Dynatest: Rapid Pavement Tester (RAPTOR)

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Dynatest RAPTOR

Trailer length = 31 ft
Total length = 43 ft

- Measurements using line lasers
- Climate controlled trailer
- Integrated calibration system
- Data correlation with FWD
- Axle load range 13–22 kips
- Deflection measurements with Lasers

- Optional Measurements:
- Pavement Imaging
- Profiling
- GPR

RAPTOR Applications

- Network level structural pavement evaluation at traffic speed
- Identify areas of concern
- Structural indexes

- Better performance prediction models for pavement management
- Limit lane closures / Reduce user costs / Safety

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Dynatest RAPTOR

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Custom Built Trailer

Dynatest RAPTOR

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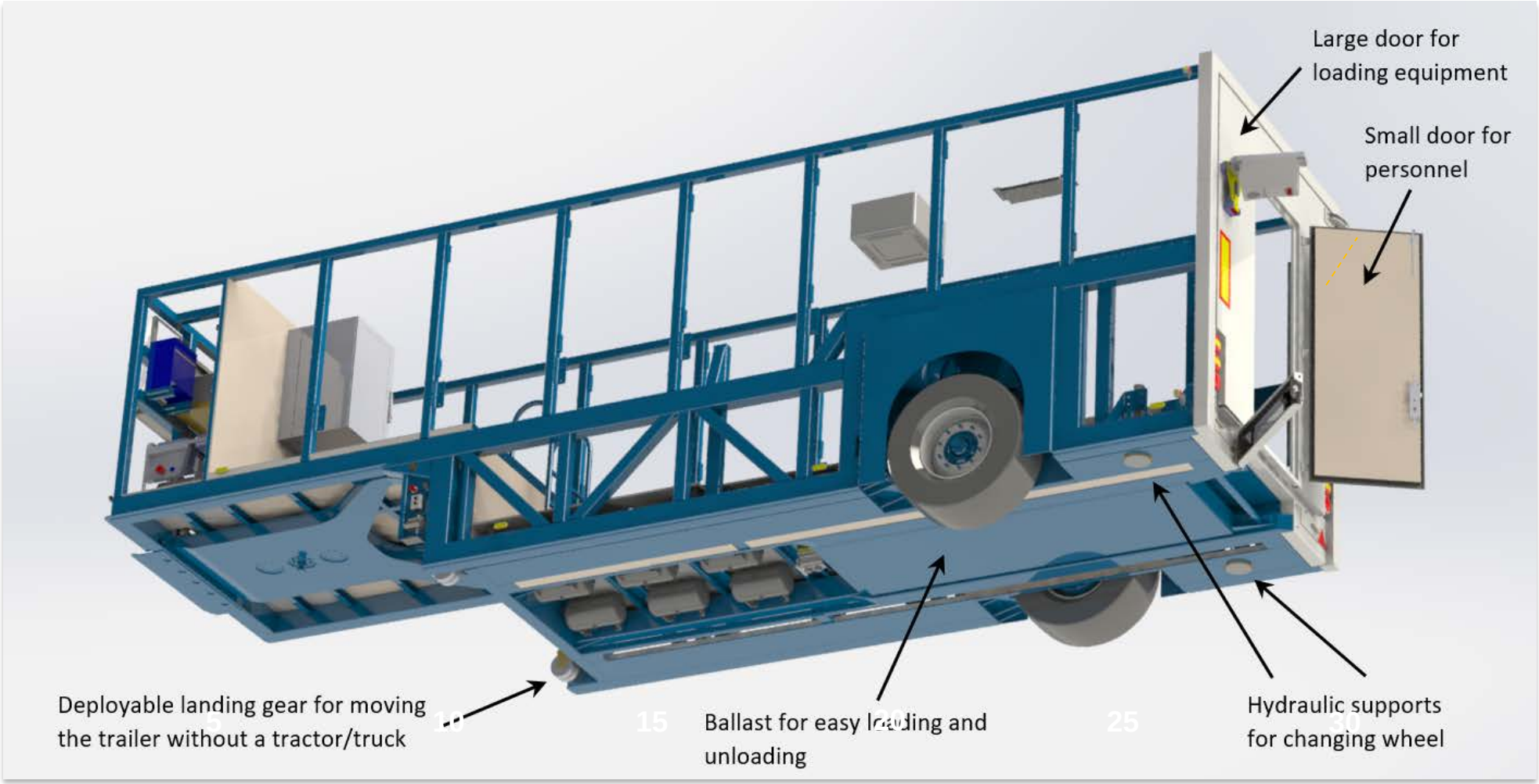

Dynatest RAPTOR

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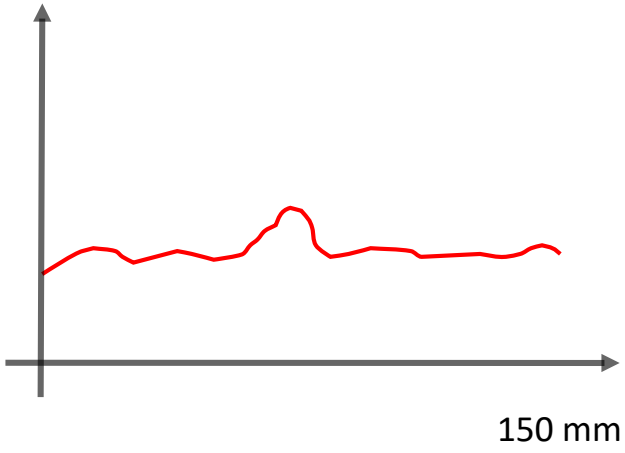
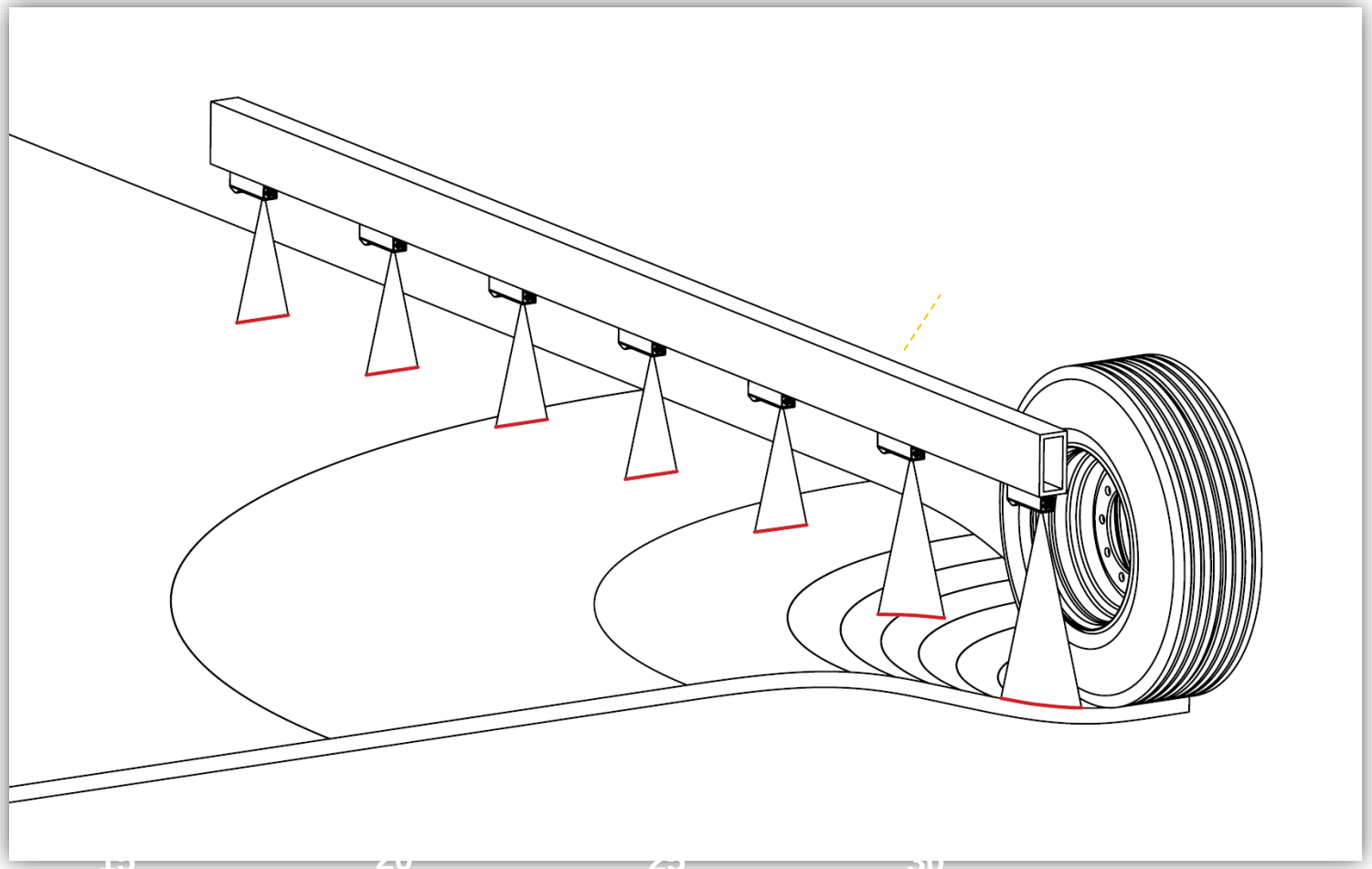
Pavement Expertise in Action

Gocator 2340 Line Lasers



1280 distance measurements



Dynatest RAPTOR

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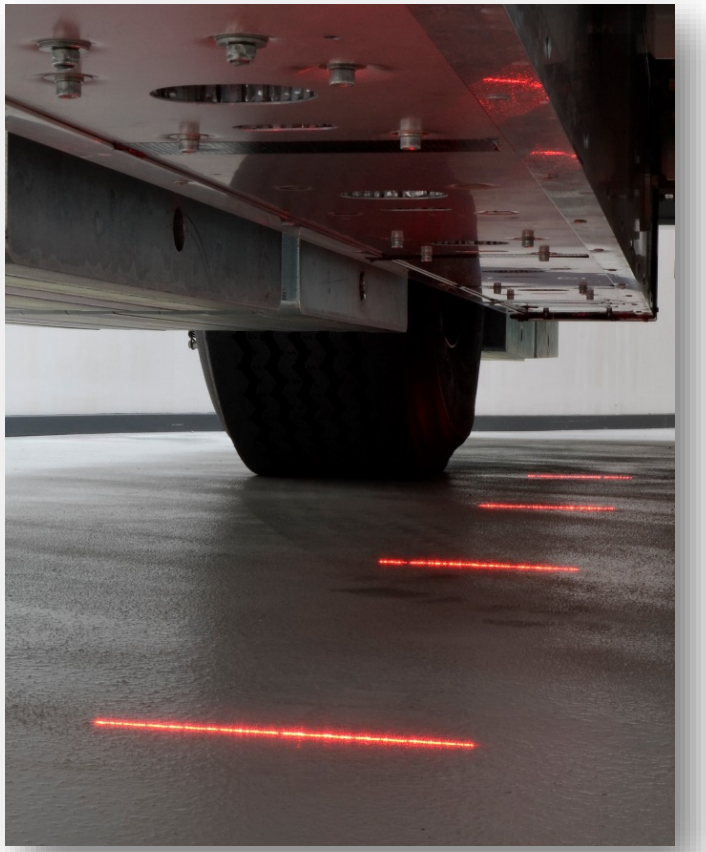

Dynatest RAPTOR

Dynatest®
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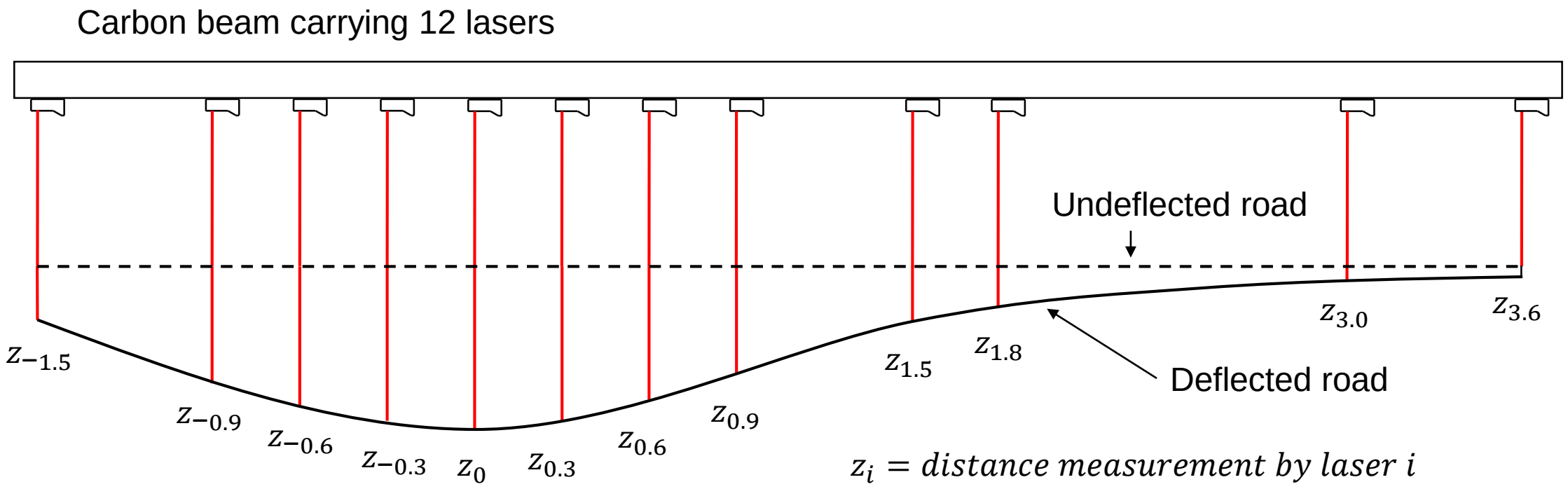
Dynatest RAPTOR

Dynatest
Pavement Expertise in Action



Dynatest RAPTOR:

- Dynatest delivered RAPTOR presentations at 18 state DOTS.
- Collected pavement deflection data with RAPTOR on state designated routes.
- Tested NCAT Pavement Test Track and Lee Rd.
- Below charts are from NCAT sections and various states (states are not identified for confidentiality)

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Dynatest RAPTOR:

- Performed **NCAT** Data collections at different testing variables:
  - **8 different driving speeds; (5 mph, 15 mph, 25 mph, 35 mph, 40 mph, 45mph, 50mph, 55mph) in addition to a "stop-go" run.**
  - **Five different load levels between approximately 13.0 kips to 22.0 kips were utilized**
  - **Findings of this experiment will be presented and published on TRB 2020**

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NCAT Pavement Test Track

NCAT Pavement Test Track was tested in June 2019.

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RAPTOR Testing on the NCAT Track

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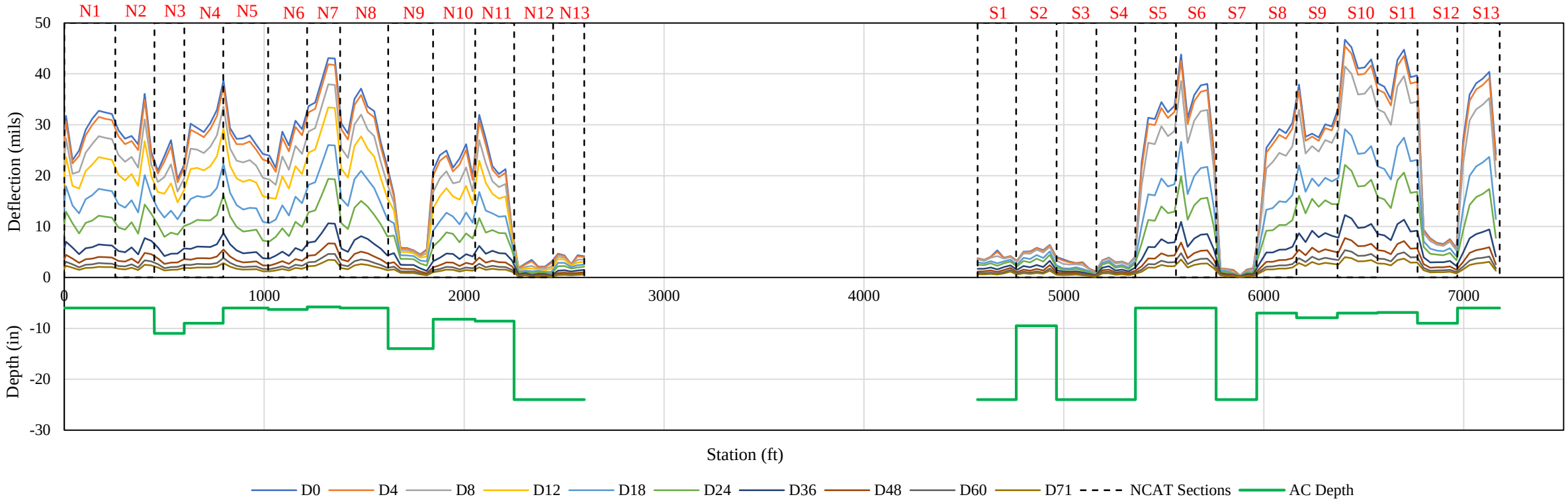
The graph below shows RAPTOR based deflection basin (average of three runs at 40 mph)

