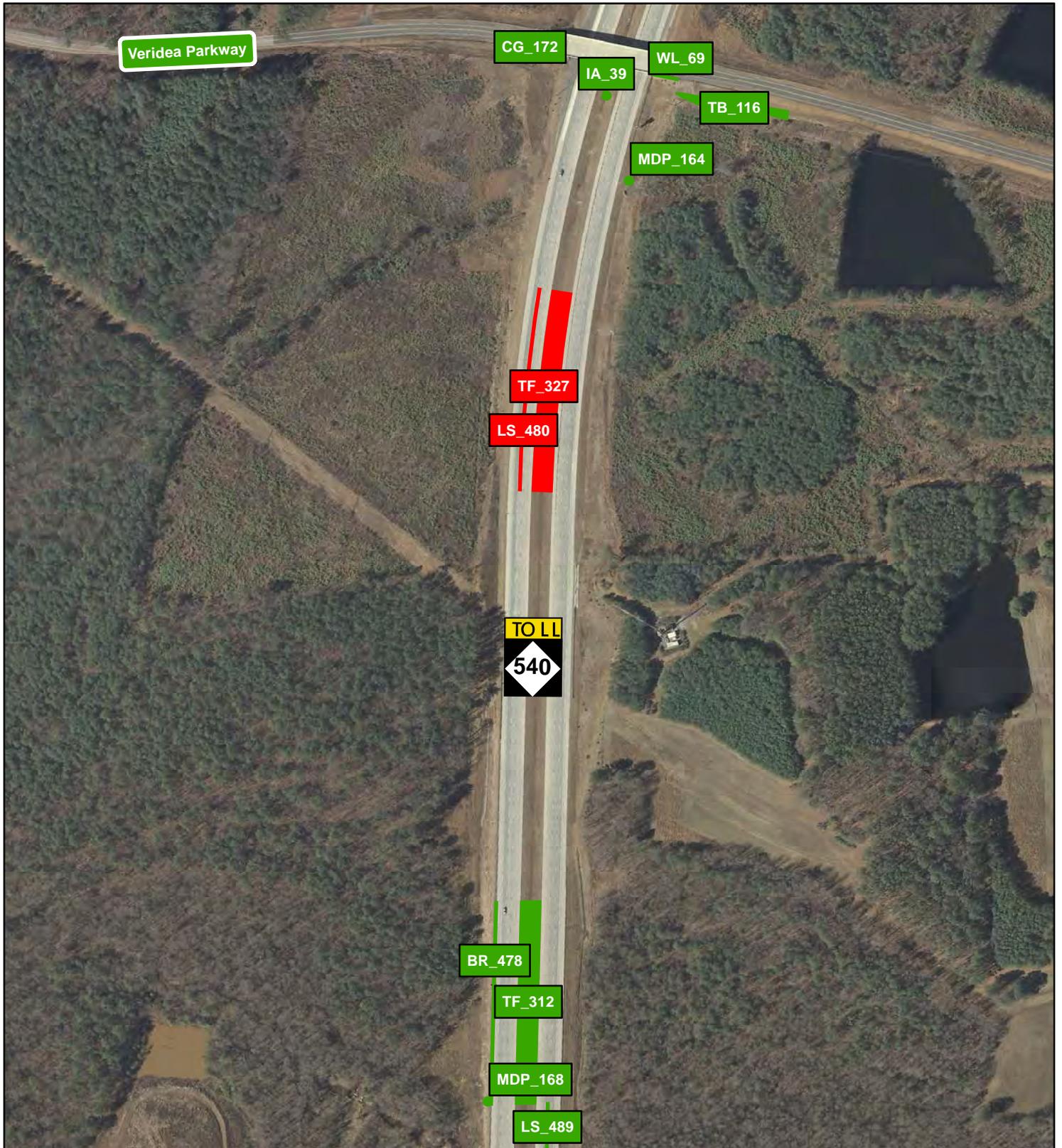


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

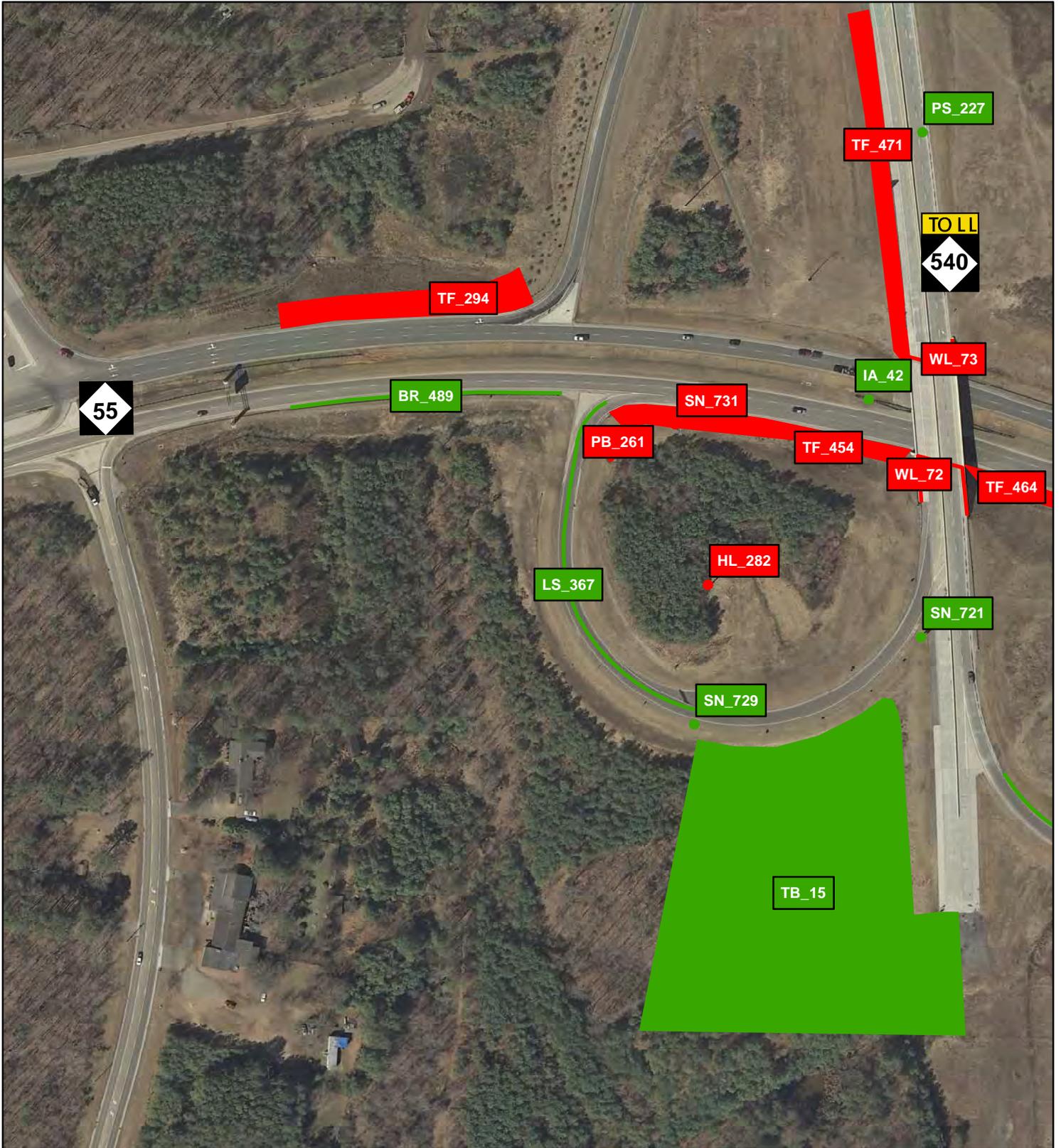


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

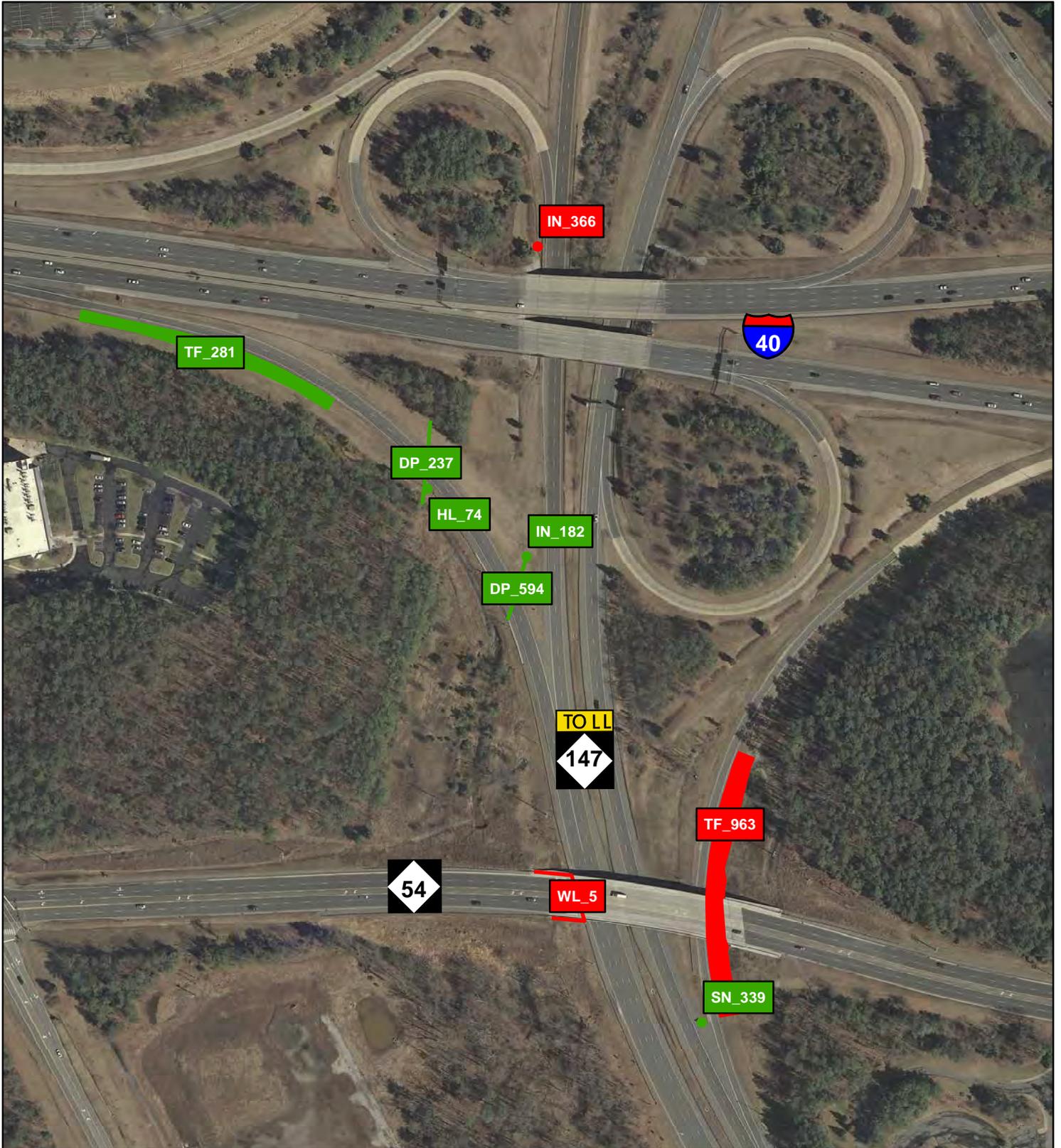


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

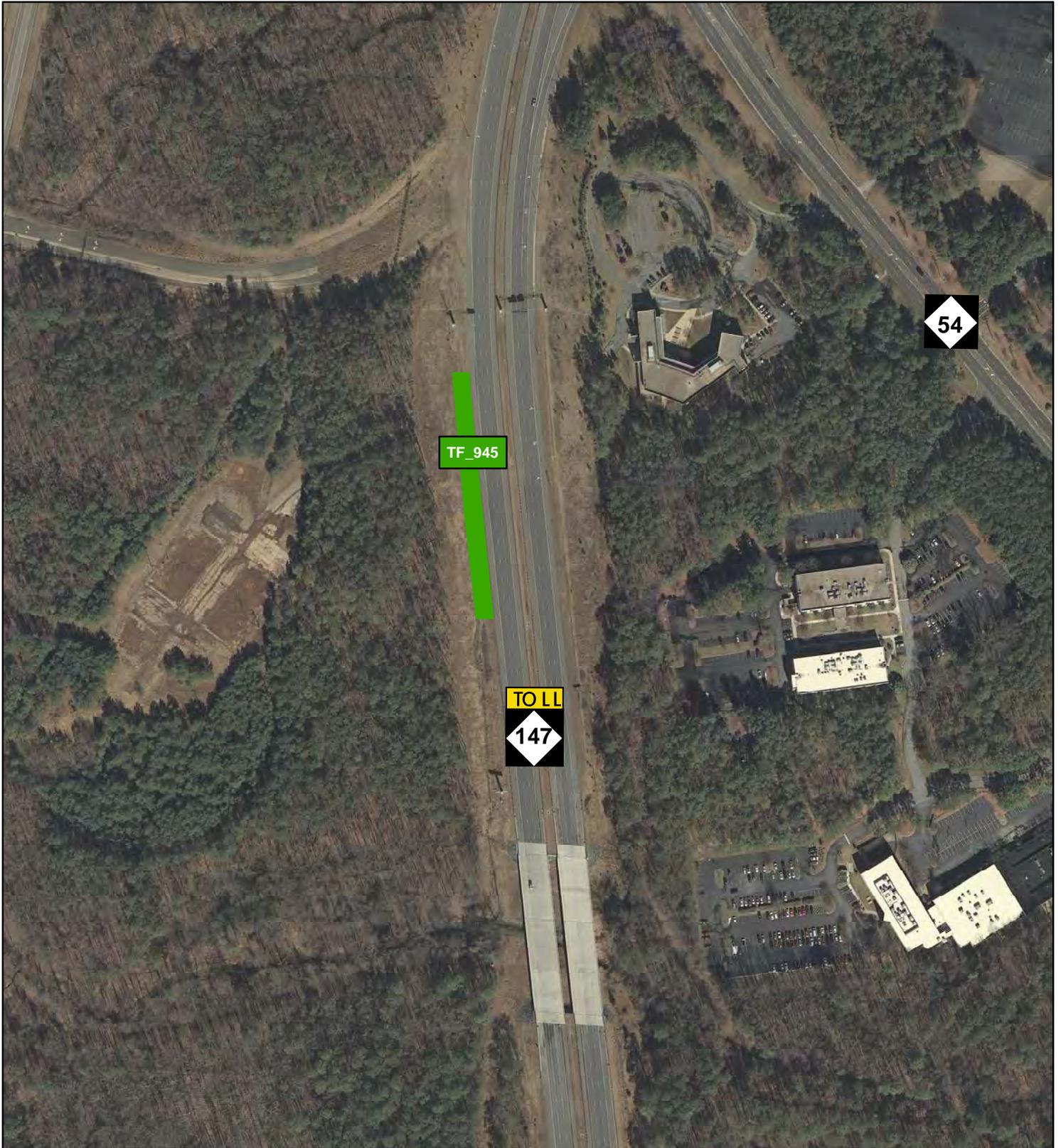


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

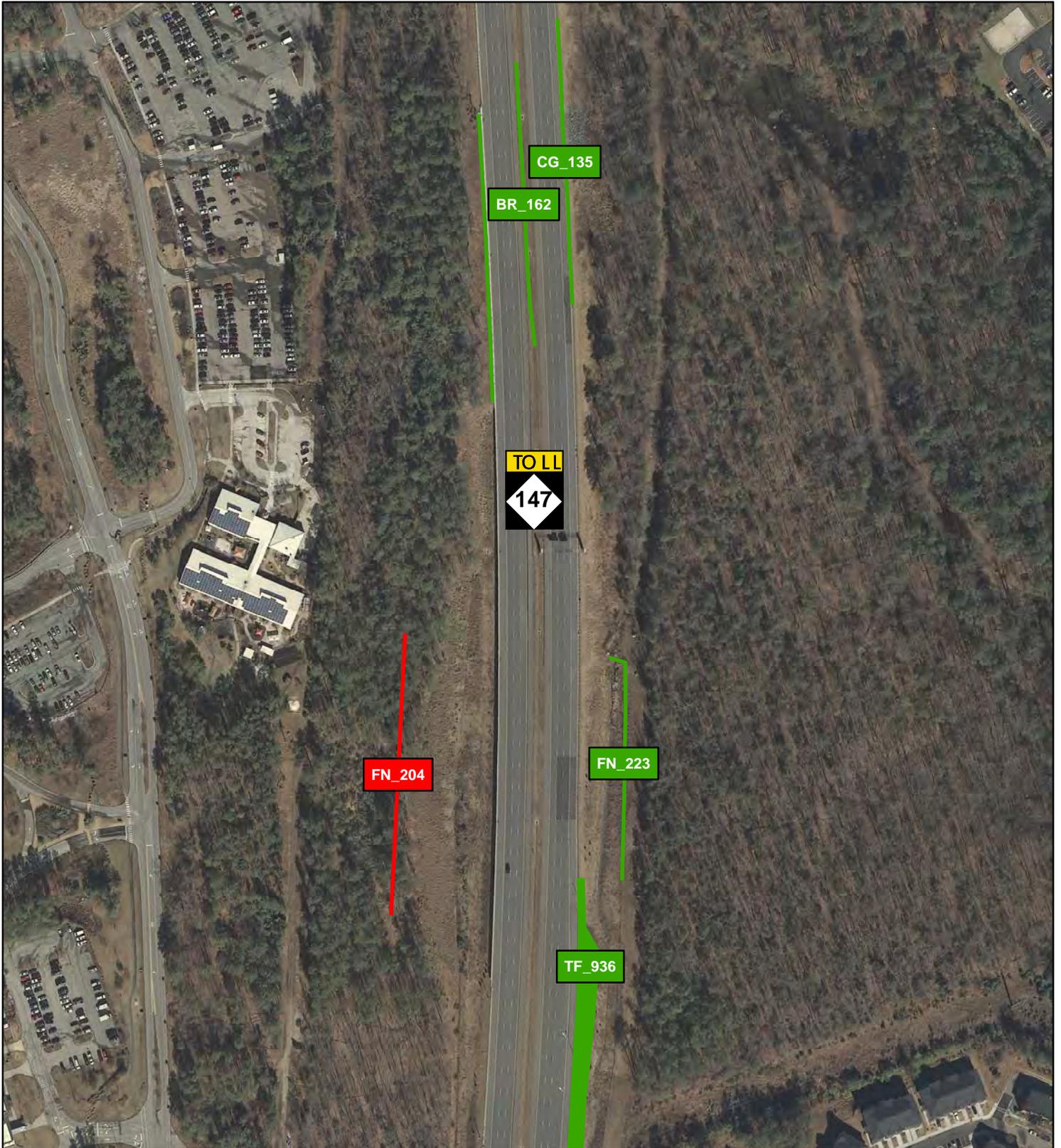


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

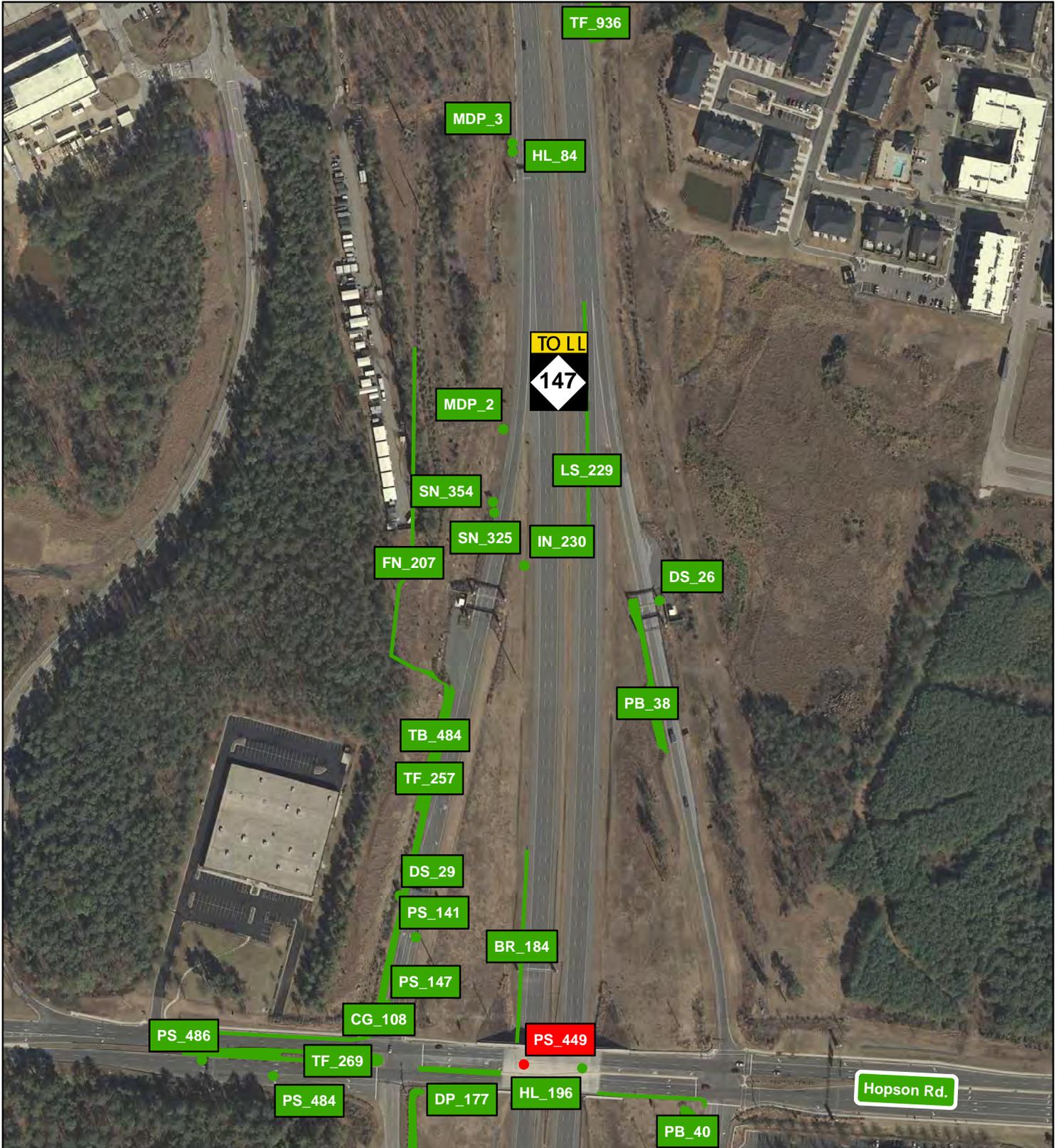


Legend

