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Audubon Parkway Slab Lifting at MP 22.75 — Bridge Approach and Departure Settlement

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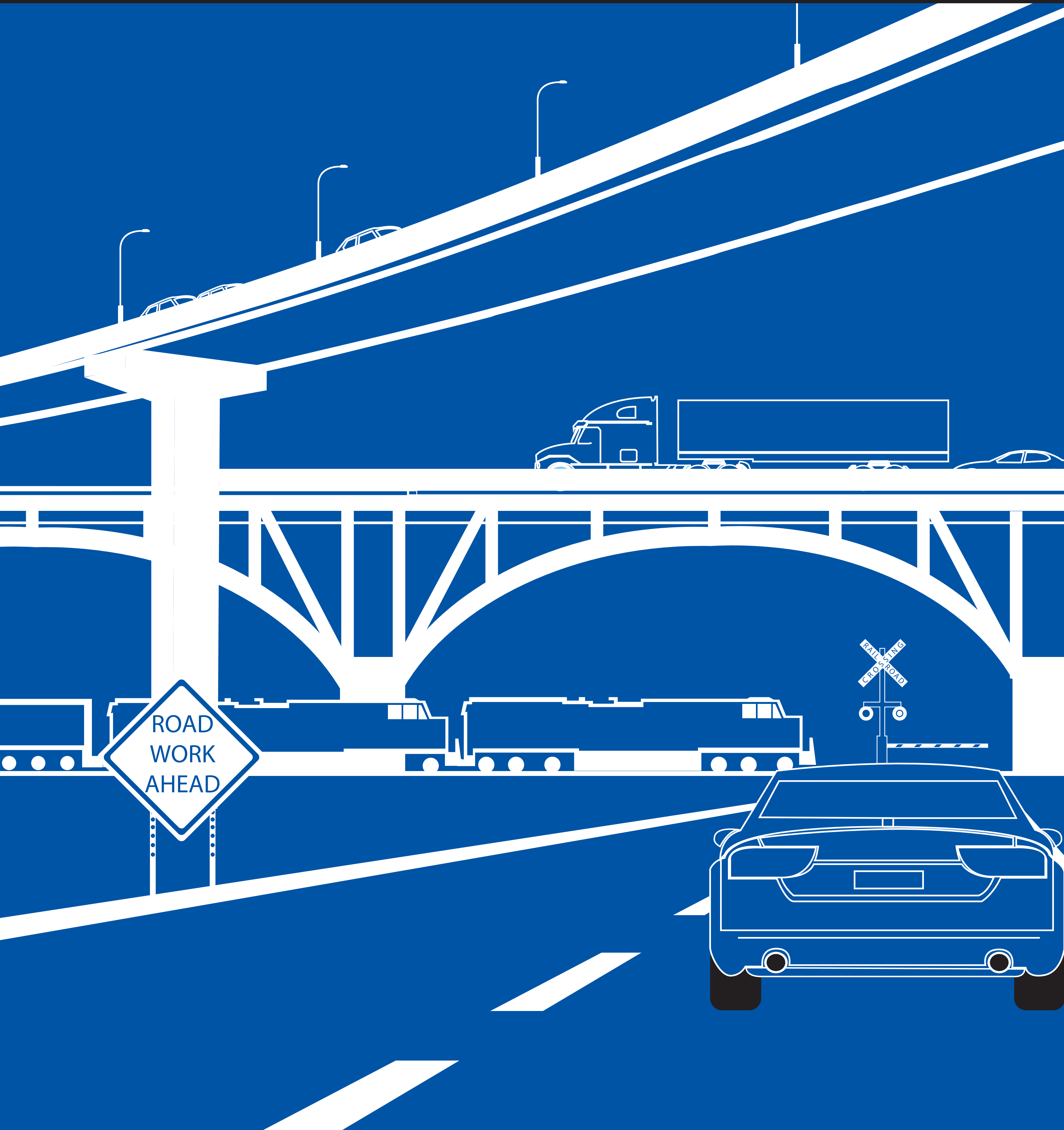

Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with
Kentucky Transportation Cabinet
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Research Report
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Table of Contents

1. Problem Statement

The approach/departure Portland Cement Concrete (PCC) panels on the eastbound and westbound side of Audubon Parkway at MP 22.75 over route KY 2120 began to exhibit settlement and cracking in a few locations, which created an uncomfortable ride for motorists. To address this problem, the Kentucky Transportation Cabinet (KYTC) contracted with MasterDry to repair the PCC panel settlement. MasterDry claims that its two-part polyurethane material expands into a rigid foam that fills voids, stabilizes slabs, and lifts concrete. The polyurethane material is injected through 5/8-inch holes drilled in the PCC panel. Once injected, a chemical reaction converts the liquid urethane components to a strong, rapidly-setting foam material. With a compressive strength of 100 pounds per square inch, polyurethane offers the necessary strength to support heavy loads.

At the request of KYTC the Kentucky Transportation Center (KTC) has monitored and evaluated the performance of MasterDry's polyurethane foam treatment. To determine effectiveness of the lifting agent, elevation data were collected. A falling weight deflectometer (FWD) was used to assess the condition of in situ base materials and load transfer efficiency (LTE).

2. Injection Zone

MasterDry drilled holes at three-foot intervals along the bridge abutment to begin lifting panels back into place. They then moved away from bridge for a total of five slabs. This process was repeated for each approach and departure. Drilling occurred on both sides of all transverse joints at three-foot intervals. MasterDry technicians placed levels along the transverse joint to monitor lifting of PCC panels. Figure 1 presents an aerial diagram of the injection zone.

3. In Situ Base Material Evaluation

Although MasterDry does not claim its product improves in situ base material strength, KTC nonetheless evaluated the site using a FWD because it can be used to determine the in situ condition of all base materials as well as the roadway surface. FWD data were collected along the outside edges of pavement and in the middle of each lane. All transverse joints were tested to determine LTEs.

The term *load transfer* refers to the transfer (or distribution) of load across discontinuities such as joints or cracks. When a wheel load is applied to a joint or crack, both the loaded slab and adjacent unloaded slab deflect. The amount the unloaded slab deflects is directly related to joint performance. If a joint performs perfectly, the loaded and unloaded slabs deflect in equal amounts. Load transfer efficiency is calculated using the following equation:

$$\text{Efficiency (\%)} = \frac{\Delta_a}{\Delta_l} \times 100$$

where:
Δ_a = approach slab deflection
Δ_l = departure slab deflection

Data were collected in the center of all PCC mid panels. By collecting data in the center of the panel a stiffness value can be attained. To determine stiffness, the applied load value is divided by the #1 sensor's deflection value. The #1 sensor is located directly below the load plate. This calculation helps to establish the strength of in situ base materials and the pavement surface.

