Appendix A

KCSRC Bridge Demolition Checklist

Appendix A

KCSRC Bridge Demolition Checklist

1. All materials removed to outside Railroad right-of-way. Work site neat and safe.
2. No work within 50 ft. while trains pass the work area.
3. Flagman required when work is performed on Railroad right-of-way.
4. Plan and elevation of bridge and all access road locations.
5. Location of Railroad tracks noted and type of track noted.
6. Bridge removal sequence noted.
7. Type of equipment, number and location noted.
8. Clearances to temporary shoring noted.
9. Site drainage considered.
10. Details limits and location of protective covers.
11. Estimated time of removal of structures over tracks noted.
12. Utilities protected and noted.
13. Location and details of track crossing noted.
14. Limits of demolition of substructures (greater of 3 ft. below grade or 2 ft. below base of rail).
15. Details of on-site fire suppression.
16. Stability of existing structure checked (esp. removal of last girder).
17. Plans sealed by registered engineer. Inspection of shoring, bracing and protective covers noted in documents and certifications on site.
18. Coordination with railroad noted.
19. Work progress reviewed and logged by Contractor's Engineer and any deviations noted to KCSRC
20. Debris and equipment moved a minimum distance of 8 ft.–6 in. from nearest rail during train passage, and to an elevation no higher than the top of rail. Debris and equipment are to be moved a minimum distance of 10 ft.-0 in. from nearest rail and down to original grade at the end of the day.
21. Track protection acceptable.
22. No construction equipment permitted on tracks, unless protected.
23. Temporary track crossing for haul roads meet KCSRC standards and placement scheduled with Road master.
24. Track protection required for all equipment operating within 25 ft. of tracks, including rubber-tired equipment.

25. Crane capacity sufficient.
26. Crane mats submitted for comment.
27. Protective covers extend 20 ft. beyond the edge of the structure.
28. Geo fabric placed over existing ballast to keep fine demolition material from ballast.

Section IV

Design and Construction of Shoring Adjacent to and on Railroad Right-of-Way

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Design and Construction of Shoring Adjacent to and on Railroad Right-of-Way

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Appendix A
Shoring Design Checklist

Appendix B
Drawing No. 005106 General Shoring Requirements

Chart A – Boussinesq Surcharge Pressure Due to E-80 Live Load (psf) for Shoring Parallel to the Track

AREMA Figure 8-20-1 Lateral Pressure Diagrams
AREMA Figure 8-20-2 Pressure Distribution for Strip Load
AREMA Figure 8-20-3 Pressure Distribution for Line Load

1. Scope

The scope of this guideline is to inform public Agencies, design engineers, Contractors and inspectors KCSRC current standards and requirements concerning the design and construction of temporary shoring, supporting active Railroad tracks.

The term Contractor is defined as any party gaining access to work on KCSRC right-of way or other operating locations.

These guidelines supplement the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual of Recommended Practice.

The specific requirements for shoring addressed in this document shall be followed for all locations that KCSRC operates on FRA track Class 1 through 5, regardless of track ownership.

Safe rail operations shall be required for the duration of the project. The Railroad's personnel, tracks and property shall be protected at all times.

To expedite the review process of shoring plans, it is required that the drawings submitted by the Contractors adhere to the project specifications, AREMA and other KCSRC requirements.

2. General Criteria

The Contractor must not begin construction of any component of the shoring system affecting the Railroad Right-of-Way until such time that the Railroad approval has been received.

2.1 The Contractor shall be responsible for planning and executing all procedures necessary to construct the shoring in a safe and controlled manner. Before work can begin on the Railroad right-of-way, the Agreement between the Railroad and the Owner must be fully executed; the Contractor must obtain a right-of-entry permit and understand all railroad requirements. All structures that support or impact the Railroad tracks or operations, shall be designed and constructed to provide safe and adequate rigidity.

2.2 The Railroad requirements, construction submittal review times and review criteria should be discussed at the pre-construction meeting with the contractor.

2.3 A flagman is required when any work is performed on Railroad right-of-way. If the Railroad provides flagging or other services, the Contractor shall not be relieved of any responsibilities or liabilities as set forth in any document authorizing the work. No work is allowed within 50 ft. of the nearest rail when a train passes the work site and all personnel and equipment must clear the area within 25 ft. of track centerline when trains are present.

