# TDOT SHORT LINE RAILROAD ASSESSMENT

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# Table of Contents

## Scope

Moffatt & Nichol was tasked to provide an assessment of short line railroads across the state of Tennessee, including consideration of both the physical condition of infrastructure and the economic viability of the railroads. The analysis of infrastructure included an inventory of the existing condition of all short line railroads statewide and provided a high-level cost estimate for bringing these assets up to an appropriate state of good repair. The assessment included short line railroads that are currently affiliated with a local railroad authority and short line railroads that do not currently have a local railroad authority. The inventory of short line railroad infrastructure considered the current condition of crossties and the percentage of effective crossties, rail weight statewide with respect to 286k Gross Vehicle Weight service car operations, and Federal Railroad Administration (FRA) classes of track and track safety standards for operation at varying classes of track.

Moffatt & Nichol assessed all feasibly accessible bridges by visual means using the National Bridge Inspection Standards (NBIS) grading system for each component. Assessment of the bridges were completed to the best of the ability of the inspector from vantage points such as the stream bank, ballast line, hi-rail vehicle, walkable deck sections, and public crossings. Equipment other than the hi-rail vehicle was not used for the bridge assessment.

# TRACK ASSESSMENT

## Track Overview

According to the Federal Railroad Administration (FRA) in 1979 there were 4,036 track-caused train accidents compared to 482 in 2019 throughout the United States. This 88 percent reduction is a direct result of upgrades in track material, improved track maintenance practices, increased track inspection processes, and increased utilization of rail and geometrical defect detection technology. Railroad operations vary dependent on speed of track. The speed of track on given segments are dependent on FRAs 49 CFR 213 Track Safety Standards. Criteria for consideration under the FRA guidelines affecting class of track include but are not limited to: Tie Condition, Gage, Alignment, Cross-level, Profile, and Runoff.

## Class of Track

The FRA has defined a system of classification of railroad track quality. These are defined as specific track classifications, which range from Excepted Track to Class 9. Each track classification dictates specific construction and maintenance details, including tolerance requirements for geometrical track measurements. These tolerances, guided by the class of track, are the determining factor on speed limits for both freight and passenger trains, and ability to operate passenger service.

If a segment of track does not meet all the requirements for its intended class of track it is reclassified to the next lower class of track for which it does meet all the requirements.

| Class of Track | Freight (MPH) | Passenger (MPH) |
|---|---|---|
| Excepted Track | 10 | - |
| 1 | 10 | 15 |
| 2 | 25 | 30 |
| 3 | 40 | 60 |
| 4 | 60 | 80 |
| 5 | 80 | 90 |
| 6 | 110 | 110 |
| 7 | 125 | 125 |
| 8 | 160 | 160 |
| 9 | 200 | 200 |

Class 1: Generally used in Rail yards, Branch lines, Short lines, and Industrial spurs

Class 2: Generally used in Branch lines, Secondary mainlines, Regional railroads, and Scenic/Tourist railroads

Class 3: Generally used in Secondary mainlines, Regional railroads, and Scenic/Tourist railroads

Class 4: Generally used in Primary mainlines (Long-haul freight railroads), and Passenger railroads

Class 5: Generally used in High-speed railroad operations

Class 6: Exclusive usage on Amtrak’s Northeast Corridor (New York, NY to Washington, DC)

Class 7: Exclusive usage on Amtrak’s Northeast Corridor (New York, NY to Washington, DC)

Class 8: Exclusive usage on Amtrak’s Northeast Corridor (New York, NY to Washington, DC)

Class 9: Exclusive usage on Amtrak’s Northeast Corridor (New York, NY to Washington, DC)

## Track Inspection Frequency

Track inspection frequency varies depending on the desired class of track for a segment of track. Tracks designated as 'Main Track' will require more frequent track inspections than tracks designated as 'Other Than Main Track'. As the designation of track is upgraded, and track inspection frequency increases, additional line budgets will need to be allocated to track inspection and track inspector time of service.

| Class of Track | Type of Track | Required Inspection Frequency |
|---|---|---|
| Excepted Track and Class 1, Class 2, and Class 3 | Main track and sidings | Weekly with at least 3 calendar days interval between inspections, or before use, if the track is used less than once a week, or twice weekly with at least 1 calendar day interval between inspections, if the track carries passenger trains or more than 10 million gross tons of traffic during the preceding calendar year. |
| Excepted Track and Class 1, Class 2, and Class 3 | Other than main track and sidings | Monthly with at least 20 calendar days interval between inspections. |
| Class 4 and Class 5 | All | Twice weekly with at least 1 calendar day interval between inspections. |

## Factors Affecting Class of Track

## Track Gage

Gage of track is the rail spacing of a track measured between the inner faces of the load bearing portions of the rail. The gage of the track is negatively impacted by lateral train forces which primarily are found in curved track, road crossings, turnouts, and jointed rail connections. In these areas, over time the crossties begin to weaken and allow for the track gage to widen. When the track gage reaches its threshold the rails that support train traffic will fail to support the load resulting in a track caused derailment.

| Class of Track | The gage must be at least— | But not more than— |
|---|---|---|
| Excepted Track | N/A | 4’ 10 1/4” = 58 ¼” |
| Class 1 | 4’8” = 56” | 4’ 10” = 58” |
| Class 2 and Class 3 | 4’8” = 56” | 4’ 9 3/4” = 57 ¾” |
| Class 4 and Class 5 | 4’8” = 56” | 4’ 9 1/2” = 57 ½” |

## Track Alignment

Track Alignment is the position of the track in the horizontal plane expressed as 'tangent' or 'curve'. There are many factors that could adversely affect the track alignment. Poor tie condition, insufficient rail fasteners, unadjusted rail, and poor surface can cause track to buckle. Track buckling is also known as misaligned track. Misaligned track is a track condition which alters the alignment of the track. Trains that operate over sections of misaligned track that measure greater than the threshold allowable for the class of track are susceptible to derail.

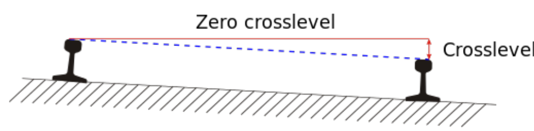
| Class of Track | Tangent track | Curved track | |
|---|---|---|---|
| | **The deviation of the mid-offset from a 62-foot line 1 may not be more than—(inches)** | **The deviation of the mid-ordinate from a 31-foot chord 2 may not be more than—(inches)** | **The deviation of the mid-ordinate from a 62-foot chord 2 may not be more than—(inches)** |
| Class 1 | 5 | N/A | 5 |
| Class 2 | 3 | N/A | 3 |
| Class 3 | 1 ¾ | 1 ¼ | 1 ¾ |
| Class 4 | 1 ½ | 1 | 1 ½ |
| Class 5 | 3/4 | 1/2 | 5/8 |

## Track Surface

There are other track geometrical aspects that are equally as important to adhere to FRA guidelines for compliance with desired classes of track which may not be as easily visible as track alignment.

Crosslevel: The measurement of the difference in height between the top surface of the two rails at any point on the track.

Difference in Crosslevel: The measurement of the difference in height between the top surface of the two rails at any point on the track taken with respect to the measurement of the difference in the height between the top surface of the two rails at another location within 62'.




Profile: The measurement of the difference in uniform vertical rail movement at any point on the track taken with respect to the measurement of the difference in uniform vertical rail movement at another location within 62'.

According to the FRA in 2019 throughout the US, Track Geometry was the leading cause of track caused train accidents accounting for 182 of the 482 reported track caused train accidents. The FRA requires all rail equipment accidents/incidents to be reported if the property damage is greater than $10,700. As such, all incidents are not reportable events. Installation of new crossties, track surfacing and smoothing, reduction of rail joints, and maintaining proper drainage play vital roles in alleviating track geometry defects. Identification and proper remediation of geometry defects help to ensure operation at the desired class of track. Special consideration for harmonic rocking must be considered for operating Class 2 through Class 5 with staggered joints. The crosslevel differences shall not exceed 1 ¼ inches in all 6 consecutive pairs of joints as created by 7 low joints. Track is considered to have staggered joints only when the joints are 10 feet apart or greater.

| **Track surface (inches)** | **Class of track** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| The deviation from zero crosslevel at any point on tangent or reverse crosslevel elevation on curves may not be more than | 3 | 2 | 1 ¾ | 1 ¼ | 1 |
| The deviation from uniform profile on either rail at the mid-ordinate of a 62-foot chord may not be more than | 3 | 2 ¾ | 2 ¼ | 2 | 1 ¼ |

| | | | | | |
|---|---|---|---|---|---|
| The difference in crosslevel between any two points less than 62 feet apart may not be more than | 3 | 2 ¼ | 2 | 1 ¾ | 1 ½ |

## Crosstie Condition

Crossties serve as a key track component in attaining and maintain desired class of track. Crossties transfer rolling stock loads to the ballast and subgrade, keep the rails in a fixed upright position, and maintain track gage, surface, and alignment. Over time crossties begin to weather, rot, crack, split, and break. The FRA requires a certain number of effective ties to be evenly distributed within a 39-foot rail section to meet desired classes of track. Characteristics that would constitute as non-effective ties include ties that are broken through, split or impaired to the extent that they will allow ballast to work through them, or crossties that will not hold spikes or rail fasteners.

Additionally, non-effective crossties are deteriorated to the extent that the tie plate can move laterally ½ inch or have been cut by the tie plate more than 40 percent of the crossties thickness. If the crosstie is broken through or deteriorated to the extent that the prestressing material is visible it is non-effective. Crossties that allow rail fastener assemblies to be pulled out or moved laterally more than 3/8 inch relative to the crosstie are also considered non-effective.

Crossties cannot be deteriorated under the base of the rail ½ inch or more. Crosstie deterioration that allows the base of the rail to move laterally more than 3/8 inch in curves greater than 2 degrees or allow the base of the rail to move laterally more than ½ inch on straight track or curves less than 2 degrees are regarded as non-effective ties.

| Class of Track | Minimum Number of Effective Crossties - Tangent Track, Turnouts, and Curves | |
|---|---|---|
| | Tangent Track and Curved Track less than or equal to 2 degrees | Turnouts and Curved Track greater than 2 degrees |
| Class 1 | 5 | 6 |
| Class 2 | 8 | 9 |
| Class 3 | 8 | 10 |
| Class 4 and Class 5 | 12 | 14 |

Crossties have an expected lifespan of 25 years in an active track with 55 million gross tons of traffic. Within the 25-year lifespan it is recommended that crossties be replaced on a 10-year cycle to renew the track surface and maintain class of track standards.

## Rail Size Selection

The average lifespan of rail depends upon the size of rail, size of tie plates, number of shoulders of tie plates, rail manufacturing process, metallurgy of the rail, annual gross tonnage of track, maintenance of rail joints, maintenance of track surface, and curvature of track. On average, rail has a 55 million gross ton lifespan if properly maintained over its course of service. With consideration of annual tonnage for Tennessee short line railroads an estimation of 110 years lifespan for rail has been determined.

A primary factor in attaining maximum rail lifespan is standardization of rail size selection. An increase in rail size from the current 85-pound and 90-pound rail sections to heavier rail size of 132-pound rail are key in maximizing rail lifespan and serves as a step forward in 286k gross vehicle weight (GVW) service car compliance. Rail sizes less then 100-pound are not satisfactory for sustained 286k loading. Comprehensive capital investment cost for rail section upgrades for 286k GVW service car compliance is included in the cost. Additional consideration should be taken when selecting CWR (Continuous Welded Rail) vs Jointed Rail. Selection of jointed rail will result in initial cost savings, however additional maintenance and lifespan improvement measures will be required after installation of rail sections.

To attain 286k GVW service car compliance and to maximize rail lifespan selection of Class II, 132-pound secondhand rail is proposed to replace any rail size that is smaller than 100-pounds. 132-pound rail is a stronger and more durable rail which will better withstand higher train volumes and velocities. Secondhand rail is commonly referred to as relay rail. The determination of Class II 132-pound was made using the American Railway Engineering Association relay rail grading chart. The chart categorizes relay rail into different classes or grades of rail. The relay rail grading chart accounts for maximum top side rail wear, maximum gage side rail wear, general rail use, and rail condition in the rail classification process. One issue to consider if buying new rail, 132-pound rail is generally less expensive then smaller weight rail.