MasterDry determined that it needed to treat five panels before and after the bridge deck to correct settlement of the PCC panels. KTC personnel evaluated ten panels on both sides of the bridge deck to determine the treatment's effectiveness. By testing the additional panels, the effectiveness of treated areas and non-treated areas may be compared. Figures 2–17 provide LTE and mid panel stiffness results.

4. Elevation Evaluation

Elevation data were collected every three feet along all transverse joints in the injection zone prior to foam injection. After panels were lifted into place elevation data were collected a second time. Elevation information can be used to determine how effective the lifting agent is. Given the large number of data points, elevation charts were created using an average of all elevation data for each transverse joint. This site was monitored for two years. Figures 18–21 present elevation results.

5. Conclusion

There was minimal improvement in LTEs for the westbound approach/departures as well as the eastbound departure. While the eastbound approach improved after the injection, it exhibited minimal settlement prior to injection. Because this area had not experienced same degree of settlement as others, the polyurethane foam used may have aided LTEs. Mid-panel stiffness showed minimal improvement.

Elevation data showed an improvement after the initial lifting of settled PCC panels, however, after two years the panels have settled again. The westbound departure has settled back to almost its original position. If future testing is requested KTC will establish a new project for continued monitoring.

Figure 1 Aerial View of Audubon Parkway at KY 2120

Eastbound Approach LTE
Right Edge and Middle of Lane
FWD Evaluation