2.4 All removed materials will become the responsibility of the Contractor and shall be disposed of outside the Railroad right-of-way at no expense to the Railroad.

2.5 Appropriate measures for the installation and protection of fiber optic cables shall be addressed in the plans and contract documents.

2.6 Relocation of non-Railroad owned utilities or communications lines shall be coordinated with the owners and submitted to KCSRC Real Estate Department for handling. The design plans must show all underground and overhead utilities.

3. Specifications

3.1 AREMA specifications are available at:

American Railway Engineering and Maintenance-of-Way Association
8201 Corporate Drive, Suite 1125
Landover, MD 20785-2230
Phone: 301.459.3200 / Fax: 301.459.8077
www.arema.org

3.2 The following KCSRC Guidelines shall be used in conjunction with this document during the design and construction of structures:

Underpass Structures – *"Guidelines for Design and Construction of Grade Separation Underpass Structures."*

Overhead Grade Separation – *"Guidelines for Design of Highway Separation Structures over Railroad (Overhead Grade Separation)."*

Demolition – *"Guidelines for Preparation of a Bridge Demolition and Removal Plan for Structures over Railroad."*

4. Contractor Responsibility

The Contractor shall be solely responsible for the design, construction and performance of the temporary structure (AREMA 8.28.1.3)

4.1 The Contractor's work shall in no way impede the train operations of KCSRC and must be coordinated with the local operating department and Road master.

4.2 The Contractor shall develop a work plan assuming that track windows will not be available.

4.3 The Contactor's responsibility includes compliance with all state and Federal laws, county or municipal ordinances and regulations, which in any manner affect the work.

4.4 The Project Engineer for the Contractor shall evaluate the quality of materials furnished and work performed. It is ultimately the Contractor's responsibility to properly evaluate the quality of materials and the work performed.

4.5 The Contractor must monitor and record top of rail elevations and track alignment for the duration of the project.

5. Information Required

Shoring system design plans and calculations shall be in English units. If Metric units are used, all controlling dimensions, elevations, design criteria assumptions, and material stresses shall

be expressed in dual units, with English units to be in parentheses. Information shall be assembled concerning right-of-way boundary, clearances, proposed grades of tracks and roads, and all other factors that may influence the controlling dimensions of the proposed shoring system. All shoring plans, sections and details shall be drawn to scale and the scale shown.

5.1 Field Survey

Sufficient information shall be furnished in the form of a profile, cross-sections and topographical maps to determine general design and structural requirements. Existing and proposed grades and alignment of tracks and roads shall be indicated together with a record of controlling elevation of water surfaces or ground water. Indicate location of existing/proposed utilities and construction history of the area which might hamper proper installation of the piping, soldier beams, ground anchors, depth of scour or allowance for over-dredging.

5.2 Soil (AREMA 8.22.3.1.1)

For a new structure, the site investigation shall provide sufficient information to determine:

5.2.1. Location of groundwater level, at least to the extent that it is within the zone of influence, beneath the footing.

5.2.2. Bearing capacity of the soil.

5.2.3. Data on soil and/or rock properties relative to shallow and deep foundations.

5.2.4. Settlement predictions.

5.2.5. Selection of alternative types and/or depth of foundations.

5.2.6. In seismic area, evaluation of liquefaction potential of various soil strata.

5.2.7. Global site stability (massive earth movements).

5.2.8. Any backfill material required shall be specified and the method and amount of compaction or consolidation shall be shown on the drawings. All backfill shall be, at a minimum, suitable for railway embankment fill.

5.3 Loads (AREMA 8.20.2.3)

5.3.1 All design criteria, temporary and permanent loading, boring and laboratory test results, and properties of construction materials, including yield stress, should be clearly stated in the design calculations and on the contract and record plans. Temporary loads include, but are not limited to: construction equipment, construction materials, and lower water levels adjoining the bulkhead causing unbalanced hydrostatic pressure. Permanent loads include, but are not limited to: future grading and paving, Railroads or highways, structures, material storage piles, snow and earthquake.