## Rail Grading for Relay Rail

| Rail Weight | Maximum Rail Wear - Inches Top | Gage | General Rail Use & Rail Condition |
|---|---|---|---|
| **Class I** | | | |
| 140 | 1/4 | 1/2 | Main Line use - Very minor engine burns and corrugation. |
| 132-131 | 3/16 | 1/2 | |
| 122 | 5/32 | 7/16 | |
| 115 | 1/8 | 3/8 | |
| 112 | 1/8 | 1/4 | |
| 100 | 1/8 | 1/8 | |
| 90 | 1/8 | 1/8 | |
| **Class II** | | | |
| 140 | 3/8 | 3/4 | Branch Lines - Small engine burns and corrugation. |
| 132-131 | 5/16 | 3/4 | |
| 122 | 5/16 | 3/4 | |
| 115 | 5/16 | 3/4 | |
| 112 | 5/16 | 1/2 | |
| 100 | 3/16 | 1/4 | |
| 90 | 1/4 | 3/16 | |
| **Class III** | | | |
| 140 | 5/8 | 7/8 | Light Branch Lines - Medium engine burns and corrugation, may be pitted and show some oxidation. |
| 132-131 | 7/16 | 7/8 | |
| 122 | 1/2 | 7/8 | |
| 115 | 3/8 | 3/4 | |
| 112 | 3/8 | 3/4 | |
| 100 | 1/4 | 1/4 | |
| 90 | 5/16 | 5/16 | |
| **Class IV** | | | |
| 140 | 3/4 | 1 | Yards - Any burns not mashed or fractured. |
| 132-131 | 9/16 | 1 | |
| 122 | 11/16 | 1 | |
| 115 | 1/2 | 7/8 | |
| 112 | 1/2 | 7/8 | |
| 100 | 7/16 | 7/8 | |
| 90 | 3/8 | 3/8 | |

Taken from the A.R.E.A. manual for railway engineering. 4-2-60

Another key component to the lifespan of rail is the steel making process of hydrogen elimination. The steelmaking process identifies the method used to remove hydrogen from the rail steel while the steel was in the molten state or in bloom, ingot, strand, or rail selection form. The most common hydrogen elimination process in US rail steel manufacturing is the control cooled method. Methods are identified as follows:

CC – Control Cooled

BC – Bloom Cooled

VT – Vacuum Treated

HH – Head Hardened

OH – Open Hearth Method

Gases absorbed by the liquid steel during the heat process have caused the rail to shatter, crack, promoted voids, and rail inclusions. Hydrogen has been identified as a leading gas in the steel making process that adversely affects the manufacture of rail. Utilizing one of the methods reassures that hydrogen has been successfully removed from the rail.

## Rail End Mismatch

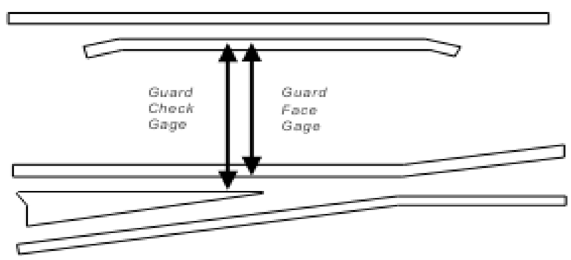
The connection of two rails using the combination of bars and bolts is a rail joint. There are two critical areas in rail joints where rail end mismatch presents an adverse effect on class of track. One area is the tread of the rail ends (top) and the second is the gage side of the rail ends (inner). Rolling stock is susceptible to "pick" the mismatch on the rail end resulting in a derailment.

| **Class of track** | **Any mismatch of rails at joints may not be more than the following—** | |
|---|---|---|
| | **On the tread of the rail ends (inch)** | **On the gage side of the rail ends (inch)** |
| Class 1 | 1/4 | 1/4 |
| Class 2 | 1/4 | 3/16 |
| Class 3 | 3/16 | 3/16 |
| Class 4 and Class 5 | 1/8 | 1/8 |

## Frogs

Turnout maintenance must be taken into consideration when selecting a desired class of track. Over time excessive rail wear, flangeway depth, and frog chipping and/or cracking will present rail defect conditions which will require remedial actions not limited to welding or component replacement to meet FRA tolerance measurements for the class of track desired.

The frog of a turnout is a component that is susceptible to excessive wear and has additional component tolerances and measurement specification requirements depending on the desires class of track. The flangeway depth measured from a plane across the wheel-bearing area of a frog on Class 1 (10MPH) track cannot be less than 1 3/8 inches, or less than 1 1/2 inches on Classes 2 through Class 5 track. Additionally, if a frog point is chipped, broken, or worn more than 5/8 inch down and 6 inches back, operating speed over the frog cannot exceed Class 1 (10 MPH). Furthermore, if the tread portion of a frog casting is worn down more than 3/8 inch below the original contour, operating speed over that frog cannot exceed Class 1 (10 MPH).




| Class of Track | Guard check gage - The distance between the gage line of a frog to the guard line 1 of its guard rail or guarding face, measured across the track at right angles to the gage line 2, may not be less than— | Guard face gage - The distance between guard lines 1, measured across the track at right angles to the gage line 2, may not be more than— |
|---|---|---|
| Class 1 | 4' 6 1/8" = 54 1/8" | 4' 5 1/4" = 53 ¼" |
| Class 2 | 4' 6 1/4" = 54 1/4'" | 4' 5 1/8" = 53 1/8" |
| Class 3 and Class 4 | 4' 6 3/8" = 54 3/8" | 4' 5 1/8" = 53 1/8" |
| Class 5 | 4' 6 1/2" = 54 ½" | 4' 5" = 53" |

## Rail Defects

In time rail defects will occur. These defects can occur in any type of rail because of several different conditions. Rail defects usually originate from the rail manufacturing process, cyclical loading, rolling stock impact, rail wear, and/or plastic flow. Internal rail defects require a form of stresses to initiate their progression to a detectable size. There are 3 planes for rail stresses:

Vertical Plane – stresses progressing in a longitudinal direction normal to rail length

Horizontal Plane – stresses progressing horizontally along the rail

Transverse Plane – stresses progressing transversely along the cross section of the rail

There are FRA mandated inspection criteria to identify rail defects, this report does not speak to the current practices of the individual short lines. External rail defects can be detected during track inspection. It is recommended that each railroad complete quarterly walking inspections and monthly train riding inspections. Hi-rail inspections should be conducted on a weekly or bi-weekly frequency. Internal rail defects can be detected by specialized ultrasonic test methods. Frequency of testing is dependent on the class of track desired.

## Rail Defect Descriptions

**Bolt Hole Crack** - a crack across the web, originating from a bolt hole, and progressing on a path either inclined upward toward the rail head or inclined downward toward the base. Fully developed bolt hole cracks may continue horizontally along the head/web or base/web fillet, or they may progress into and through the head or base to separate a piece of the rail end from the rail. Multiple cracks occurring in one rail end are a single defect. However, bolt hole cracks occurring in adjacent rail ends within the same joint must be reported as separate defects.

**Broken Base** - any break in the base of the rail.

**Compound Fissure** - a progressive fracture originating from a horizontal split head that turns up or down, or in both directions, in the head of the rail. Transverse development normally progresses substantially at a right angle to the length of the rail.

**Crushed Head** - a short length of rail, not at a joint, which has drooped or sagged across the width of the rail head to a depth of 3/8 inch or more below the rest of the rail head and 8 inches or more in length. Unlike flattened rail where the depression is visible on the rail head only, the sagging or drooping is also visible in the head/web fillet area.

**Damaged Rail** - any rail broken or otherwise damaged by a derailment, broken, flat, or unbalanced wheel, wheel slipping, or similar causes.

**Defective Weld** - a field or plant weld containing any discontinuities or pockets, exceeding 5 percent of the rail head area individually or 10 percent in the aggregate, oriented in or near the transverse plane, due to incomplete penetration of the weld metal between the rail ends, lack of fusion between weld and rail end metal, entrainment of slag or sand, under-bead or shrinkage cracking, or fatigue cracking. Weld defects may originate in the rail head, web, or base, and in some cases, cracks may progress from the defect into either or both adjoining rail ends. If the weld defect progresses longitudinally through the weld section, the defect is considered a split web for purposes of remedial action required by this section.

**Detail Fracture** - a progressive fracture originating at or near the surface of the rail head. These fractures should not be confused with transverse fissures, compound fissures, or other defects which have internal origins. Detail fractures may arise from shelled spots, head checks, or flaking.

**Engine Burn Fracture** - a progressive fracture originating in spots where driving wheels have slipped on top of the rail head. In developing downward these fractures frequently resemble the compound or even transverse fissures with which they should not be confused or classified.

**Flattened Rail** - a short length of rail, not at a joint, which has flattened out across the width of the rail head to a depth of 3/8 inch or more below the rest of the rail and 8 inches or more in length. Flattened rail occurrences have no repetitive regularity and thus do not include corrugations and have no apparent localized cause such as a weld or engine burn. Their individual length is relatively short, as compared to a condition such as head flow on the low rail of curves.

**Head and Web Separation** - a progressive fracture, longitudinally separating the head from the web of the rail at the head fillet area.

**Horizontal Split Head** - a horizontal progressive defect originating inside of the rail head, usually 1/4 inch or more below the running surface and progressing horizontally in all directions, and generally accompanied by a flat spot on the running surface. The defect appears as a crack lengthwise of the rail when it reaches the side of the rail head.

**Ordinary Break** - a partial or complete break in which there is no sign of a fissure, and in which none of the other defects described is found.

**Piped Rail** - a vertical split in a rail, usually in the web, due to failure of the shrinkage cavity in the ingot to unite in rolling.

**Split Web** - a lengthwise crack along the side of the web and extending into or through it.

**Transverse Fissure** - a progressive crosswise fracture starting from a crystalline center or nucleus inside the head from which it spreads outward as a smooth, bright, or dark round or oval surface substantially at a right angle to the length of the rail. The distinguishing features of a transverse fissure from other types of fractures or defects are the crystalline center or nucleus and the nearly smooth surface of the development which surrounds it.

**Vertical Split Head** - a vertical split through or near the middle of the head and extending into or through it. A crack or rust streak may show under the head close to the web or pieces may be split off the side of the head.

## Remedial Action for Rail Defects

**REMEDIAL ACTION TABLE**

| Defect | Length of defect (inch(es)) | | Percentage of existing rail head cross-sectional area weakened by defect | | If the defective rail is not replaced or repaired, take the remedial action prescribed in note |
|---|---|---|---|---|---|
| | More than | But not more than | Less than | But not less than | |
| Compound Fissure | | | 70 | 5 | B. |
| | | | 100 | 70 | A2. |
| | | | | 100 | A. |
| Transverse Fissure, Detail Fracture, Engine Burn Fracture, Defective Weld | | | 25 | 5 | C. |
| | | | 60 | 25 | D. |
| | | | 100 | 60 | A2, or [E and H]. |
| | | | | 100 | A, or [E and H]. |
| Horizontal Split Head, Vertical Split Head, Split Web, Piped Rail, Head Web Separation, Defective Weld (Longitudinal) | 1 | 2 | | | H and F. |
| | 2 | 4 | | | I and G. |
| | 4 | | | | B. |
| | (1) | (1) | | | A. |
| Bolt Hole Crack | ½ | 1 | | | H and F. |
| | 1 | 1½ | | | H and G. |
| | 1½ | | | | B. |
| | (1) | (1) | | | A. |
| Broken Base | 1 | 6 | | | D. |
| | 6 (2) | | | | A, or [E and I]. |
| Ordinary Break | | | | | A or E. |
| Damaged Rail | | | | | C. |
| Flattened Rail Crushed Head | Depth ≥ ⅜ and Length ≥ 8 | | | | H. |

(1) Break out in rail head.

(2) Remedial action D applies to a moon-shaped breakout, resulting from a derailment, with length greater than 6 inches but not exceeding 12 inches and width not exceeding one-third of the rail base width.