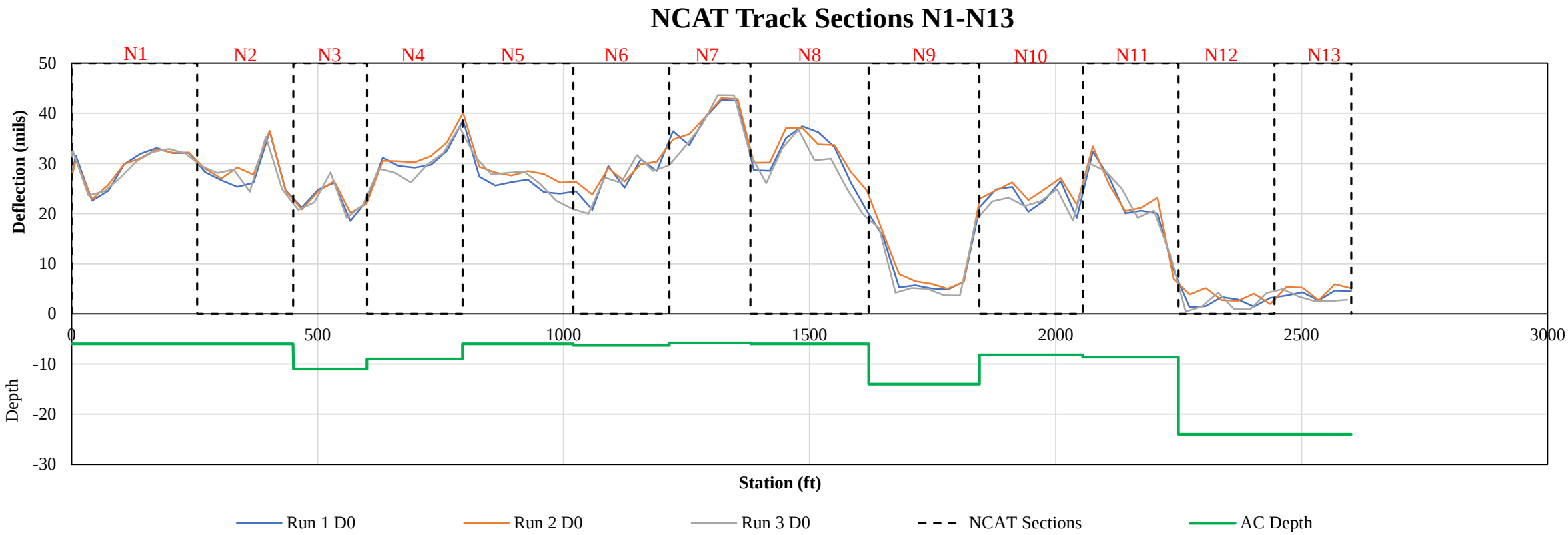


RAPTOR Deflection Basin NCAT Test Track

Repeatability of the RAPTOR Runs

Dynatest
Pavement Expertise in Action

The graph below shows the D0 measurements of 3 RAPTOR runs all at 40 mph

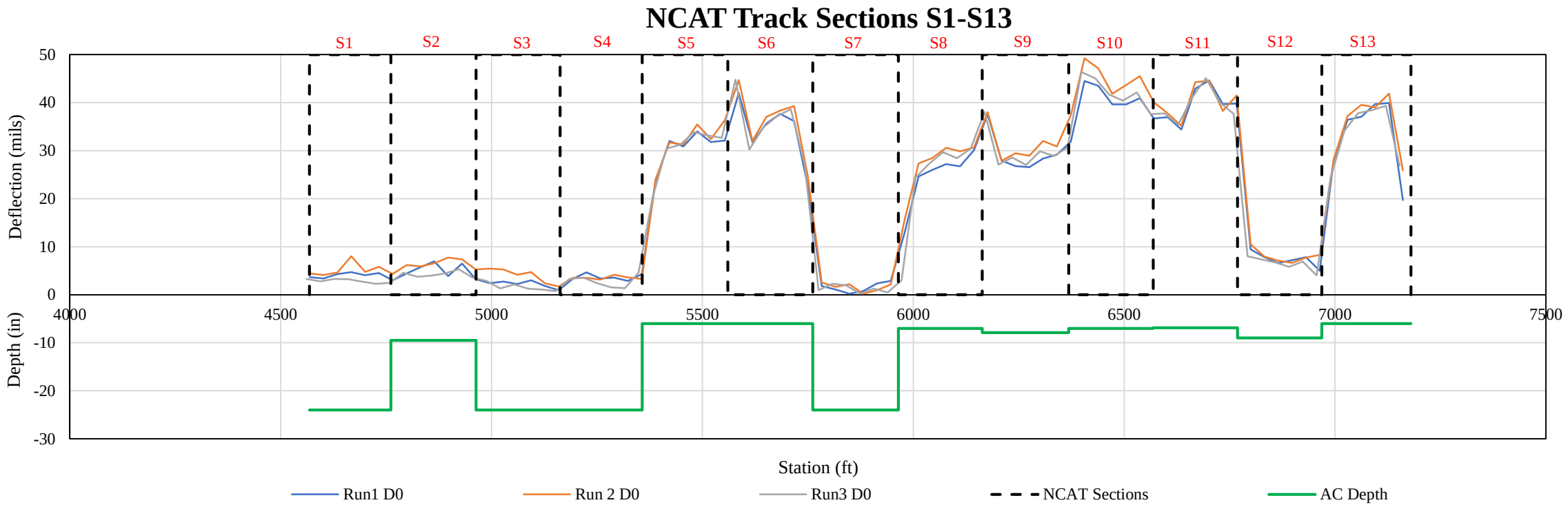


Repeatability of RAPTOR Runs, NCAT Sections N1-N13, 40 mph

Repeatability of the RAPTOR Runs

Dynatest®
Pavement Expertise in Action

The graph below shows the D0 measurements of 3 RAPTOR runs all at 40 mph

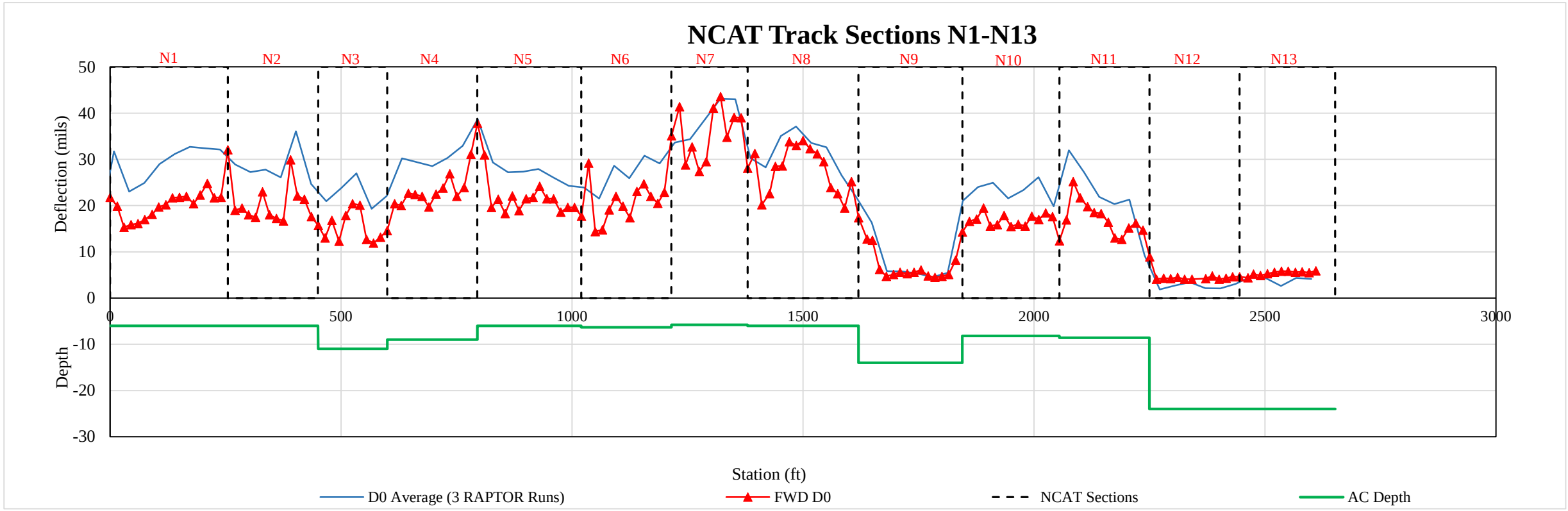


Repeatability of RAPTOR Runs, NCAT Sections S1-S13, 40 mph

Comparison With FWD Data

Dynatest®
Pavement Expertise in Action

The graph below shows Comparison between D0 from FWD at 12,000 lb. and the average D0 from three RAPTOR Runs at 40 mph

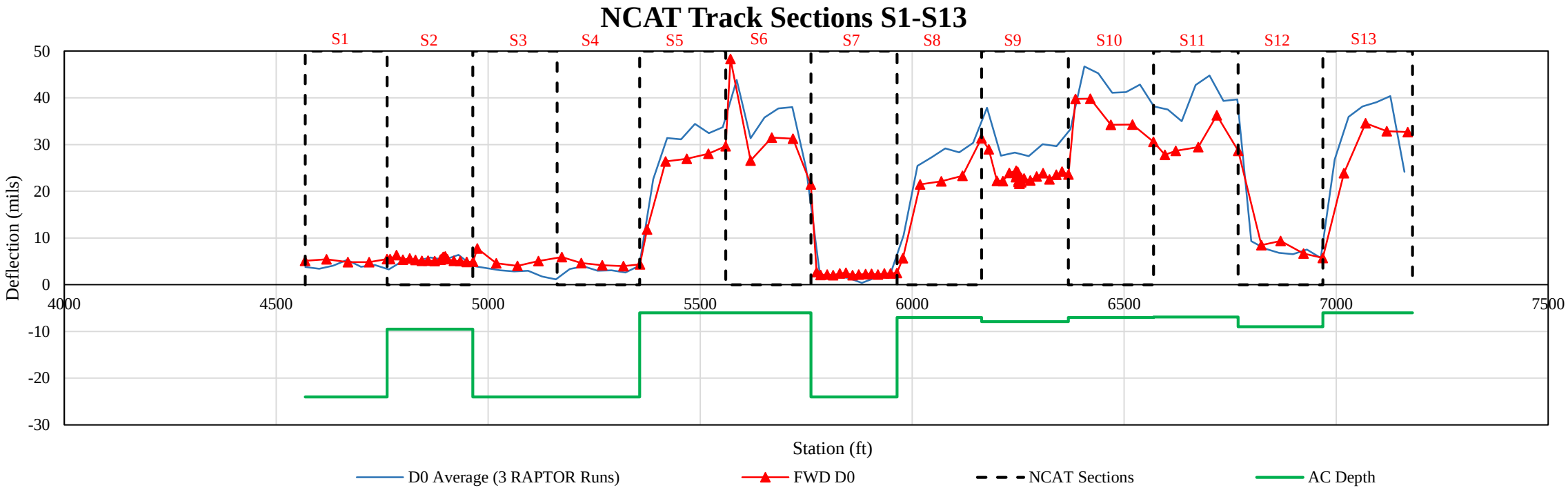


FWD vs RAPTOR, NCAT Sections N1-N13, 40 mph

Comparison With FWD Data

Dynatest
Pavement Expertise in Action

The graph below shows Comparison between D0 from FWD at 12,000 lb. and the average D0 from three RAPTOR Runs at 40 mph

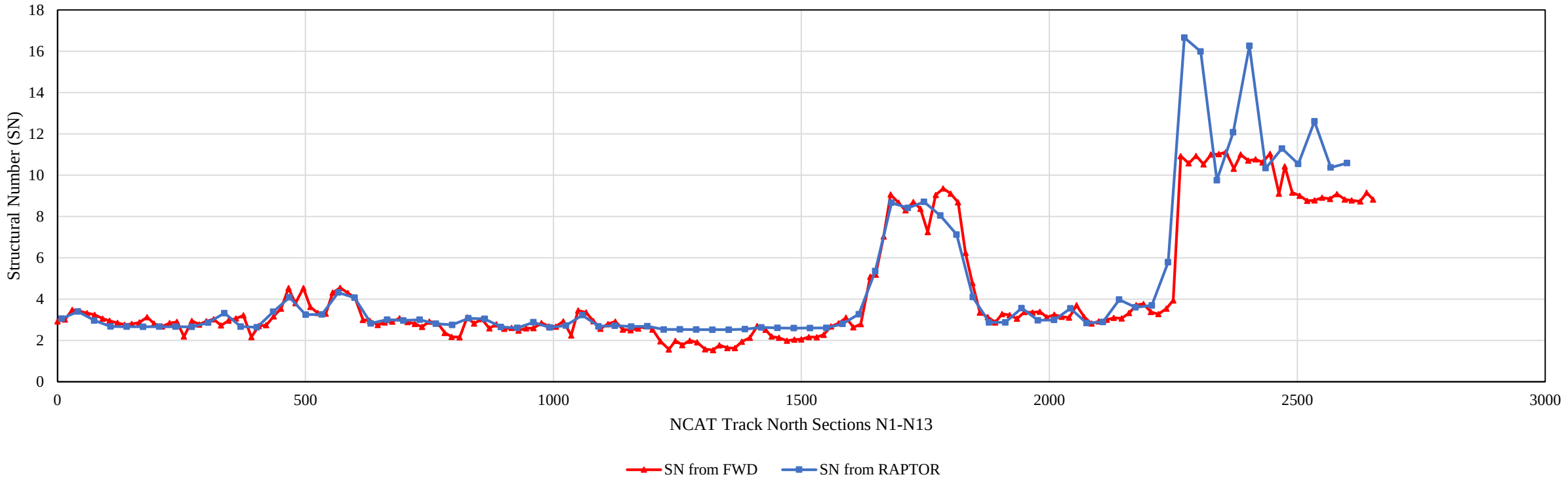


FWD vs RAPTOR, NCAT Sections S1-S13, 40 mph

Structural Number Comparison

Dynatest®
Pavement Expertise in Action

The graph below shows Comparison between SN from FWD and SN from RAPTOR, North Tangent

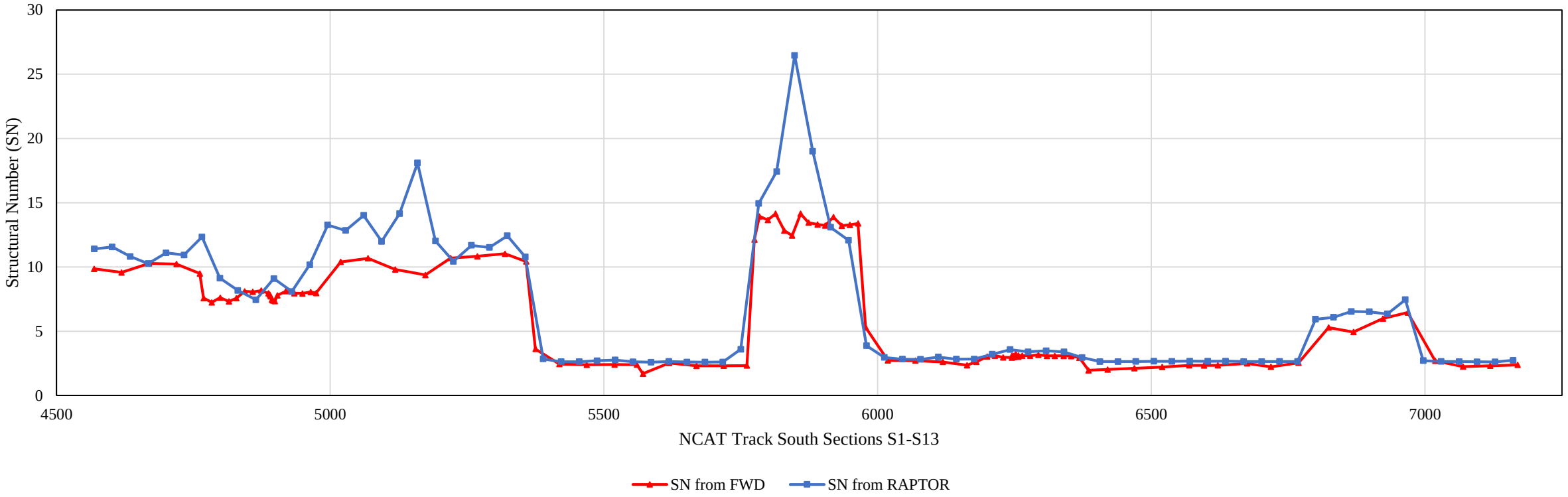


FWD SN vs RAPTOR SN, NCAT Sections SN-N13

Structural Number Comparison

Dynatest®
Pavement Expertise in Action

The graph below shows Comparison between SN from FWD and SN from RAPTOR, South Tangent

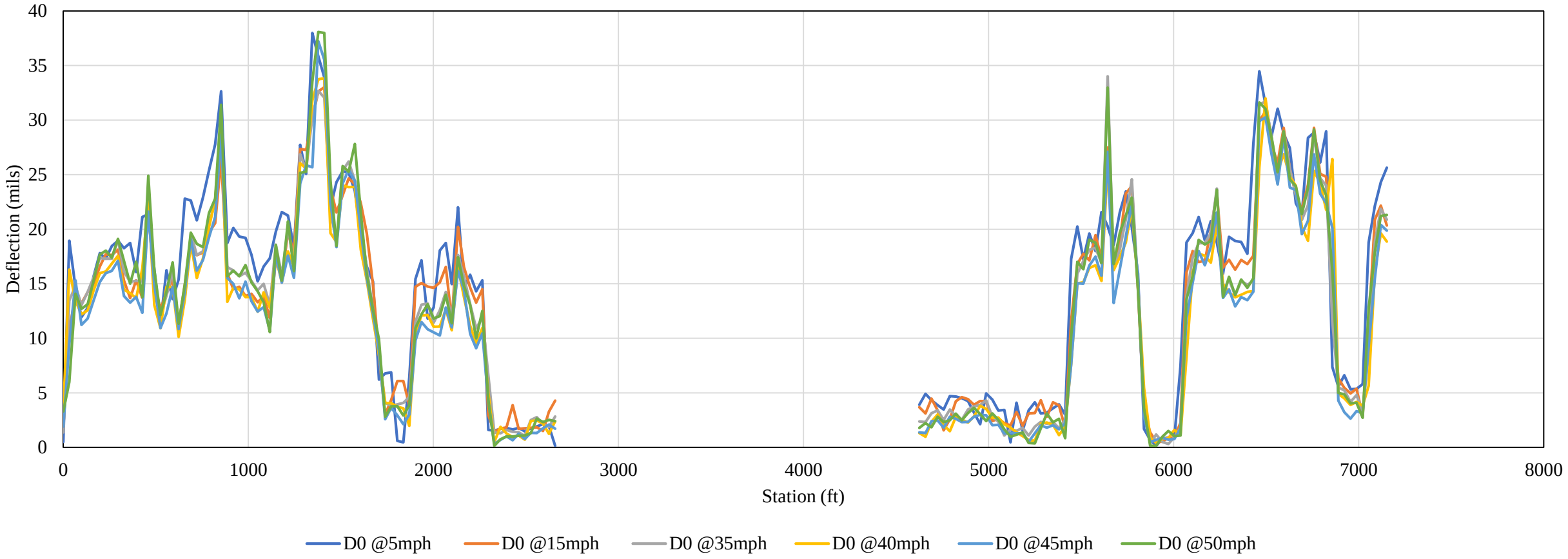


FWD SN vs RAPTOR SN, NCAT Sections S1-S13

Effect of Speed

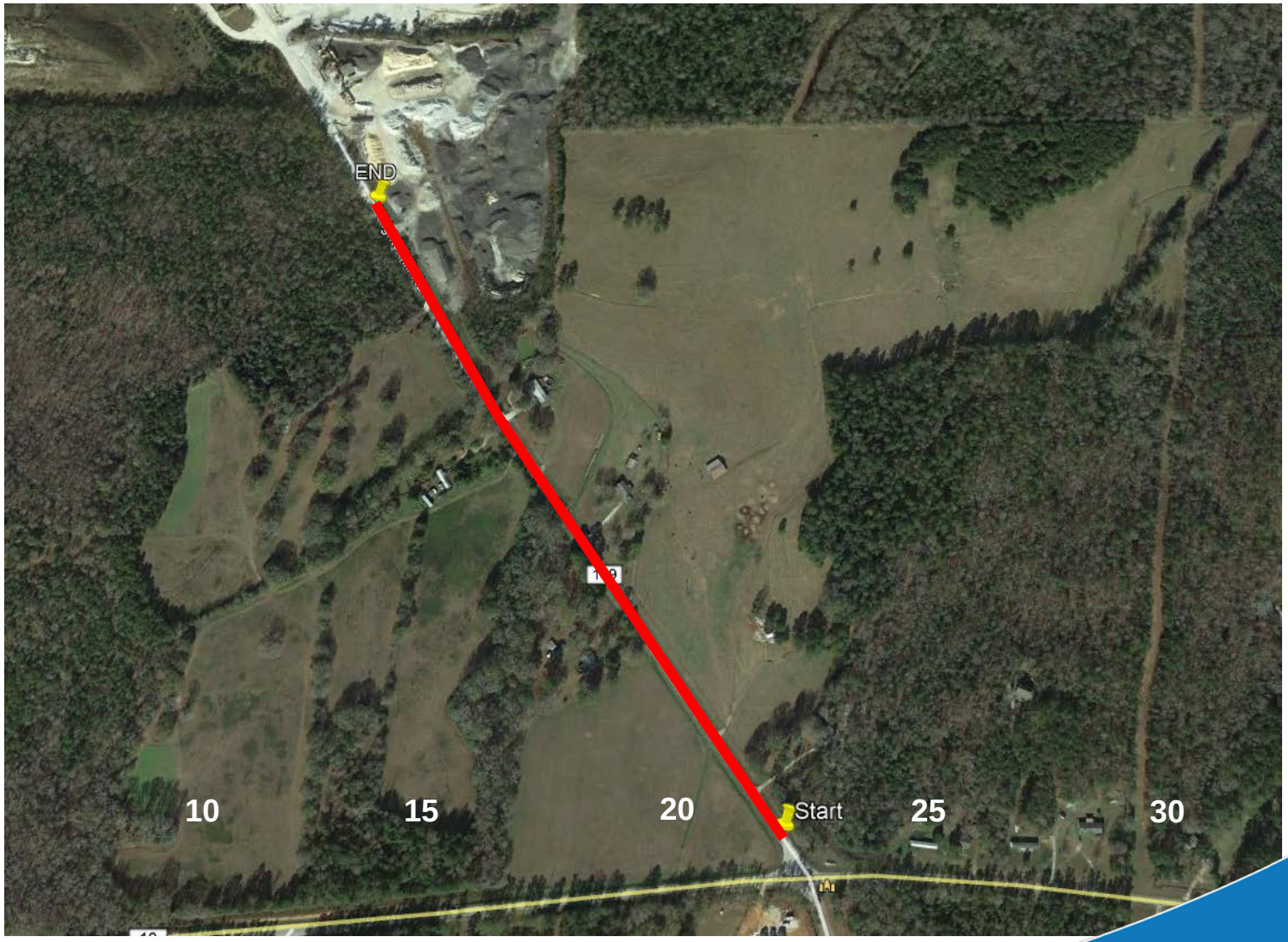
Dynatest®
Pavement Expertise in Action

The graph below shows Comparison between RAPTOR D0 at Different Speeds



RAPTOR D0 at Different Speeds

NCAT, Lee RD (US159)



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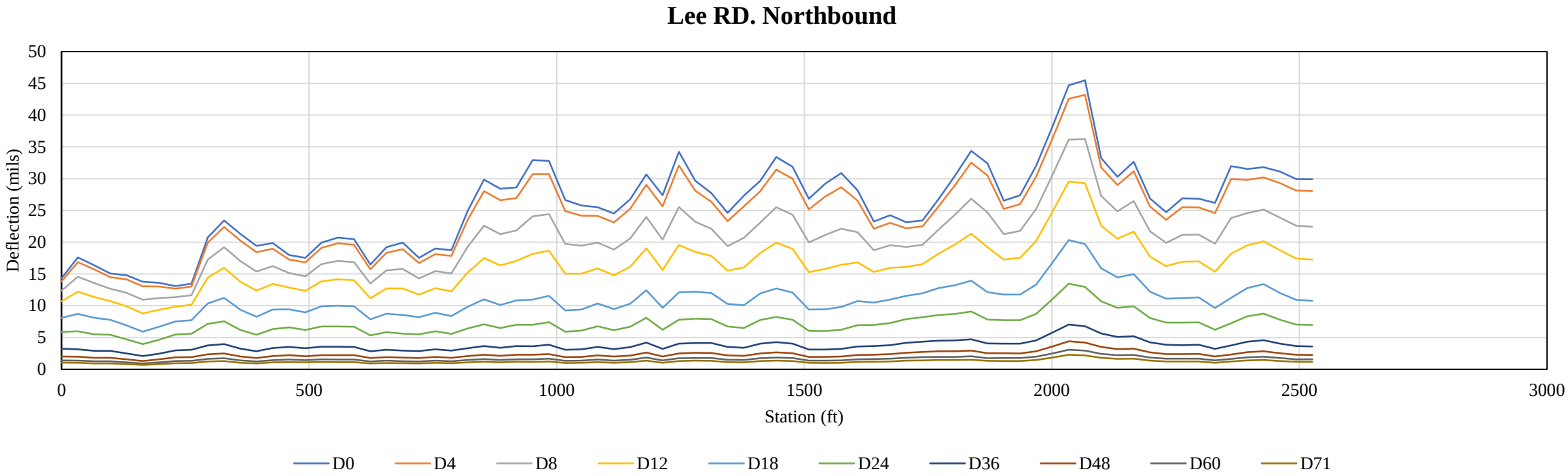
RAPTOR Testing on Lee RD (US 159)

Dynatest
Pavement Expertise in Action

The graph below shows RAPTOR based deflection basin (average of two runs at 20 mph)