5.3.2 The allowable live load after construction should be clearly shown in the plans and painted on the pavements behind the bulkheads or shown on signs at the site and also recorded on the record plans.

5.3.3 The "loads" listed above are external to the total bulkhead system. There are also internal effects that are treated as loads in the design of individual members of the bulkhead system. These internal loads are active and passive soil pressures, acting separately or combined algebraically, saturated or dry as appropriate, for granular or cohesive soil or a combination thereof.

5.4 Drainage (AREMA 8.20.2.4)

5.4.1 The drainage pattern of the site before and after construction should be analyzed, and adequate drainage provisions incorporated into the plans and specifications. Consideration should be given to under-drainage as well as surface drainage.

5.4.2 Drainage provisions for backfill should be compatible with the assumed water conditions in design.

5.5 Structural Design Calculations

5.5.1 Computerized calculations and programs must clearly indicate the input and output data. List all equations used in determining the output.

5.5.2 Handwritten calculations must be provided to support computerized output.

5.5.3 A simple free body diagram showing all applied loads on a temporary shoring system should be included.

5.5.4 Documents and manufacturer's recommendations which support the design assumptions must be included with the calculations.

5.6 Work Plan

A work plan that includes the following shall be submitted:

5.6.1 Time and date when the track is requested to perform work.

5.6.2 Time and date when no work will be performed.

5.6.3 Anticipated date to begin shoring installation.

5.6.4 Anticipated date to remove shoring.

Note: While driving piles, track time will be necessary as the leads may foul the tracks in the event of a mechanical failure or operator error.

6. General Shoring Requirements

For general shoring requirements and specific applications of the following items refer to Drawing 005106 "General Shoring Requirements".

6.1 Evaluate existing slope and stability conditions to ensure the railroad embankment will not be adversely affected.

6.2 Lateral clearances must provide sufficient space for construction of the required standard ditches parallel to the standard roadbed section. The size of ditches will vary depending upon the flow and terrain and should be designed accordingly.

6.3 For main line and branch track, no excavation shall be permitted closer than 12'-0", perpendicular distance, from the centerline of track to the trackside of shoring system. For industry track, no excavation shall be permitted closer than 7'-0". If existing conditions preclude the installation of shoring at the required minimum distance, the shifting of tracks or temporary removal of tracks shall be investigated prior to any approval. All costs associated with track shifting or traffic interruption shall be at Contractor's expense.

6.4 Vertical overhead clearance from the top of the rail to temporary shoring shall be a minimum of 21'-0".

6.5 All shoring within the limits of Zone A or Zone B must be placed prior to the start of excavation.

6.6 The top of the shoring wall must have an elevation equal to or greater than the elevation required to meet the limits of Zone B.

6.7 Shoring types which place lagging elements as the excavation proceeds are not permitted within the limits of Zone A.

6.8 Standard handrails, fence, or other barrier methods meeting OSHA and FRA requirements must be used around open excavations on or near Railroad right-of-way.

6.9 The most stringent project specifications of the Public Utilities Commission Orders, Department of Industrial Safety, OSHA, FRA, AREMA, KCSRC or other governmental agencies shall be used.

6.10 Second-hand material is not acceptable unless the Engineer of Record submits a full inspection report, which verifies the material properties and condition of the second-hand material. The report must be signed and sealed by the Engineer of Record.

6.11 If cantilever sheet pile is used for shoring adjacent to any operating track the shoring system should be at least twelve (12) feet away from the centerline of track and its maximum height shall not exceed ten (10) feet from the base of the excavation to the top of Zone "B". Cantilever sheet pile walls shall be used only in granular soils or stiff clays. Material at the excavation line, near the bulkhead, shall be kept free of water and shall not be disturbed by men or equipment. If the above conditions cannot be met, cantilevered sheet pile shoring shall not be used.

6 12 All components of the shoring system are to be removed and all soil voids filled. The Contractor may request to abandon in-place specific elements of the shoring system, which are a minimum of six (6) feet below grade provided specific justifications are given.

6.13 Slurry type materials are not acceptable for soldier beams in drilled holes. Concrete and flowable backfill will prevent removal of the shoring system.

7. Types of Shoring

7.1 The following shoring systems are acceptable for use where KCSRC equipment is operating. Definitions are included for clarity from AREMA 28.1.4.1.