A. Assign qualified person to visually supervise each operation over the defective rail.

A2. Assign qualified person to make visual inspection. After visual inspection that person may authorize operation to continue without continuous visual inspection at maximum 10 MPH for up to 24 hours prior to another visual inspection or replacement or repair of the rail.

B. Limit operating speed over defective rail to 30 MPH or maximum allowable speed for class of track.

C. Apply joint bars within 10 days. Limit operating speed over defective rail to 30 MPH or maximum allowable speed for class of track, whichever is lower, until joint bars are applied. Thereafter, limit operating speed to 50 MPH or maximum allowable speed for the class of track, whichever is lower. When internal defects are found that require remedial action C, limit operating speed over defective rail to 50 MPH or maximum allowable speed for class of track, whichever is lower, for a period not to exceed 4 days. If the defective rail has not been removed from the track or a permanent repair made within 4 days of discovery, limit operating speed over defective rail to 30 MPH or maximum allowable speed for class of track, whichever is lower, until joint bars are applied, thereafter limit operating speed to 50 MPH or maximum allowable speed for class of track, whichever is lower. When joint bars have not been applied within 10 days, limit operating speed over defective rail to 10 MPH until joint bars are applied.

D. Apply joint bars within 7 days. Limit operating speed over defective rail to 30 MPH or maximum allowable speed for the class of track, whichever is lower, until joint bars are applied. Thereafter, limit operating speed to 50 MPH or maximum allowable speed for class of track, whichever is lower. When joint bars have not been applied within 7 days, limit operating speed over defective rail to 10 MPH until joint bars are applied.
E. Apply joint bars.
F. Inspect and re-inspect the rail within 90 days after it is determined to continue the track in use. If not inspected within 90 days, limit operating speed over rail to 25 MPH or maximum allowable speed for the class of track, whichever is lower until it is inspected.
G. Inspect and re-inspect the rail within 30 days after it is determined to continue the track in use. If not inspected within 30 days, limit operating speed over rail to 25 MPH or maximum allowable speed for the class of track, whichever is lower until it is inspected.
H. Limit operating speed over defective rail to 50 MPH or maximum allowable speed for the class of track, whichever is lower.
I. Limit operating speed over defective rail to 30 MPH or maximum allowable speed for the class of track, whichever is lower.

# General Maintenance

## Thermite Welding

The presence of rail joints encourages an escalation in track deterioration. Adverse track effects that are created from rail joints include battered rail ends, rail end mismatch, broken bars, gage issues, track profile, track crosslevel, track pumping, and stripped joints. All these conditions affect class of track, and ultimately could result in train accidents. Removal of rail joints through thermite welding process is recommended as a general maintenance practice to maximize crosstie lifespan.

## Wayside Rail Lubricators

Installation of rail lubricators significantly reduces rail wear. Outside of track cost benefit there is assumed benefit in reduction of wheel wear, and reduction of fuel cost. Wayside rail lubricators apply a consistent and controlled amount of lubrication to the rail and hold it in place allowing the wheels of passing trains to grab and carry lubrication around a curved track. Installation of wayside lubrication systems is recommended as a general maintenance practice to maximize rail lifespan.

## Field Assessment

In the state of Tennessee, Moffatt & Nichol (MN) assessed 19 short line railroads equaling 817.2 miles of track. Rail joint bars and rail fastening mechanisms were not covered by this assessment.

Assumptions

- All tracks are assumed to have sufficient track geometry measurements for its designated class of track. Geometrical measurement data for the assessed tracks was not made available for our review.
- Recommended track structure upgrades described herein are capital improvement upgrades and are not considered to be part of routine maintenance. This includes crosstie and rail replacement which are classified as capital improvement for the purposes of this report.

## Assessment Method

The track structures were assessed by visual means using the Federal Railroad Administration (FRA) 49 CFR Part 213 – Track Safety Standards as a guideline to determine regulatory compliance to determine crossties needed for operational compliance for Class I track and Class II track. Rail sizes were assessed by using visual assessment of the rail size stamp on rail sections. Assessors conducted a combination of walking and hi-rail visual assessments of each track segment to provide a condition of the track structure within varying segments of each track to determine the overall track structure needs. The condition of rail spikes, rail fasteners, joint bars, and ballast were not assessed individually. What was seen on a segment of track was extrapolated and applied to the entire track within that segment of track. As the assessment was only visual, there may be rail defects or track geometry conditions that were not identified that may require the use of hand tools and ultrasonic testing to be found.

During the assessment process track crosstie needs were assessed based on crosstie condition, curvature of track, grade of track, and presence of jointed rail vs CWR. During the assessment crosstie needs were evaluated in 39-foot segments of track per 49 CFR Part 213 – Track Safety Standard requirements for Class I and Class II effective crossties. For Class I track standard compliance in tangent track or curved track less than 2 degrees the minimum desired number of effective crossties is 5; and in turnouts and curved track greater than 2 degrees the minimum desired number of effective crossties is 6. The number of effective crossties needed within a 39-foot segment of track increases as the class of track increases.

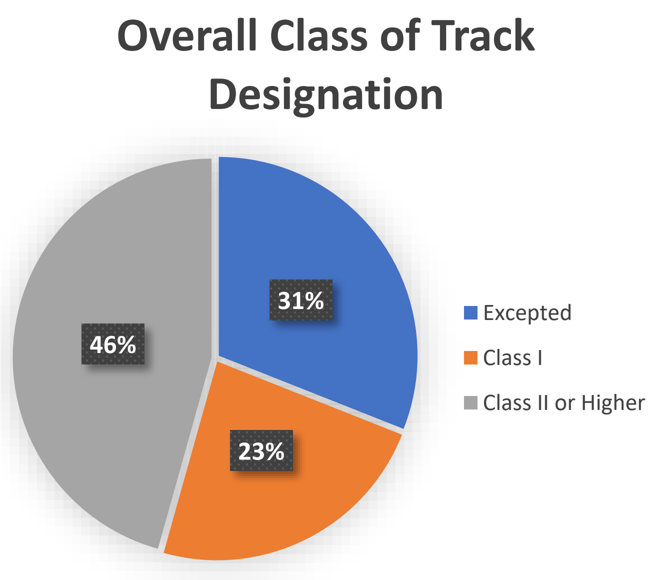
For Class II track standard compliance in tangent track or curved track less than 2 degrees the minimum desired number of effective crossties is 8; and in turnouts and curved track greater than 2 degrees the minimum desired number of effective crossties is 9. The most recurring tie conditions that assessors found which deemed crossties ineffective were crossties that were broken through, crossties that had been split, crossties that were cut by the crosstie plate, and an insufficient number of effective crossties at rail joints.

## Findings

Of the 817.2 miles MN assessed, 31 percent of operations are on track designated as Excepted Track, 23 percent of operations are on track designated as Class I Track, and 46 percent of operations are on track designated as Class II Track or higher. Approximately 63.86 percent and 25.54 percent of the tie conditions were sufficient for Class I and Class II track operation, respectively. Condition of effective crossties is determined by FRA requirement for minimum number of effective crossties to be present within a 39-foot segment of track. A summary of the data can be found in the charts and tables that follow.

By class of track designation, the breakdown is as follows:

- 31% of operations are on Excepted Track.
- 23% of operations are on Class I Track.
- 46% of operations are on Class II Track or Higher.
  - Many of the short line railroads currently operate under FRA Excepted Class track designation. This class provides railroads flexibility in permissible track maintenance standards, yet still allowing train operation up to 10 MPH.

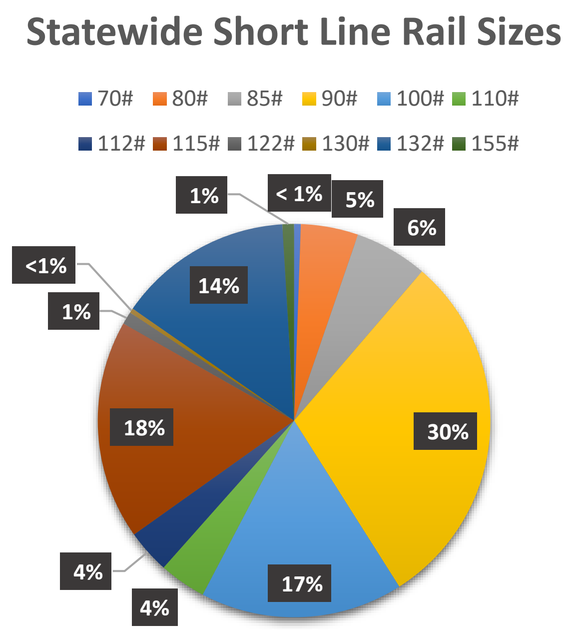



| | Class I (Mi) | Class II (Mi) |
|---|---|---|
| **Good Crossties** | 521.86 (63.86%) | 208.75 (25.54%) |

An assessment for rail replacements required to support 286k GVW service cars was also conducted. Rail sections for each short line railroad were assessed based on rail size. Rail sizes less than 100-pounds are not suitable for 286k GVW service car operation. Unlike effective crossties, rail size selections are independent of class of track. 70-pound rail accounts for less than 1 percent of the statewide rail. 80-pound rail and 85-pound rail account for 5 percent and 6 percent of the statewide rail sizes, respectively. 90-pound rail is the most used rail size of all the statewide short line rail sizes and accounts for 30 percent of the statewide rail. 100-pound rail accounts for 4 percent of the statewide rail, 110-pound rail accounts for 4 percent of the statewide rail, 112-pound rail accounts for 4 percent of the statewide rail, 115-pound rail accounts for 18 percent of the statewide rail, 122-pound rail accounts for 1 percent of the statewide rail, 130-pound rail accounts for less than 1 percent of the statewide rail, 132-pound rail accounts for 14 percent of the statewide rail, and 155-pound rail accounts for 1 percent of the statewide rail. Assessors determined that 41.36 percent of the 1,634 miles of rail within the state must be replaced to attain 286k GVW service car operation. 58.64 percent of the statewide rail on short lines is satisfactory for 286k GVW service car operations. A summary of the data can be found in the charts that follow.

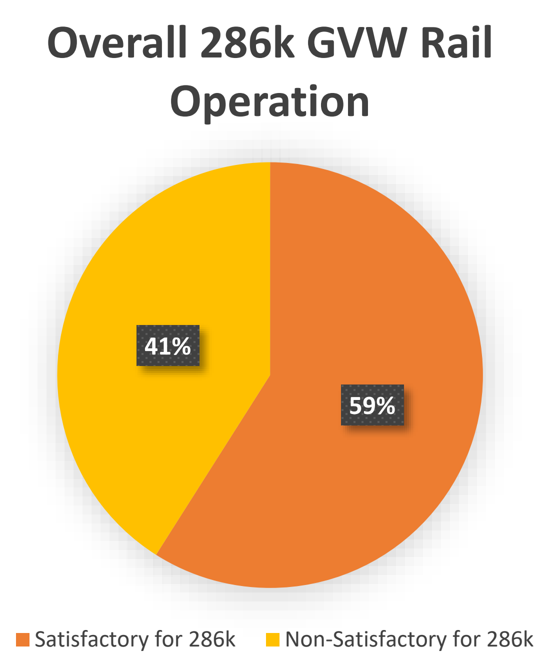
By rail size, the breakdown is as follows:

- <1% are 70# Rail
- 5% are 80# Rail
- 6% are 85# Rail
- 30% are 90# Rail
- 17% are 100# Rail
- 4% are 110# Rail
- 4% are 112# Rail
- 18% are 115# Rail
- 1% are 122# Rail
- <1% are 130# Rail
- 14% are 132# Rail
- 1% are 155# Rail



