DESIGN MEMORANDUM FOR
STRUCTURAL REPLACEMENT OF THE MERCHANTS BRIDGE WEST APPROACH

PROJECT DESCRIPTION

Terminal Railroad Association (TRRA) of St. Louis wishes to replace the west approach spans of the Merchants Bridge. The main spans of the bridge cross the Mississippi River just north of downtown St. Louis, Missouri, and the west approach services numerous industries and railroads to the north, south, and southwest of the river crossing. The structure dates back to 1903, and consists of a series of deck girder spans that are supported atop steel bent towers. It consists of a wye with two branches that merge from the north and south into a single structure approaching the main river spans.

In 2005, just over five hundred feet of the west approach structure, directly adjacent to the main spans, was replaced due to deterioration and maintenance concerns. Recent inspections of the remaining approach spans have identified a substantial number of steel defects, ranging in severity from moderate to critical. The goal of this project is to replace the remaining portion of the west approach, extending west to the north and south abutments.

Currently, the bridge carries large volumes of heavy freight rail traffic. The overall length of structure to be replaced is approximately 1,700 feet, including 360 feet on approach to the main spans, with an additional 610 feet accessing the north abutment, and an additional 730 feet accessing the south abutment.

One of the objectives of the project is to accommodate a future high-speed rail line that would service the downtown St. Louis region. The new structure will be constructed on an alignment that is similar to that of the existing structure, with the exception that the south approach leg will be realigned slightly southward to provide the required curvature for future high-speed rail operations.

PARAMETERS

In 2005, TRRA completed the construction of replacement spans for a portion of the west approach located directly adjacent to the main river spans. These spans were constructed using an open-deck, steel plate girder superstructure atop concrete bents, which are supported on micropile foundations. The new structure will be constructed similar to the spans that were built in 2005, with the exception that the new structure will support ballasted track in lieu of open-deck track. The structure will transition from open deck to ballasted deck where the proposed construction abuts the 2005 construction.

Except as noted herein, the design of the structure will conform to the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering. The new structure will be constructed for a design speed of 30 MPH, and will allow for the future widening of track centers from the existing twelve-foot spacing to fourteen-foot spacing. Both the north and south branches of the approach will accommodate two tracks to match the current construction. However, only one track of the north leg will be placed at this time, leaving the adjacent track bed open for future expansion of the north branch.

TRRA wishes to maintain traffic to the greatest extent possible during the construction of the replacement spans. This will require a phased approach to construction in which everything below track level will be constructed under traffic, prior to taking any tracks out of service. When the contractor is prepared to replace the spans, the existing tracks will be taken out of service, one at a time, in order to maintain service along at least one track at all times. TRRA will consider a full closure of the single track along the north leg of the approach for a limited period of time.

ENVIRONMENTAL

The Missouri Department of Transportation (MoDOT) has agreed to handle the National Environmental Policy Act (NEPA) submittal. The NEPA process will need to be completed prior to the start of final design.

GEOTECHNICAL INVESTIGATION

In agreement with MoDOT and the Federal Railroad Administration (FRA), the geotechnical investigation for this project will be deferred to the final design phase. It is anticipated that the foundations for the proposed structure will extend to bedrock, which is expected to range in depth from approximately thirty feet to seventy feet.

FOUNDATIONS

Due to the constraints of the project, the foundations will have to be largely installed beneath the existing structure, and the loads will require that they be socketed into bedrock. Therefore, micropiles are being proposed as the most feasible option, though drilled shafts may also be considered. A system of anywhere from fifteen to twenty-one piles are expected to be installed at each bent location, depending on the required capacity, which is primarily affected by the adjacent span lengths and the number of tracks carried.

SUBSTRUCTURE

Since the footings and bent walls will be built while the existing structure is in place and in service, it is being proposed that the new bents should be constructed between the existing bent towers. The bents would consist of a largely rectangular footing, bent wall, and bent cap with relatively simple geometry.