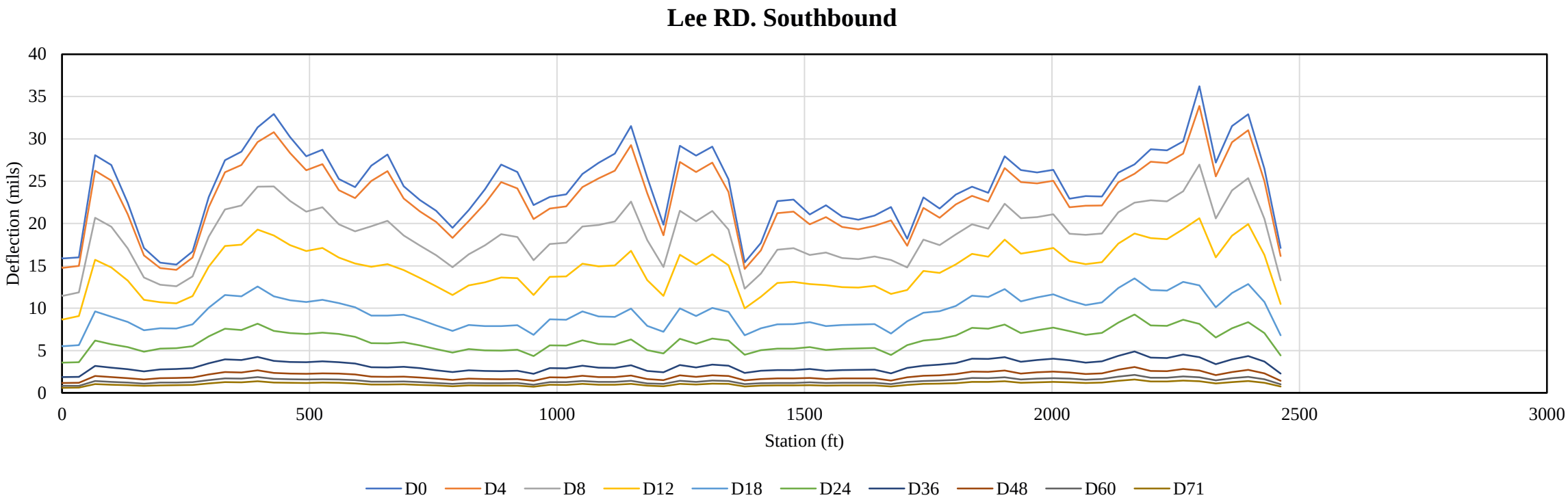


RAPTOR Deflection Basin Lee RD, Northbound

RAPTOR Testing on Lee RD (US 159)

Dynatest
Pavement Expertise in Action

The graph below shows RAPTOR based deflection basin (average of three runs at 20 mph)

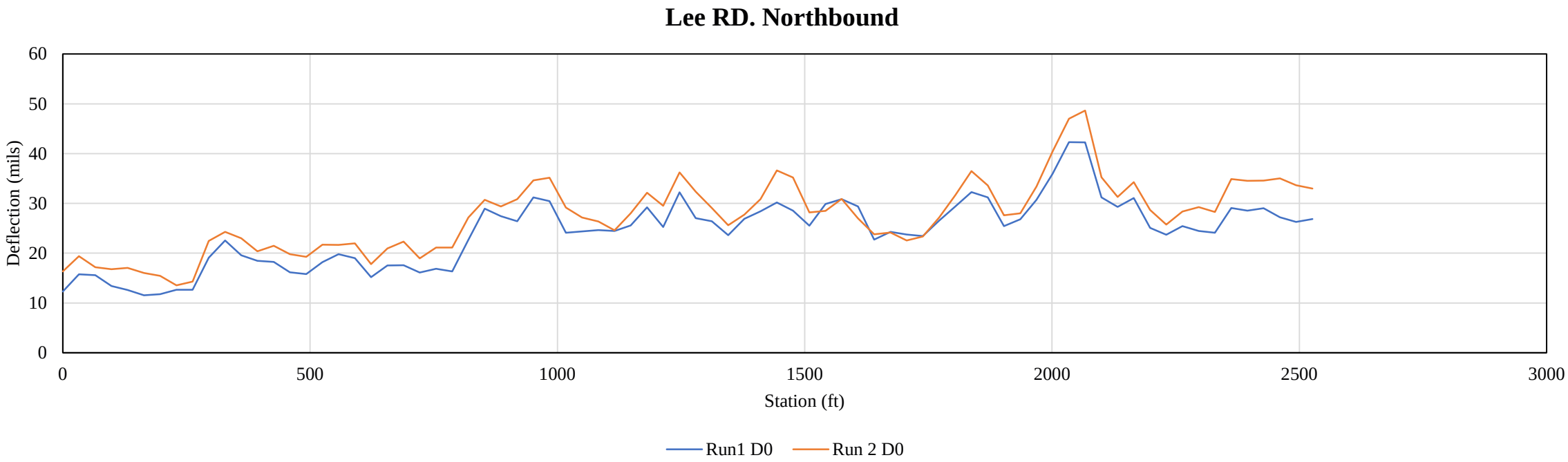


RAPTOR Deflection Basin Lee RD, Southbound

Repeatability of the RAPTOR Runs

Dynatest®
Pavement Expertise in Action

The graph below shows the D0 measurements of 2 RAPTOR runs at 20 mph



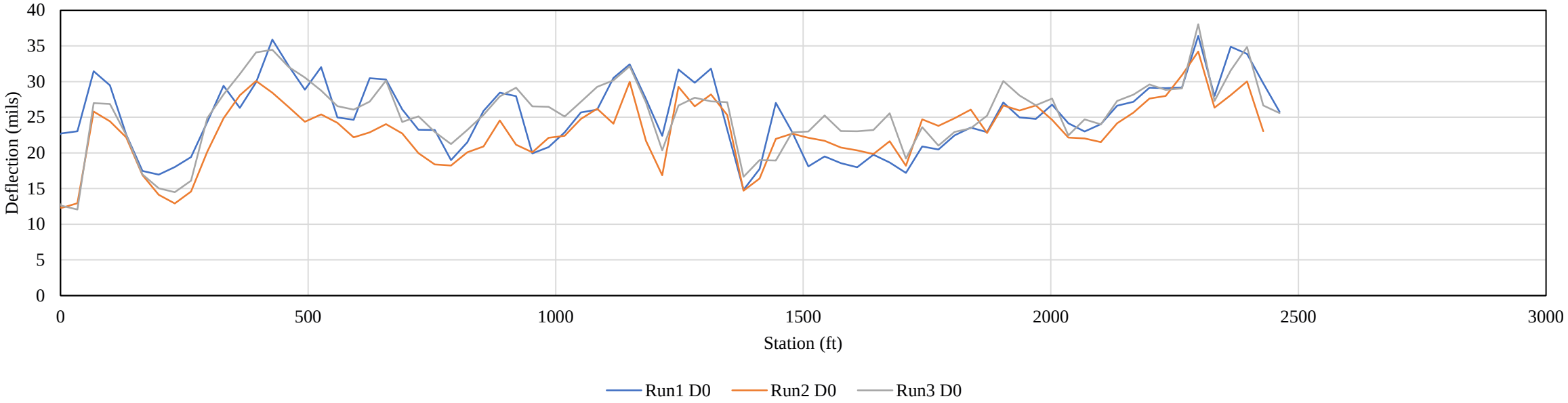
RAPTOR Repeatability, Lee RD, Northbound

Repeatability of the RAPTOR Runs

Dynatest®
Pavement Expertise in Action

The graph below shows the D0 measurements of 3 RAPTOR runs at 20 mph

Lee RD. Southbound



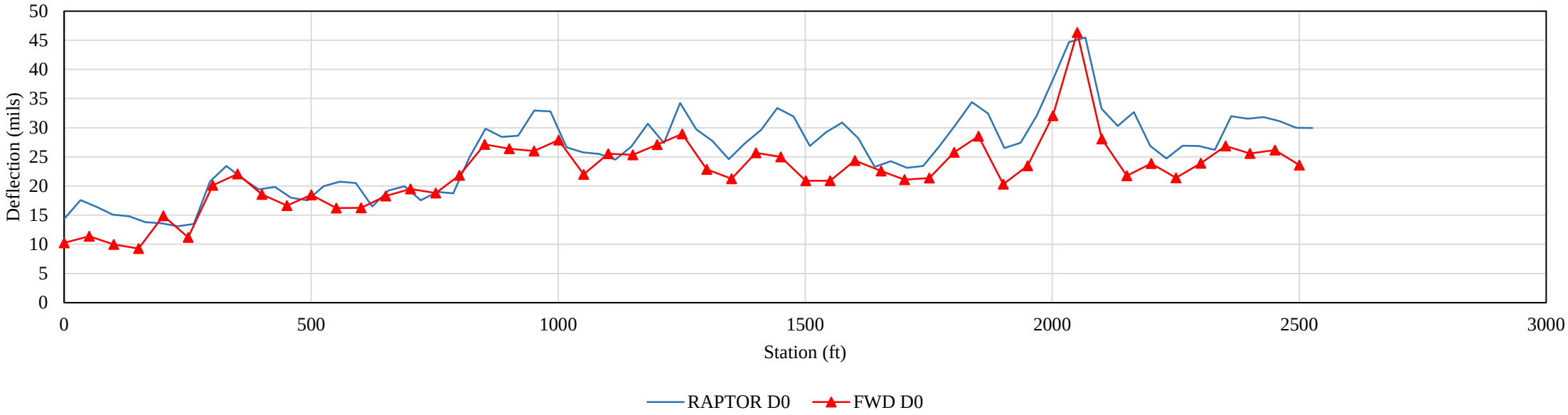
RAPTOR Repeatability, Lee RD, Southbound

Comparison With FWD Data

Dynatest®
Pavement Expertise in Action

The graph below shows Comparison between D0 from FWD at 12,000 lb. and the average D0 from 2 RAPTOR Runs at 20 mph

Lee RD. Northbound

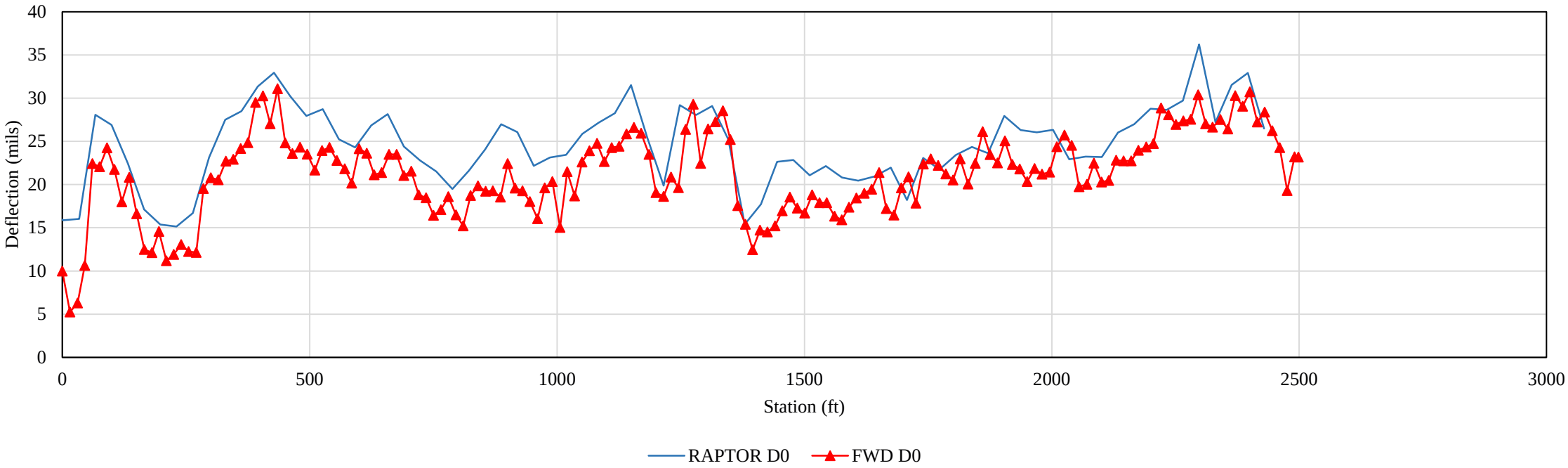


FWD vs RAPTOR, Lee RD, Northbound

Comparison With FWD Data

Dynatest®
Pavement Expertise in Action

The graph below shows Comparison between D0 from FWD at 12,000 lb. and the average D0 from 3 RAPTOR Runs at 20 mph



FWD vs RAPTOR, Lee RD, Southbound

In addition to testing at NCAT,

- Below are Pavement Deflections obtained by RAPTOR testing from various state designated routes.
- States are not identified for privacy.

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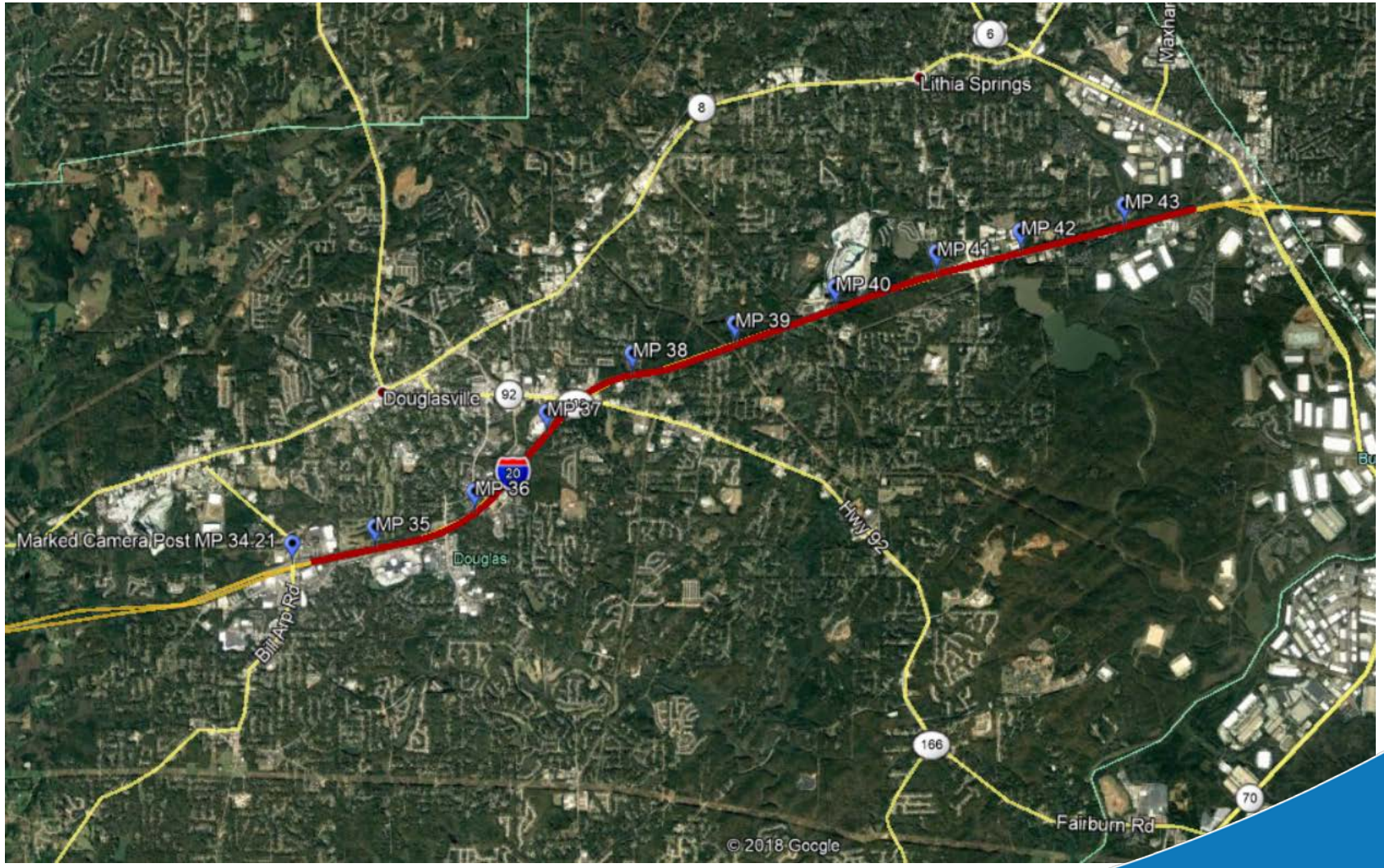
Project Location (I-20)



Dynatest®

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Pavement Expertise in Action

Project Overview

- This section of I-20 has 3 lanes in each direction, and the pavement structure is full-depth asphalt (averaging approximately 12.5 in of asphalt concrete).
- The state DOT conducted Falling Weight Deflectometer (FWD) testing on this section in April 2018. RAPTOR testing was in March 2019.
  - FWD testing was conducted in Lanes 1 and 3, in both directions. The middle lane was not tested due to safety reasons.
  - FWD testing was conducted at approximately 250 ft. intervals, with 4 recorded load-levels (6, 9 ,12 and 16 kips) at each test location.

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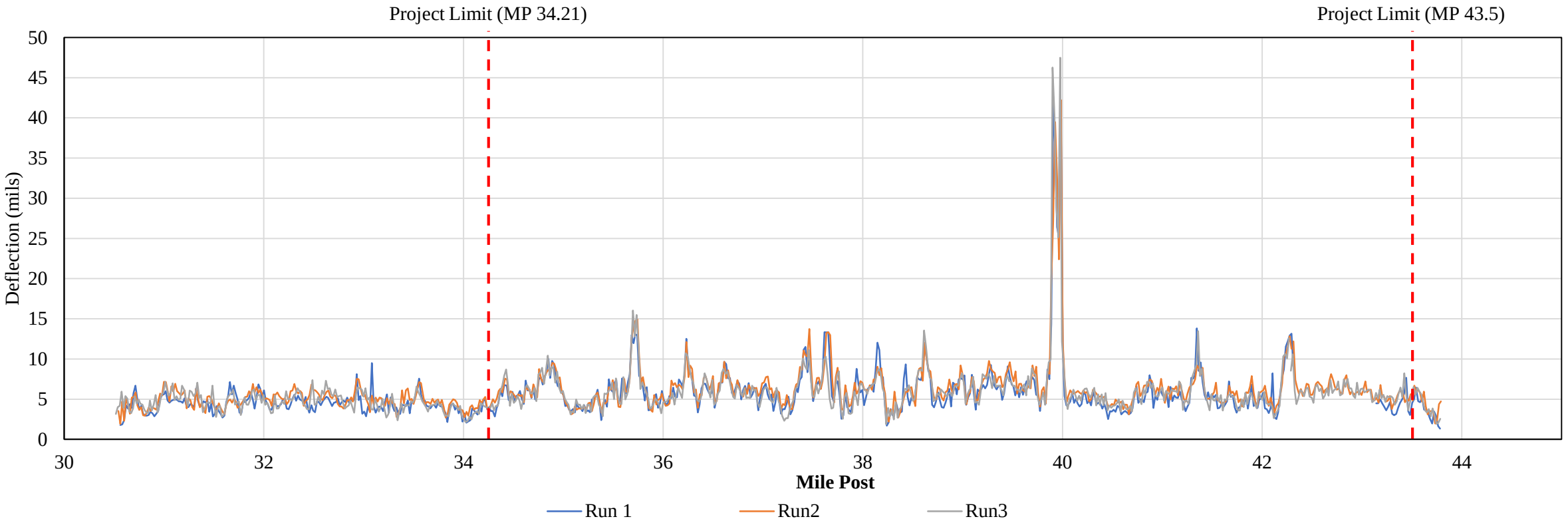
RAPTOR Testing Effort

- RAPTOR Data Collection Specifics
  - 3 repeat runs in Lane 3, in both Eastbound and Westbound directions
  - 1 run in Lane 2, in both Eastbound and Westbound directions
  - Testing speed of 50mph
- Extra data was collected 4 miles beyond the project limit in the West direction (to MP 30.4)
- RAPTOR data presented here has been averaged at 100 ft. intervals, and all deflections have been normalized to 9,000 lbs.