7.1.1 A cantilever sheet pile wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the sheet pile is embedded.

7.1.2 An anchored sheet pile wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the sheet pile is embedded and the tensile resistance of the ground anchors.

7.1.3 A cantilever soldier beam with lagging wall is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the soldier beam is embedded.

7.1.4 An anchored soldier beam with lagging wall is a structure designed to provide lateral support or a soil mass and derives stability from passive resistance of the soil in which the soldier beam is embedded and the tensile resistance of the ground anchors.

7.1.5 For purposes of these specifications, soldier beams include steel H-piles, wide flange sections or other fabricated sections that are driven or set in concrete in drilled holes. Lagging refers to the members spanning between soldier beams.

7.1.6 For purposes of these specifications, ground anchors shall be cement-grouted tiebacks designed, furnished, installed, tested and stressed in accordance with these specifications.

7.1.7 Anchored soldier beams with lagging walls are generally designed as flexible structures, which have sufficient, lateral movement to mobilize active earth pressures and a portion of the passive pressure.

7.1.8 A braced excavation is a structure designed to provide lateral support for a soil mass and derives stability from passive resistance of the soil in which the vertical members are embedded and from the structural capacity of the bracing members.

7.1.9 For purposes of these specifications, the vertical members of the braced excavation system include steel sheet piling or soldier beams comprised of steel H-piles, wide flange sections, or other fabricated sections that are driven or installed in drilled holes. Wales are horizontal structural members designed to transfer lateral loads from the vertical members to the struts. Struts are structural compression members that support the lateral loads from the wales.

7.1.10 A cofferdam is an enclosed temporary structure used to keep water and soil out of an excavation for a permanent structure such as a bridge pier or abutment or similar structure. Cofferdams may be constructed of timber, steel, concrete or a combination of these. These specifications consider cofferdams primarily constructed with steel sheet piles.

7.2 Variance to use other shoring systems such as shoring box requires KCSRC Chief Engineer's review and approval. A shoring box is a prefabricated shoring system, which

is installed as the excavation progresses. Soil is typically removed from the inside of the shoring box. The shoring box is moved down into the excavation by gravity or by applying vertical loading from excavation equipment. This shoring system is not preferred by KCSRC. The system is allowed in special applications only where Railroad live load surcharge is not present.

8. Computation of Applied Forces

The following variables are used in the following section:

q = intensity of strip load (Live load) (in units of pounds per square foot)

$$q = \frac{80{,}000 \text{ lbs}}{(5 \text{ feet})(8.5 \text{ feet})}$$

Axle spacing = 5 feet

Typical tie length = 8.5 feet

γ = unit weight of soil

$$K_A = \tan^2 \left(45 - \frac{\phi}{2}\right)$$

$$K_P = \tan^2 \left(45 + \frac{\phi}{2}\right)$$

ϕ = angle of internal friction in degrees

α and β are angles measured in radians

8.1 Live load pressure due to E80 loading for track parallel to shoring system. Strip Load q (AREMA 8.20.3.2.2).

A continuous strip of surcharge load q (pounds per square foot) parallel to the bulkhead is shown in AREMA Figure 8-20-2 "Pressure Distribution for Strip Load" (See Appendix B). The intensity of pressure at a given point may be computed by:

$$P_S = \frac{2q}{\pi} (\beta + \sin\beta \sin^2\alpha - \sin\beta \cos^2\alpha)$$

Chart A provided in Appendix B shows the results of this equation for E80 live load. Overlapping surcharge live loads from the adjacent tracks are not cumulative.

8.2 Live load pressure due to E80 loading for tracks at right angle to the shoring system use the following equation to determine the applied loading:

$$P_s = K_A q$$

The entire load shall be taken as distributed uniformly on the surface of the ballast immediately below the tie, over a width equal to the length of the tie, typically 8.5 feet).

8.3 Active Earth Pressure Due to Weight of Backfill:

8.3.1 The active earth pressure due to the weight of the backfill may be computed by the Coulomb Theory and is represented in the loading diagram by Area 1, AREMA Figure 8-20-1 "Lateral Pressure Diagrams" (see Appendix B).

