A new Route 66 bridge provides safe passage over Oklahoma's Turner Turnpike.

Get Your Kicks Under ROUTE 66

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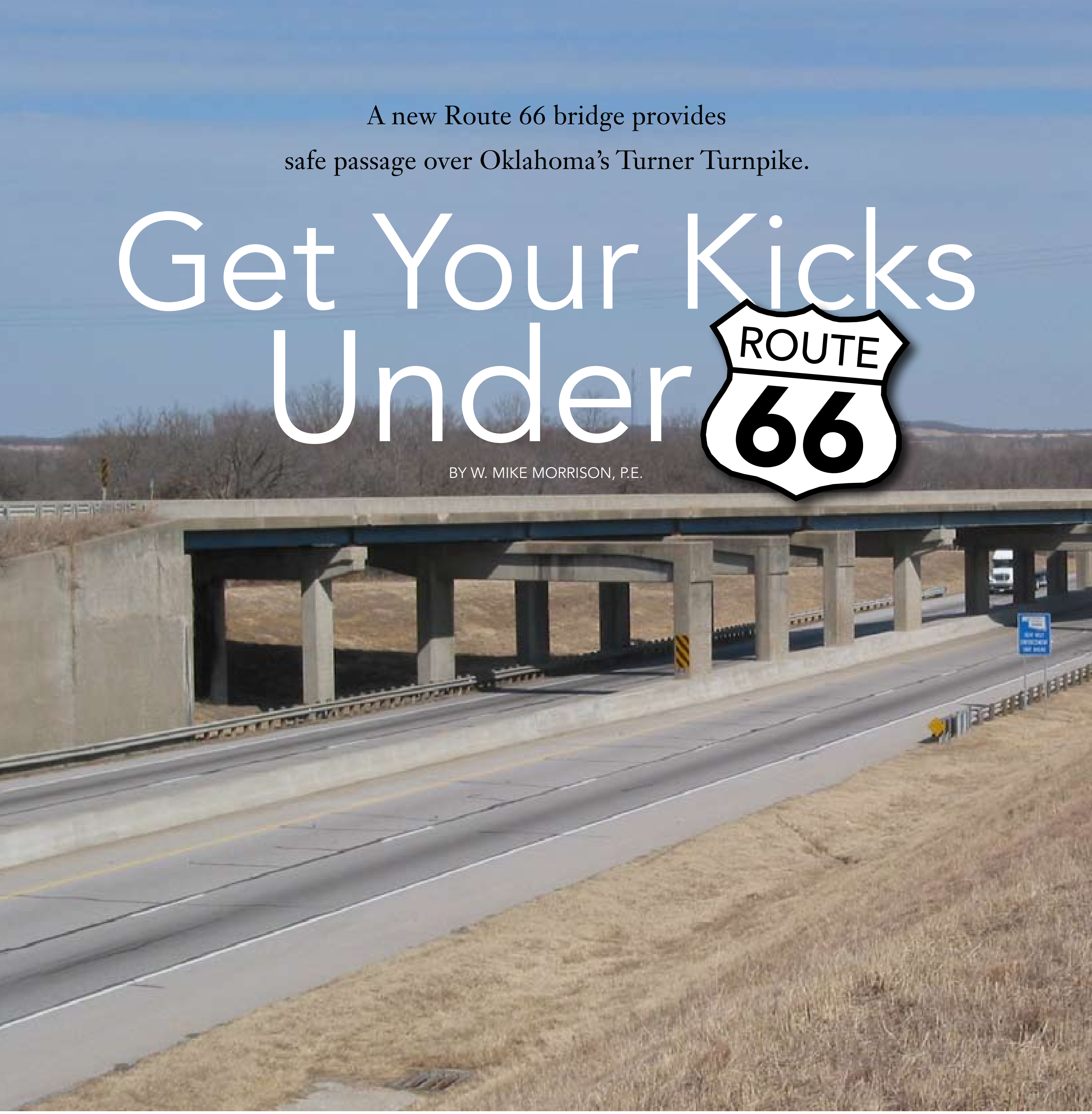

THE TURNER TURNPIKE has provided a link between Oklahoma's two largest cities for nearly six decades.