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-  Passing Asset

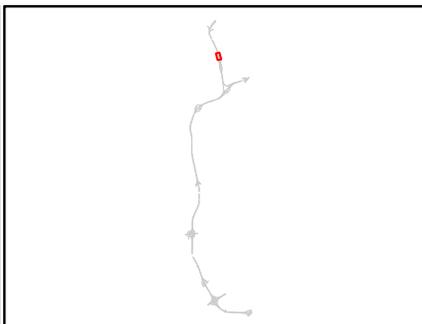


Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

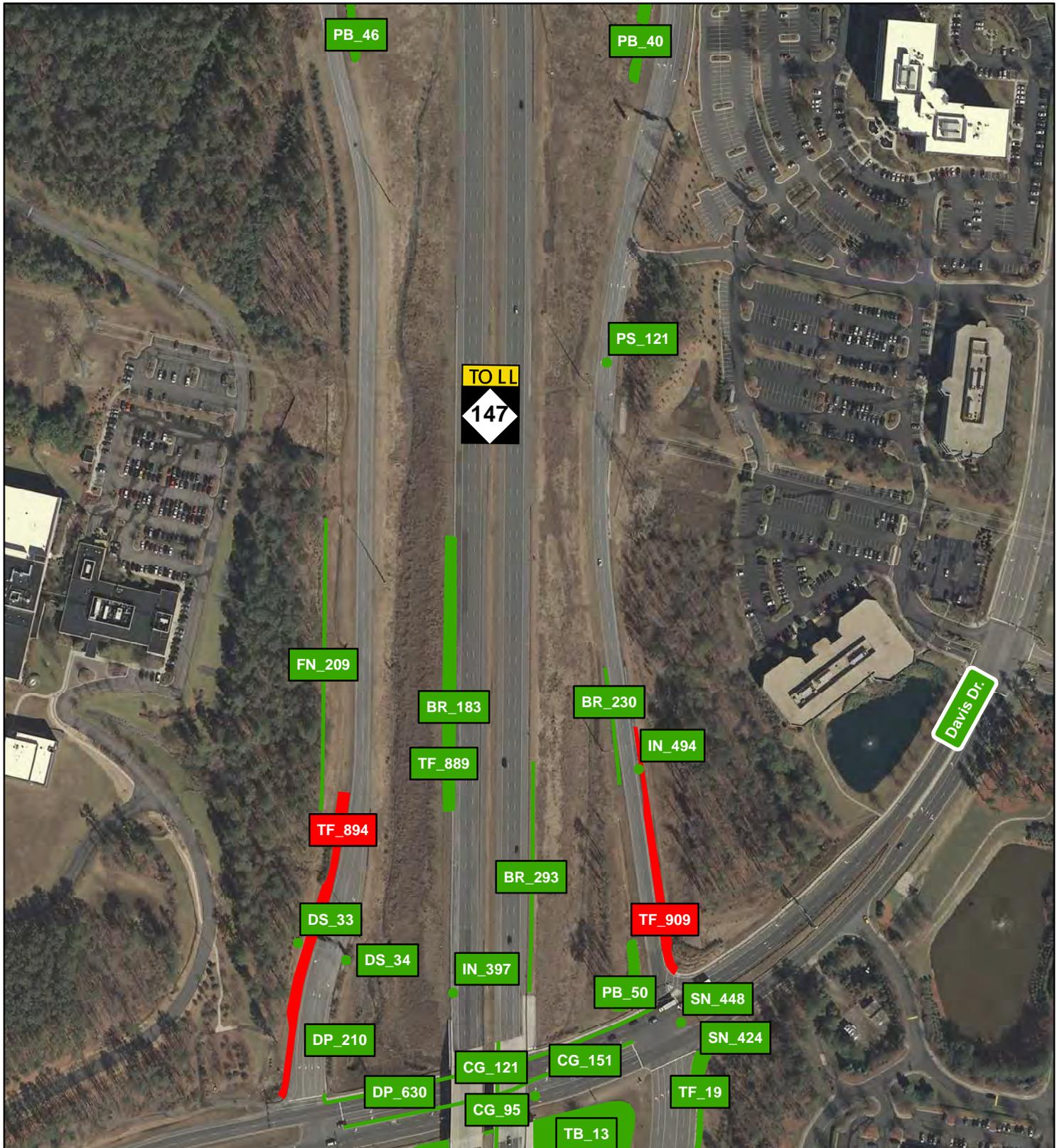


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

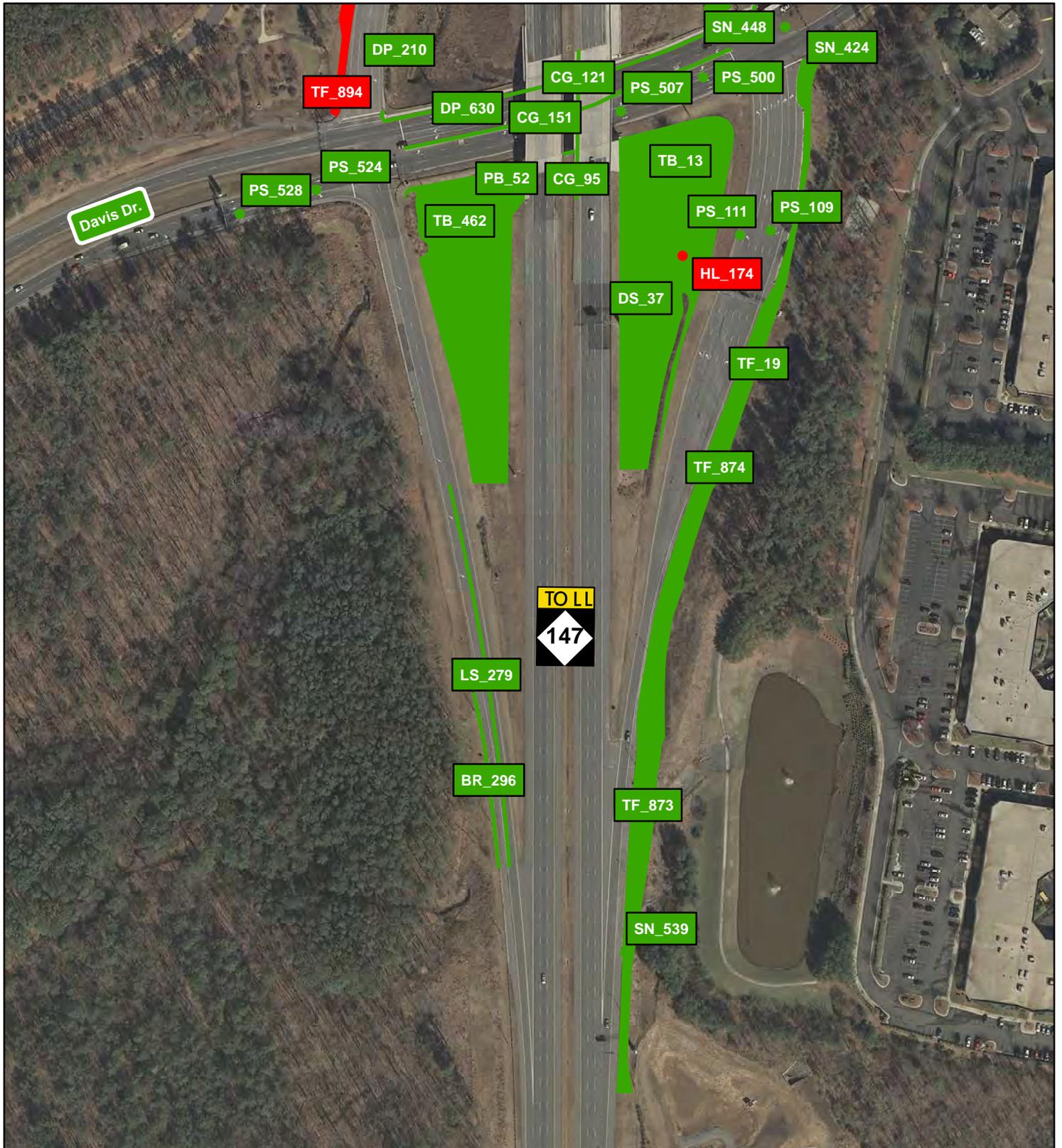


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

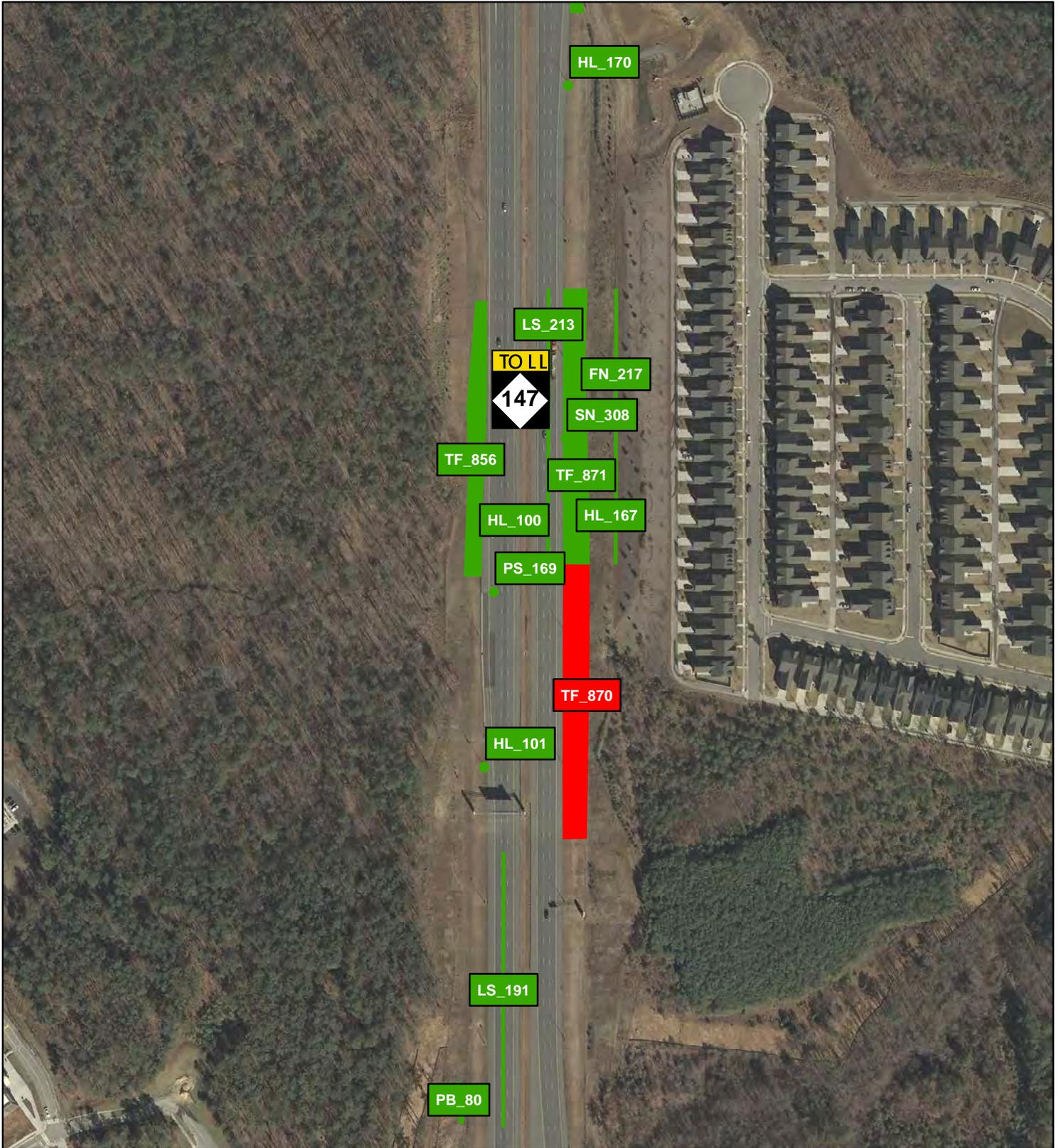


Legend

- Failing Asset
- Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations

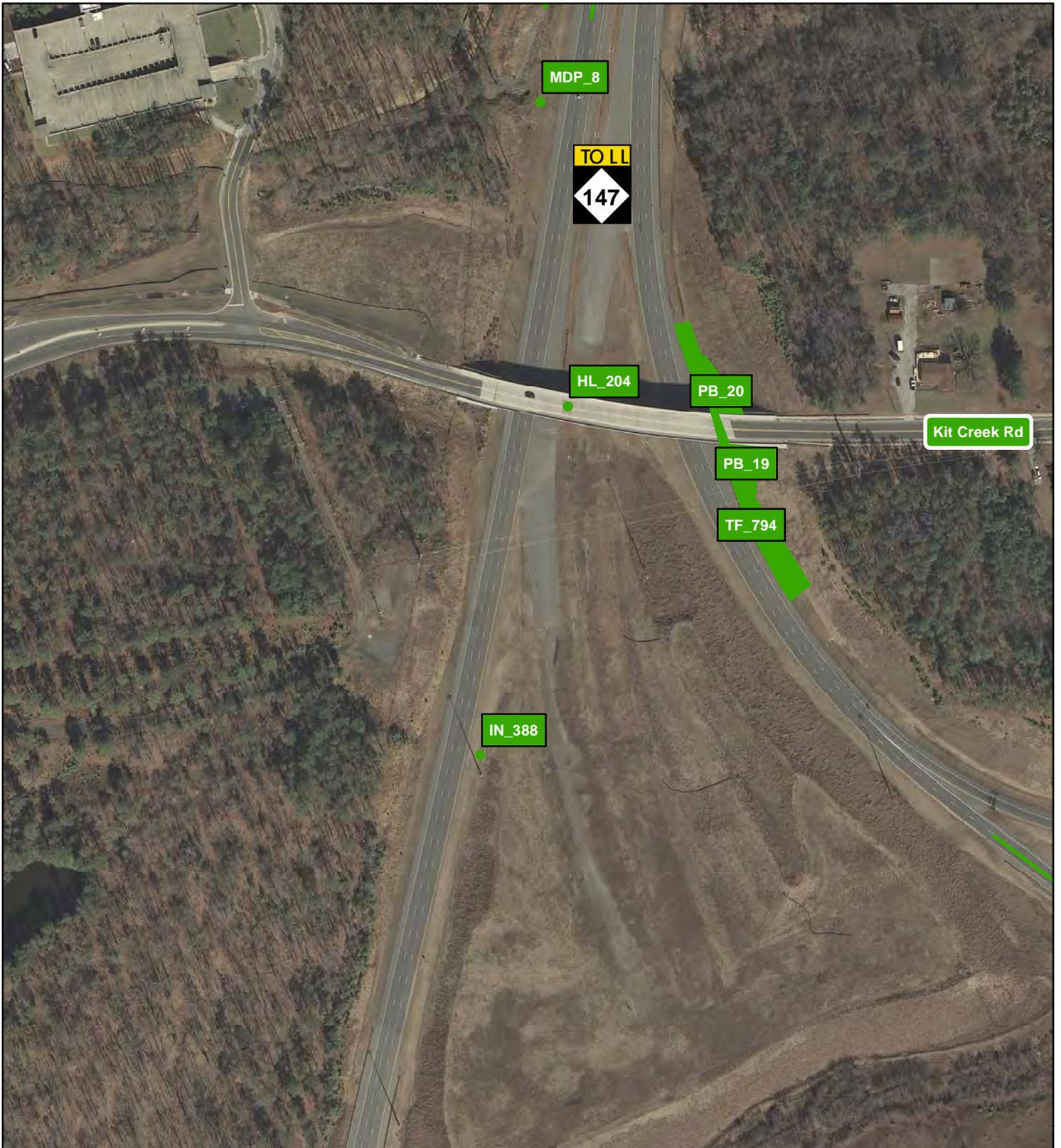


Legend

-  Failing Asset