Repeatability of the RAPTOR Runs

Dynatest®
Pavement Expertise in Action

The graph below shows RAPTOR based deflection D0 from 3 repeat runs



D0, Eastbound Lane 3

Note: There is a gap in the Run-1 data (near MP 42.5) as we entered the weight station.
In Runs 2 and 3, we drove continuously on the Interstate without entering the weight station

Repeatability of the RAPTOR Runs

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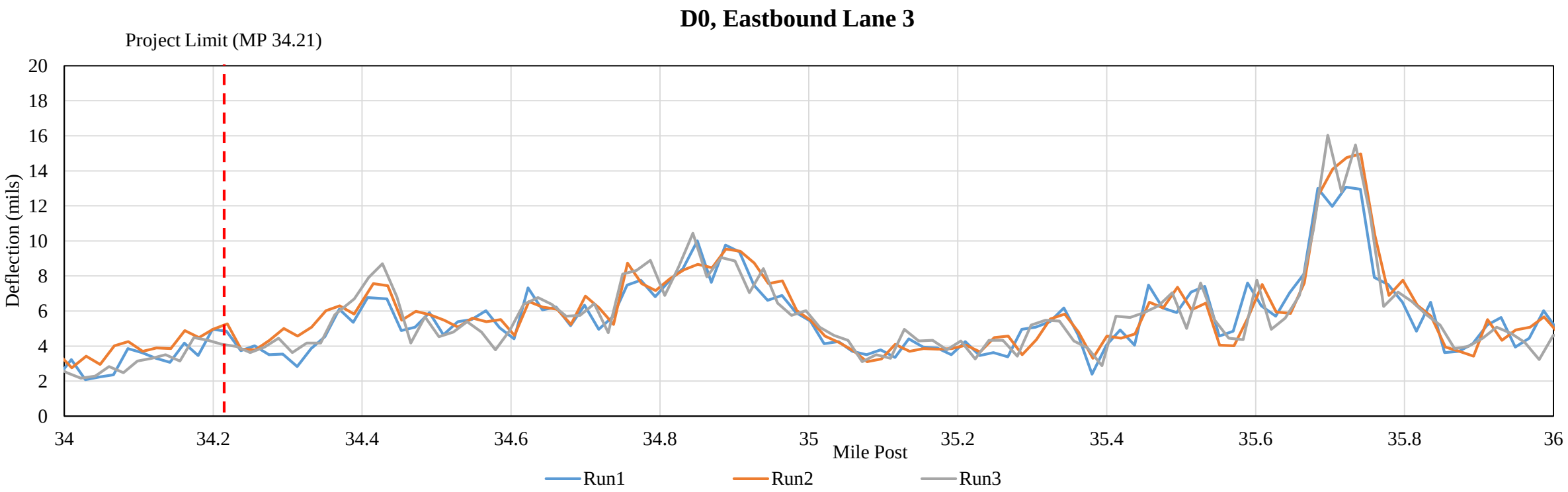
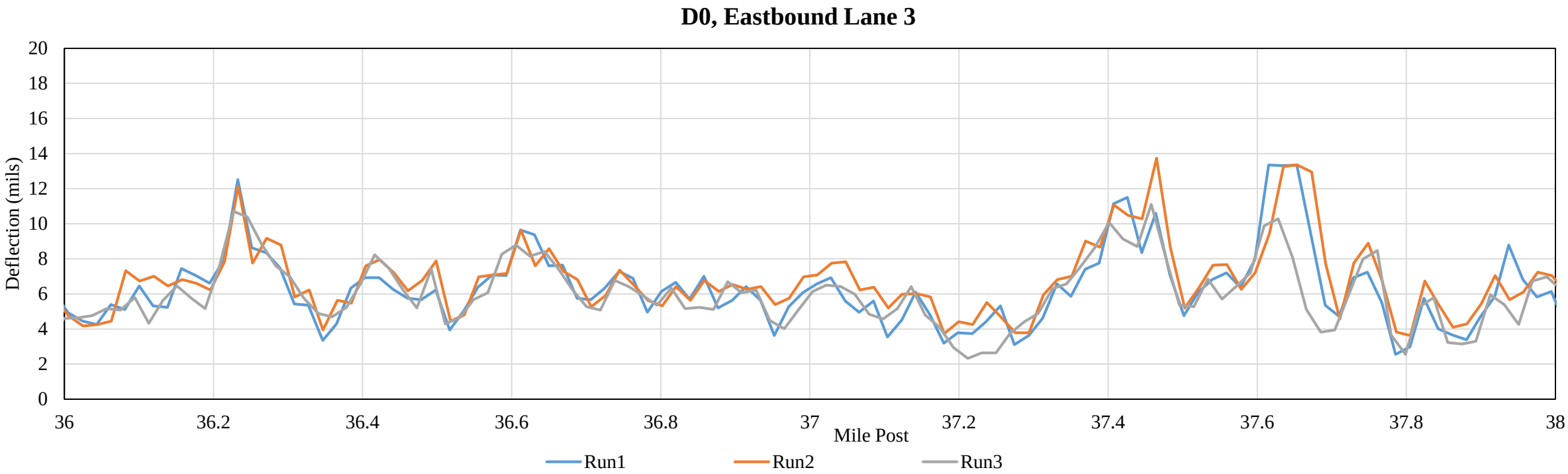
Pavement Expertise in Action



Detail, Presented in 2-mile intervals

Repeatability of the RAPTOR Runs

Dynatest®
Pavement Expertise in Action

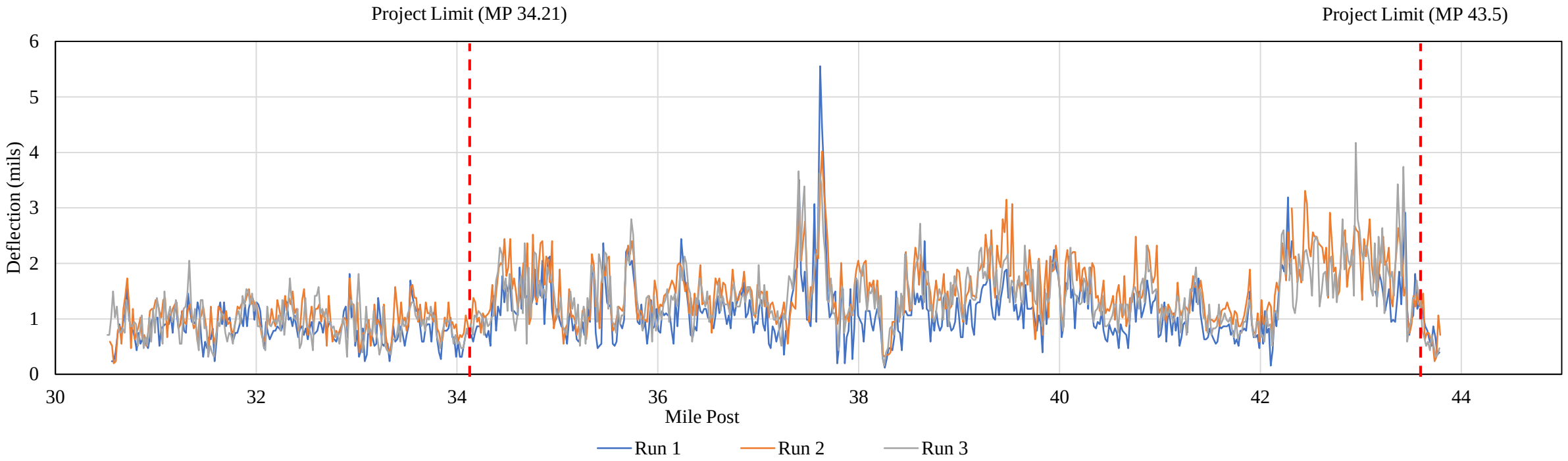


Detail, Presented in 2-mile intervals

Repeatability of the RAPTOR Runs

Dynatest®
Pavement Expertise in Action

The graph below shows RAPTOR based deflection D60 from 3 repeat runs

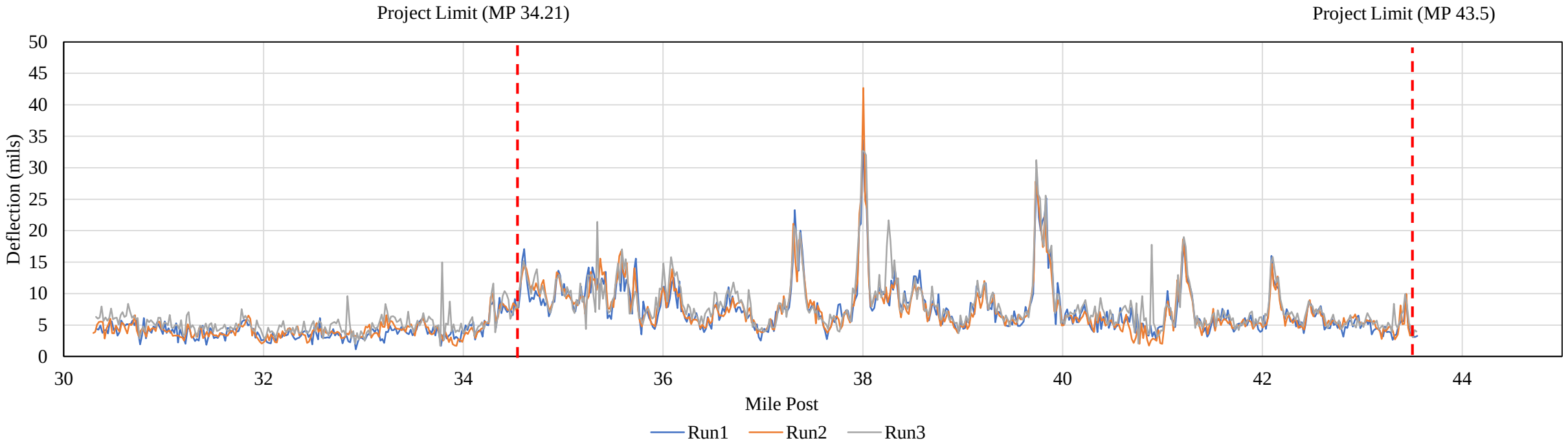


D60, Eastbound Lane 3

Repeatability of the RAPTOR Runs

Dynatest®
Pavement Expertise in Action

The graph below shows RAPTOR based deflection D0 from 3 repeat runs



D0, Westbound Lane 3

Comparison of RAPTOR data with 2018 FWD Data

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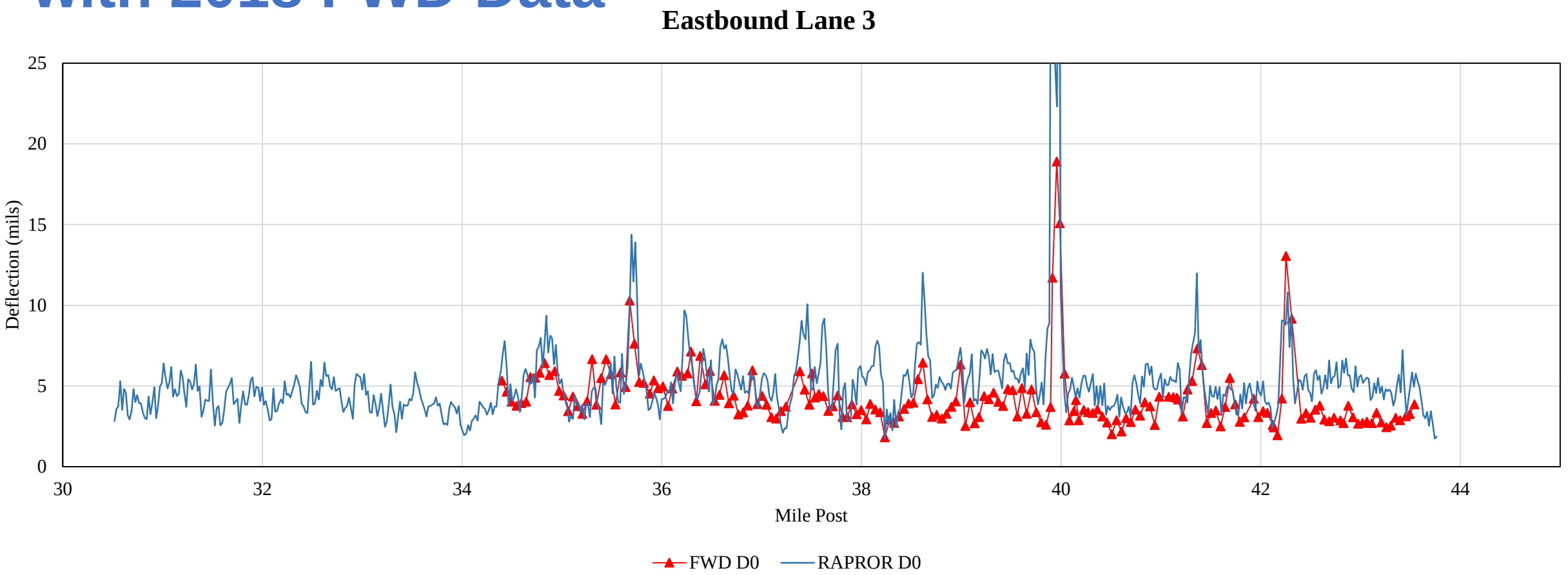
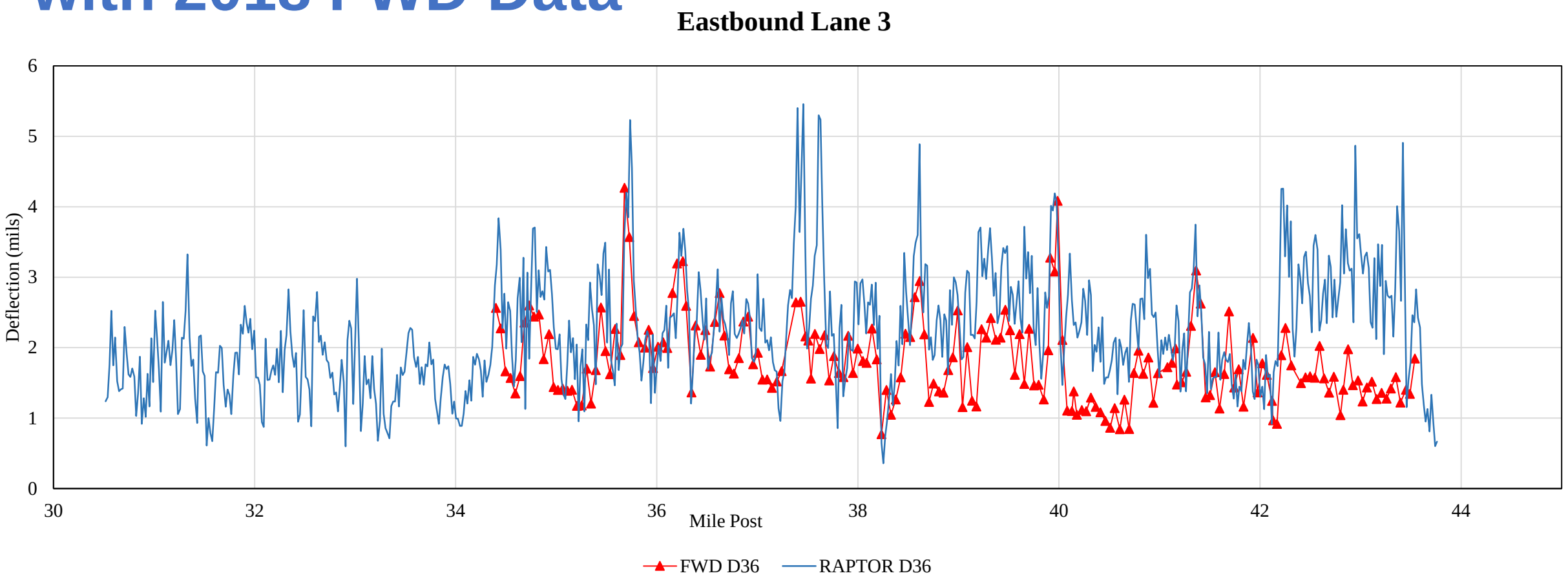


FWD D0 vs. RAPTOR D0 (Run-2), Eastbound Lane 3

Note: RAPTOR Run 2 was selected for this graph as Run 1 had a gap (near MP 42) due to entering the weight station

Comparison of RAPTOR data with 2018 FWD Data

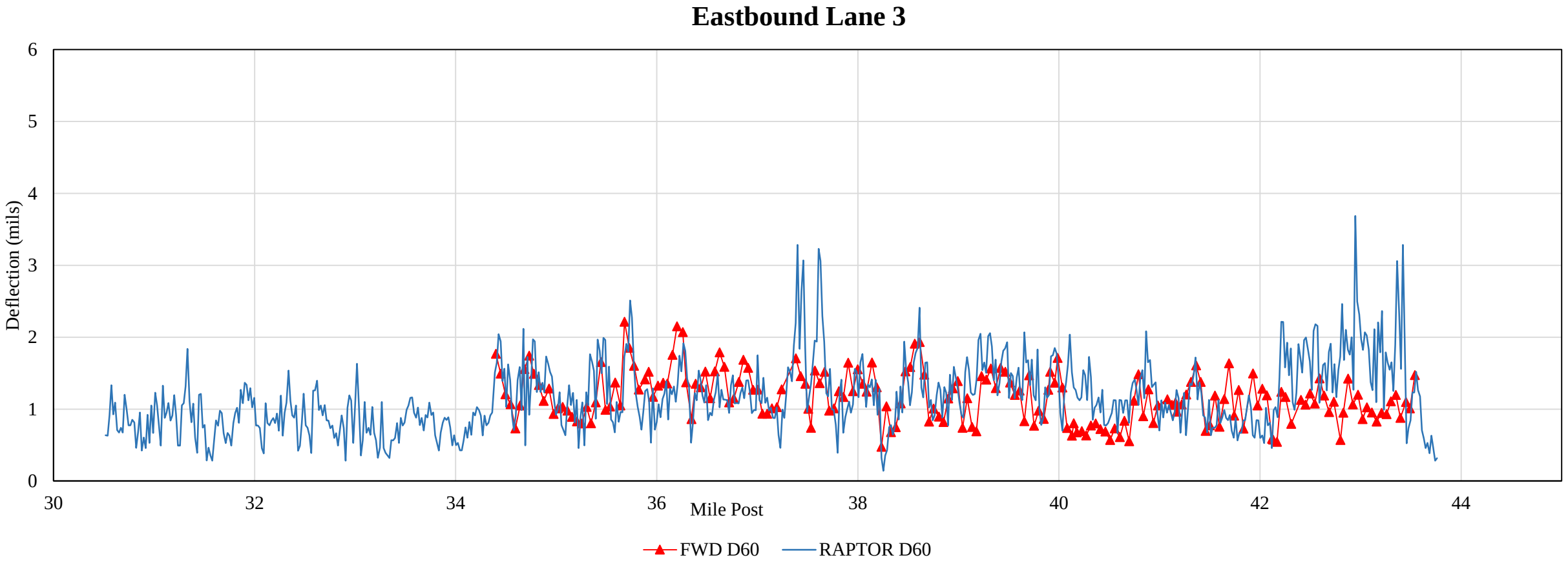
Dynatest®
Pavement Expertise in Action



FWD D36 vs. RAPTOR D36 (Run-2), Eastbound Lane 3

Comparison of RAPTOR data with 2018 FWD Data

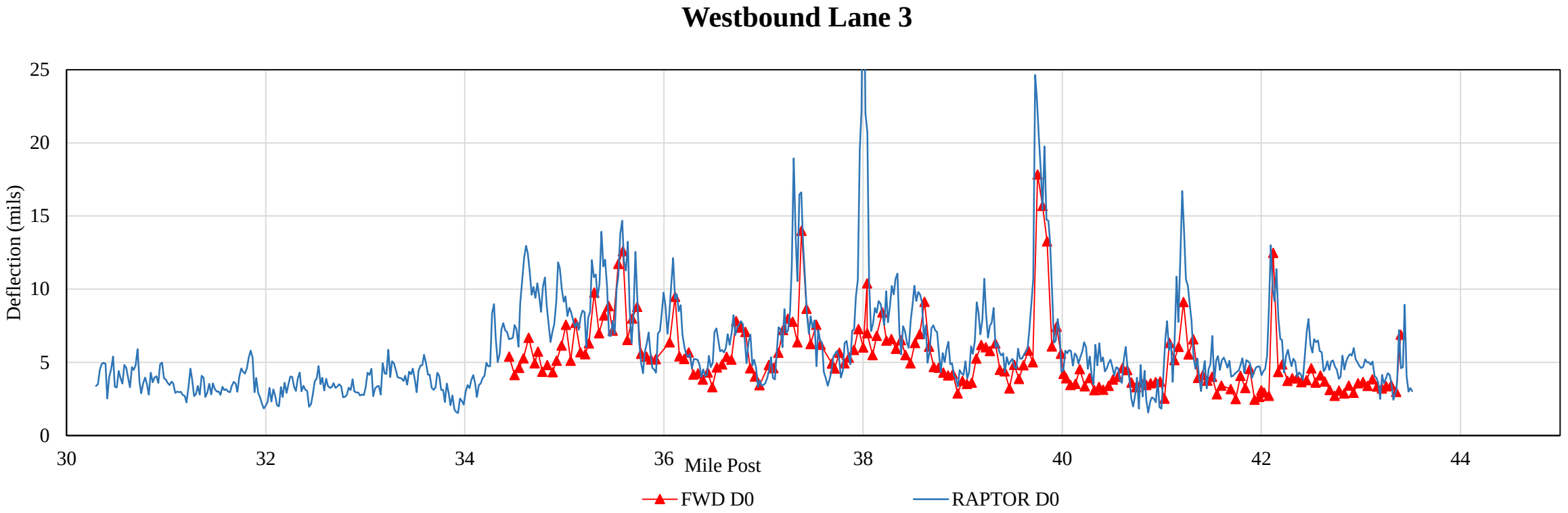
Dynatest®
Pavement Expertise in Action



FWD D60 vs. RAPTOR D60 (Run-2), Eastbound Lane 3

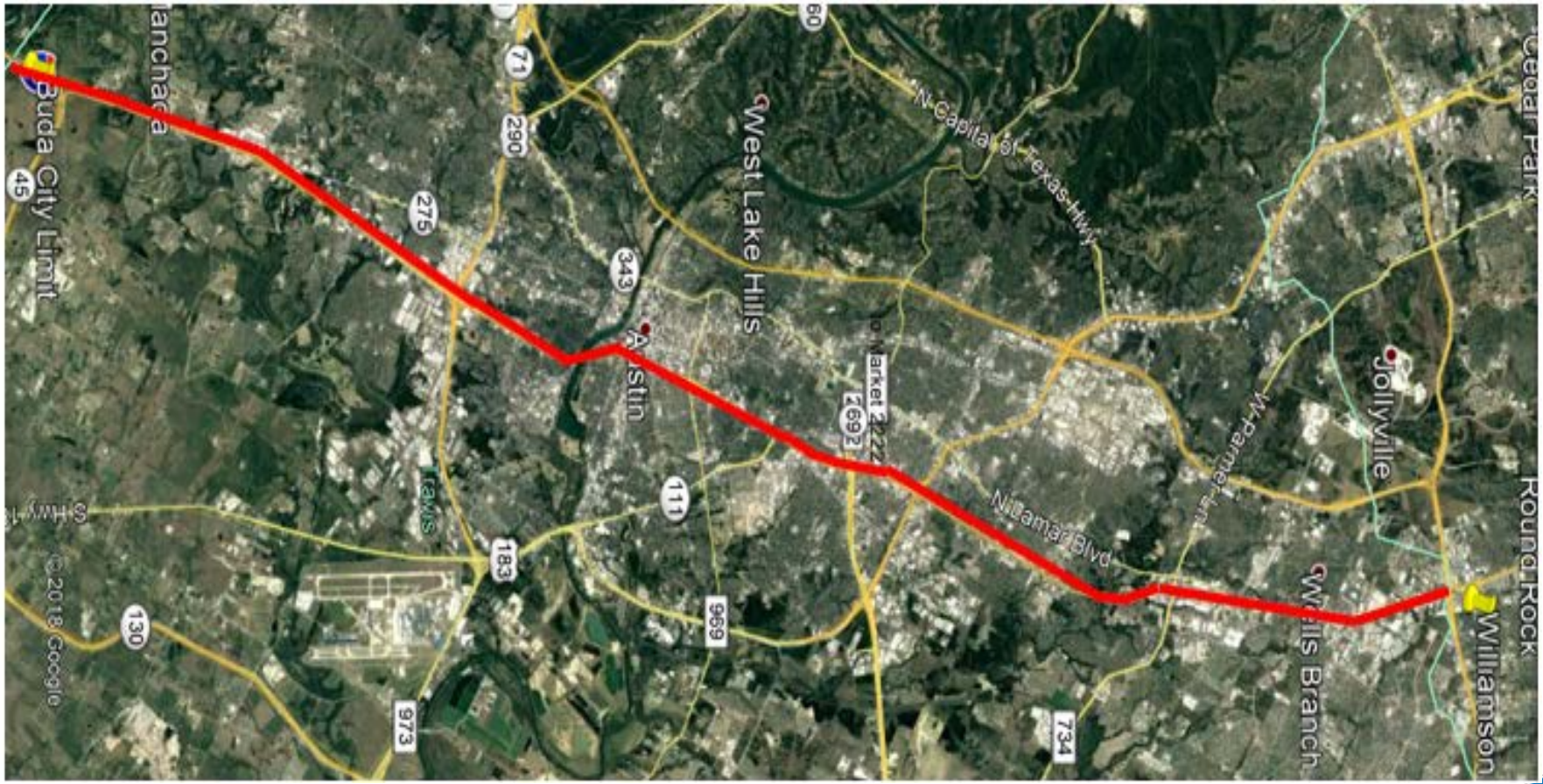
Comparison of RAPTOR data with 2018 FWD Data