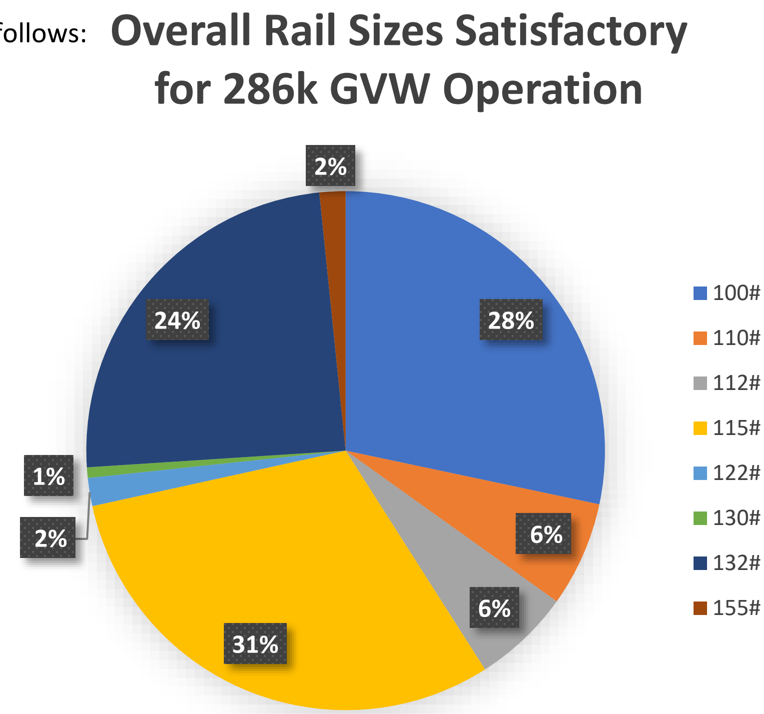

By Rail Size, the breakdown is as follows:

- 59% of rail sizes are Satisfactory for 286k GVW Operation (100# rail and above)
- 41% of rail sizes are Non-Satisfactory for 286k GVW Operation (less than 100# rail)



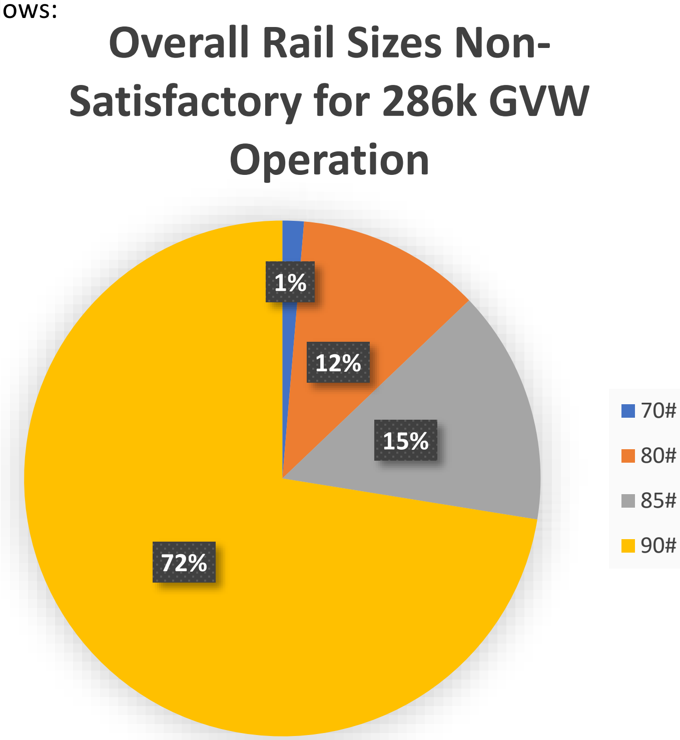
By Satisfactory Rail Size, the breakdown is as follows:

- 28% are 100# Rail
- 6% are 110# Rail
- 6% are 112# Rail
- 31% are 115# Rail
- 2% are 122# Rail
- 1% are 130# Rail
- 24% are 132# Rail
- 2% are 155# Rail




By Non-Satisfactory Rail Size, the breakdown is as follows:

- 1% are 70# Rail
- 12% are 80# Rail
- 15% are 85# Rail
- 72% are 90# Rail



## Cost Estimate

Crosstie replacement is assumed to upgrade class of track to desired Class I and/or Class II Track. Rail section replacement is assumed to upgrade track to 286k loading. Actual costs may vary based on the agreed plan and material staging and track accessibility. Crosstie and rail replacements are based on the types of repairs necessary to upgrade the typical track types found during field observations. Costs do not include money for engineering, permitting, flagging etc.

A crosstie cost estimate on the short line railroads statewide to upgrade to Class I and/or Class II was conducted. Estimators placed a $60 per installed crosstie value on crossties determined to be replaced. The cost included the value of a new 8-foot 6-inch crosstie and installation. The cost for tie disposal was not included in these numbers. To upgrade all short line railroads statewide to Class I would cost $3,250,000 whereas to upgrade to Class II would cost $10,470,000. A rail cost estimate on the short line railroads statewide to upgrade to 286k GVW service car compliance was conducted. Estimators placed a $60 per linear foot value on rail sections determined to be replaced. The cost included the value of relay 132-pound rail material, other track material (OTM), and installation. To upgrade all short line railroads statewide to 286k GVW service car compliance would cost $214,300,000.

There is potential for Tennessee to recoup funds through recovery and scrapping the replaced rail sections. Bids for contractors performing rail replacement work could contain language surrounding the scrapping of replaced rail sections and how replaced rail sections are to be disposed. Regional scrap recovery indicates an averaged scrap value of $200 per ton of rail. Estimators determined the gross weight of rail sections to be replaced to be 51,150 tons which would return approximately $10,250,000 in scrap rail. Crossties are a waste material that are hazmat material and are typically included in the crosstie replacement portion of the bid for crosstie replacement projects to limit potentially harmful environmental incidents and for railroad right of way aesthetics. The bid price includes crosstie disposal in the cost of new crosstie.

Section 2

# BRIDGE ASSESSMENT

## Bridge Overview

In the state of Tennessee, Moffatt & Nichol (MN) assessed 518 bridges equaling 71,561 linear feet (13.55miles). Culverts were not addressed by this assessment. Culverts were identified in the field by each railroad. Concrete arches and concrete slab structures identified by the railroad as needing an assessment due to height were included in the reports. Bridges are structures comprised of three components- deck, superstructures, and substructure.

Assumptions

- All bridges are assumed to have been capable of carrying 286k loading when initially constructed. Load rating information for most of the assessed bridges was not made available for our review.
- Repairs described herein are structural repairs and are not considered to be part of routine maintenance. This includes the replacement of structural ties which are classified as structural repairs for the purposes of this report.

## Assessment Method

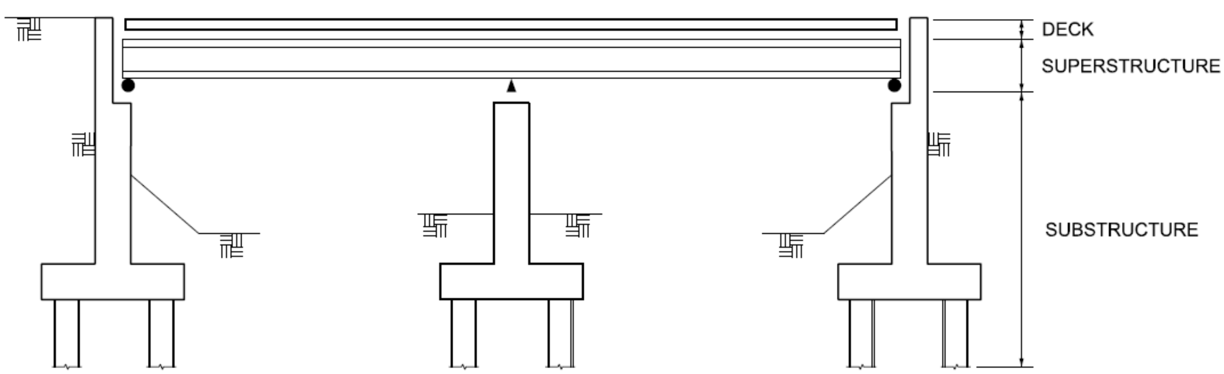
Bridges were accessed via hi-rail vehicle. Assessments were made by visual means following the Federal Highway Administration's Bridge Inspector's Reference Manual (BIRM) grading system for each major component (Deck, Superstructure, Substructure). The assessment was solely based on visual observations and did not include hands on assessment of individual components, destructive or non-destructive testing (NDT), or any assessment of underwater elements or scour. Scour can occur quickly, critically affect bridge capacity, and be expensive to repair. Assessors spent 10-45 minutes at each bridge observing and documenting the general condition of major components to provide a snapshot condition of the overall bridge. Spans, bents, beams, etc. were not assessed individually; observations made on one portion of the bridge were extrapolated and applied to the entire bridge.

The visual assessments made were intended to capture the general condition of each bridge and identify any outstanding maintenance needs. As the assessment was only visual, there may be defects to individual components that were not identified or require the use of hand tools, access equipment (boat, under bridge inspection equipment, ladders, etc.), or a fracture critical and/or underwater inspection to be accurately documented. Prior to any bridge rehabilitation, we recommend that an in-depth assessment of each bridge be completed in order to more accurately capture the condition of the components.

## Bridge Components and Rating

Three major components were assessed during our field visits. These are items 58, 59, and 60 (Deck, Superstructure, and Substructure) as identified in the Bridge Inspector's Reference Manual (BIRM). The primary components are described as follows:

- The **Deck** consists of elements that distribute the railway loads from the rails to the primary structural members. The deck consists of items such as structural ties, and concrete/timber/metal decks on ballasted bridges. Assessment of the rails and approach ties are not included in the Deck rating but are evaluated as separate units under the track assessment.
- The **Superstructure** consists of the primary load carrying elements that span between Substructure units. Superstructure elements include but are not limited to beams/girders/trusses, bearings, stringers, and diaphragms. In the case of slab bridges, the Deck and Superstructure grades are the same as the two components are merged together.
- The **Substructure** transfers loads into the foundation and is typically considered everything below the bearings such as the pier caps, piles, columns, and cross bracing



Each of the three components described above were evaluated on the National Bridge Inspection Standards (NBIS) scale 0-9. The following is a summary of how these grades were assigned.

## Condition Ratings

During the visual assessment process, bridge components are graded on a 0-9 scale and approximate percent maintenance recommended was assigned to each of the three main structural components (Deck, Super, Substructure) with the substructure being broken into subcategories of abutments, pier caps, and piles. Maintenance for the purposes of this assessment are activities that are necessary to restore structural capacity to the element and are not covered by routine maintenance. Following is a summary of what each condition score means:

**9:** **New component. No defects. No maintenance required.**

**8:** **Maximum value for in-service components. No defects other than freckled rust on steel components. No maintenance required.**

**7:** **Minor defects. Minimal maintenance required.**

Deck:
- <30% of structural ties or deck boards in need of replacement.
- <10% of steel deck needs repair.
- Concrete decks have hairline cracks.

Superstructure:
- Steel girders have surface rust. This rust may be isolated or widespread, however flaking and measurable loss of section has not initiated.
- Timber beams are weathered, have minor surface decay, and/or checks and shakes.
- Cast in place concrete components have isolated surface spalls (<1” deep) and minimal cracking (isolated locations with widths less than <1/32” wide, no shear cracks)

Substructure:
- Steel components (cap and/or piles) have surface rust.
- Timber caps have minor surface decay and/or checks and shakes.
- Timber piles have checks/shakes but no decay.
- Concrete components (cap and or piles/columns) have isolated surface spalls and minimal narrow cracking (isolated locations, no shear cracks)

**6:** **Minor deterioration. Some maintenance may be required.**

Deck:
- 30% -49% of structural ties in need of replacement.

Superstructure:
- Isolated steel girders require repair plates (<15%), isolated flaking rust may be present but section loss is negligible
- <20% of timber beams need replacement.
- Prestressed concrete components may have minor narrow cracks and spalls (<6” diameter and <1” deep, no exposed strands)
- Cast in place concrete components have isolated spalls but no exposed primary reinforcement. Minimal narrow cracking (isolated locations) may be present including isolated shear cracks.

Substructure:
- Isolated instances of piles needing replacement (<20%)
- Isolated timber caps need replacement. (< 20%)
- Steel components (cap and/or piles) may have isolated flaking rust but section loss is negligible.

- Timber caps have surface decay affecting <10% of their cross section.
- Concrete components (cap and or piles/columns) have spalls but no exposed primary reinforcement and minimal narrow cracking, hairline shear cracks may be present.