8.3.2 The active earth pressure at depth "z" is:

$$p_A = K_A \gamma z$$

z = depth of soil influencing the passive pressure

8.4 Active Earth Pressure Due to Unbalanced Water Pressure (AREMA 8.20.3.3)

8.4.1 When bulkheads are used for waterfront construction, the bulkhead is subjected to a maximum earth pressure at the low water stage. During a rainstorm or a rapidly receding high water, the water level behind the bulkhead may be several feet higher than in front, as shown in AREMA Figure 8-20-5. The unbalanced water pressure is represented by Area III in AREMA Figure 8-20-1 (see Appendix B).

8.4.2 Drained conditions in backfill apply when clean sand or clean sand and gravel, as defined in AREMA Article 20.2.5 are used and adequate permanent drainage outlets are provided. Where drained conditions exist, the design water level may be assumed at the drainage outlet elevation.

8.5 Active Earth Pressure Due to Surcharge Load

The active earth pressure due to a uniform surcharge load q (pounds per square foot) is:

$$p_u = K_A q$$

which is represented by Area II, AREMA Figure 8-20-1 (see Appendix B)

8.6 Passive Earth Pressure

The passive earth pressure, p_ρ, in front of the bulkhead may also be computed by the Coulomb Theory. This pressure is also shown in AREMA Figure 8-20-1 (see Appendix B)

$$P_\rho - K_\rho \gamma z$$

z = vertical distance not to exceed embedment depth.

8.7 Include and compute other loading that is impacting the shoring system.

9. Structural Integrity

Structures and structural members shall be designed to have design strengths at all sections at least equal to the required strengths calculated for the factored loads and forces in such combinations as stipulated in AREMA Chapter 8, Article 2.2.4, which represents various combinations of loads and forces to which a structure may be subjected. Each part of the structure shall be proportioned for the group loads that are applicable, and the maximum design required shall be used.

9.1 Stability (AREMA 8.20.4)

The stability requirements of AREMA 8.20.4 shall be met and shown in the submitted calculations. For well-defined loading conditions and thoroughly determined soil parameters, the minimum factor of safety is 1.3 (AREMA 8.20.4.1). Geotechnical investigations shall consider global stability and massive earth movements as shown in AREMA Figure 8-20-6.

9.2 Depth of Embedment

The total depth of embedment is equal to 1.3 times the minimum calculated depth of embedment. (AREMA 8.20.5.1).

9.3 The allowable stresses based on AREMA requirements are as follows:

9.3.1 Sheet Pile Sections – 2/3 Tensile Yield Strength for Steel (AREMA 8.20.5.7)

9.3.2 Concrete – 1/3 Compressive Strength (AREMA 8.20.5.7)

9.3.3 Structural Steel – 0.55 Fy Compression in extreme fiber (AREMA Ch. 15, Table 15-1-11, page 15-1-36, 2004 Edition)

9.3.4 Anchor Rods – 1/2 Tensile yield strength for steel (AREMA 8.20.5.7)

9.4 AISC allowances for overstressing due to temporary loading conditions are not acceptable.

9.5 Proposed deflections of temporary shoring system and top of rail elevation shall not exceed the following criteria in Table 1 below:

Table 1 – Deflection Criteria

Horizontal Distance from Shoring to Track CL	Maximum Horizontal Movement of Shoring System	Maximum Acceptable Horizontal or Vertical Movement of Rail
12' < X < 18'	3/8"	3/16"
18' < X < 24'	1/2"	1/4"

10. Soil Characteristics

10.1 Subsurface Exploration (AREMA 8.5.2.2)

10.1.1 Sufficient borings shall be made along the length of the structure to determine, with a reasonable degree of certainty, the subsurface conditions. Irregularities found during the initial soil boring program may dictate that additional borings be taken.

10.1.2 The subsurface investigation shall be made in accordance with the provisions of AREMA Chapter 8, Part 22, Geotechnical Sub-surface Investigation.

10.2 Type of Backfill (AREMA 8.5.2.5)

10.2.1 Backfill is defined as all material behind the wall, whether undisturbed ground or fill, that contributes to the pressure against the wall.