Dynatest®
Pavement Expertise in Action



FWD D0 vs. RAPTOR D0 (Run-1), Westbound Lane 3

Project Location (I-35) MP 222 to MP 250



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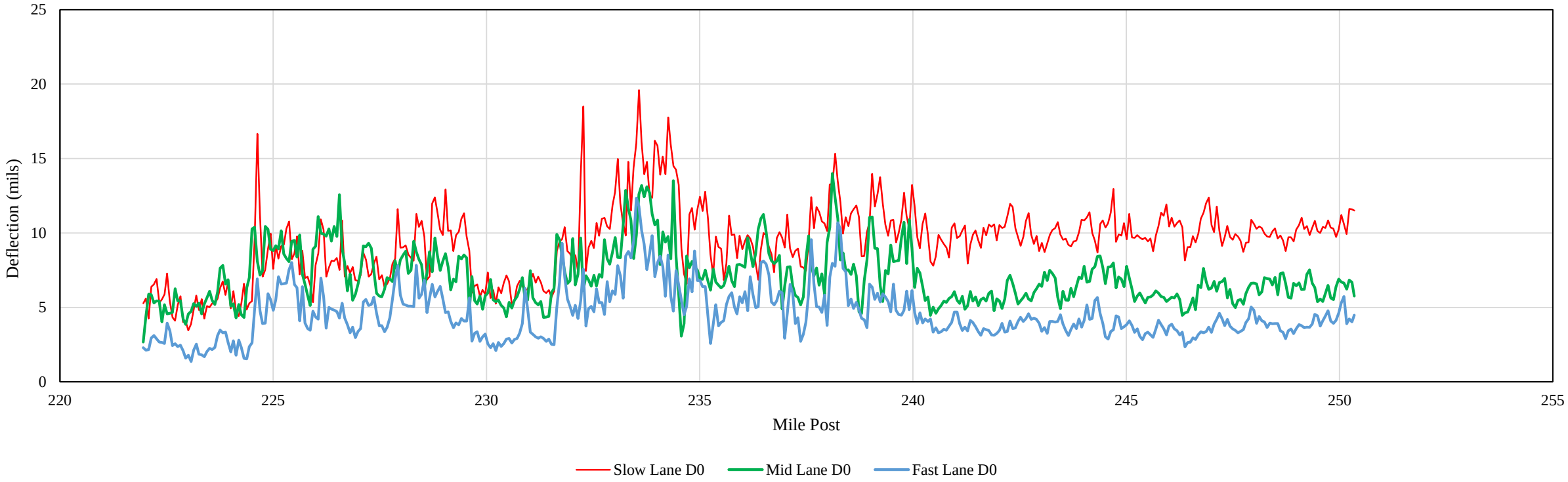
I-35 Main Lanes NB RAPTOR Data



RAPTOR D0 , NB 3 lanes (300ft Interval)

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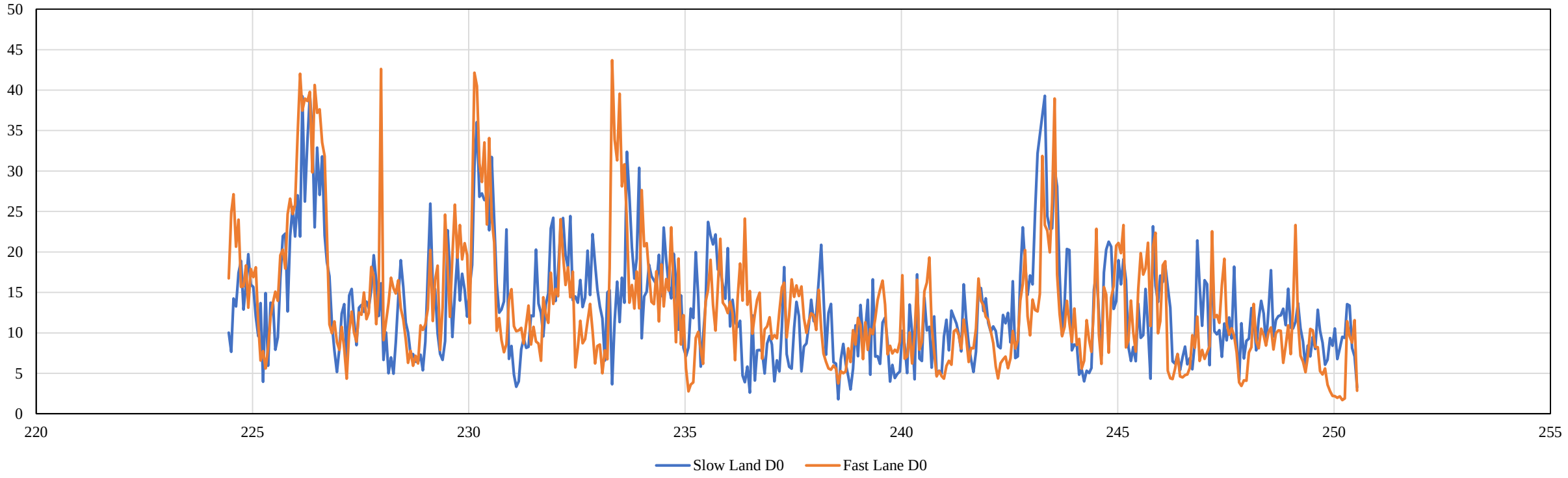
Pavement Expertise in Action

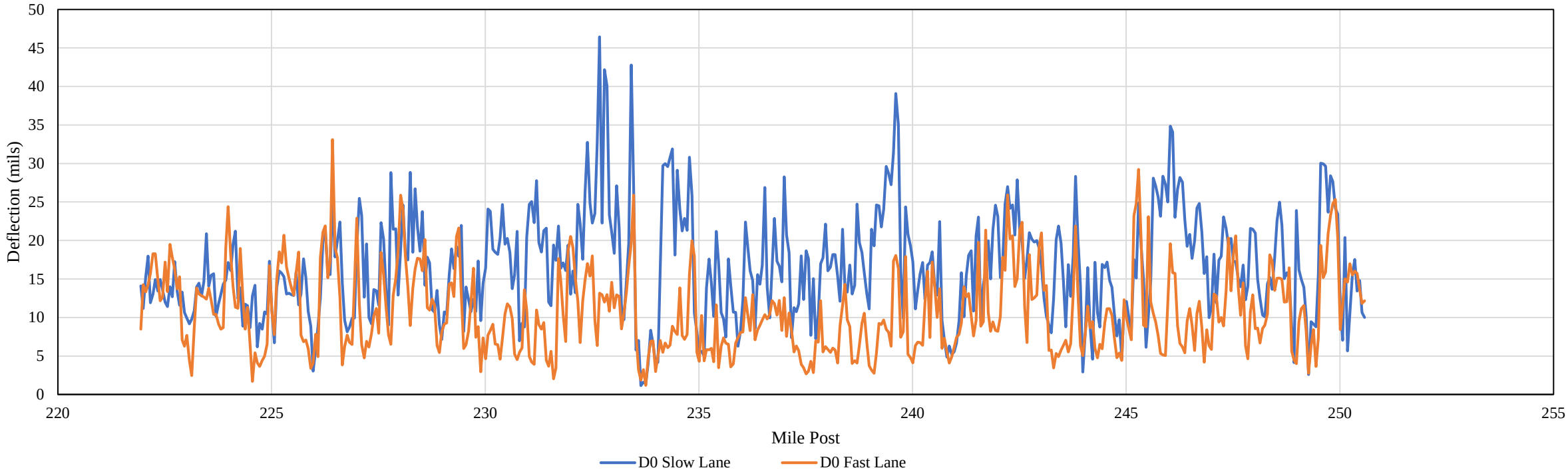
I-35 Frontage SB Road RAPTOR Data



RAPTOR D0 , Frontage Rd SB 2 lanes (300ft Interval)

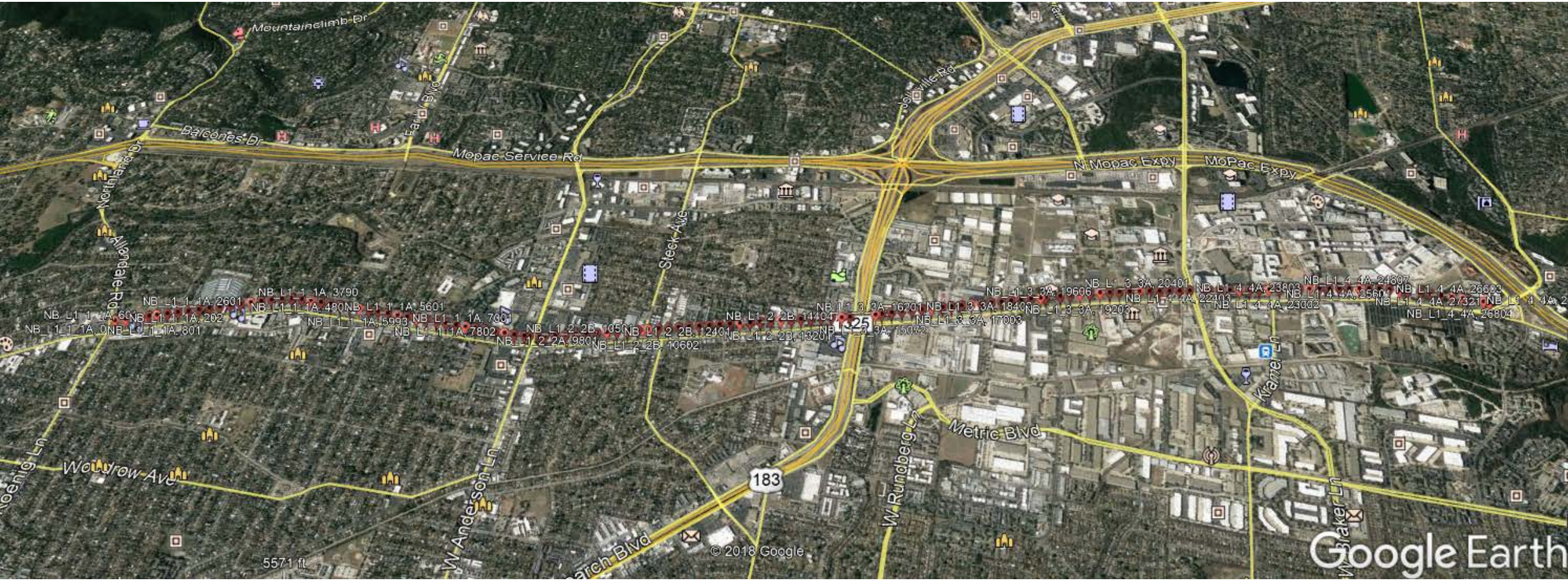
Dynatest®
Pavement Expertise in Action

I-35 Frontage NB Road RAPTOR Data



RAPTOR D0 , Frontage Rd NB 2 lanes (300ft Interval)

Project Location Burnet RD (Austin)



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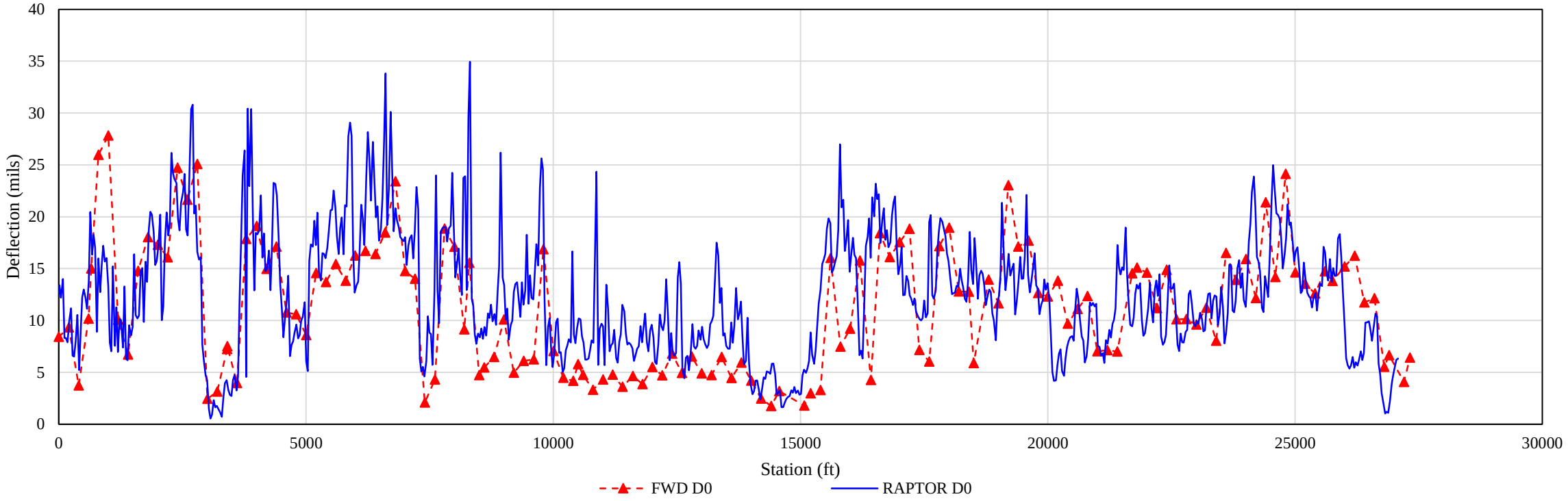
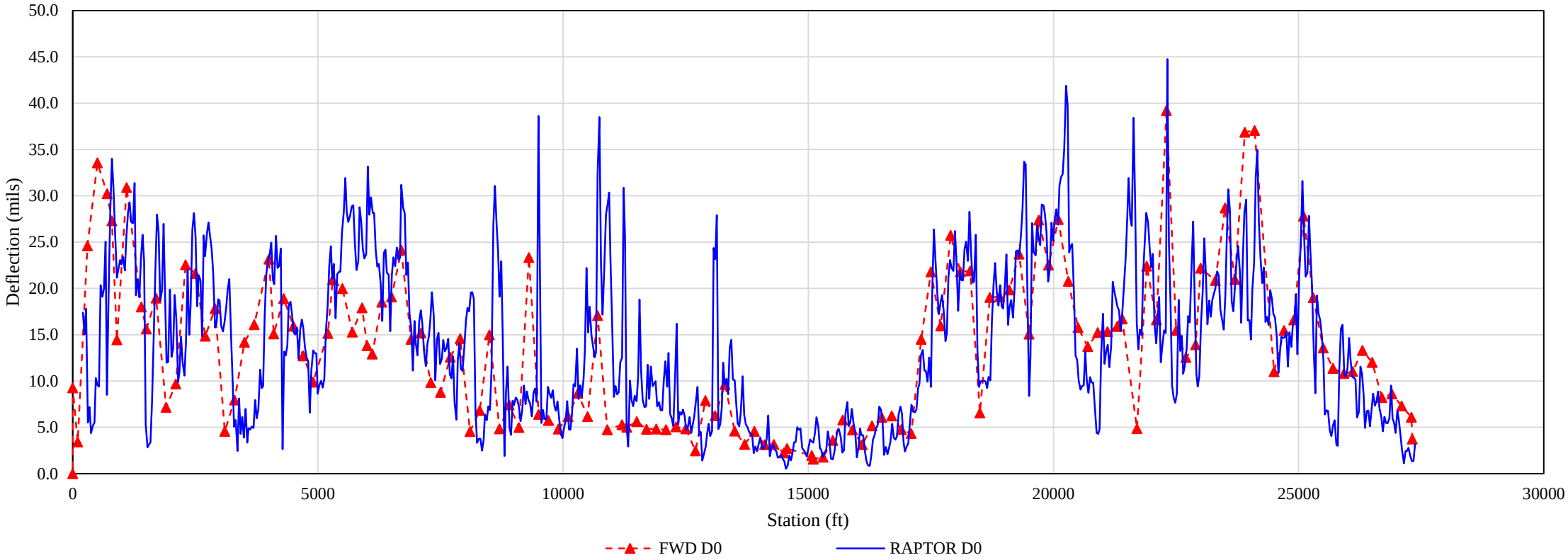
Burnet RD NB Lane 1 FWD Vs RAPTOR