**5: Major deterioration. Maintenance may be required.**

Deck:
- 50% - 69% of structural ties in need of replacement.

Superstructure:
- Steel girders require additional repair plates. (16% - 30%), flaking rust may be present and section loss appears minimal
- Multiple adjacent timber beams in need of replacement. (21% - 40%)
- Prestressed concrete components may have isolated wide cracks and spalls <6" diameter and <1" deep with exposed strands without loss of section.
- Cast in place concrete components have widespread spalls, some with exposed primary reinforcement but negligible section loss. Narrow may be widespread including shear cracks.

Substructure:
- Steel cap and/or piles require repair plates; (21%-30%) flaking rust may be present and section loss is apparent
- Isolated caps require replacement; multiple piles require replacement. (21% - 30%)
- Concrete components (cap and or piles/columns) have spalls that may have exposed primary reinforcement with negligible loss of section and narrow cracking, shear cracks may be present

**4: Advanced deterioration. Maintenance required. Component replacement recommended.**

Deck:
- >70% of structural ties in need of replacement.

Superstructure:
- Steel girders require additional repair plates. (>30%), noticeable, widespread section loss.
- Prestressed concrete components may have wide cracks and spalls >6" diameter and >1" deep with exposed strands exhibiting signs of section loss.
- Cast in place concrete components have widespread spalls, some with exposed primary reinforcement and exhibiting section loss. Wide cracking may be widespread including shear cracks.
- Multiple adjacent timber beams in need of replacement. (>40%)

Substructure:
- Steel cap and/or piles require repair plates (>30%); flaking rust may be present and section loss is noticeable and widespread.
- Multiple caps require replacement; multiple piles require replacement. (>30%)
- Concrete components (cap and or piles/columns) have spalls that may have exposed primary reinforcement with noticeable loss of section and/or wide cracking, shear cracks may be present.

**3: Advanced deterioration. Local failures are possible. Maintenance required. Component replacement required.**

2: **Critical deterioration. Bridge closure may be required. Component replacement required. Bridge replacement recommended.**

1: **Critical deterioration. Bridge is closed due to structural deterioration. Component replacement required. Bridge replacement required.**

0: **Structural failure. Bridge replacement required.**

Grades of 7 and above are considered "good," grades 5 and 6 are considered "fair," and grades of 4 and below are considered "poor." Components graded "good" may require routine maintenance that is not part of this analysis; components graded "poor" or below are recommended for replacement. Components graded "fair" may require a repair. The repair options for fair components are included in subsequent sections of this report.

## Cost Estimate

Repairs are assumed to return the load rating to 286k. Actual costs may vary based on the findings of the in-depth inspection, the location within the state and how remote the site is, and the type of repair. A breakdown of the assumed repairs and the cost per repair is provided in the Appendix. These repairs are based on the types of repairs necessary to repair the typical bridge types found during field observations. Costs do not include money for engineering, permitting, etc.

## Bridge Replacement

If a bridge needs to be replaced either due to inadequate capacity for Cooper E80 (286k) loading or due to the cost of rehabilitation exceeding 2/3 of the replacement cost. Replacement cost is based on single track, ballasted deck bridges, with ~20' span precast pre-stressed concrete slab units supported on driven HP 14 X 89 3-pile bents with pre-stressed concrete caps, abutments, and wings. The service life of these replacement bridges is taken as 50 years for the purpose of this analysis.

## Element Repair/Replacement

Bridge repairs are for repair of the element in kind. Repairs are assumed to add 10 years of life to the bridge. Element replacement (i.e. new deck, superstructure, or substructure) provides up to 25 years of life to the bridge via complete replacement of the element in kind. Bridges showing no visible signs of distress at this time are assigned a remaining service life of greater than 25 years. In the event the cost of the element repairs be greater than 50 percent of the cost to replace the component, then replacement is recommended.

For deck repairs and maintenance involving structural ties, there is no effect on the lifespan of the bridge but the associated cost of those repairs has been included in this analysis. Values used in cost estimating element replacement come from one of four sources:

- 2018 RSMeans Heavy Construction Costs
- TDOT bid averages 2016-2019

- Regional rail bridge replacement projects completed in the last ten years. Values have been adjusted for inflation (TDOT CSR Project No. 08-029, December 2018; NCDOT project R-4047, C203393, June 2014)

A summary of the repair activities for each component and material type follows.

## DECK

### *CONCRETE*

Concrete deck cost is provided in cost per linear foot. This calculation assumes 20' spans that are 14' wide, supported on beams of any type and includes the following components:

- Elevated flat 4000 psi concrete slab with drops. Cost includes formwork, grade 60 rebar, concrete, placement, and finishing. *RSMeans*
- 1' x 2' Concrete Parapet. *R-4047*
- 42" steel handrail. *RSMeans*
- Heavy duty timber cross ties, 7" x 9" x 8'-6", 19.5" on center, with 10' of ties on each approach. *RSMeans*
- Ballast, 1' deep, extending 11.5' along each approach. *CSR Project No. 08-029*
- Membrane layer and 1" asphalt planking. *R-4047*

### *STEEL*

Steel deck cost is provided in cost per linear foot. This calculation assumes decking that is 14' wide, supported on beams of any type and includes the following components:

- ¾" thick plate steel. *RSMeans*
- 1' x 2' Concrete Parapet. *R-4047*
- 42" steel handrail. *RSMeans*
- Heavy duty timber cross ties, 7" x 9" x 8'-6", 19.5" on center, with 10' of ties on each approach. *RSMeans*
- Ballast, 1' deep, extending 11.5' along each approach. *CSR Project No. 08-029*
- Membrane layer and 1" asphalt planking. *R-4047*

### *TIMBER*

Timber deck cost is provided in cost per linear foot. This calculation assumes a 14' width supported on beams of any type. Cross members are estimated to be half the depth of ties but twice the length with two ties placed longitudinally as ballast retainers. No waterproofing is applied to timber ballasted decks.

## SUPERSTRUCTURE

### Beams/Girders

#### *CONCRETE*

Concrete beam replacements are handled as full superstructure replacements. See "Bridge Replacement".

#### *TIMBER*

Timber beam replacement cost will be on an "each" basis assuming 8' spans and 8" X 16" timber beams.

#### *STEEL*

Steel girder repair cost will be based on plating with ¾" plates and 5/16" welds. Cost will be estimated at two rating levels. At a superstructure rating of 6, the estimate will include 2 plates, either in the flanges or web. At a superstructure rating of 5, the estimate will include 4 plates, one for each flange and two for the web. Cost includes:

- ¾” plate. *RSMeans*
- 5/16” welds, single pass. *RSMeans*
- Weld labor. This will include a 300 percent multiplier for overhead welds. *RSMeans*

Steel beam replacements are handled on a per linear foot basis with an assumed cost of $4000 dollars per linear foot for spans up to 45’. Cost increases by $500 per linear foot for every 15’ increase in length. The table below summarizes these values:

| Span Length | Cost/ft |
|---|---|
| <45’ | $4,000 |
| 45-60’ | $4,500 |
| 60-75’ | $5,000 |
| 75-90’ | $5,500 |

Replacement cost covers only the cost of the superstructure and deck cost would be added separately.

## SUBSTRUCTURE

### Abutment

#### *CONCRETE/MASONRY*

Concrete abutment cost for pile supported abutments is based on precast pre-stressed concrete abutments as outlined in “Bridge Replacement”. Mass concrete abutments observed did not require repairs and thus have not been costed at this time.

### Piles

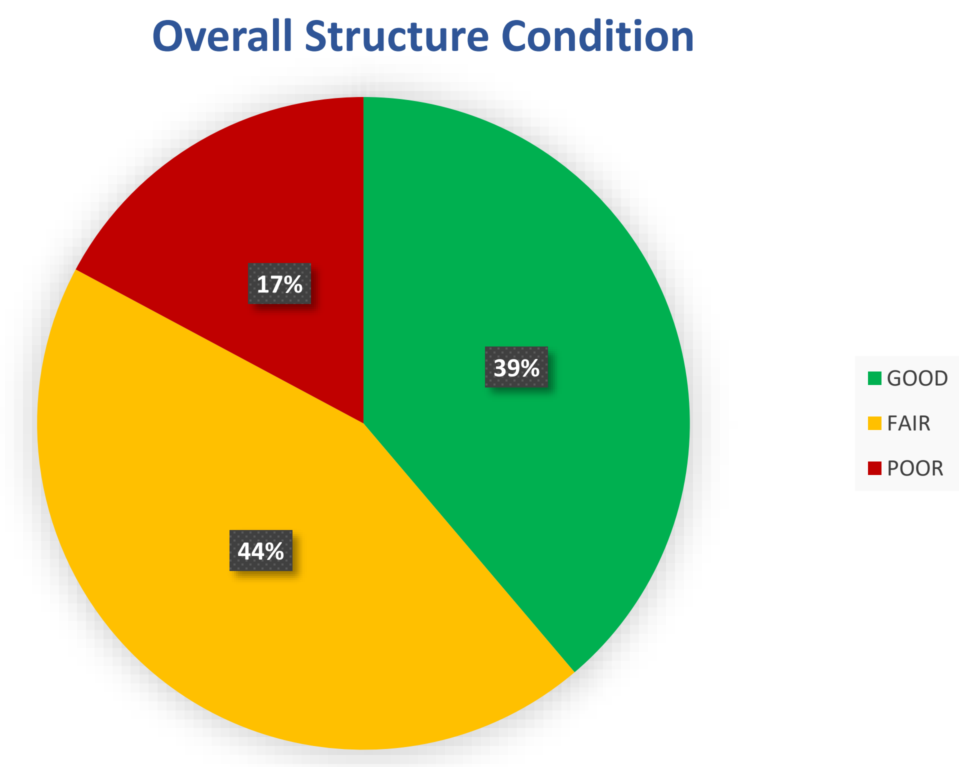
Pile replacement cost will be based on crutch bents with (2) driven HP 10 X 42 steel piles and a HP 10 X 42 steel cross cap. Two estimates are included: one for decked bridges, and one for open deck bridges. Cost includes:

- HP 10x42 piles, including material cost, equipment, and labor. *TDOT bid averages 2016-2019*
- Drilling 12” deck holes for pile installation, one per pile. (RSMeans)
- Ballast removal/replacement. Removal is based on installation cost minus material cost, with a 400 percent labor multiplier. *RSMeans*
- Cross tie removal/replacement. Removal is based on installation cost minus material cost, with a 200 percent labor multiplier. *RSMeans*
- Weld labor. This will include a 300 percent multiplier for overhead welds. *RSMeans*

## Findings

Out of the 518 bridges MN assessed, approximately 38.8 percent are in overall Good condition, 44.0 percent in Fair, and 17.2 percent in Poor. Condition of a bridge is controlled by its least component rating score. A summary of the data can be found in the tables and charts that follow.

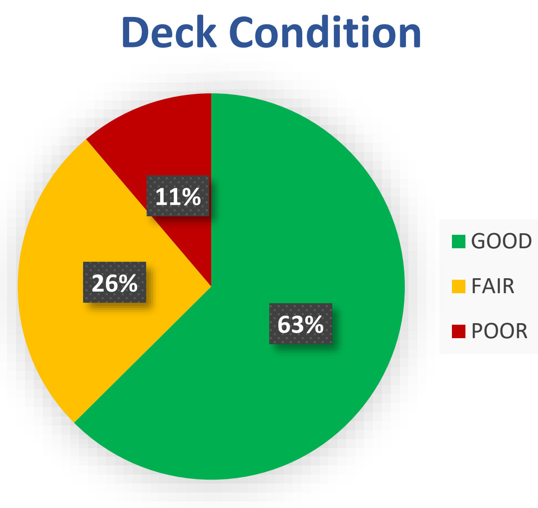
| | **Overall** | **Deck** | **Super** | **Sub** |
|---|---|---|---|---|
| **GOOD** | 201 (38.80%) | 324 (62.55%) | 353 (68.15%) | 315 (60.81%) |
| **FAIR** | 228 (44.02%) | 136 (26.25%) | 144 (27.80%) | 180 (34.75%) |
| **POOR** | 89 (17.18%) | 58 (11.20%) | 21 (4.05%) | 22 (4.25%) |



By component, the breakdown is as follows:

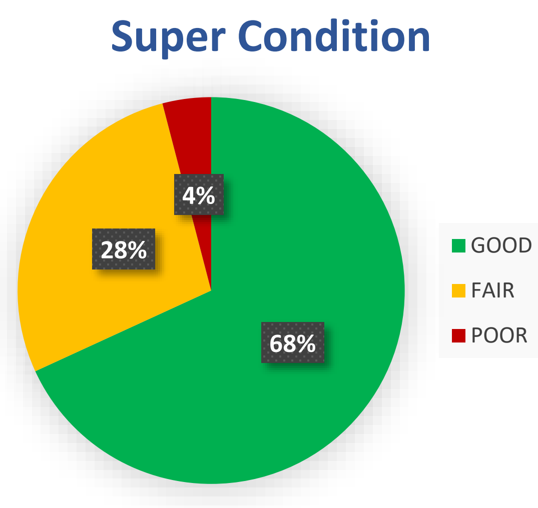
- 62.6% have decks in Good condition, 26.3% in Fair, and 11.2% in Poor.
- 68.2% have superstructures in Good condition, 27.8% in Fair, and 4.1% in Poor.
- 60.8% have substructures in Good condition, 34.8% in Fair, and 4.3% in Poor.