The footings are expected to be approximately 22 feet longitudinally, and would vary in the transverse direction. The transverse dimension would range from 40 feet at typical sections to 70 feet, as necessary, to accommodate the width of the structure as the north and south legs diverge. The bent walls would be approximately seven feet thick, and the transverse dimension would vary from 30 feet at typical sections to 60 feet, as necessary, to accommodate the width of the structure as the north and south legs diverge. The bent caps will match the thickness of the bent walls, with a cantilever of two to four feet at each end. The combined height of the wall and cap will be such that it can be constructed below the existing steel.

The north and south abutments will be constructed similar to the existing abutments. However, to expedite the transition of traffic from the old structure to the new, they will be built in front of the existing abutments. The area between the new and existing abutments will be backfilled in a traditional manner, or using flowable fill. A portion of the backwall will be removed from the existing abutment during the track outage in order to prevent a hard spot from developing in the approach subgrade for the new track.

SUPERSTRUCTURE

The proposed superstructure will consist of a concrete ballast trough carried atop multiple steel beams. Along the common alignment, the cross section will include ten steel girders and a nominal concrete ballast trough that is 34 feet wide.

As the north and south branches diverge, additional steel beams will be added to widen the structure up to the point where the two branches separate. The ballast trough will be widened accordingly. At the point where the two branches separate, the cross section will return to a ten girder system for each of the two branches. The spans will be chorded through the curves. The steel girders will be made from ASTM A588 Grade 50 weathering steel.

Two spans, one each near the north and south leg abutments, will be moderately longer than the other spans of the approach structure. The span along the north alignment will be approximately 112 feet in length in order to span a 78-inch reinforced concrete combined sewer. The span along the south alignment will be approximately 95 feet in length in order to span Ferry Street. Both of these spans will incorporate an eight

girder cross section with slightly deeper beams. The width of the ballast trough will match that of the adjacent spans.

The ballast trough will include two-foot tall curbs at each edge to retain the ballast, and a 42-inch handrail constructed of angle iron and steel cable. The ballast trough will be non-composite with the supporting girders, but positively connected to inhibit movement. Extra space is provided outside the track limits on each side of the deck for walkways, and to facilitate removal and replacement of the ties, and as needed, the trough will be widened slightly to maintain this space along the curved segments of the north and south approach legs. The concrete deck will be composed of a series of precast panels, and it is expected that the precast panels will be either prestressed or traditionally reinforced. Waterproofing and drainage of the ballast trough will be provided in conformance with the recommended practices outlined in AREMA.

One of the objectives of the preliminary span design was to minimize the depth of the superstructure in order to avoid conflicts with the existing cross girders during staged construction. This would allow the existing substructure to remain serviceable as the first of the two tracks is taken out of service. To accomplish this goal, the preliminary spans were not designed in the most economical manner. Final design of the structure should include some consideration for optimizing the span depths, and evaluating the ramifications that a deeper superstructure will have on the desired approach to staged construction.

EXISTING STRUCTURE MODIFICATIONS

In order to place the new approach spans while the existing structure carries at least one track of traffic, the existing substructure will need to be modified or temporarily supported to some extent. While it may be possible to avoid substructure modifications in some cases by limiting the depth of the superstructure, it should be expected that part of the final design will include some sort of temporary measure that will allow the existing structure to support one track of traffic while the other is taken out of service.

TRACK

The new approach spans will be constructed with a ballasted track system. The track structure will consist of new 136-pound continuously welded rail, new OTM, and new nine-inch by nine-inch by ten-foot long wood ties. The ballast section will consist of twelve-inch ballast shoulders with the initial ballast depth (top of tie to top of deck) being seventeen inches, and allowing for a future depth of twenty-four inches. Ballast material will be granite mainline ballast for the track structure with walkway ballast located between the tracks.