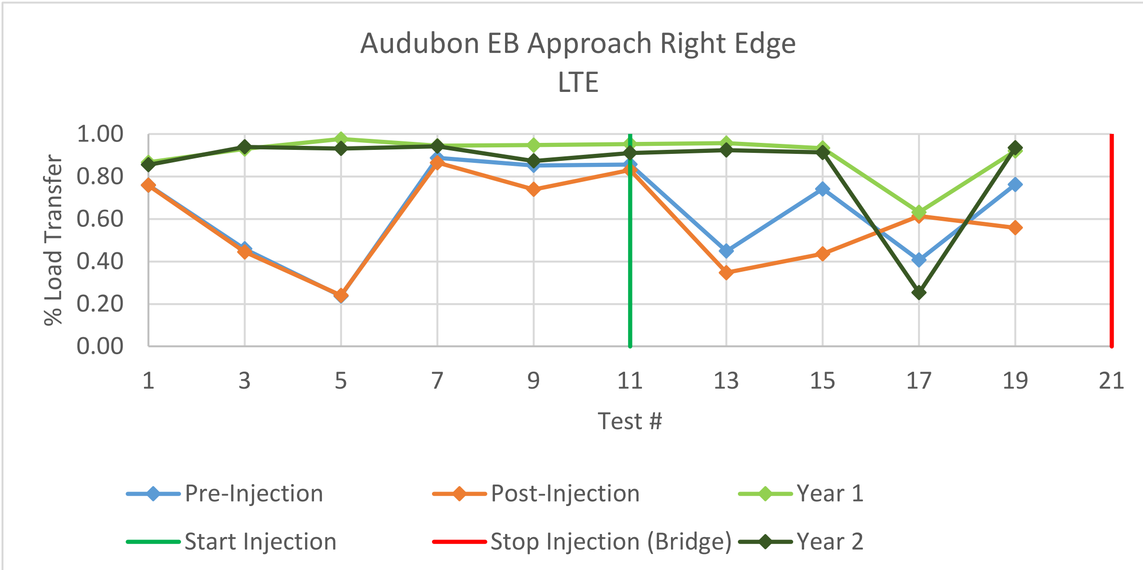

Figure 2 Load Transfer Efficiency Right Edge

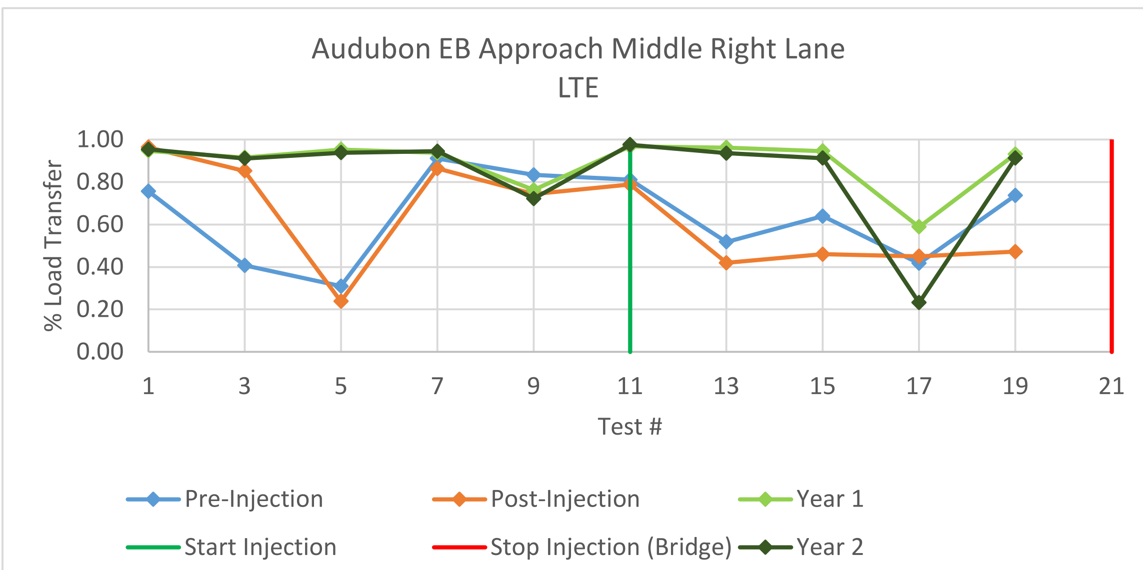

Figure 3 Load Transfer Efficiency Middle of Lane

Eastbound Approach Stiffness
Right Edge and Middle of Lane
FWD Evaluation

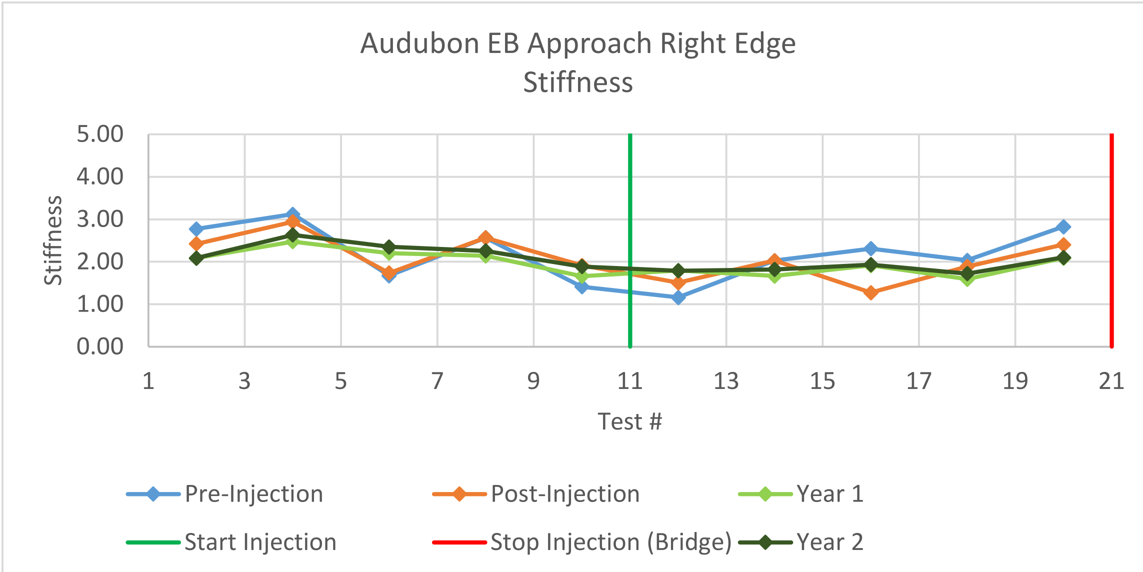

Figure 4 Stiffness Right Edge

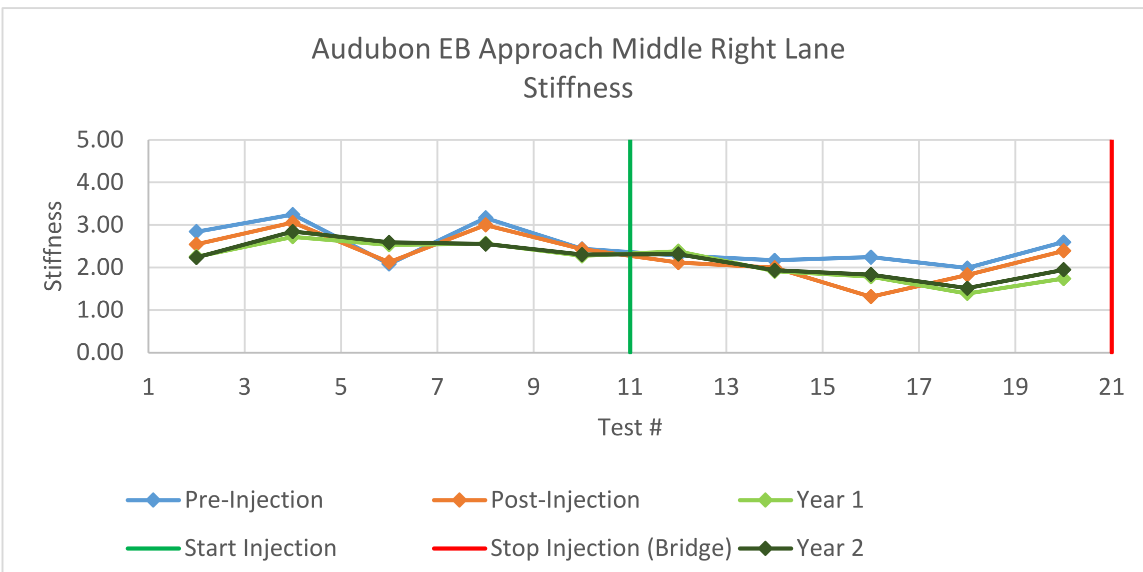

Figure 5 Stiffness Middle of Lane

Eastbound Departure LTE
Right Edge and Middle of Lane
FWD Evaluation

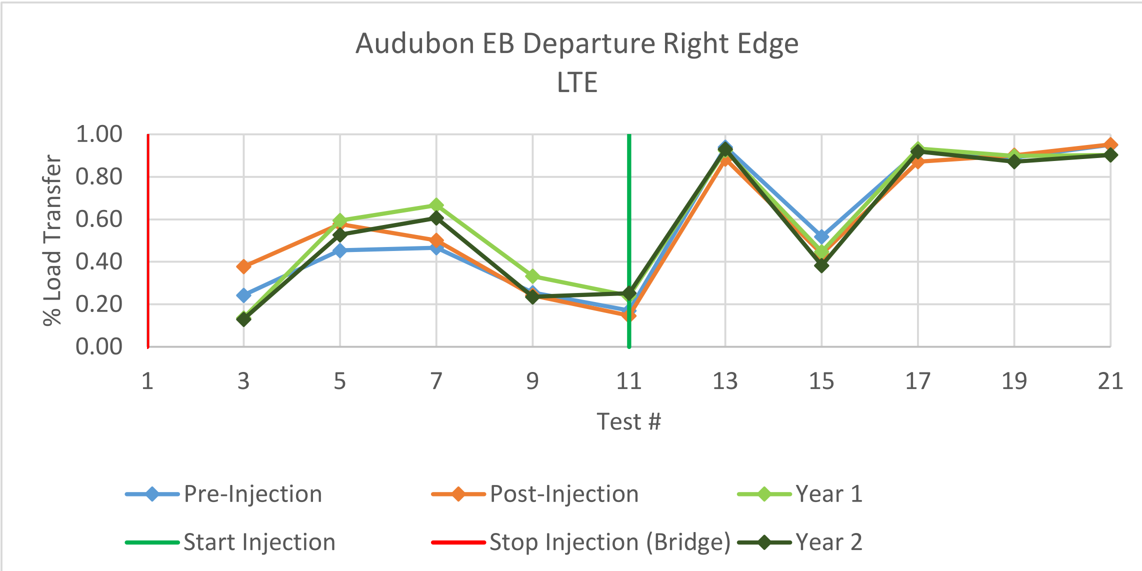

Figure 6 Load Transfer Efficiency Right Edge

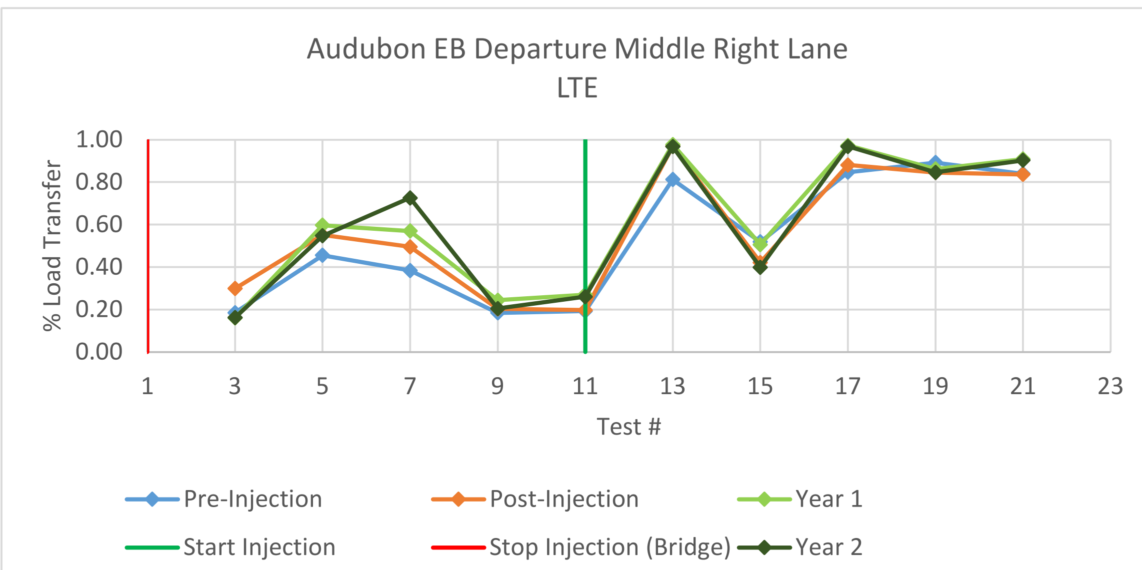