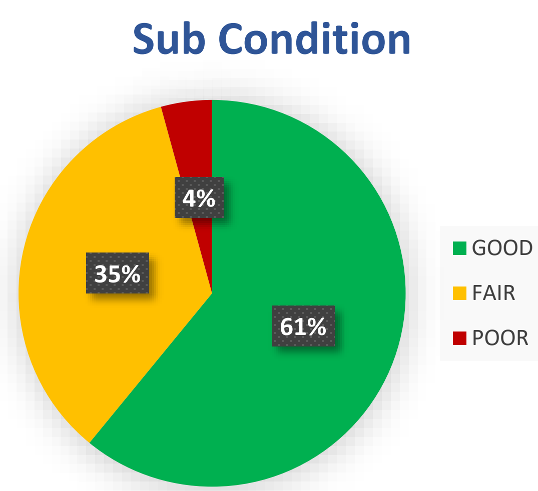
The estimated cost of repairs for the short line system is $69,895,000 which includes the cost of 16 bridges that have been identified as special cases (i.e. large river bridges in need of repairs, riveted trusses in need of repair or replacement, etc.)




## Reports

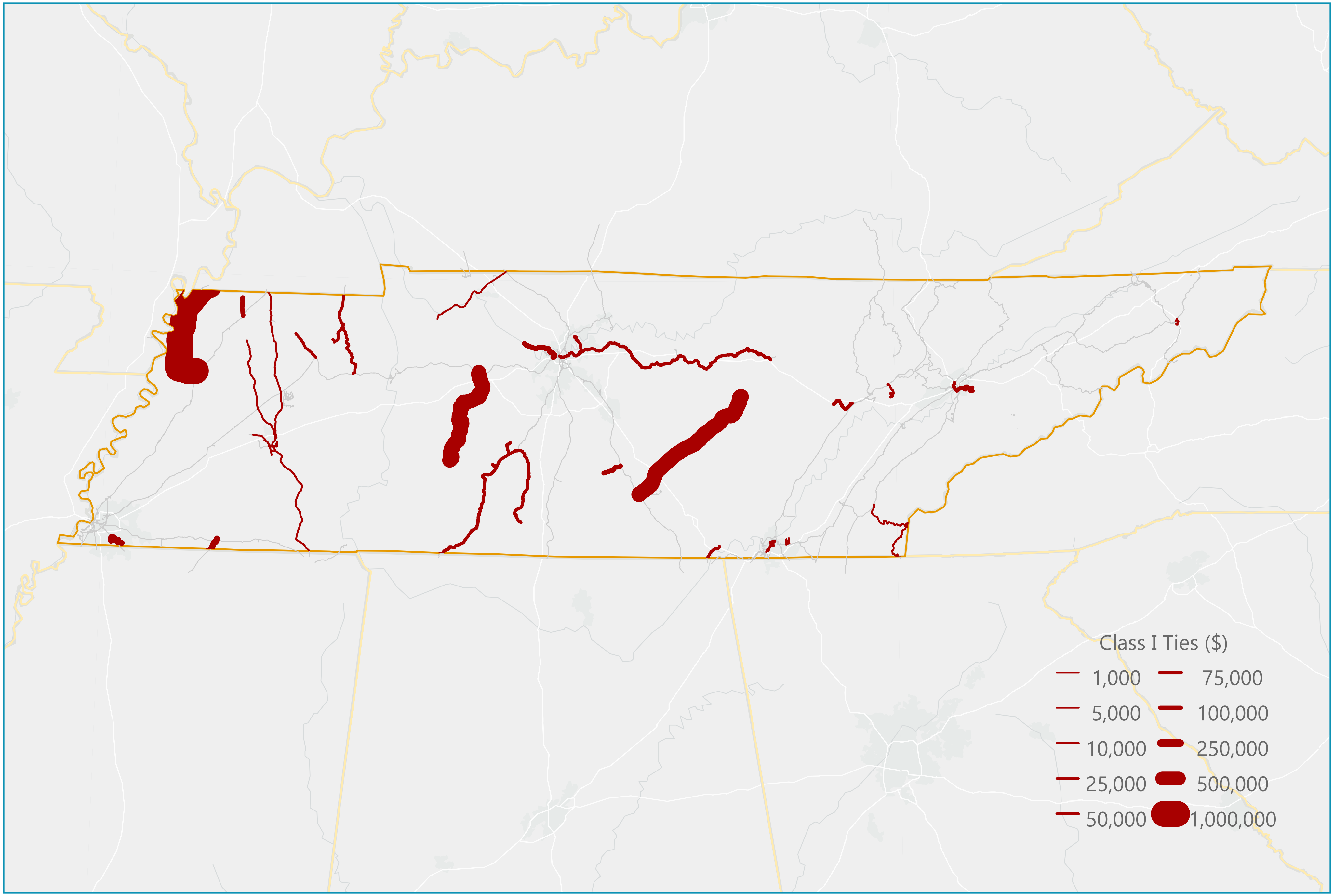
Individual bridge assessment reports were provided to each short line and the Department of Transportation.



# APPENDIX

| Parent Company Name | Railroad Name | Subsidiary Railroad | Miles | Class 1 Ties ($) 10 mph | Class 2 Ties ($) 25 mph | Rail ($) 286k loading | Bridge ($) 286k loading | Total ($) |
|---|---|---|---|---|---|---|---|---|
| RJ Corman | Nashville and Eastern | NERR | 128.9 | 58,608 | 315,216 | 44,744,960 | 660,228 | **45,779,012** |
| | Nashville and Western | NWRR | 16.2 | 139,392 | 269,280 | 3,928,320 | 5,601,528 | **9,938,520** |
| | Memphis Line | RJCM | 36.3 | 0 | 287,496 | 0 | 6,618,145 | **6,905,641** |
| | Tennessee Terminal | RJCK | 14.2 | 138,057 | 394,517 | 6,048,600 | 2,198 | **6,583,371** |
| Ironhorse | Caney Fork & Western Railroad | CFWR | 60 | 554,400 | 1,236,720 | 29,492,160 | 7,935,110 | **39,218,390** |
| | Sequatchie Valley Switching Co. | SQVR | 7 | 51,480 | 106,920 | 2,724,480 | 725,486 | **3,608,366** |
| | Walking Horse Railroad | WHOE | 8 | 112,800 | 209,880 | 4,942,080 | 0 | **5,264,760** |
| | Mississippi Tennessee Railroad | MTNR | 1 | 15,840 | 31,680 | 506,880 | 0 | **554,400** |
| Patriot Rail Company | Tennessee Southern Railroad | TSRR | 108.5 | 282,486 | 1,588,773 | 26,433,792 | 1,825,045 | **30,130,096** |
| Tennessee Valley Railroad Museum | East Chattanooga Belt Railway Co. | ECTB | 4.3 | 0 | 72,230 | 639,936 | 0 | **712,166** |
| | Chattanooga District Branch | TVRM | 4.2 | 0 | 1,584 | 0 | 932,726 | **934,310** |
| | Hiwassee River Railroad | TOHX | 44 | 7,920 | 364,320 | 0 | 3,231,461 | **3,603,701** |
| | Tyner Terminal | TNTX | 9.1 | 24,948 | 121,968 | 396,000 | 298,113 | **841,029** |
| Western Tennessee Railroad Group | West Tennessee Railroad | WTNR | 181 | 7,920 | 527,472 | 33,073,920 | 32,972,798 | **66,582,110** |
| | Tennken Railroad | TKEN | 41 | 928,047 | 1,726,560 | 9,504,000 | 1,066,475 | **13,225,082** |
| | South Central Tennessee Railroad | SCTR | 48 | 430,640 | 1,237,700 | 19,008,000 | 2,887,982 | **23,564,322** |
| Indiana Business Group | Union City Terminal | UCT | 9.4 | 104,840 | 259,776 | 696,960 | 404,278 | **1,465,854** |
| Genessee & Wyoming Railroad | Kentucky West Tennessee Railway | ETRY | 4 | 2,376 | 36,432 | 190,080 | 41,305 | **270,193** |
| | East Tennessee Railway | KWT | 48.8 | 47,520 | 550,144 | 19,641,600 | 2,584,379 | **22,823,643** |
| Gulf & Ohiio Railroad | Knoxville and Holston Railroad | KXHR | 19.3 | 65,736 | 426,888 | 3,389,760 | 453,036 | **4,335,420** |
| Lhoist | Franklin Industrial Minerals Railroad | FIMX | 17.5 | 74,448 | 351,648 | 3,674,940 | 1,494,629 | **5,595,665** |
| Energy Solutions | Heritage Railroad | HR | 9.5 | 23,760 | 66,360 | 1,457,280 | 159,262 | **1,706,662** |
| Pioneer Rail | Mississippi Cnetral Railroad | MSCI | 6 | 182,160 | 287,200 | 3,801,600 | 0 | **4,270,960** |
| Total Cost ($) | | | 817.6 | **3,253,378** | **10,470,764** | **214,295,348** | **69,894,182** | **297,913,672** |




Tennessee Short Line Assessment

moffatt & nichol

Cost by Location

Class I Ties ($)