-  Passing Asset



Appendix A: Triangle Expressway 2017 Third Quarter Asset Assessment Locations



Legend

-  Failing Asset
-  Passing Asset



Appendix B

Triangle Expressway 2017 Third Quarter Table Results of Assets Failing MRP

Appendix B: Triangle Expressway 2017 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 Structure (MDP)	7
Fence and Control of Access (FN)	10
Graffiti (GR)	11
Highway Lighting (HL)	12
Impact Attenuators (IA)	15
Inlets (IN).....	16
Landscaping (PB)	19
Paved Lanes – Asphalt (LS).....	20
Paved Lanes – Concrete (LS)	21
Paved Shoulders (LS).....	22
Unpaved Shoulders (LS)	23
Front/Back Slopes (LS)	24
Unpaved Lateral and Outfall Ditches (LS)	25
Litter (LS)	26
Roadway Sweeping (LS)	27
Pavement Striping (LS).....	28
Pavement Markers (LS).....	29
Delineators (LS)	30
Paved Ditches (PD).....	31
Pavement Words and Symbols (PS).....	32
Signs (SN)	33
Tree and Brush (TB).....	34
Turf Condition (TF)	35
MSE/Retaining Walls, Sound Barrier Walls and Screen Walls (WL).....	39

The Inventory ID and GIS Reference Page number correspond to the maps provided in Appendix A, to allow for