RAPTOR D0 Vs FWD D0 , Burnet Rd NB lane 1

Dynatest®
Pavement Expertise in Action

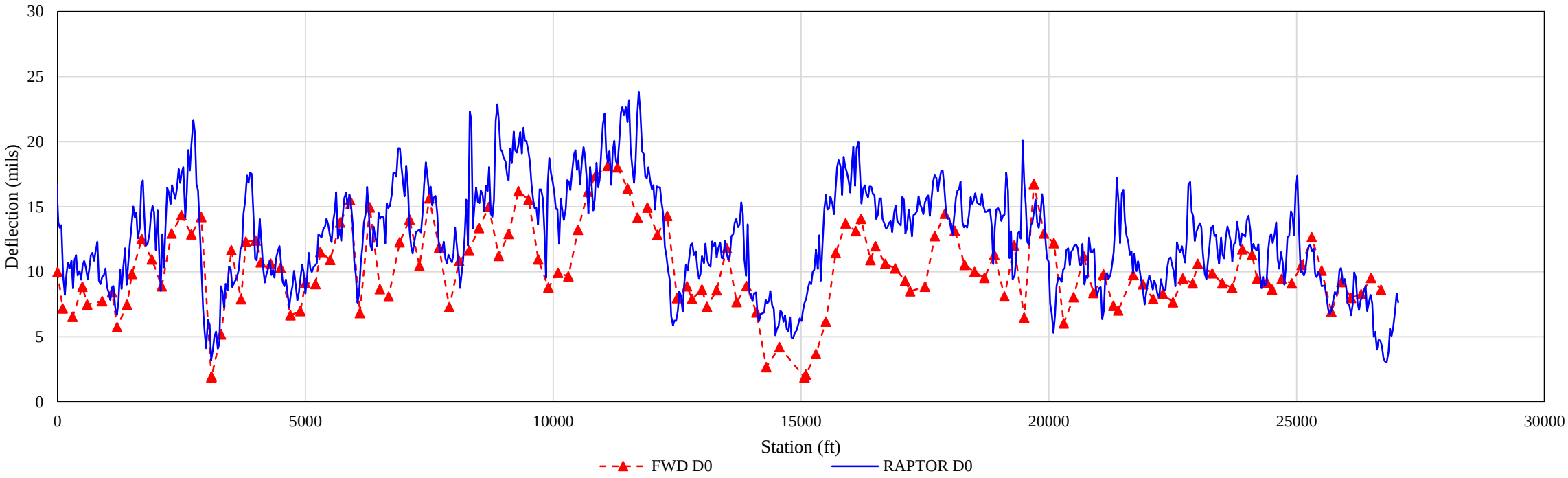
Burnet RD SB Lane 1 FWD Vs RAPTOR



RAPTOR D0 Vs FWD D0 , Burnet Rd SB lane 1

Dynatest®
Pavement Expertise in Action

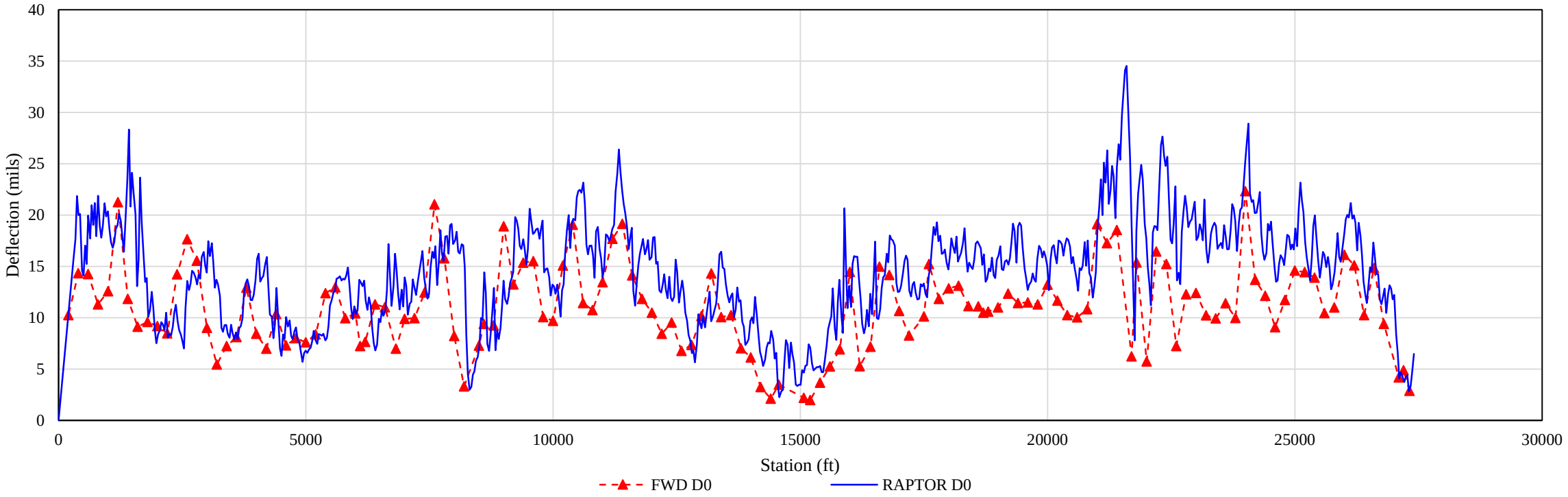
Burnet RD NB Lane 2 FWD Vs RAPTOR



RAPTOR D0 Vs FWD D0 , Burnet Rd NB lane 2

Dynatest®
Pavement Expertise in Action

Burnet RD SB Lane 2 FWD Vs RAPTOR

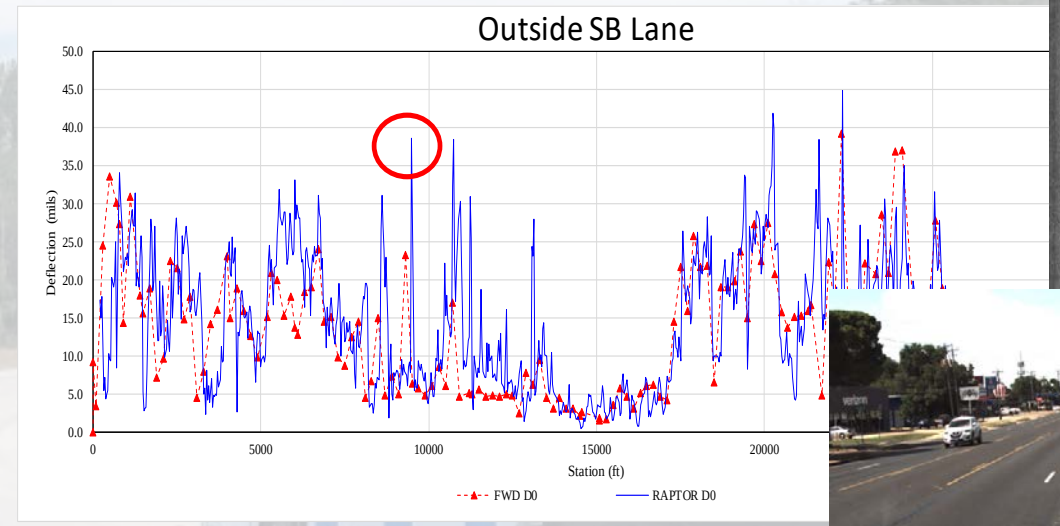


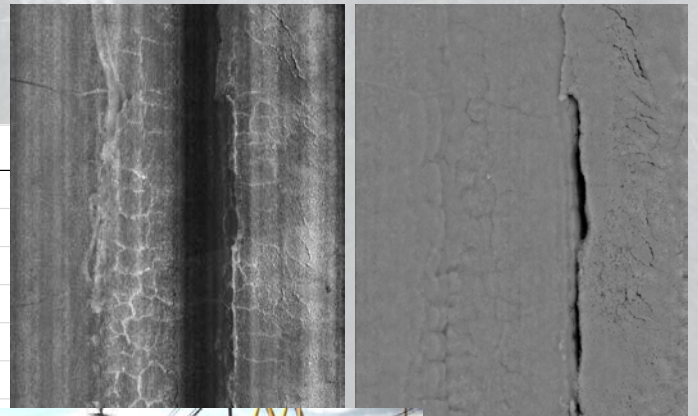
RAPTOR D0 Vs FWD D0 , Burnet Rd SB lane 2

Dynatest
Pavement Expertise in Action

Burnet RD Structural Vs Functional

Burnet at Ashdale



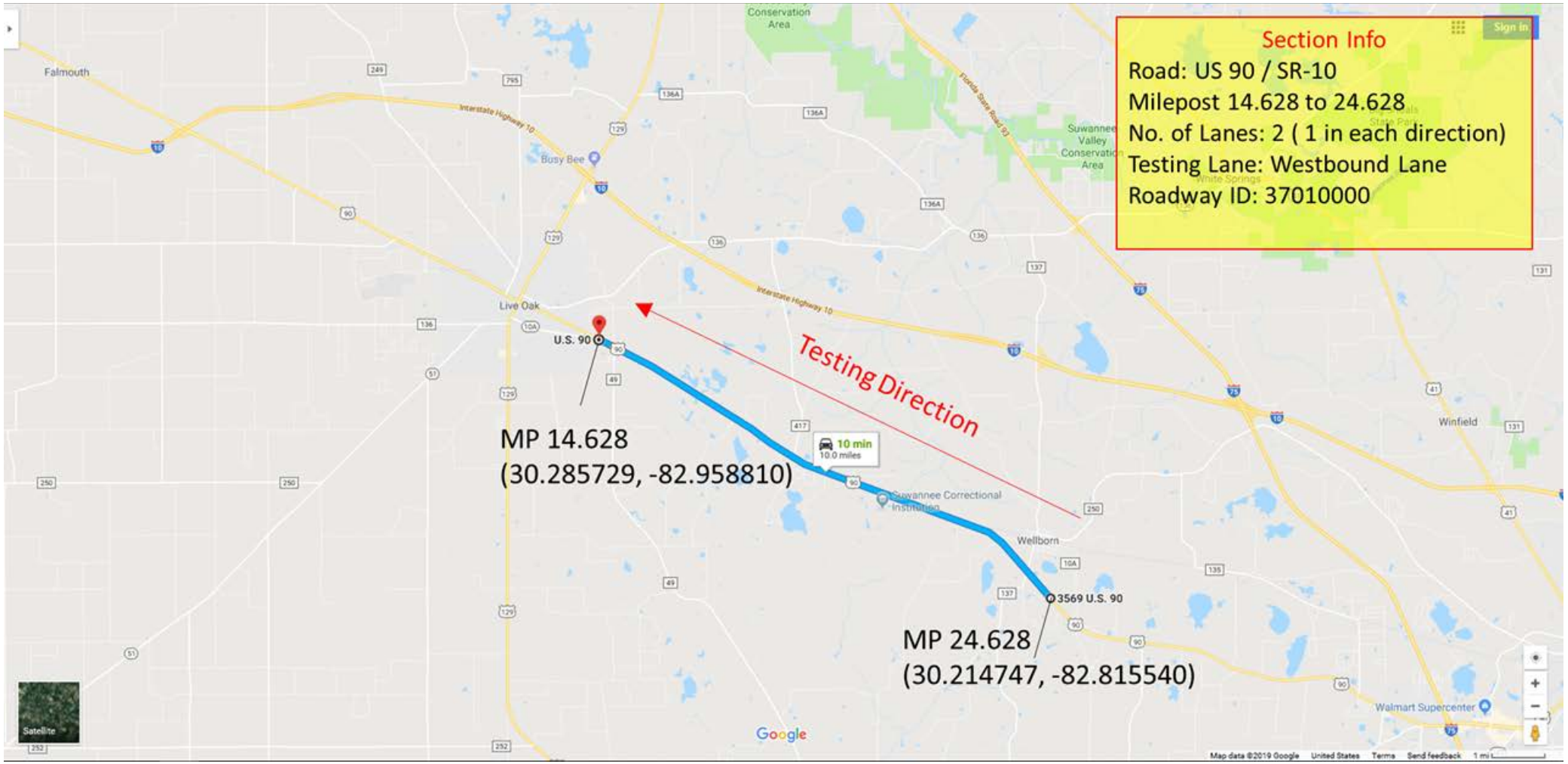


Distressed Pavement

- Fatigue Cracking
- Failed Pavement

Burnet Rd Functional Vs Structural Condition

Project Location (US90/SR10)



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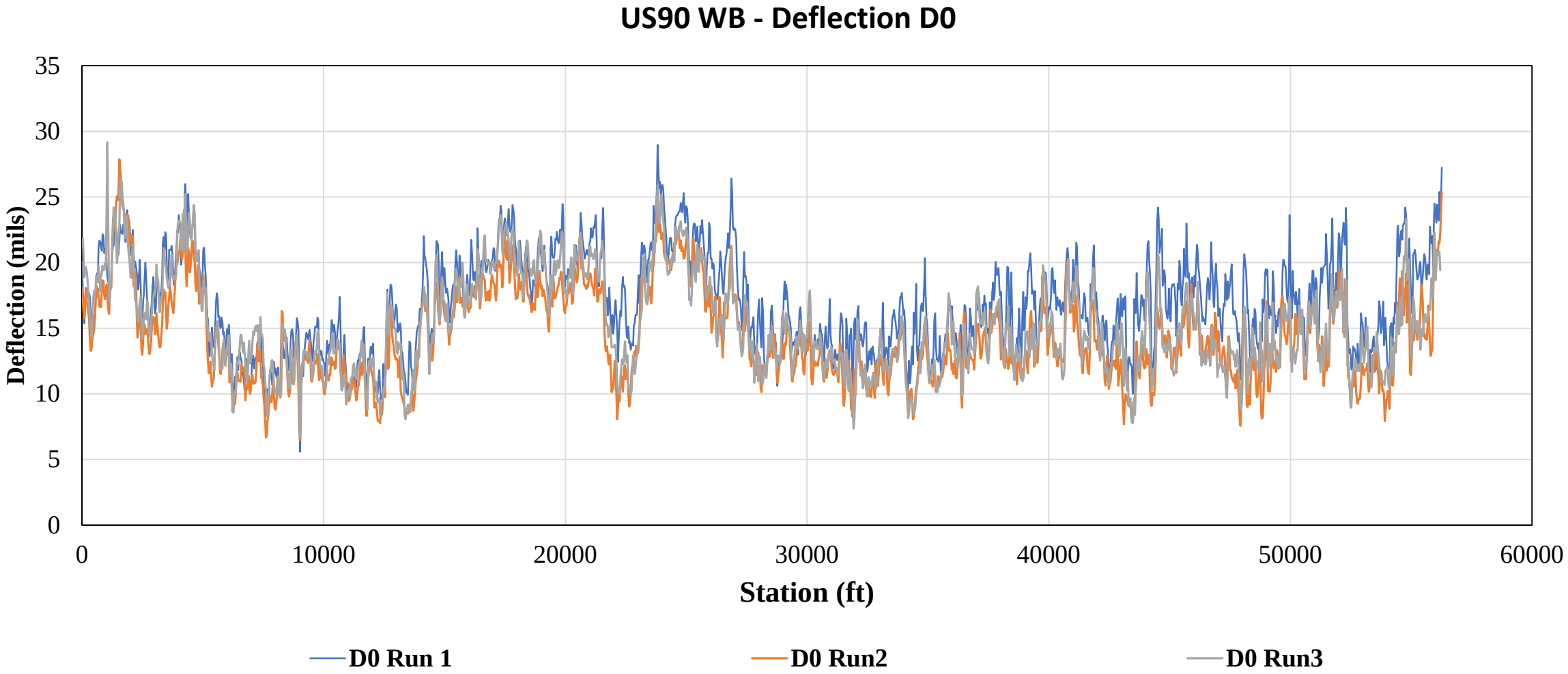
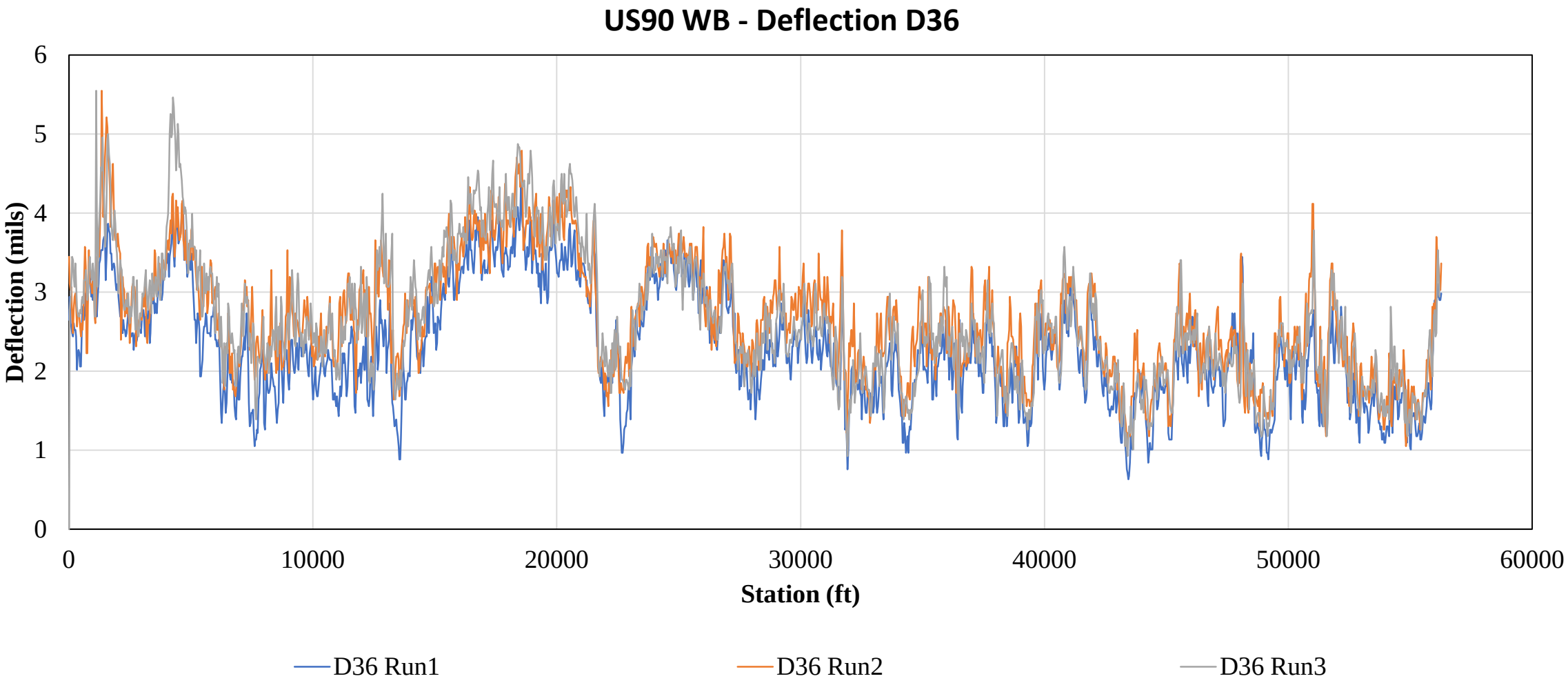
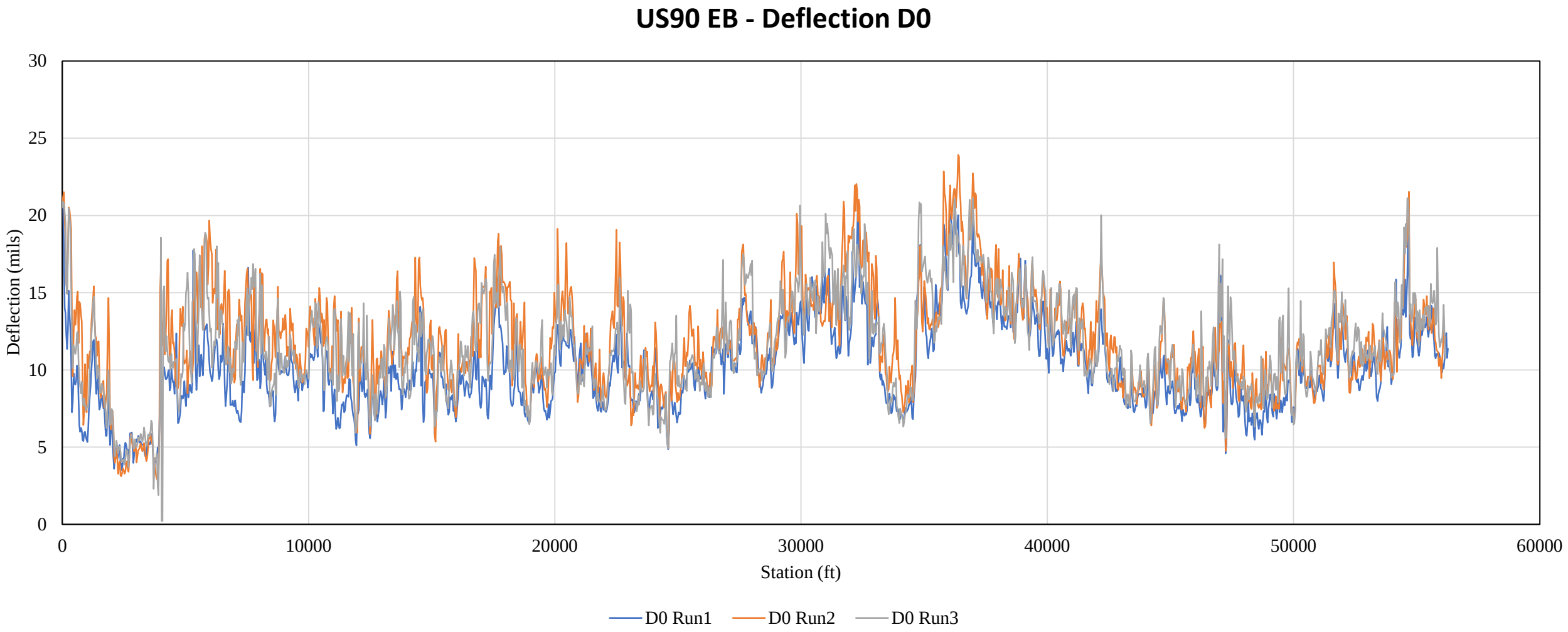
RAPTOR Results



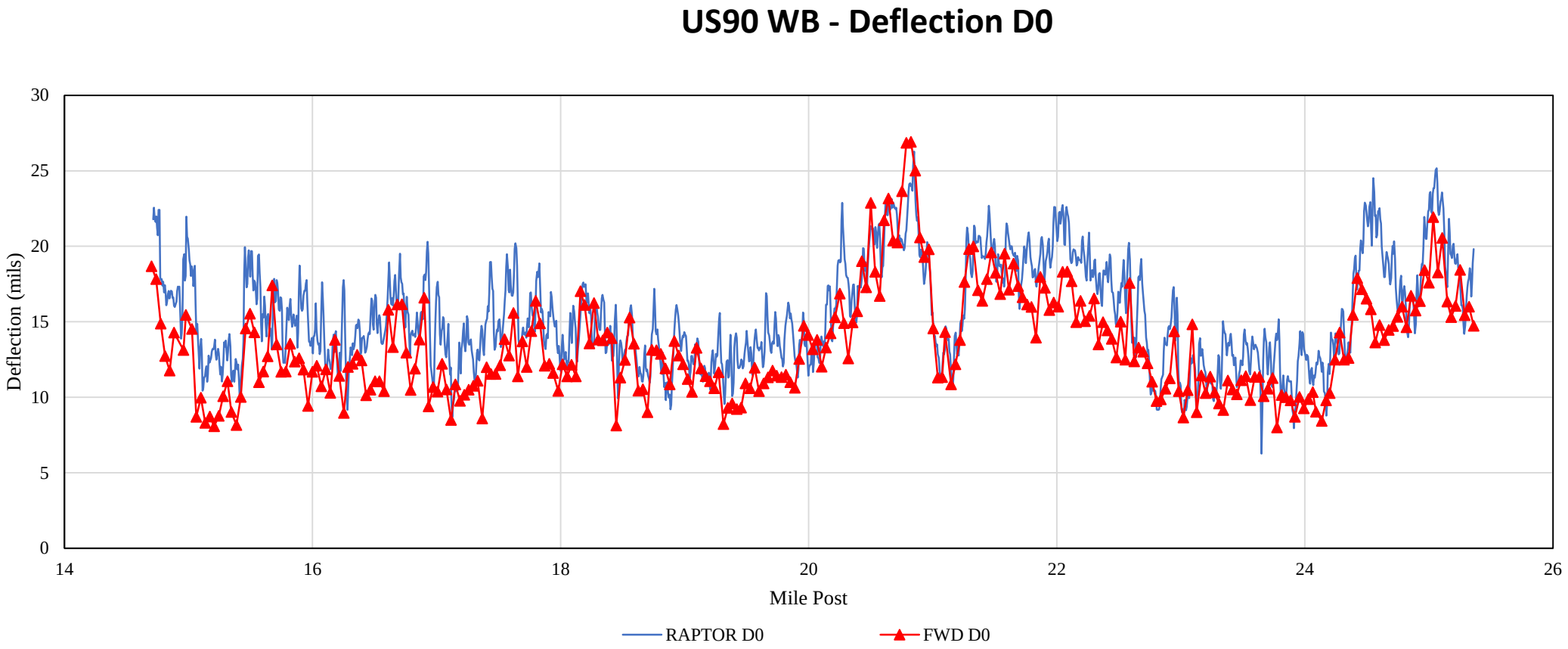
RAPTOR Results



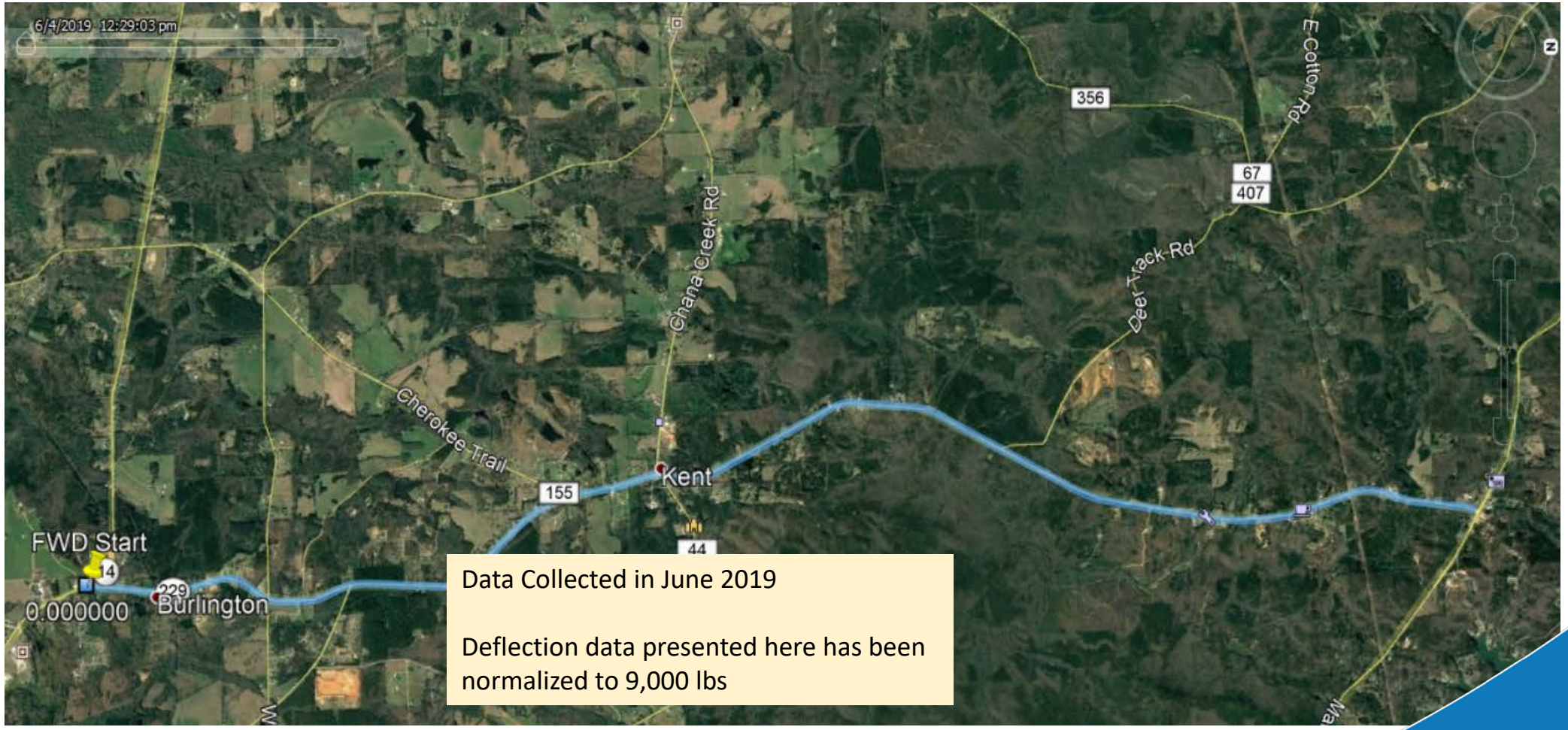
Repeatability of RAPTOR Measurements



Comparison with FWD Data



Project Location (US 229 NB)