0 25 50 100 Miles

N
W E
S

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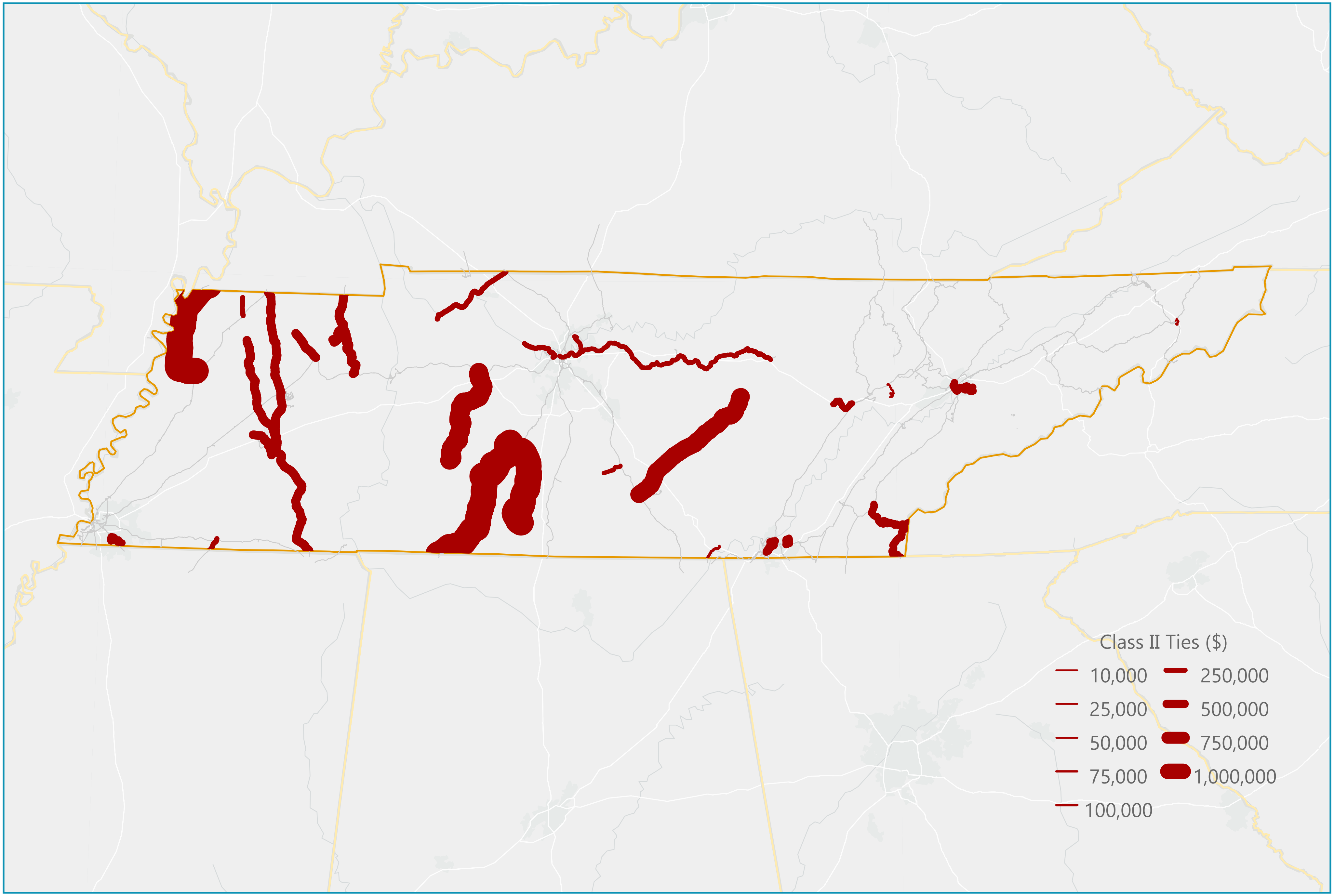


**Tennessee Short Line Assessment**

moffatt & nichol

Cost by Location

Class II Ties ($)

0 25 50 100 Miles

N
W E
S

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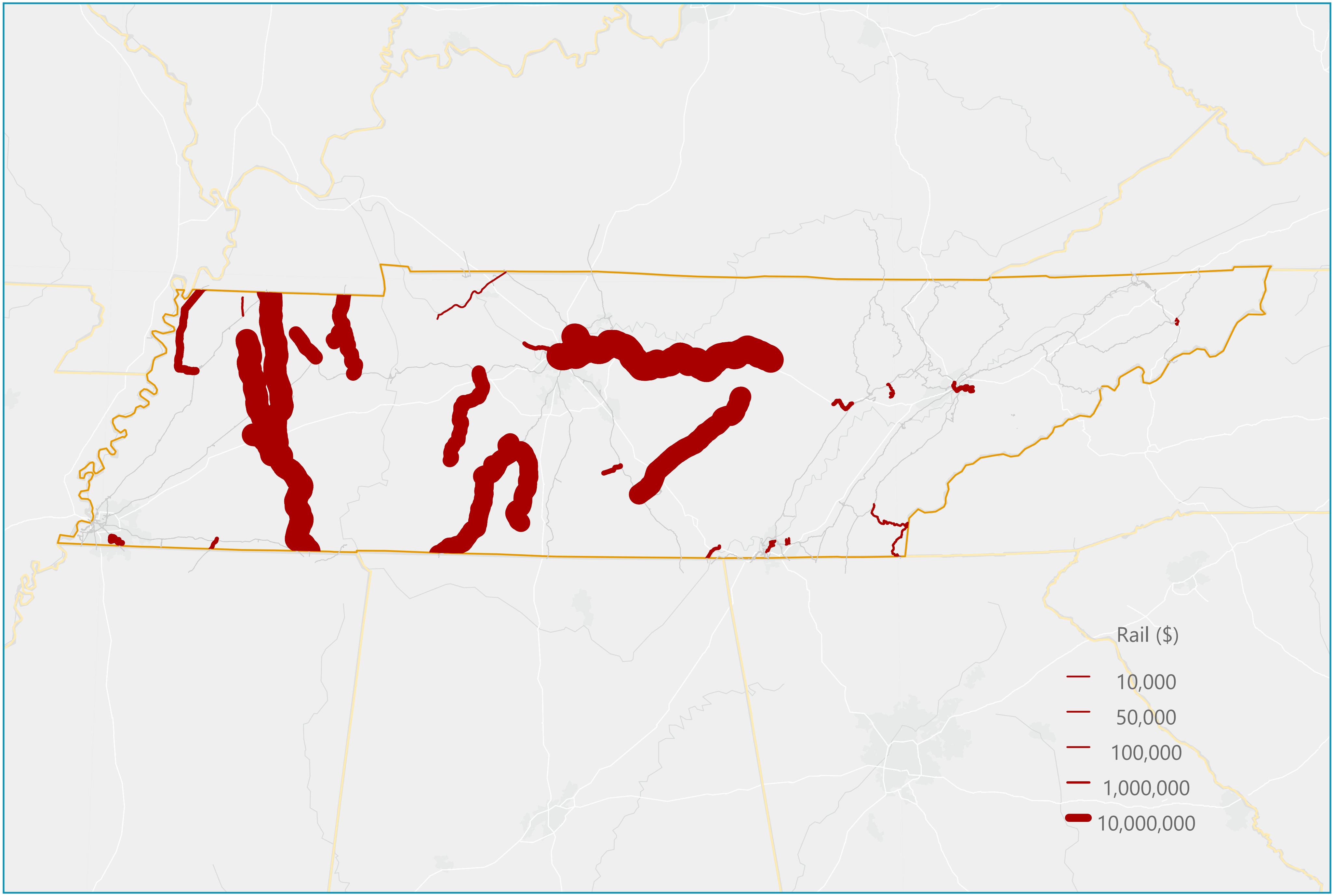
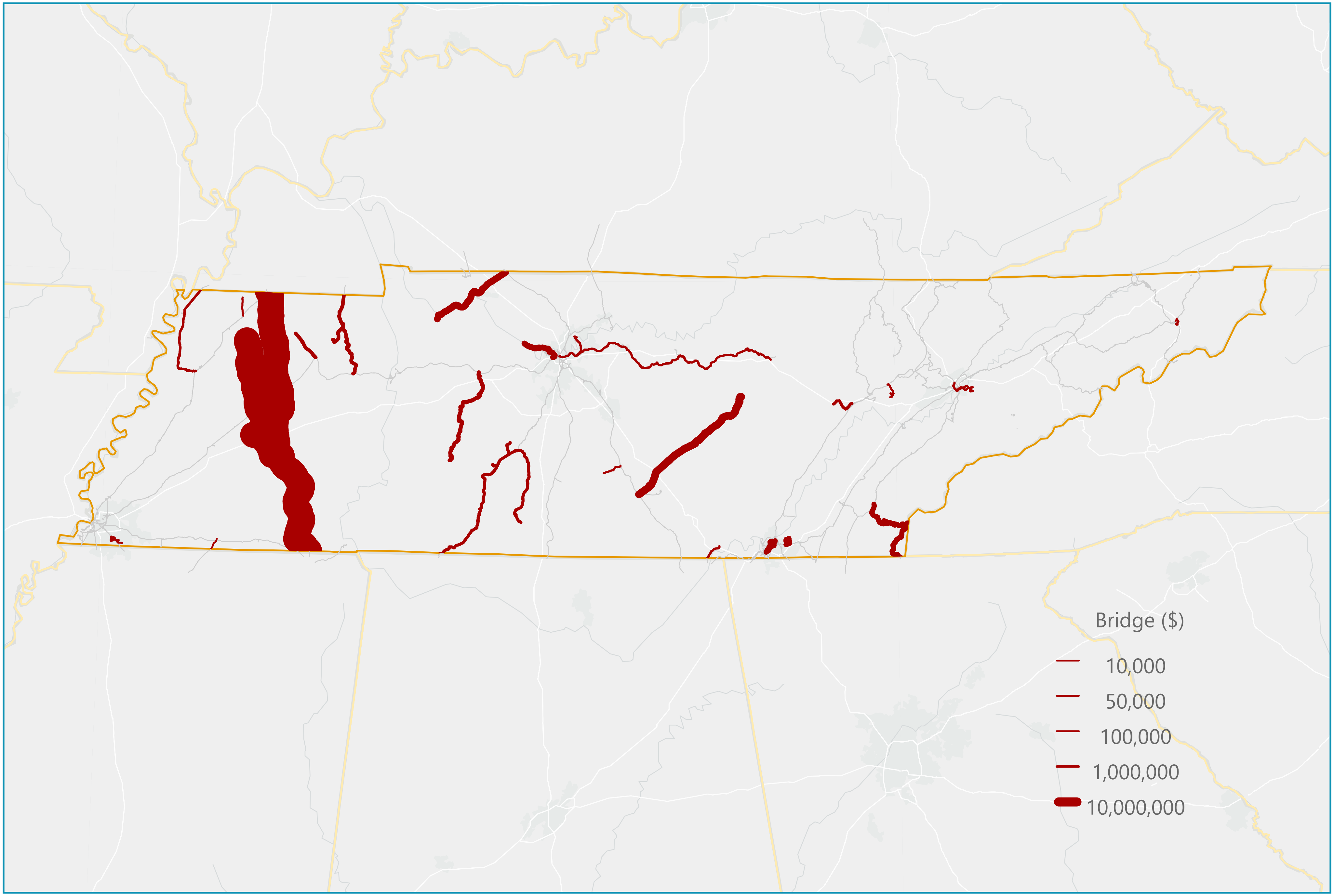



**Tennessee Short Line Assessment**

moffatt & nichol

Cost by Location

Rail ($)




**Tennessee Short Line Assessment**

moffatt & nichol

Cost by Location

Bridge ($)

0 25 50 100 Miles

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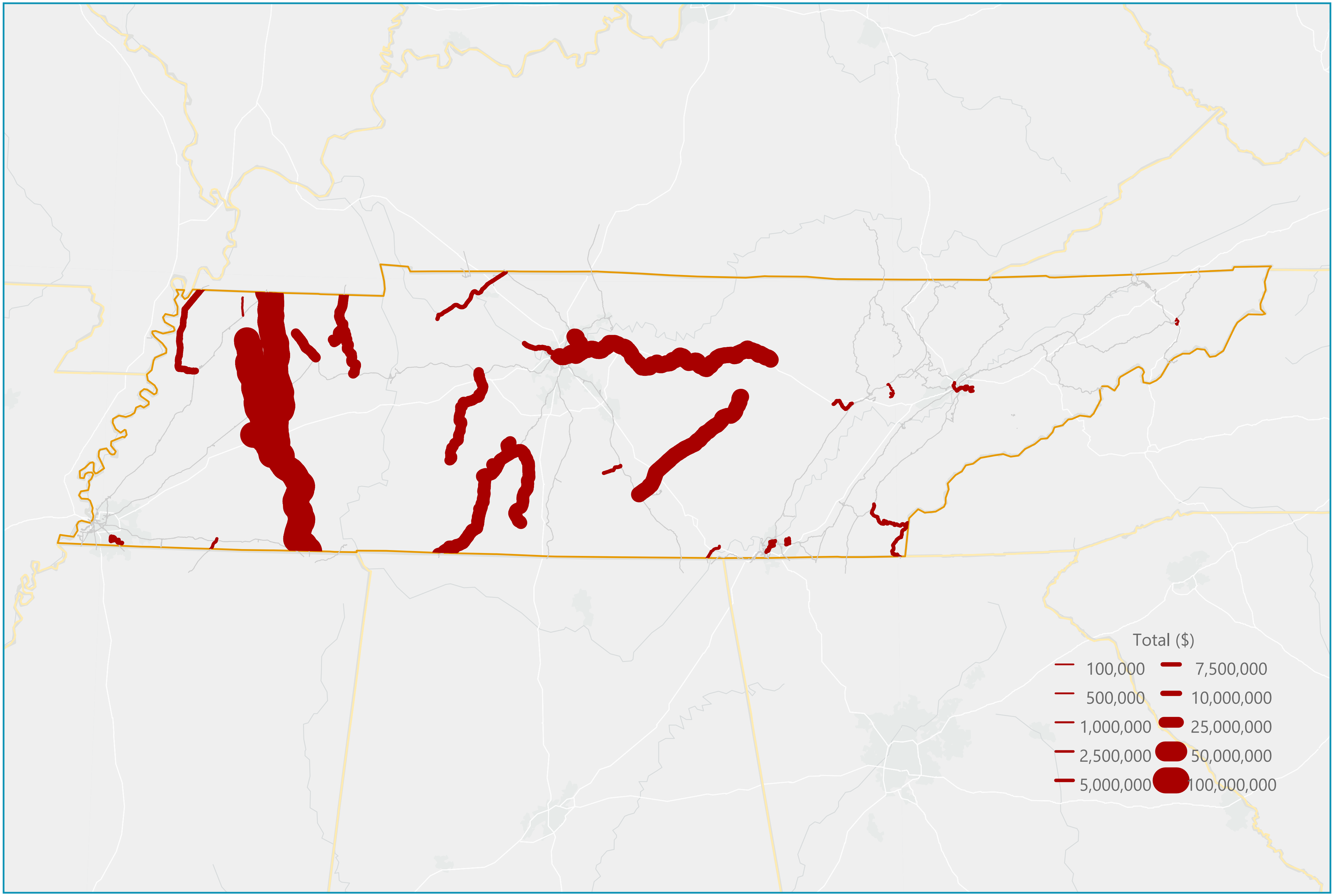