the quick location of particular asset failures. Photos of failures are provided when applicable.

Guardrail, Concrete Barrier and End Anchors (BR)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Guardrail	BR_206	Functional Damage		A6
2	Guardrail	BR_597	Functional Damage, Missing Parts		A38

Curb and Gutter (CG)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Valley	CG_14	Obstruction		A21
2	Valley	CG_66	Obstruction		A12
3	Valley	CG_265	Obstruction		A33

Decorative Supports (DS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Sign Support	DS_305	Paint Scaling		A18

Drainage Pipes (DP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Lateral Pipe	DP_1109	Obstruction		A27

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Shoulder Drain	MDP_22	Obstruction	 A photograph showing a concrete shoulder drain opening in a grassy area. The drain is partially blocked by a dense mass of dry, brownish vegetation and debris, preventing water from flowing through.	A14
2	Shoulder Drain	MDP_29	Obstruction	 A photograph of a shoulder drain opening surrounded by tall green grass. The drain is almost completely blocked by a thick layer of dry, tangled vegetation and debris.	A16
3	Shoulder Drain	MDP_34	Obstruction, Erosion	 A photograph showing a shoulder drain opening. The drain is heavily obstructed by dry vegetation. There is significant erosion around the drain, with a deep, narrow channel of water flowing through the debris and soil.	A17
4	Shoulder Drain	MDP_43	Obstruction	 A photograph of a shoulder drain opening. The drain is blocked by a large pile of dry, brown vegetation and debris, with some water pooling around the opening.	A18