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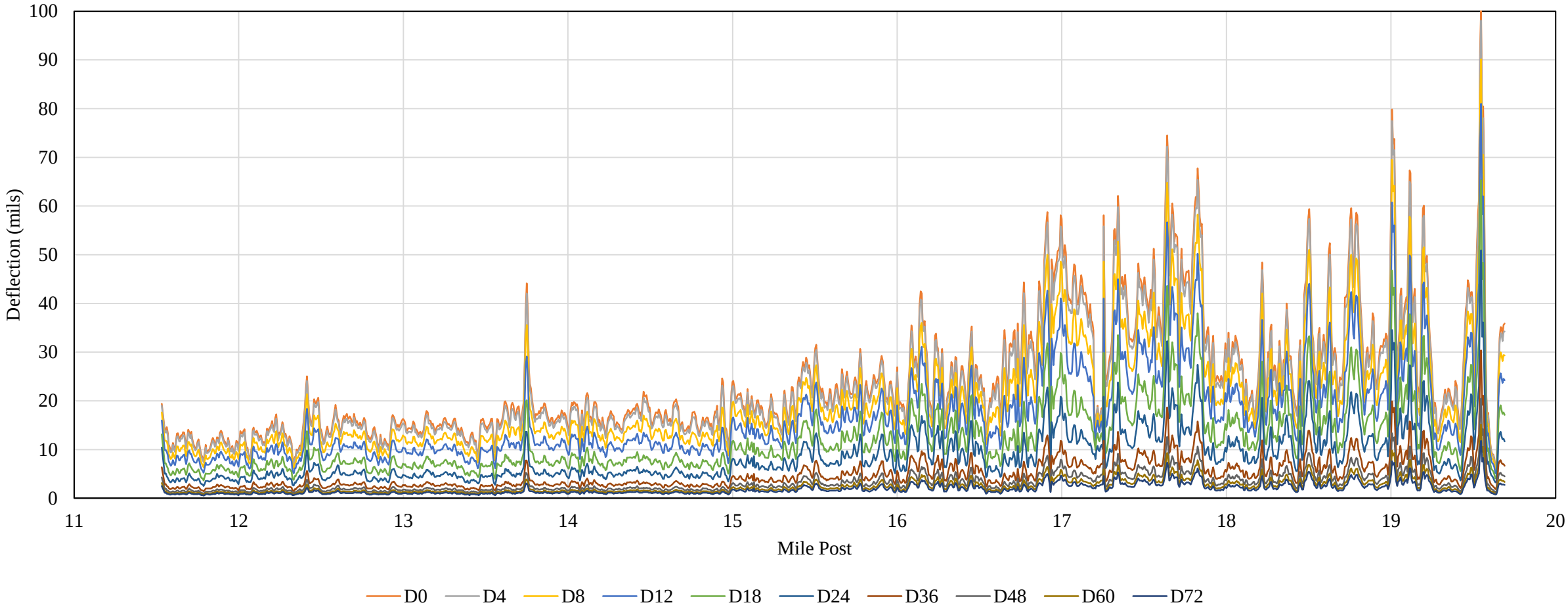
RAPTOR Results

The Figure below shows the full RAPTOR deflection basin on US 229 Northbound (Run1)



Repeatability of RAPTOR Measurements

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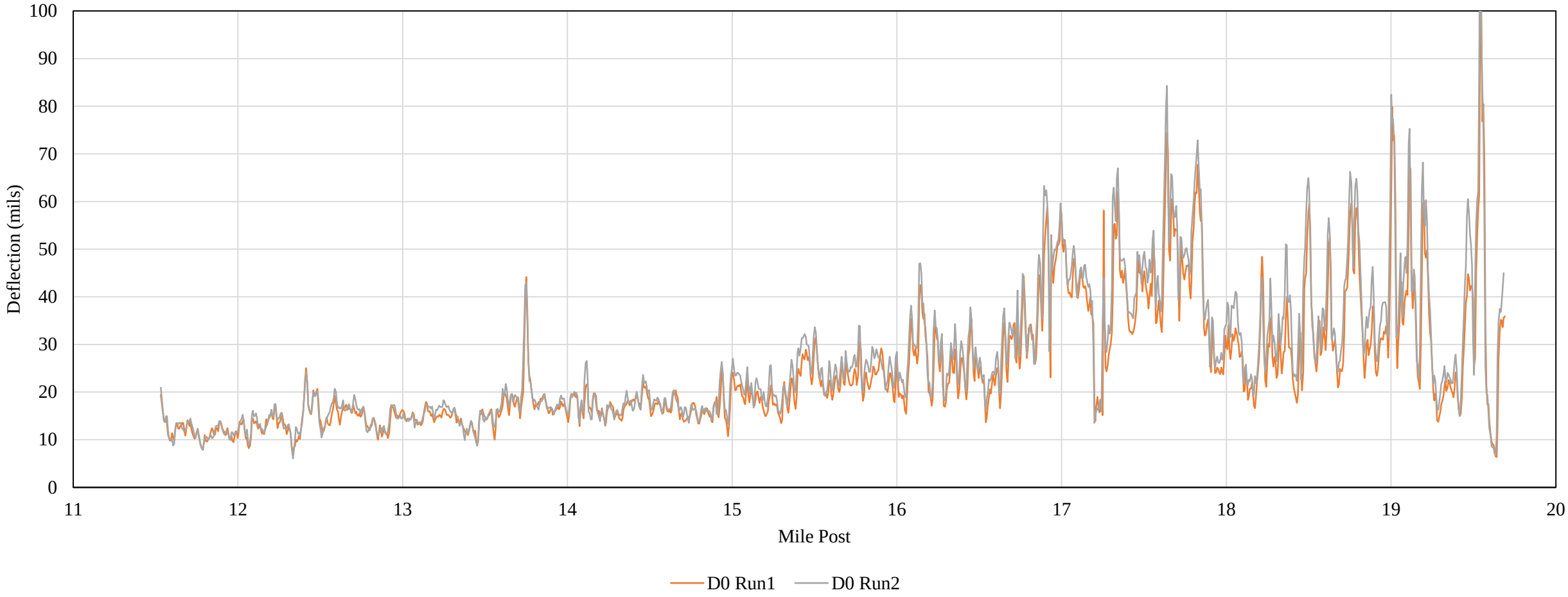
The Figure below shows the repeatability of two RAPTOR runs on US 229 Northbound (D0)



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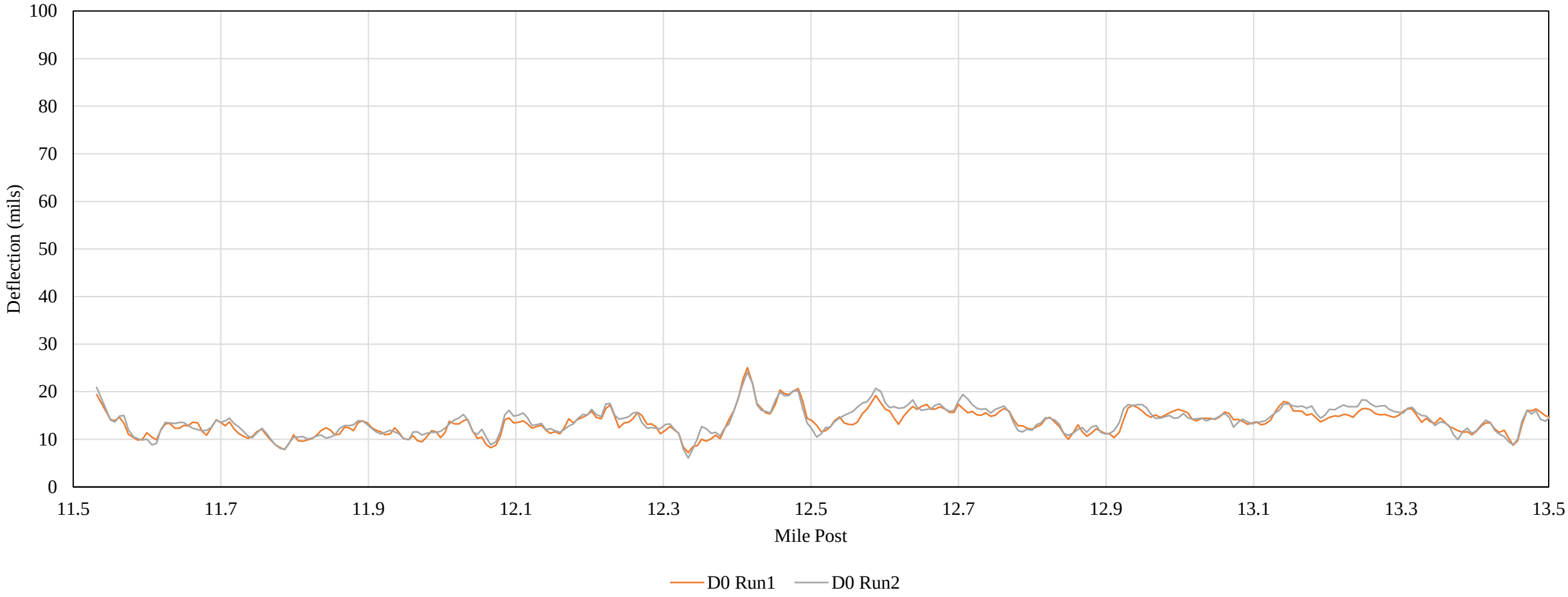
Repeatability of RAPTOR Measurements

The Figure below shows the repeatability of two RAPTOR runs on US 229 Northbound (D0)
(Graph detail – 2 mile intervals)



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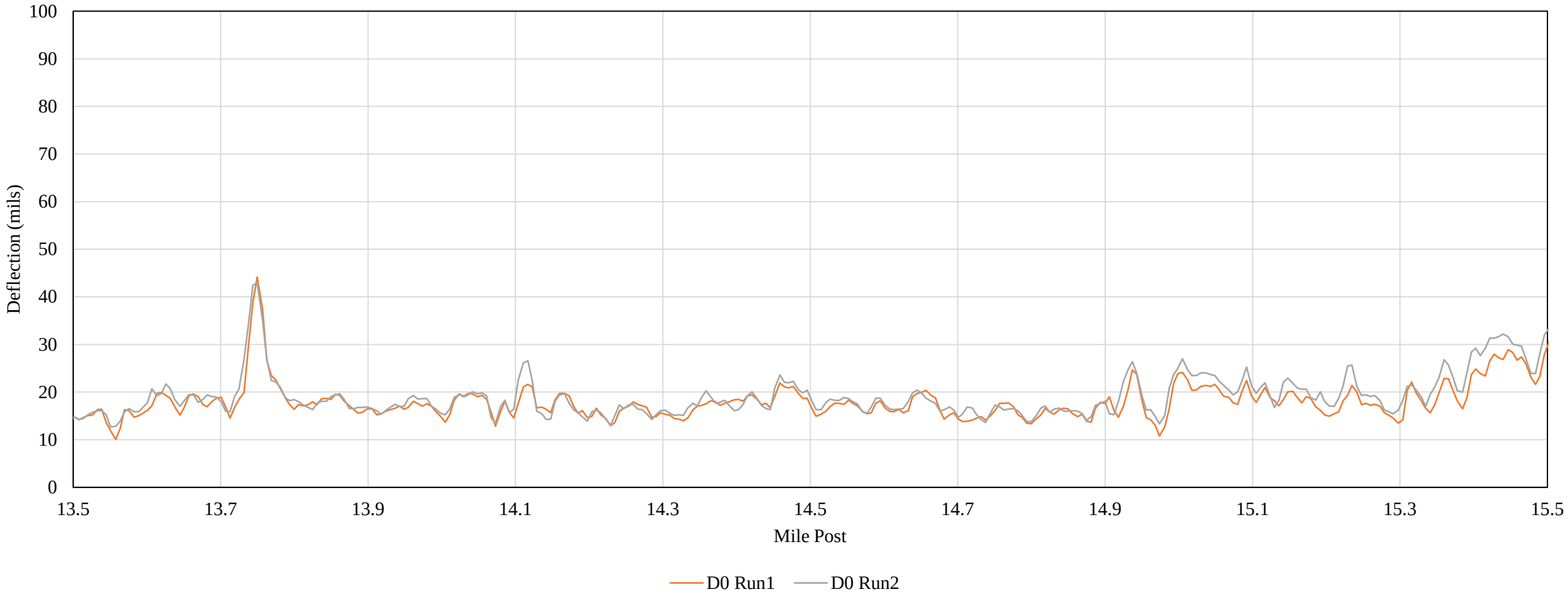
Repeatability of RAPTOR Measurements

The Figure below shows the repeatability of two RAPTOR runs on US 229 Northbound (D0)
(Graph detail – 2 mile intervals)



Repeatability of RAPTOR Measurements

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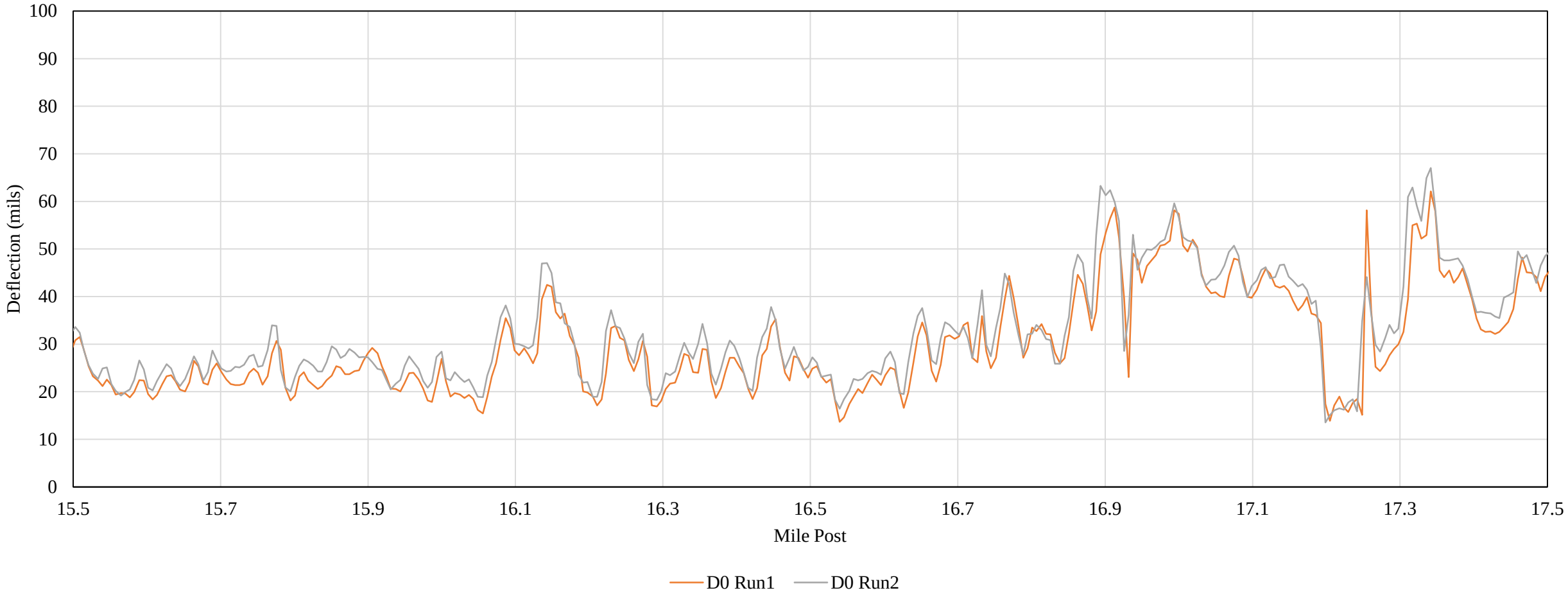
The Figure below shows the repeatability of two RAPTOR runs on US 229 Northbound (D0)
(Graph detail – 2 mile intervals)



Repeatability of RAPTOR Measurements

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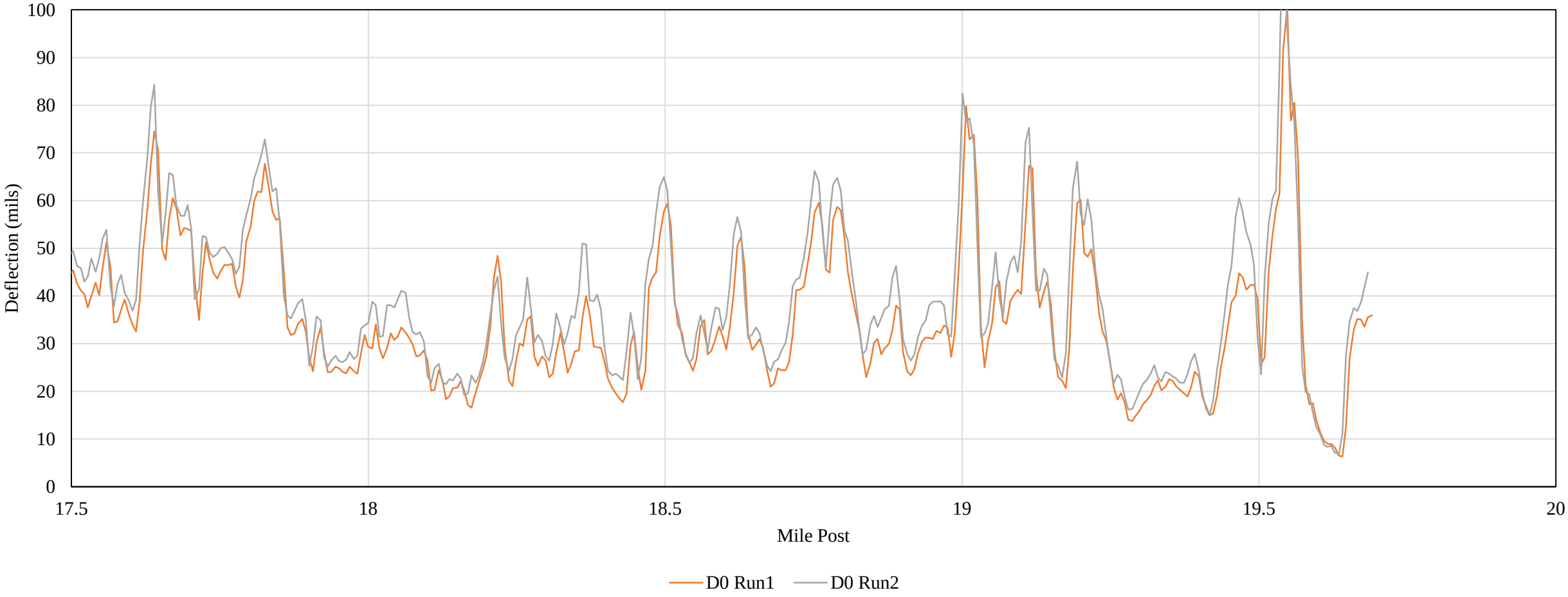
The Figure below shows the repeatability of two RAPTOR runs on US 229 Northbound (D0)
(Graph detail – 2 mile intervals)