The existing #10 turnout (20mph), and #12 crossovers will be relocated eastward and replaced with a new #15 turnout (36mph) and #15 crossovers to increase the allowable speed limit through the turnouts. The eastern crossover will be relocated to the approach spans that were constructed in 2005, and will require a retrofit using jack stringers to accommodate the crossover move between the tracks. These jack stringers and the supported crossover will be installed in the early stages of the project to allow access to either track from the main spans throughout the duration of the construction.

SIGNALS

The existing wayside signals, power switch machines and signal cable will be removed from the existing structure by TRRA forces. The signal control bungalow on the ground along Ferry Street will also be moved to facilitate construction. Upon completion of construction, TRRA forces will return the signals and power operated switch machines to the structure. New signal cable will be installed from the relocated signal control bungalow to the track circuits, signals, switch heaters and power operated switch machines on the new structure. New PTC train control equipment will be installed in the signal control bungalow.

UTILITIES

There are a number of utilities that will be affected by the construction of the new west approach structure, and it is expected that the cost of relocating the affected utilities will be quite significant. As proposed, several fiber-optic lines, a gas line, a water line, and an underground electric line will need to be permanently relocated. Overhead electric distribution lines will need to be relocated, as will TRRA signal services, both of which can be resituated at the completion of construction. There are high voltage power lines just beyond the east end of the project limits, which Ameren has stated can only be taken out of service during periods of low demand. It is assumed that these lines will not be affected.

There is a large, abandoned and obsolete brick sewer that runs down the center of Ferry Street. It is our understanding that this utility is under the jurisdiction of MSD. However, MSD has made no remarks on their desire to protect this utility during construction of the new approach spans. For the preliminary design, it has been assumed that the bridge foundations and footings can be constructed with no need to avoid this utility. If necessary, it is feasible to redesign the bridge foundations and footings to span this sewer.

Before commencing construction, an in-depth subsurface investigation should be performed in order to more precisely locate the utilities that may potentially be affected by the new structure. Ideally, this work should be performed prior to the completion of final design.

FERRY STREET

Construction of the new structure and its proximity to Ferry Street will undoubtedly interrupt traffic and access during construction. Traffic through the area is extremely limited as the street dead-ends at railroad tracks that are located just beyond the east end of the proposed project limits.

The new structure will intrude upon the existing alignment of Ferry Street. While the City of St. Louis does want to maintain the street after construction, they have not expressed any objection to a slight realignment of the street. The current street is a gravel road, and is expected to be replaced as such. The overhead clearance for the span over Ferry Street at the south leg of the approach will be either maintained or improved.

Both Lange-Stegmann and MSD have access roads off of Ferry Street. Lange-Stegmann rarely uses their access road, and has only requested advanced notification of any closure or blockage of the road. MSD will be constructing facilities at their Bissell Point Plant, which is scheduled to begin in the summer of 2012. Therefore, they are requesting that access to their facility via the south access road be maintained for regular construction traffic at all times. They would be agreeable to relocating the access point as long as it is maintained. Infrequent oversize or otherwise atypical construction traffic can access the plant via the main entrance off of Hall Street.

CONSTRUCTION STAGING

Construction staging will need to be coordinated with the Metropolitan St. Louis Sewer District (MSD). The area directly to the south of the bridge is owned by Lange-Stegmann of St. Louis, and has been designated as a brownfield site. In addition, the northeast corner of their property has been designated as historically significant. It is recommended that this property be altogether avoided during construction in order to avert any arduous and time-consuming environmental requirements.

MSD has stated that they would allow access to their property, within reason, for construction operations. They have a fenced parcel of land at the southwest end of the bridge, which is currently fenced in with an access gate. They would like to keep the area fenced and locked at all times during construction, and returned to its original condition at the conclusion of the work. To the north of the structure, MSD has additional property that could be used. This property lies between the bridge and the MSD Bissell Point treatment facility settling basins. By law, the basins shall remain fenced in at all times. MSD has expressed a willingness to allow their fence to be relocated, as long as it is replaced in its original location and condition following construction.