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Shoulder Drain	MDP_50	Obstruction		A18
6	Shoulder Drain	MDP_60	Erosion		A20
7	Shoulder Drain	MDP_140	Obstruction, Grate Damage		A36
8	Shoulder Drain	MDP_144	Obstruction		A37

Misc. Drainage Structure (MDP)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Shoulder Drain	MDP_149	Obstruction		A37
10	Shoulder Drain	MDP_154	Obstruction		A38

Fence and Control of Access (FN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Woven	FN_151	Fence Height		A9
2	Woven	FN_177	Fence Height		A10
3	Woven	FN_181	Fence Height		A10
4	Chain Link	FN_204	Fence Height		A48

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_16	Functional Damage	Not Available for Nighttime Failure.	A19
2	Single Roadway	HL_31	Functional Damage	Not Available for Nighttime Failure.	A21
3	Single Roadway	HL_36	Functional Damage	Not Available for Nighttime Failure.	A22
4	High Mast	HL_67	Damaged Lock		A12
5	Single Roadway	HL_124	Functional Damage	Not Available for Nighttime Failure.	A10
6	High Mast	HL_134	Missing Rodent Screen		A7
7	High Mast	HL_135	Missing Lock		A6
8	Single Roadway	HL_149	Functional Damage	Not Available for Nighttime Failure.	A5

Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	High Mast	HL_155	Damaged Lock		A6
10	High Mast	HL_156	Functional Damage, Damaged Lock		A7
11	High Mast	HL_174	Damaged Lock		A51
12	High Mast	HL_282	Functional Damage, Missing Lock		A44

Highway Lighting (HL)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	High Mast	HL_291	Functional Damage, Damaged Lock		A35
14	Single Roadway	HL_294	Functional Damage	Not Available for Nighttime Failure.	A35
15	Double Roadway	HL_316	Functional Damage	Not Available for Nighttime Failure.	A40
16	High Mast	HL_320	Damaged Lock		A39
17	High Mast	HL_351	Functional Damage	Not Available for Nighttime Failure.	A12

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_22	Surface Damage		A25
2	Inlets	IN_26	Obstruction		A24
3	Inlets	IN_173	Obstruction		A11
4	Inlets	IN_366	Obstruction		A46

Inlets (IN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Inlets	IN_474	Erosion, Surface Damage		A8
6	Inlets	IN_594	Obstruction		A43
7	Inlets	IN_683	Obstruction		A28
8	Inlets	IN_853	Erosion, Surface Damage		A40

Inlets (IN)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Inlets	IN_935	Obstruction		A31

Landscaping (PB)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Plant Bed	PB_30	Health		A35
2	Plant Bed	PB_261	Health, Weeds		A44
3	Plant Bed	PB_298	Health		A27

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	Concrete	LS_112	Paved Shoulder Joint		A15
2	Concrete	LS_492	Paved Shoulder Crack		A43

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
1	Asphalt	LS_547	Litter		A40

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_302	Nighttime Visibility, Line Width		A3
2	Concrete	LS_316	Nighttime Visibility	Not Available for Nighttime Failure.	A5
3	Concrete	LS_406	Nighttime Visibility, Line Missing		A30
4	Concrete	LS_423	Line Missing		A33
5	Concrete	LS_480	Nighttime Visibility, Line Missing		A42

Pavement Markers (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Asphalt	LS_302	Nighttime Reflectivity, Missing Markers, Markers Count		A3
2	Asphalt	LS_547	Nighttime Reflectivity	Not Available for Nighttime Failure.	A40

Delineators (LS)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Concrete	LS_112	Missing Markers		A15
2	Asphalt	LS_302	Missing Markers		A3

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
1	Left Turn	PS_449	Nighttime Reflectivity, Day Time Assessment		A49
2	Right Turn	PS_641	Nighttime Reflectivity, Day Time Assessment		A11, A12

Signs (SN)

#	Sign Type	Object ID	Failure Type	Photo	GIS Reference Page
1	Mile Post	SN_88	Nighttime Reflectivity	Not Available for Nighttime Failure.	A15
2	Exit	SN_242	Nighttime Reflectivity	Not Available for Nighttime Failure.	A21
3	Message Board	SN_407	Nighttime Reflectivity	Not Available for Nighttime Failure.	A10
4	NC Route	SN_731	Sign Missing		A44
5	Other	SN_1003	Nighttime Reflectivity	Not Available for Nighttime Failure.	A4

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_108	Bare Ground		A27
2	Turf	TF_140	Bare Ground		A40
3	Turf	TF_189	Bare Ground		A39
4	Turf	TF_237	Bare Ground		A39

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
5	Turf	TF_294	Bare Ground		A44
6	Turf	TF_327	Bare Ground		A42
7	Turf	TF_454	Bare Ground		A44, A45
8	Turf	TF_464	Bare Ground		A44, A45

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
9	Turf	TF_471	Bare Ground		A44, A45
10	Turf	TF_643	Bare Ground		A15
11	Turf	TF_791	Bare Ground		A6
12	Turf	TF_870	Bare Ground		A52

Turf Condition (TF)

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
13	Turf	TF_894	Bare Ground		A50, A51
14	Turf	TF_909	Bare Ground		A50
15	Turf	TF_963	Bare Ground		A46
16	Turf	TF_1006	Bare Ground		A21

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

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
1	MSE Wall	WL_5	Unsealed Joint, Paint Scaling		A46
2	MSE Wall	WL_32	Paint Scaling		A11
3	MSE Wall	WL_72	Paint Scaling		A44, A45

MSE - Mechanically Stabilized Earth Wall

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

#	Material Type	Object ID	Failure Type	Photo	GIS Reference Page
4	MSE Wall	WL_73	Paint Scaling		A44, A45

MSE - Mechanically Stabilized Earth Wall