10.2.2 The backfill shall be investigated and classified with reference to the soil types described in Table 8-5-1.

10.2.3 Types 4 and 5 backfill shall be used only with the permission of the Engineer. In all cases the wall design shall be based on the type of backfill used.

AREMA Table 8-5-1. Types of Backfill for Retaining Walls

BACKFILL TYPE	BACKFILL DESCRIPTION
1	Coarse-grained soil without admixture of fine soil particles, very free-draining (clean sand, gravel or broken stone).
2	Coarse-grained soil of low permeability due to admixture of particles of silt size.
3	Fine silty sand; granular materials with conspicuous clay content; or residual soil with stones
4	Soft or very soft clay, organic silt; or soft silty clay.
5	Medium or stiff clay that may be placed in such a way that a negligible amount of water will enter the spaces between the chunks during floods or heavy rains

10.3 Computation of Backfill Pressure (AREMA 8.5.3.2.a)

10.3.1 Values of the unit weight, cohesion, and angle of internal friction of the backfill material shall be determined directly by means of soil tests or, if the expense of such tests is not justifiable, by means of Table 8-5-2 referring to the soil types defined in Table 8-5-1. Unless the minimum cohesive strength of the backfill material can be evaluated reliably, the cohesion shall be neglected and only the internal friction considered. (See Part 20, Flexible Sheet Pile Bulkheads, Table 8-20-3).

AREMA Table 8-5-2 Properties of Backfill Materials

Type of Backfill	Unit Weight Lbs. Per Cu.Ft.	Cohesion "c"	Angle of Internal Friction
1	105	0	33° 42' (38° for broken stone)
2	110	0	30°
3	125	0	28°
4	100	0	0°
5	120	240	0°

Loads exclusive of Earth Pressure (AREMA 8.5.3.1)

10.3.2 In the analysis of piers, retaining walls and abutments, due account shall be taken of all superimposed loads carried directly on them, such as building walls, columns, or bridge structures; and of all loads from surcharges caused by railroad tracks, highways, building foundations, or other loads supported on the backfill. Piers must also be designed for stream flow pressures as well as ice flow pressures and collision forces where applicable.

10.3.3 In calculating the surcharge due to track loading on an abutment and on wing walls that are in line with the abutment back walls, the entire load shall be taken as distributed uniformly on the surface of the ballast immediately below the tie, over a width equal to the length of the tie. With increased depth, the width for distribution can be increased on slopes of 1 horizontal to 2 vertical with surcharge loads from the adjacent tracks not being permitted to overlap.

10.3.4 To account for variability in backfilling and the dynamic effects of axle loads, abutment back walls above bridge seats shall be designed for earth pressures and live load surcharge increased by 100%. This does not apply to the portion of the abutment below the bridge seat or the stability of the abutment.

10.3.5 In calculating the surcharge due to track loading above a wall and parallel, or roughly parallel, to the wall, the entire load shall be taken as distributed uniformly over a width equal to the length of the tie.

10.3.6 The stability of the abutment or wall as a whole unit, regardless of the distribution of the loads and surcharges, shall always be checked and shall conform to the requirement of AREMA Section 8.5.4, Stability Computation.

10.3.7 Live Load impact shall not be considered in the design of an abutment or pier unless the bridge bearings are supported by a structural beam, such as the seat of a spill-through abutment or a pier cap supported by individual columns, piles or shafts. In such a case, the impact shall be applied to the beam only, and not to footings or piles.

11. Shoring Design

Shoring design shall conform to AREMA Section 8.28.5

12. Submittals

Submittals for design and construction of shoring projects shall be coordinated and submitted through the Manager of Contracts. To expedite reviews, submittals must be complete, clearly explained and orderly. Design review for shoring shall be reviewed by the Director of Engineering in the office of the Chief Engineer and/or through an outside consultant at the expense of the owner. Prior to any review, Manager of Contracts shall receive authorization from the agency agreeing to pay all review costs for the design and construction phases of the project. Once such an agreement is established, Manager of Contracts shall request and secure a proposal from an outside consultant to cover review expenses. Review expenses shall include all costs for in-house personnel and/or consultants retained by the Railroad. This estimated cost of Plan Review and the construction monitoring phase of the project shall be provided to the submitting agency for review and approval. Once the Manager of Contracts has received the submitting agency's written acceptance of the estimated cost, the review of plans can begin. If, during the review process, the estimated costs are determined to be insufficient to cover said costs, the owner will be advised. The original estimated costs will not be the upper limit of the costs, but will provide a guideline for budgeting purposes. Regardless, all reasonable costs incurred during the plan review process and construction monitoring phase of the work will be fully recoverable from the agency.