Figure 7 Load Transfer Efficiency Middle of Lane

Eastbound Departure Stiffness
Right Edge and Middle of Lane
FWD Evaluation

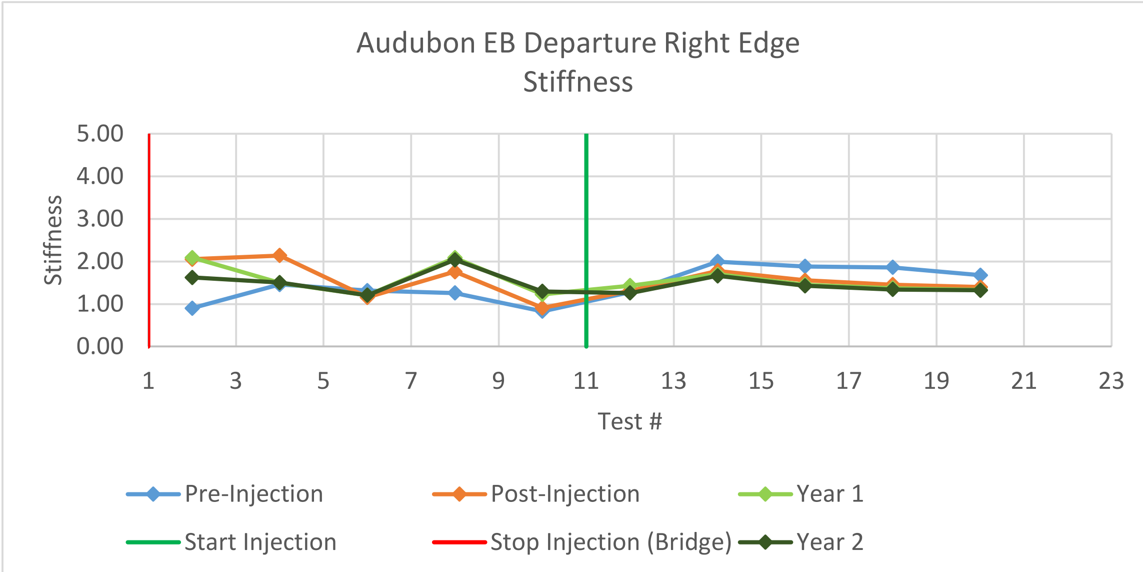

Figure 8 Stiffness Right Edge

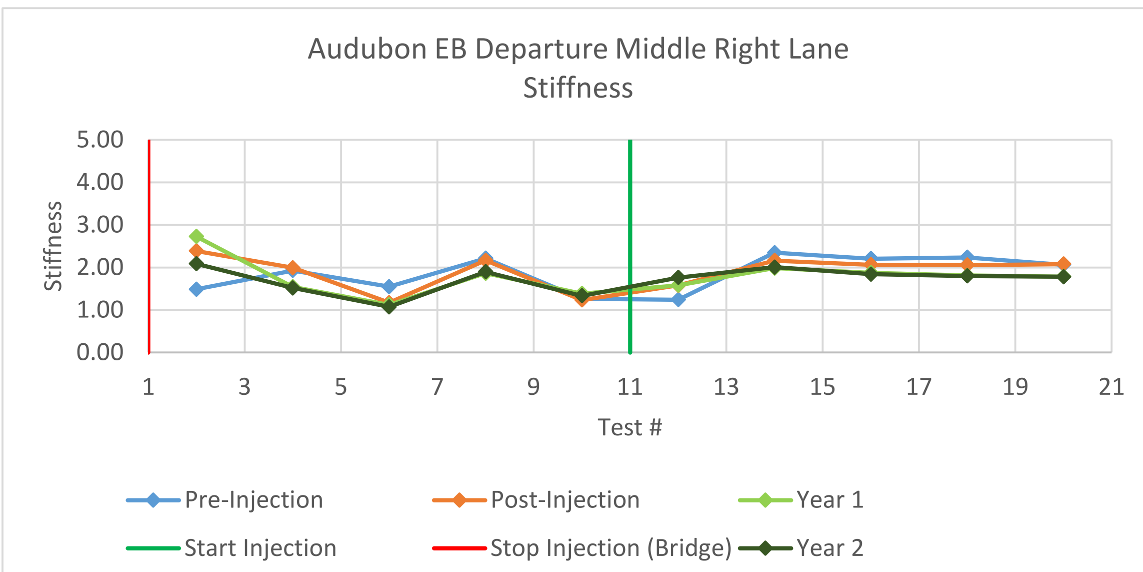

Figure 9 Stiffness Middle of Lane

Westbound Approach LTE
Right Edge and Middle of Lane
FWD Evaluation

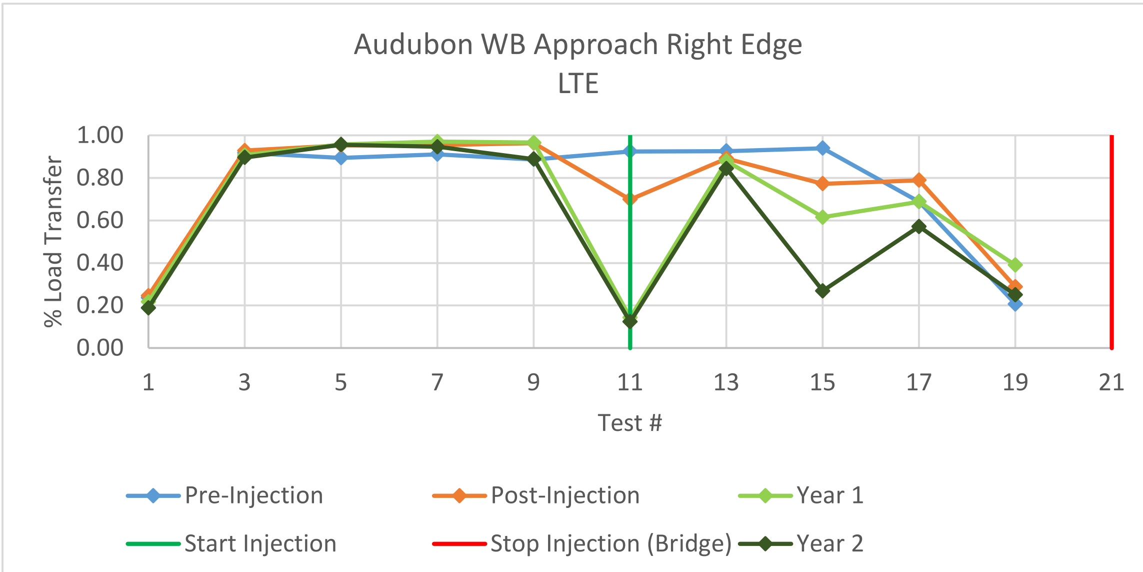

Figure 10 Load Transfer Efficiency Right Edge

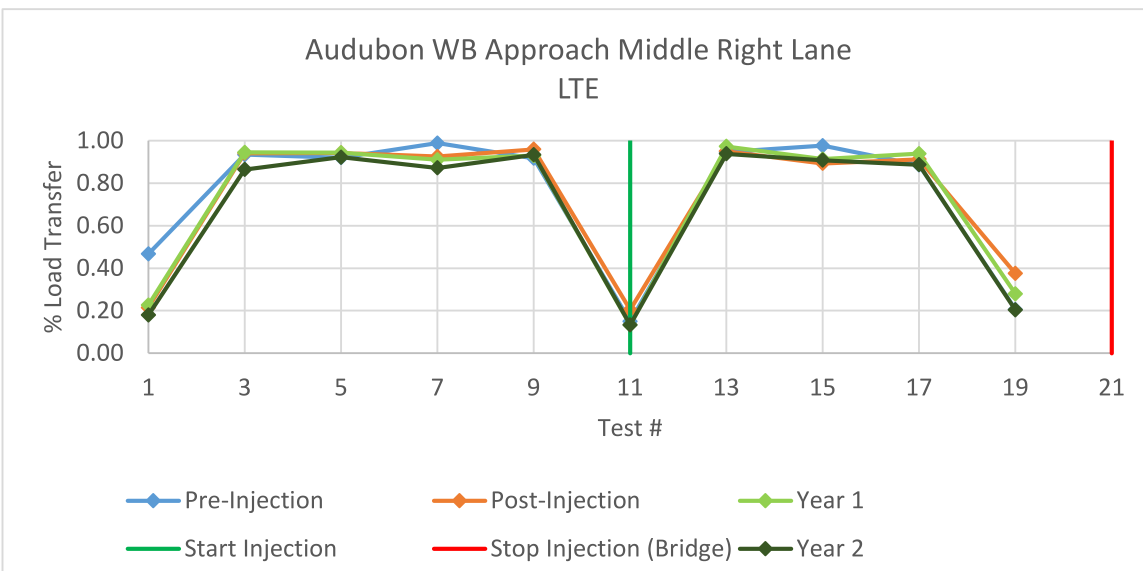

Figure 11 Load Transfer Efficiency Middle of Lane

Westbound Approach Stiffness
Right Edge and Middle of Lane
FWD Evaluation