Opened to traffic in 1953 and assigned the Interstate 44 designation between Oklahoma City and Tulsa, the four-lane, 86-mile stretch was constructed in roughly 30 months at a cost of $38 million.

With traffic volumes increasing every decade since the corridor's opening, the Oklahoma Turnpike Authority (OTA) began planning for a six-lane widening of the Turnpike in the early 1990s. Several ideas were studied—including the environmental, utility and right-of-way impacts—and presented in a 1995 report suggesting an offset alignment, parallel to and north of the existing alignment, with a wider median and a six-lane typical section. Several major bottlenecks along the Turnpike were also identified, including the Route 66 Bridge (Bridge 68.2) that crosses the Turnpike in Creek County, known locally as the "Grasshopper Bridge" due to its staggered piers.

When it opened to traffic, the Turner Turnpike essentially replaced historic Route 66, crossing the original highway at several locations. At this location, Route 66 crosses the Turnpike on a very sharp 16° angle, which required a fairly long bridge, 423 ft, using somewhat unconventional straddle-beam


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➤ The original bridge crossed the Turner Turnpike on a 16° angle. The staggered pier columns prompted its nickname, the "Grasshopper Bridge."

➤ The new bridge crosses the Turnpike on a 30° angle, supported by four steel plate girder spans.


Steve Cilberg, OTA

piers to clear the Turnpike below. The original bridge was comprised of 11 steel I-beam spans, ranging from 35 ft to 54 ft in length, resting on two vertical abutments and ten piers, eight of which straddled the Turnpike in four locations on each side of the highway.

With overhead pier caps and columns along both shoulders and down the median, driving through the original bridge resembled driving through a tunnel, with only approximately 6 ft and 15 ft of lateral and vertical clearances, respectively. The limited overhead clearance resulted in several of the straddle beam pier caps being struck by tall vehicles, causing major concrete damage and exposing the main reinforcing steel. The bridge geometrics on Route 66 were also limited, with two lanes of traffic on a 28-ft-wide roadway. The existing bridge was unsafe for both throughways and because of the collision damage, it was labeled structurally and geometrically deficient, with a sufficiency rating of 42.4 (out of 100). The Grasshopper Bridge would have to be replaced.

The OTA put the widening plan to rest for several years before reconsidering the idea in the early 2000s. The first portion of the project began near Tulsa, with the replacement of one of the larger bridges in that area. Following that project, with the Grasshopper Bridge being the next major bottleneck to the west, the OTA hired W2M Consulting in 2006 to perform a design study and prepare the final design for its replacement.

The primary objective of the OTA was to design a grade separation that would meet current design standards and significantly improve the lateral and vertical clearances along the Turnpike, while also accommodating for the future widening. One of the first courses of action was to determine whether the existing bridge had any historical significance due to its odd configuration and for its location on Route 66. Fortunately, the bridge was not listed on the National Register of Historic Places, nor was it registered or eligible in the Oklahoma Department of Transpor-

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▲ Roadway view along the new bridge deck. Note the reverse superelevation transition near the middle of the bridge.

▼ View below span 3, showing the five girder lines with inverted K braces and the drainage collection system.

tation (ODOT) publication *Spans of Time*, so it could be removed without raising historical concerns.

Four options were developed for the realignment of Route 66 at this location. Full lateral clear zones, with safety slopes, were incorporated along the Turnpike, using a six-lane configuration with a minimum vertical clearance of 16 ft, 9 in. over the Turnpike.

Alternates 1 and 2, based upon the suggestion in the 1995 report, offset the new bridge to the southwest of the existing bridge on a more appropriate skew angle, the only difference between the two options being the degree of curvature (1°30' and 2°) for the horizontal curves on Route 66 approaching the bridge. Both options included a 60° skewed bridge with spans of 104 ft, 162 ft, 162 ft and 104 ft.