**Tennessee Short Line Assessment**

moffatt & nichol

Cost by Location

Total ($)

0 25 50 100 Miles

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## BRIDGE COST ESTIMATE VALUES:

## BRIDGE REPLACEMENT COST ESTIMATE:

| | | | |
|---|---|---|---|
| Total from Bid: | $476,600.49 | | *20181214 Submitted Bids.pdf* |
| 1% Contingency: | $4,799.51 | | |
| Engineering: | $33,600.00 | | % Engineering: 7.05 % |
| | | | |
| Use: | $375,170.49 | | |
| Contingency (1%): | $3,961.00 | | |
| Engineering (7%): | $26,728.50 | | |
| Mobilization (5%): | $18,758.52 | | |
| Total: | $424,618.52 | | |
| | | | |
| Bridge Length: | 92.17 | ft | |
| No. Spans: | 4 | | |
| Cost per LF of bridge: | $4,403.54 | /ft | *(does not include mobilization)* |
| Cost per new 23' span: | $101,465.00 | /span | *(does not include mobilization)* |

## Deck Cost

Assume 20' spans 14' wide

| | | | | | |
|---|---|---|---|---|---|
| Spans = | 1 | | No. approach ties = | 13 | |
| Span Length = | 20 | ft | L approach ties = | 0 | ft |
| Span Width = | 14 | ft | Tie Length = | 8.5 | ft |
| Span Area = | 280 | $ft^2$ | Tie Width = | 0.75 | ft |
| Deck Height = | 15 | in | Length of approach ballast = | 11.5 | ft |
| Deck Volume = | 12.96 | cy | Ballast depth = | 1 | ft |
| | | | Ballast volume = | 8.89 | cy |
| | | | Ballast mass = | 12.44 | tons (assume 1.4 tons per cy) |

## Steel Railing Cost

| Section | Designation | Daily Output | Unit | Cost | Total Price: | Description |
|---|---|---|---|---|---|---|
| **05 52 13.50** | 2050 | 120 | lf | $186.00 | $3,720.00 | 42" steel handrail |
| | | | | Total per Rail = | $3,720.00 | |

## Timber Track Cross Tie Cost

| Section | Designation | Daily Output | Unit | Cost | Total Price: | Description |
|---|---|---|---|---|---|---|
| **34 11 33.16** | 1900 | 70 | ea. | $216.00 | $2,808.00 | Heavy Duty, 7" x 9" x 8'-6", CL lots, removal and installation; 19.5" on-center spacing, single track |

## Ballast Cost

| Section | Designation | Daily Output | Unit | Cost | Total Price: | Description |
|---|---|---|---|---|---|---|
| **Avg. From Bids** | | | ton | $106.00 | $1,319.11 | Crushed stone ballast |
| **4047** | | | sy | $145.00 | $5,477.78 | Membrane layer waterproofing |
| | | | sy | $75.00 | $2,833.33 | 1" Asphalt planking |
| | | | | Total = | $9,630.22 | |

## Concrete Deck Cost

| Section | Designation | Daily Output | Unit | Cost | Total Price | Description |
|---|---|---|---|---|---|---|
| **03 30 53.40** | 1900 | 38.45 | cy | $775.00 | $10,046.30 | Elevated slab (4000 psi) flat slab, 20' span (includes forms, grade 60 rebar, concrete, placement, and finishing, Means Price Adjusted with DOT bid tabs) |
| **From NC R-4047** | | | lf | $587.99 | $23,519.49 | 1' x 2' Parapet |
| | | | | Total = | $33,565.79 | |

## Steel Deck Cost

| Section | Designation | Daily Output | Unit | Cost | Total Price: | Description |
|---|---|---|---|---|---|---|
| | | | lb. | $2.00 | $17,325.00 | 3/4" Steel plate deck, installed, and primed. |
| **From NC R-4047** | | | lf | $587.99 | $23,519.49 | 1' x 2' Parapet |
| | | | | Total = | $40,844.49 | |

## Timber Deck Cost

| | |
|---|---|
| **Curb beam count:** | 6 |
| **Deck beam count:** | 54 |
| **Total count, deck ties:** | 60 |

| Section | Designation | Daily Output | Unit | Cost | Total Price: | Description |
|---|---|---|---|---|---|---|
| **34 11 33.16** | 1900 | 70 | ea. | $152.73 | $9,163.80 | 6", CL lots, installation only |

## Deck System Cost Summary

| Deck System | Total Cost | Cost per lf |
|---|---|---|
| **Ballast, concrete deck, without rails** | $46,004.01 | $2,300.20 |
| **Ballast, timber deck, without rails** | $21,602.02 | $1,080.10 |
| **Ballast, Steel deck, without rails** | $53,282.72 | $2,664.14 |
| **Open deck, without rails** | $2,808.00 | $140.40 |
| **Steel Rail (cost per rail)** | $3,720.00 | $186.00 |

## Superstructure Cost

## Concrete Superstructure

| | | |
|---|---|---|
| L: | 23 | ft |
| W: | 14 | ft |
| H: | 1.83 | ft |
| Concrete spans from low bid = | $41,000.00 | each |
| | $1,782.61 | per lf |
| Concrete spans from bid avg.= | $47,740.00 | each |
| | $2,075.65 | per lf |

## Timber Superstructure

| | | |
|---|---|---|
| Beam L : | 8 | ft |
| Size: | 10 | in |
| by | 16 | in |

| Section | Designation | Description | Daily Output | Unit | Cost |
|---|---|---|---|---|---|
| 06 13 23.10 | 1500 | 10" X 16" | 16 | mbf | $4,800.00 |
| | | | | Cost/lf/beam: | $64.00 |

## Steel Superstructure

| | | |
|---|---|---|
| Plate: | 0.75 | in |
| Weld: | 0.31 | in |
| Beam L: | 1 | ft |

3/4" plating with 5/16" welds, assume 12" wide. Assume beams are 20' long and welded on each side of plate.

| Section | Designation | Description | Daily Output | Unit | Cost |
|---|---|---|---|---|---|
| 05 12 23.65 | 450 | 3/4" plate | N | sf | $45.50 |
| 05 05 21.90 | 1610 | 5/16" thick, 0.4#/LF, single pass | 38 | lf | $5.90 |
| 05 05 21.90 | 20 | Field welding, 1/8", cost per welder | | day | $888.00 |
| 05 05 21.90 | 2700 | Overhead joint welding, add | | % | 300 |

| Rating | # plates | Passes | Cost | Duration (days) | Cost/lf |
|---|---|---|---|---|---|
| 6 | 2 | 4 | $395.02 | 0.25 | $395.02 |
| 5 | 4 | 8 | $790.04 | 0.25 | $790.04 |

## Substructure Cost

## Pile Crutch Bent, Decked Bridge

| | | |
|---|---|---|
| Section: | HP 10x | 42 |
| Cap Length: | 6 | ft |
| No. Piles: | 2 | ft |
| Length of Pile: | 40 | lf |
| Total Length: | 86 | lb |
| Total Weight: | 3612 | sf |
| Beam surface area/ft length: | 4.96 | |
| Splice: | 2.5 | ft per pile |
| # passes, welding: | 4 | |
| # coats of paint: | 2 | |
| Concrete Deck thickness: | 15 | in |
| Max. # of removed ties: | 4 | |
| Removed/replaced ballast: | 6 | lf |

| Section | Designation | Description | Daily Output | Unit | Cost | Total Cost |
|---|---|---|---|---|---|---|
| **31 62 16.13** | 1100 | HP 10x42 | 540 | vlf | $100.00 | $8,600.00 |
| **03 82 13.10** | 1300 | 6" Core drilling, 12" diameter | 11 | ea | $115.00 | $230.00 |
| **03 82 13.10** | 1350 | ^ for each additional inch of slab thickness | 206 | ea | $10.00 | $180.00 |
| **34 01 23.51*** | 600 | Ballast removal/replace | 250 | lf | $20.27 | $243.28 |
| **34 11 33.16*** | 1900 | Tie removal/replace | 35 | ea | $76.96 | $615.65 |
| **05 05 21.90** | 2010 | Cont. fillet, 1/2" thick, 4 passes | 22 | lf | $55.00 | $1,100.00 |
| **05 05 21.90** | 20 | Field welding, 1/8", cost per welder | | hr | $111.00 | $2,664.00 |
| **05 05 21.90** | 2700 | Overhead joint welding, | | | 300.00% | |

* adjusted values

Total per bent: $13,632.93

## Pile Crutch Bent, Open Deck Bridge

| | | |
|---|---|---|
| Section: | HP 10x | 42 |
| Cap Length: | 6 | ft |
| No. Piles: | 2 | |
| Length of Pile: | 40 | ft |
| Total Length: | 86 | lf |
| Total Weight: | 3612 | lb |
| Beam surface area/ft length: | 4.96 | sf |
| Splice: | 2.5 | ft per pile |
| # passes, welding: | 4 | |
| # coats of paint: | 2 | |
| Max. # of removed ties: | 4 | |
| Removed/replaced ballast: | 6 | lf |

| Section | Designation | Description | Daily Output | Unit | Cost | Total Cost |
|---|---|---|---|---|---|---|
| **31 62 16.13** | 1100 | HP 10x42 | 540 | vlf | $100.00 | $8,600.00 |
| **34 11 33.16*** | 1900 | Tie removal/replace | 35 | ea | $76.96 | $615.65 |
| **05 05 21.90** | 2010 | Cont. fillet, 1/2" thick, 4 passes | 22 | lf | $55.00 | $1,100.00 |
| **05 05 21.90** | 20 | Field welding, 1/8", cost per welder | | hr | $111.00 | $2,664.00 |
| **05 05 21.90** | 2700 | Overhead joint welding, | | | 300.00% | |

* adjusted values

Total per bent: $12,979.65

## Pile End Bent, Average Bid Cost

| Item | Qty | Unit | Unit | Total |
|---|---|---|---|---|
| F&I HP14x89 Piling | 375 | lf | $ 256.75 | $ 96,281.25 |
| F&I Pile Rock Tips | 15 | ea | $ 283.75 | $ 4,256.25 |
| F&I C10x20 Lateral Bracing | 96 | lf | $ 289.25 | $ 27,768.00 |
| F&I Precast Concrete Abutment Cap | 2 | ea | $ 25,548.75 | $ 51,097.50 |
| F&I Precast Concrete Bent Cap | 3 | ea | $ 18,005.00 | $ 54,015.00 |
| F&I Precast Wing Wall | 4 | ea | $ 6,835.00 | $ 27,340.00 |
| | | | Total/bent: | $ 52,151.60 |

75 Years

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