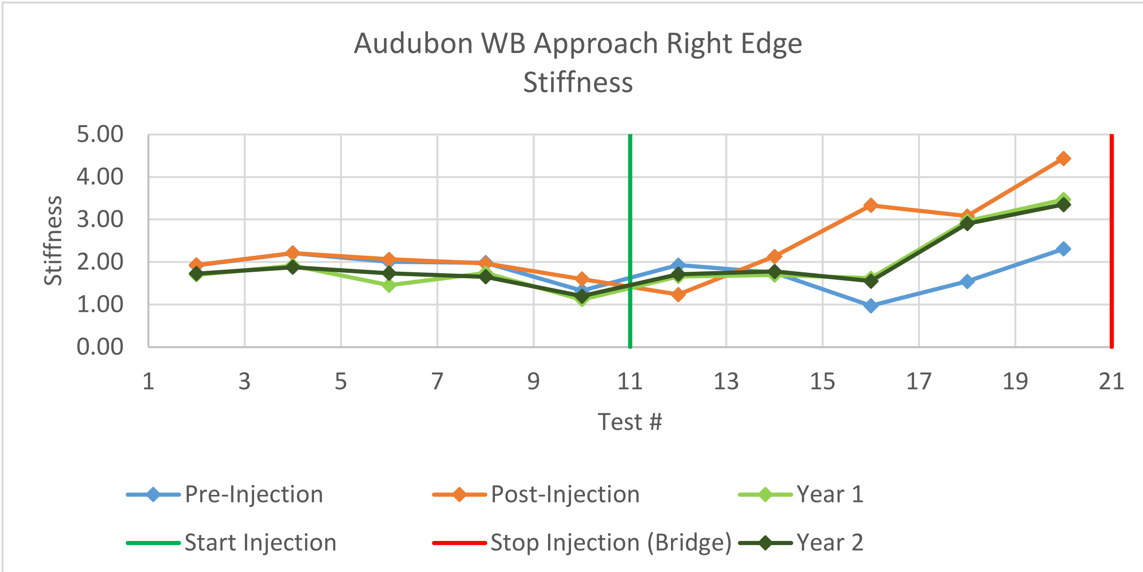

Figure 12 Stiffness Right Edge

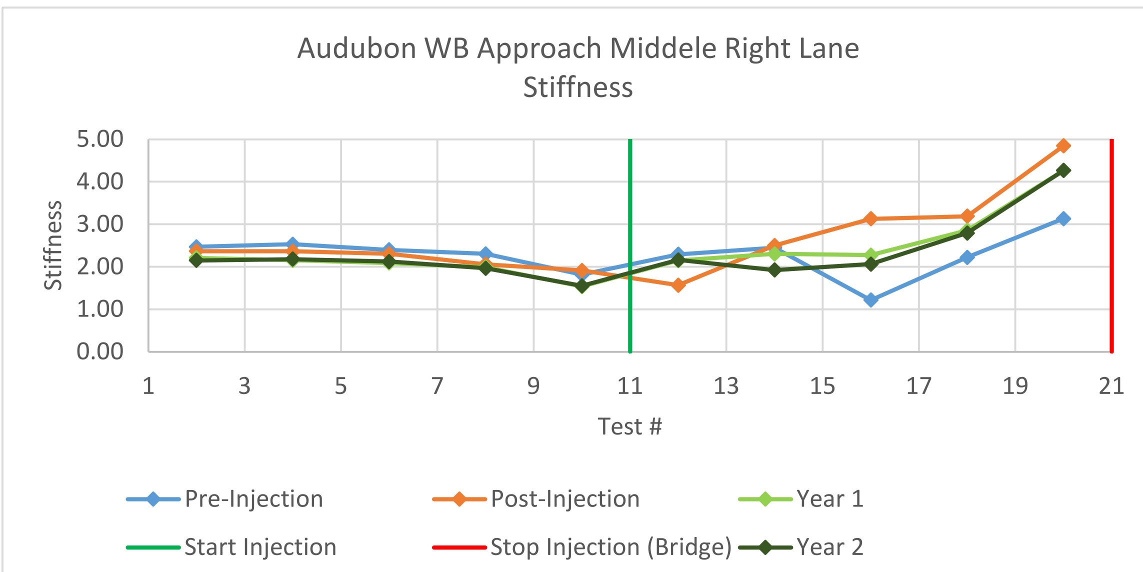

Figure 13 Stiffness Middle of Lane

Westbound Departure LTE
Right Edge and Middle of Lane
FWD Evaluation

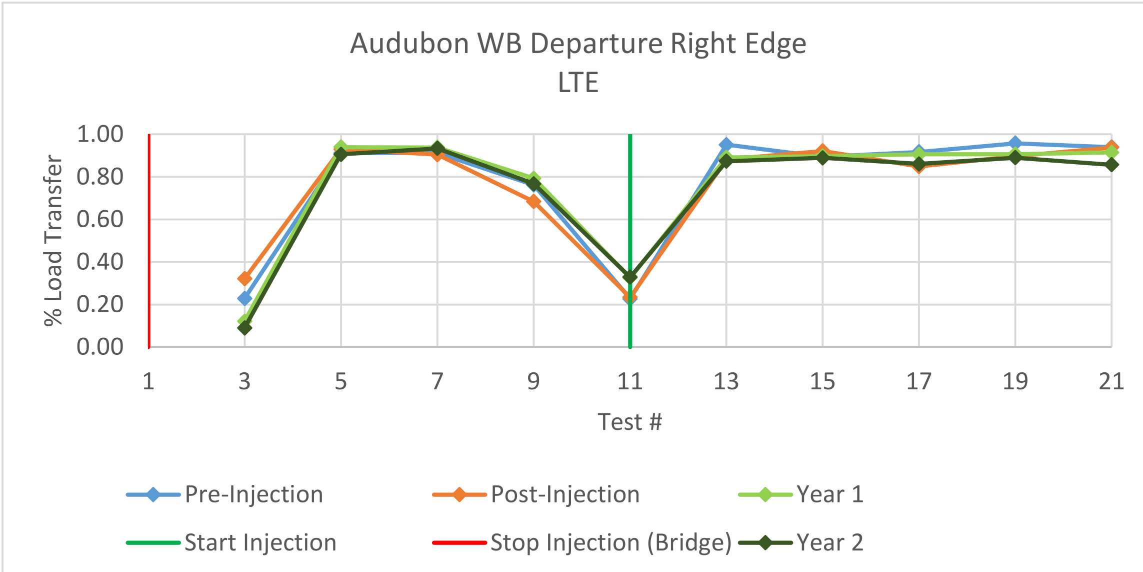

Figure 14 Load Transfer Efficiency Right Edge

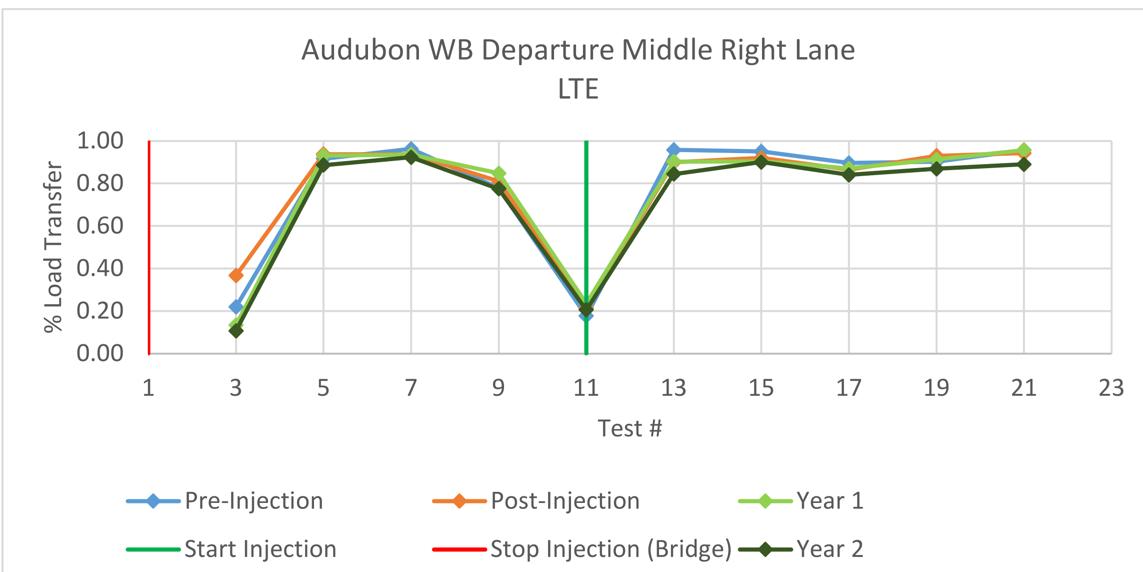

Figure 15 Load Transfer Efficiency Middle of Lane

Westbound Departure Stiffness
Right Edge and Middle of Lane
FWD Evaluation

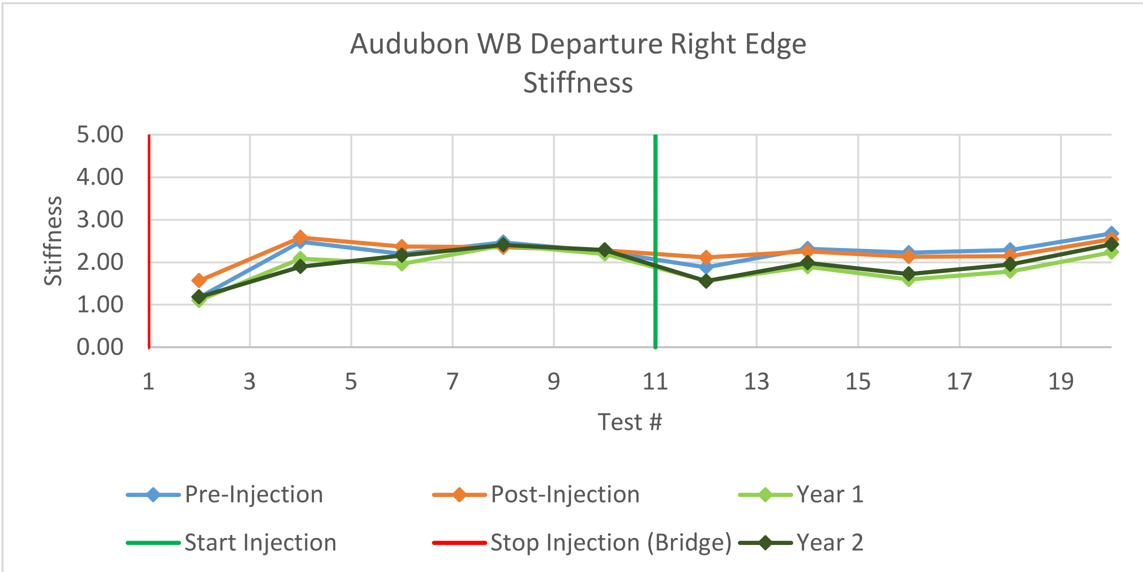

Figure 16 Stiffness Right Edge

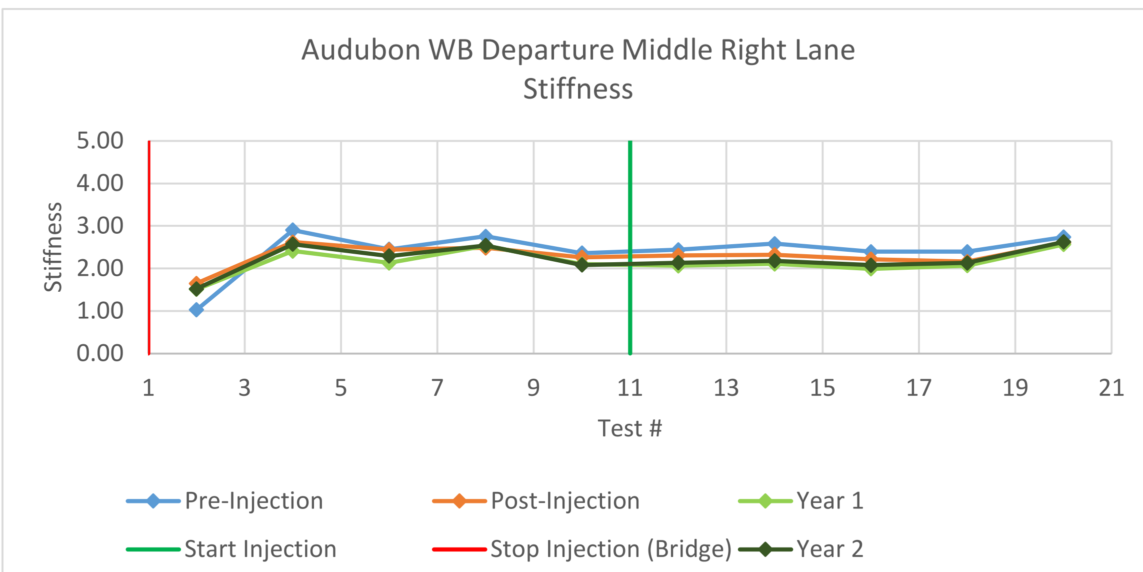