12.1. Two (2) sets of plans and two (2) sets of the calculations shall be submitted to the Manager of Contracts. Drawings and calculations for excavations which encroach into railroad live load surcharge Zone "A" (see General Shoring Requirements Sheet S1.0) shall be sealed by a registered professional engineer in the applicable state. Allow two (2) weeks for in-house review by the Director of Engineering. The Manager of Contracts will then forward the plans along with KCSRC comments to the outside consultant for review. Allow three (3) additional weeks for review by the outside consultant.

Appendix A

Shoring Design Checklist

Appendix A

Shoring Design Checklist

The checklist is intended to act as a reminder to design or check for specific important aspects of the shoring system. It is not a substitute for plan and/or design criteria or specification requirements.

Instructions:

Respond to every question on the checklist. Submit the checklist with the design plans and calculations to KCSRC. Attach to the checklist detailed explanation of any negative response.

	QUESTIONS	YES	NO	N/A
1.	Are the steps for method of installation and removal of shoring system given?			
2.	Are the shoring design plans and calculations prepared by, stamped, and signed by an engineer registered to practice engineering in the jurisdiction in which the project is being constructed?			
3.	Are shoring plans in compliance with the requirements of the construction plans, project specifications and general notes?			
4.	Are all existing, adjusted or new utilities in proximity with the proposed shoring shown on the shoring plans and is protection of these utilities addressed?			
5.	Are minimum construction clearance requirements of 12 feet horizontal at right angle to centerline of track and 21 feet vertical from top of rail satisfied and shown on the shoring plans?			
6.	Has E80 loading been used to design the shoring system?			
7.	Has the pressure of E80 live load from continuous strip of surcharge load q (psf) parallel to shoring been computed using the equation shown below? $P_S = \frac{2q}{\pi}(\beta + \sin\beta \sin^2\alpha - \sin\beta \cos^2\alpha)$ where $q = \frac{80{,}000 \text{ lbs}}{(5 \text{ feet})(8.5 \text{ feet})}$			
8.	Are the magnitude and location of all loads incorporated into the design plans and calculations?			
9.	Are the material properties used to determine design stresses for each different shoring member shown on the shoring plans?			
10.	Are all components of shoring system designed per AREMA and KCSRC requirements?			
11.	Are the allowable stress and the calculated stress listed in the summary for each different shoring member?			
12.	If "finished' lumber is specified for shoring by the shoring designer, are the actual lumber dimensions used in calculation shown?			
13.	Have ground water elevation and seepage into the excavation been addressed?			
14.	Are steel structural shapes and plates identified by ASTM specification number on the shoring plan and in the calculations?			
15.	Have steel beams been checked for bending, shear, web crippling and buckling of the compression flange and any other potential failure mode?			
16.	Has buckling been evaluated for all compression members?			
17.	Has bracing been provided at all points of assumed support for compression members?			
18.	Are bracing strength and stiffness sufficient for the intended purpose?			
19.	Has the deflection of the shoring system been calculated and found to meet the			

	requirements of Table 1?			
20.	Do the shoring plans indicate the Contractor will monitor top-of-rail elevation and track alignment?			

	QUESTIONS	YES	NO	N/A
21.	Have seismic concerns been considered and addressed?			
22.	Are all construction components clearly shown on the plans?			
23.	Do the drawings show all controlling dimensions and elevations of shoring system?			
24.	If second-hand material will be utilized, is the inspection report included?			
25.	Are protective fencing height and limits shown on the plans? If a fence is not practical, is an alternative closure system provided?			
26.	Do the plans and specifications identify the backfill material and the compaction requirements?			
27.	Are two (2) copies of the shoring design plans and two (2) copies of the complete design calculations included in the submittal package to KCSRC?			
28.	For excavations in Zone "A", are drawings and calculations sealed by a registered professional engineer?			