Since Route 66 was on a straight alignment for nearly two miles in each direction from the bridge, the design team also felt obligated to provide an option for reconstructing the bridge on the existing alignment. However, this option would have required closing Route 66 for construction since there was no feasible method for staging the construction efforts around the existing bridge. Because of the lateral constraints along the Turnpike, the required bridge length for this option was much longer, 618 ft, with essentially the same substructure configuration as the existing bridge (straddle-beam piers). This option was listed as Alternate 4, using two three-span continuous units of 94 ft, 121 ft and 94. Alternate 3 incorporated the same substructure configuration as Alternate 4, but on a 100-ft offset and parallel alignment to the south of the existing highway that allowed construction without closing the existing bridge. Alternate 3 also used two three-span continuous segments, but with span lengths of 107 ft, 101 ft and 101 ft. Due to conflicts with the existing foundations, though, the span arrangements for Alternate 3 were not as practical for design economies as the layout for Alternate 4. Nevertheless, it was the only viable layout for the offset and parallel option.

Through several meetings with the OTA and ODOT, Alternates 3 and 4 were discarded in favor of Alternate 2: the southwest offset alignment on a 30° crossing with longer radius horizontal curves. The major factor in not selecting Alternates 3 or 4 was the straddle beam pier caps, as they were deemed "fracture critical" components, as opposed to the more conventional piers that would be placed parallel to the Turnpike in Alternate 2.

The allowable superstructure depth and the grades on both the Turnpike and Route 66 played a large role in determining the girder types for the different bridge configurations. Both facilities were already on fairly mild downward grades with very good site distances. However, the Turnpike grade could not be changed, leaving all the grade modifications to the profile on Route 66. With the already low clearance to the Turnpike, the girders had to be as shallow as possible to lessen the grade impact on Route 66. For the span lengths involved in all four options, steel was the only viable material for minimizing the superstructure depth. A two-span bridge was considered, but it required considerably deeper steel members or post-tensioned concrete box girders up to 12 ft, 6 in. deep that simply would

◄ Channel and plateend diaphragms at an expansion pier.

not work geometrically. Shorter spans for using prestressed concrete beams were also considered, but those options were discounted due to the skew of the crossing and the substructure conflicts along the Turnpike. A four-span, steel bridge, again on a 30° crossing, was clearly the best arrangement.

After being asked to relax the clear zone requirements to reduce the overall bridge length, the final configuration was established at four spans of 112 ft, 136 ft, 136 ft and 112 ft, using a 40-ft clear roadway on the bridge with F-shaped concrete parapets. The outer spans were designed as simply supported while the two interior spans were made continuous across the middle pier. And although the bridge is straight, a reverse super-elevation transition was required directly over pier 2 between the reverse horizontal curves on each end of the bridge.

The steel design was based on the 4th Edition LRFD *Bridge Design Specifications* using the HL-93 and the ODOT policy "Oklahoma Overload Truck." Five steel plate girders on 9-ft centers with an 8-in. concrete slab comprise the superstructure on a -0.6% grade along the length of the bridge. Grade 50W steel was provided with constant depth 54-in. webs and 18-in. flanges of varying thicknesses. Inverted K braces were provided perpendicular to the girders throughout the bridge, and channel and plate diaphragms were provided at the abutments and expansion piers 1 and 3, along the skew. In addition, bolted field splices were designed and detailed at the dead load contra-flexure points on either side of pier 2 in the two-span continuous unit.

Deck drainage was also a critical design issue as runoff water was not allowed to fall to the Turnpike below. With a reverse super-elevation transition over the middle pier and the bridge on a constant down grade, runoff water had to be collected and removed from the bridge. In addition, runoff water had to be collected along each gutter line because had it been allowed to cross the roadway over pier 2 (at the super transition point), more than an inch of water would have been crossing the highway at the design flow rate. The overall project included a 496-ft-long, four-span bridge, 3,925 ft of realignment on Route 66, 3,324 ft of county road realignment and the extension of a double cell bridge box at the eastern end of the project. It was completed this spring at a cost of $8.9 million and involved 375 tons of structural steel. MSC

Author's note: This article is dedicated to the memory of my wife's grandfather, John W. Stakle, project engineer with De Leuw, Cather and Company (general consultant to the OTA) during the original design and construction of the Turner Turnpike.

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