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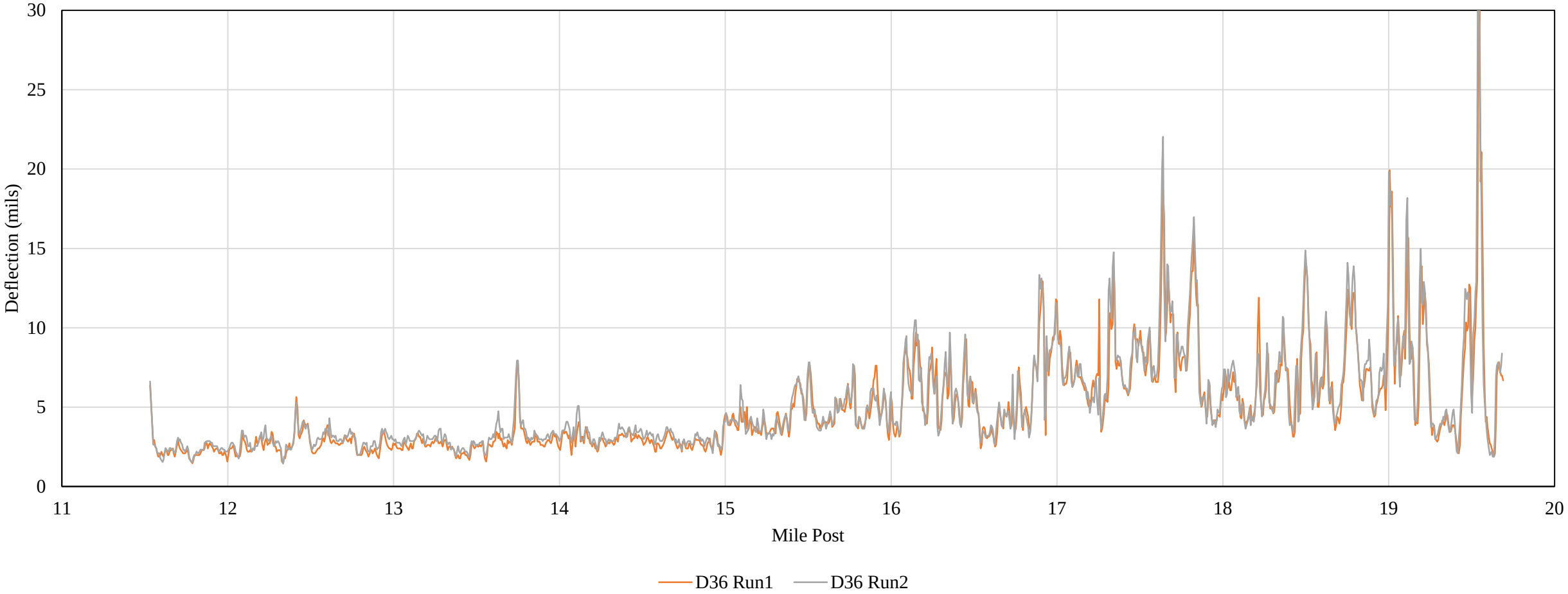
Repeatability of RAPTOR Measurements

The Figure below shows the repeatability of two RAPTOR runs on US 229 Northbound (D36)



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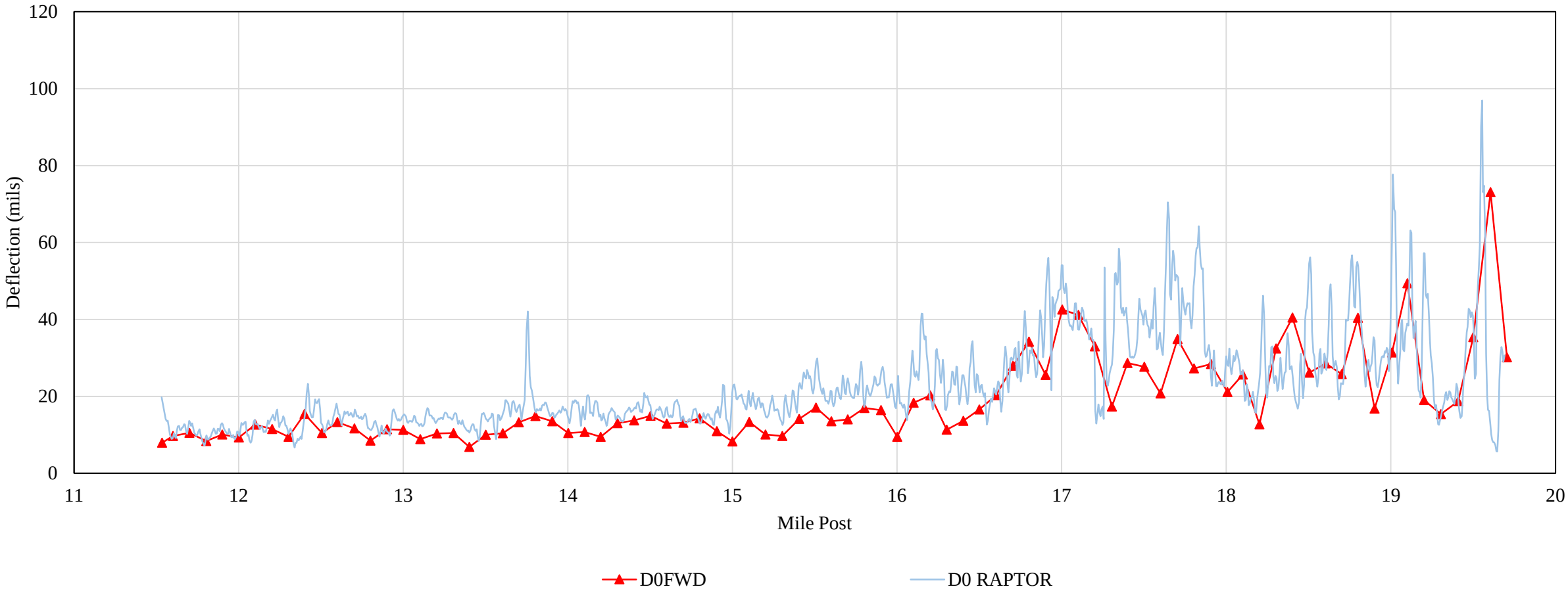
Comparison with FWD Measurements

The Figure below shows comparison of RAPTOR run1 and FWD on US 229 Northbound (D0)



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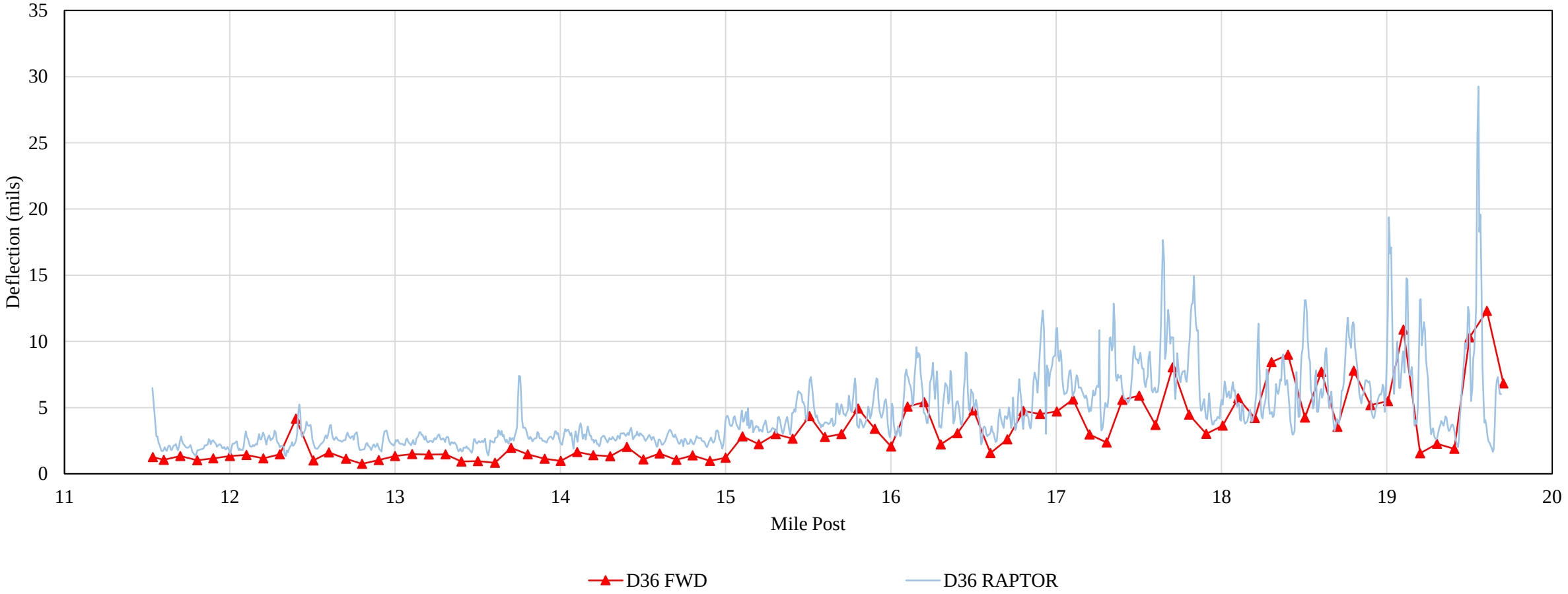
Comparison with FWD Measurements

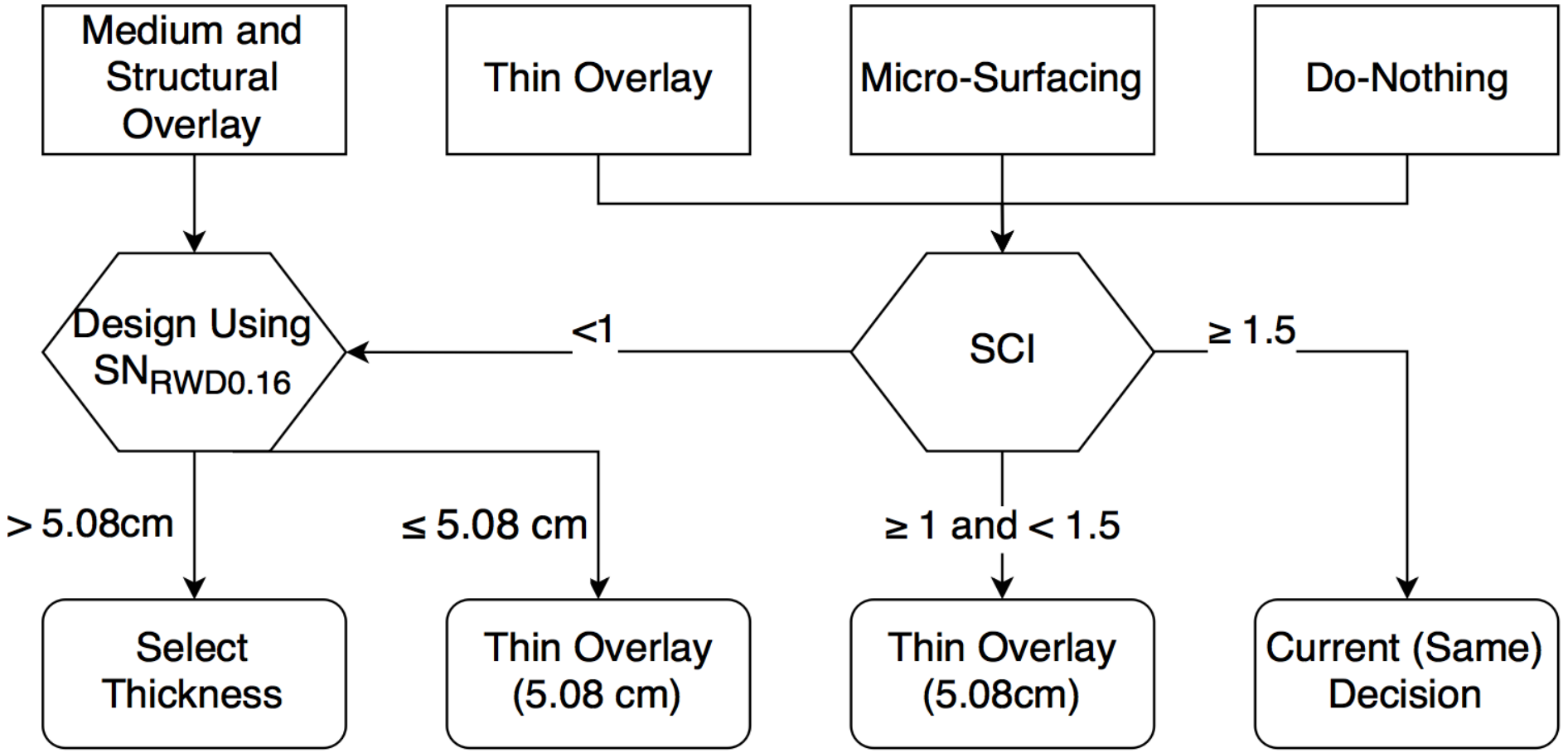
The Figure below shows comparison of RAPTOR run1 and FWD on US 229 Northbound (D36)



RAPTOR Data PMS Implementation

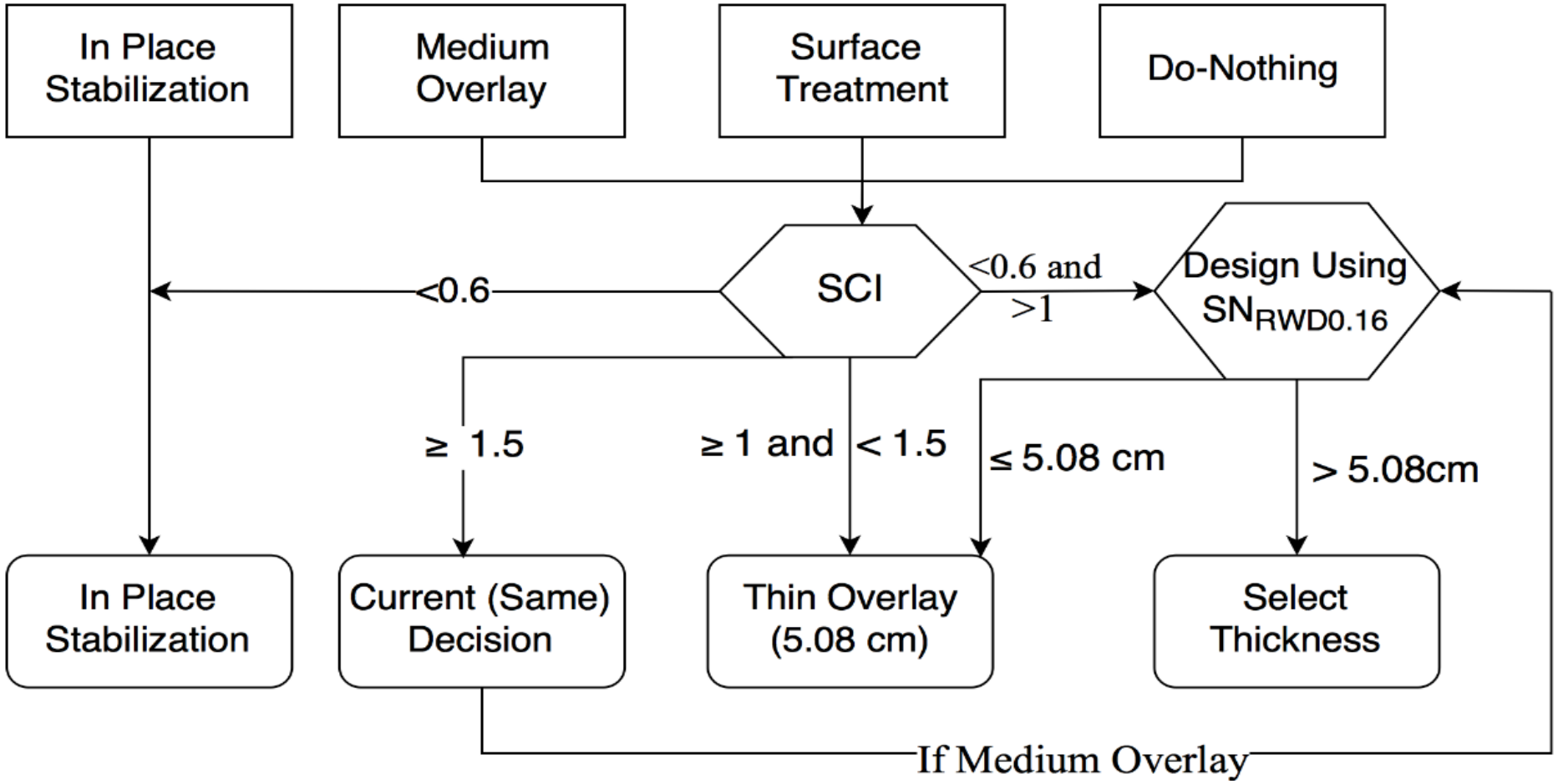
- $SCI = \frac{SN_{eff}}{SN_{req}}$
- where,
- SCI= Structural Condition Index;
- SN_{eff} = the existing (estimated) Structural Number; and
- SN_{req}= the required Structural Number.

RAPTOR Data PMS Implementation



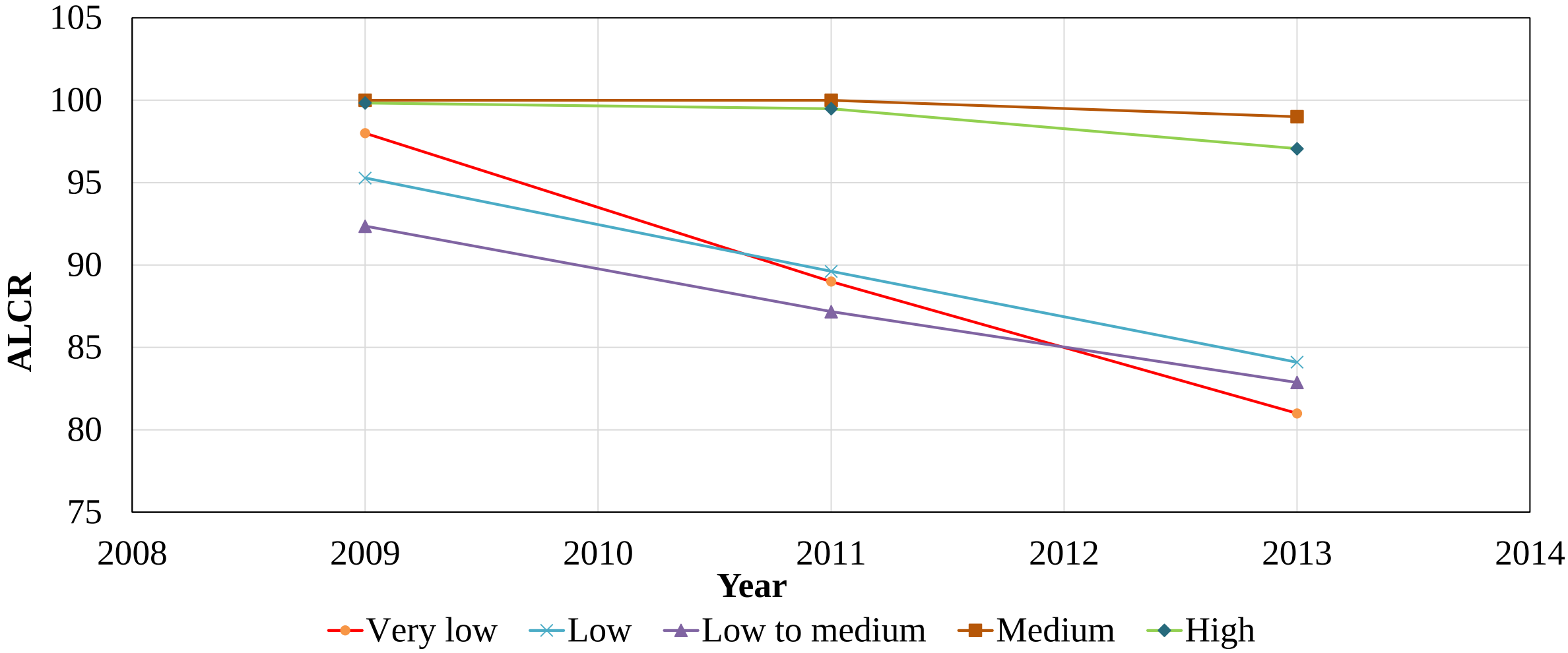
Example of a Modified Decision Tree (Louisiana)

RAPTOR Data PMS Implementation



Example of a Modified Decision Tree (Louisiana)

RAPTOR Data PMS Implementation



Example of Pavement Performance SCI Relationship

Note

- Deflection data shown in the above slides has not been corrected/adjusted to any particular reference temperature. With temperature adjustment, a better correlation may be possible.

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Conclusion

- In general, the RAPTOR based deflection data shows excellent repeatability and good correlation with FWD
- Accurate line lasers minimize texture issues experienced in former TSDDs
- Image correlation process solves the problem of measuring the same spot twice
- The deflections under the line lasers can be deduced directly from Raptor curvatures
- Deflections at other locations (ex. center deflection under the wheel) can be determined through numerical modeling

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General Information

- RAPTOR testing offered as consulting engineering service
- Raw deflection data in CSV, XLS or MDB formats
  - Full deflection basin
  - Load level, surface/air temperatures
  - Data referenced to stationing accompanied by high-accuracy GPS data
- Backcalculated layer moduli (calibrated with layer thickness info)
- Effective structural numbers (SN_{eff})*
- Reporting with presentation of data on a map

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Two More RAPTOR Units are being made!!!

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