Figure 17 Stiffness Middle of Lane

Eastbound Approach & Departure
Elevation Evaluation

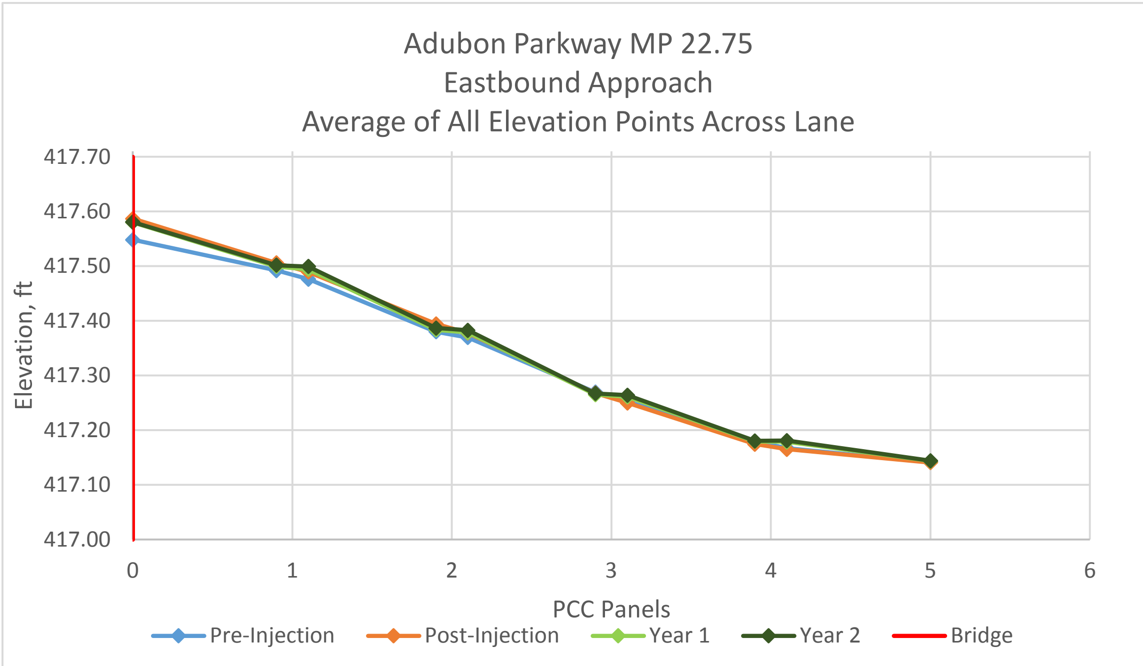

Figure 18 Average of All Elevation Points Across Lane at Bridge Approach

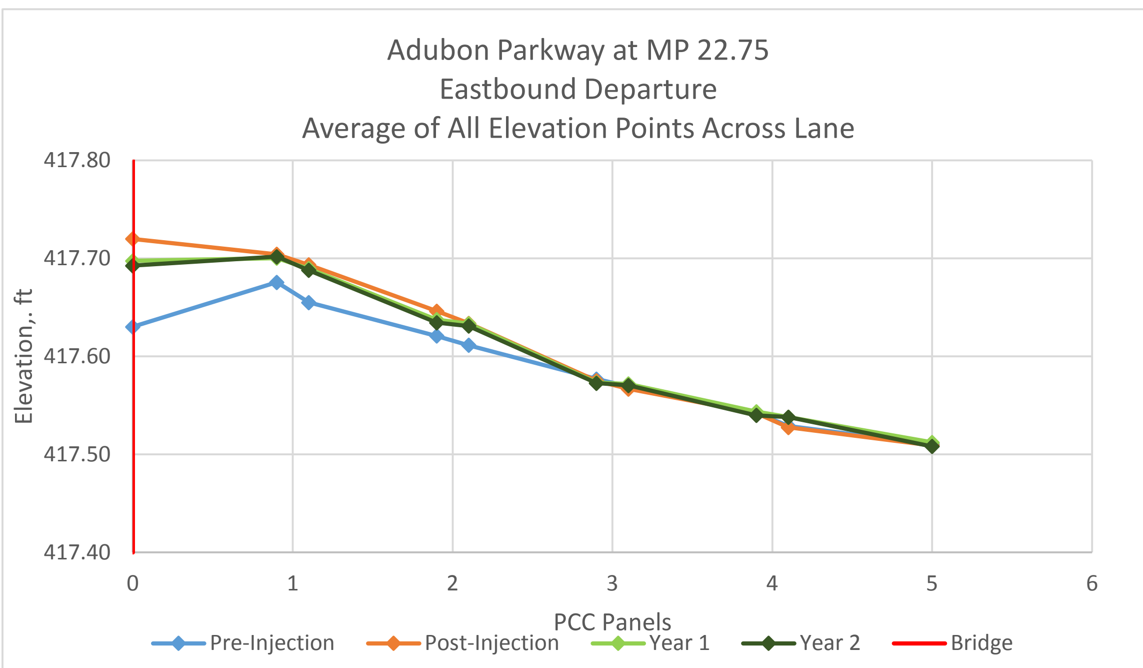

Figure 19 Average of All Elevation Points Across Lane at Bridge Departure

Westbound Approach & Departure
Elevation Evaluation

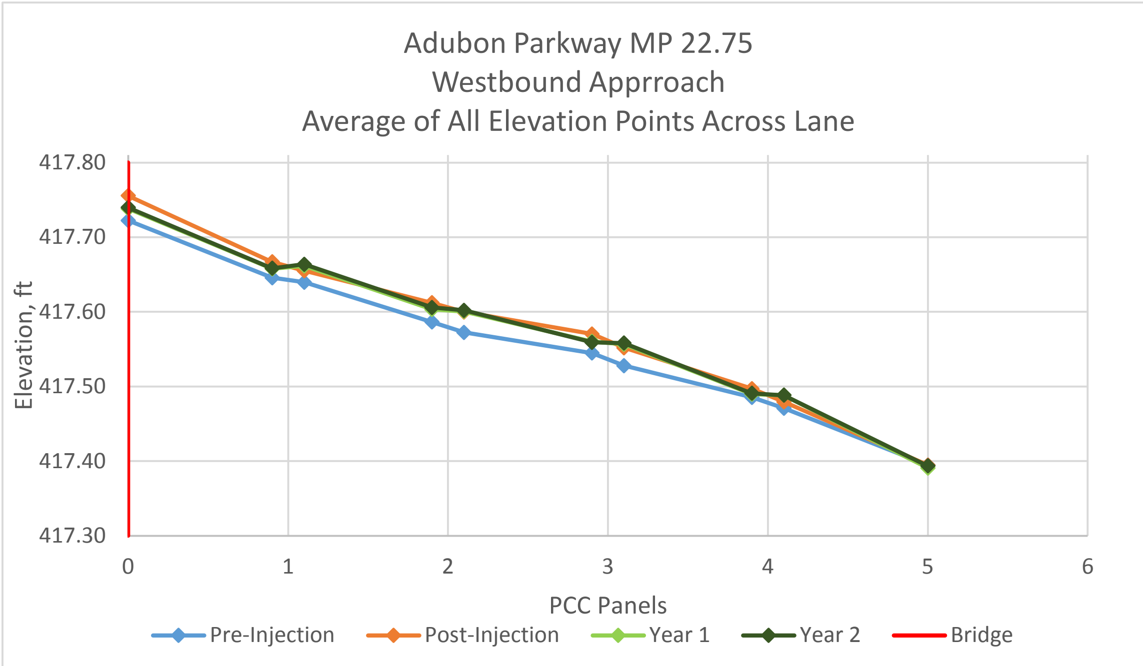

Figure 20 Average of All Elevation Points Across Lane at Bridge Approach

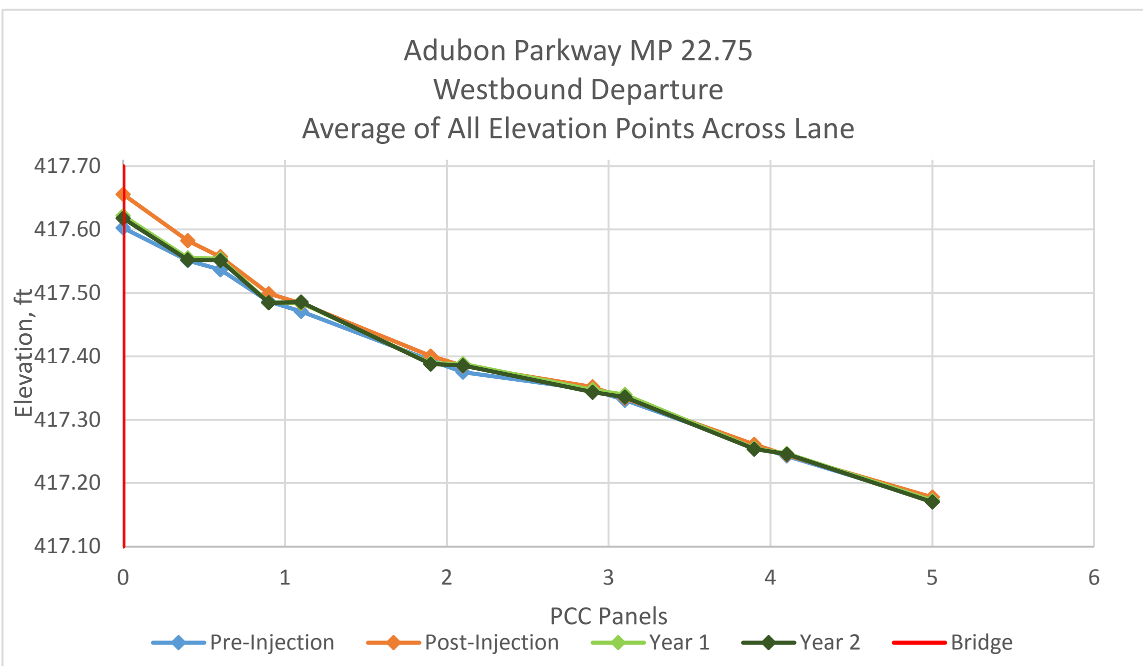

Figure 21 Average of All Elevation Points Across Lane at Bridge Departure