



Santa Cruz County Regional Transportation Commission

Santa Cruz Branch Line Structural Assessment

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SANTA CRUZ BRANCH LINE

Located in Santa Cruz County, CA

STRUCTURAL ASSESSMENT

July 2005

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This Structural Assessment report was prepared by Biggs Cardosa Associates, Inc. in consultation with Systra Consulting, Inc. in general accordance with the scope of work as per our agreement with Miller, Owen and Trost for the Santa Cruz County Regional Transportation Commission. The recommendations in this report are based on site investigations, maintenance summary excerpts, and standard engineering practice. As-built plans and detailed maintenance reports were unavailable during preparation of this report. Due to the inherent limitations in site investigations, geotechnical investigations and materials testing, it is neither uncommon to encounter unforeseen variations in conditions along the project alignment nor is it practical to determine all such variations during a program of field investigation for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a reasonable explanation and resolution.

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0. EXECUTIVE SUMMARY

0.1 Introduction

This Structural Assessment has been prepared as part of Santa Cruz County Regional Transportation Commission's (RTC's) due diligence for the proposed acquisition of the 32-mile Santa Cruz Branch Line (Branch Line) from Union Pacific Railroad Company (UP), including UP's freight rail service on the Branch Line.

Goal and Objectives

The overriding goal of this report is to provide the RTC with a structural assessment of the structures on the Santa Cruz Branch Rail Line in connection with the RTC's due diligence investigation of the Branch Line.

The primary objectives of the structural assessment are four fold:

- Supply the RTC with a snap shot of existing structural conditions
- Identify potential structural issues and conceptual costs associated with continuance of freight operations by the RTC
- Identify potential structural issues associated with the possible implementation of a future trail or passenger rail service in addition to freight service using the structure
- Identify and recommend supplemental investigations and data collection to further define the issues, refine the conceptual costs and reduce potential risk.

0.2 Summary of Structures

The major structure facilities along and/or crossing the Branch Line can be classified into the following four broad categories:

- Railroad Bridge Structures
- Highway Overhead Structures
- Culvert Structures
- Retaining Wall Structures

Summary maps of the Branch Line indicating the approximate milepost, structure type, approximate total length, approximate age, and structural condition rating associated with each Railroad Bridge Structure, Highway Overhead Structure and major Culvert Structures are included in Appendix A.

0.2.1 Railroad Bridge Structures

The Branch Line includes a total of twenty-nine (29) Railroad Bridge Crossings. Several of these crossings are comprised of two or more distinct bridge structure segments, resulting in a total of thirty-eight (38) separate Railroad Bridge Structures. The total length of these structures represents approximately 3.1% of the length of the 31.9 mile Branch Line.

The Railroad Bridge Structures are comprised of seven (7) distinct structural types as follows:

- Open Deck Timber Stringer
- Ballasted Deck Timber Stringer

- Steel Plate Truss
- Steel Plate Through Girder:
- Steel Plate Deck Girder
- Precast Concrete Box Girder
- Prestressed Concrete Trough

See Figure 0-1 for a breakdown of the number of occurrences of each bridge type and Figure 0-2 for a breakdown of the total structure length by bridge type.

Figure 0-1: Railroad Bridges - Number of Occurrence by Type

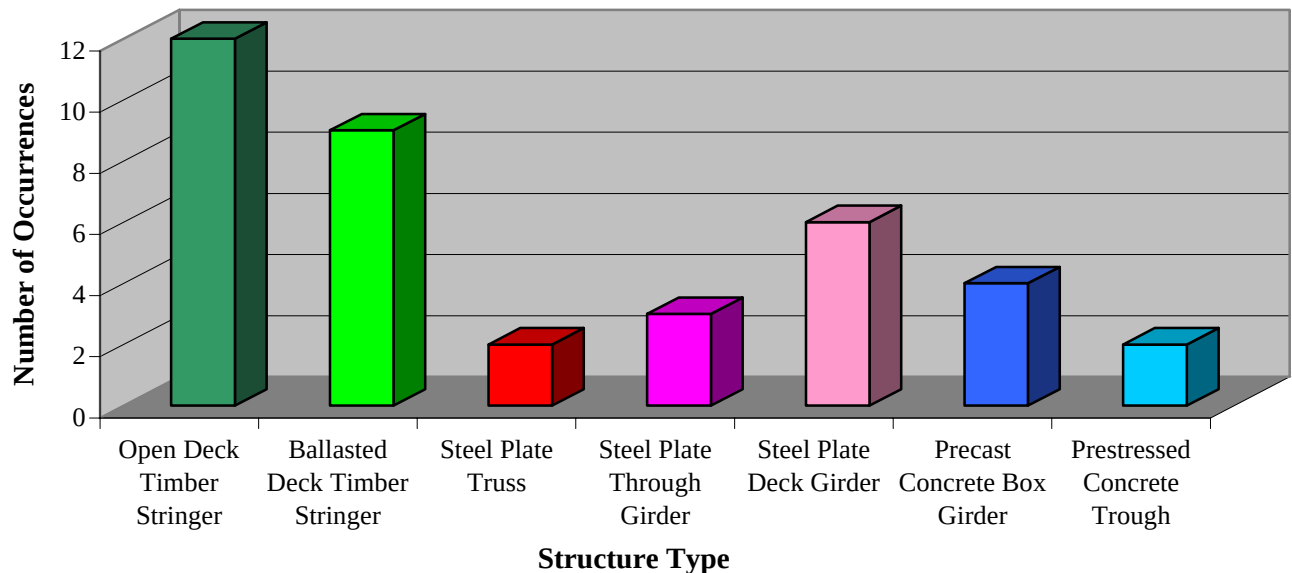
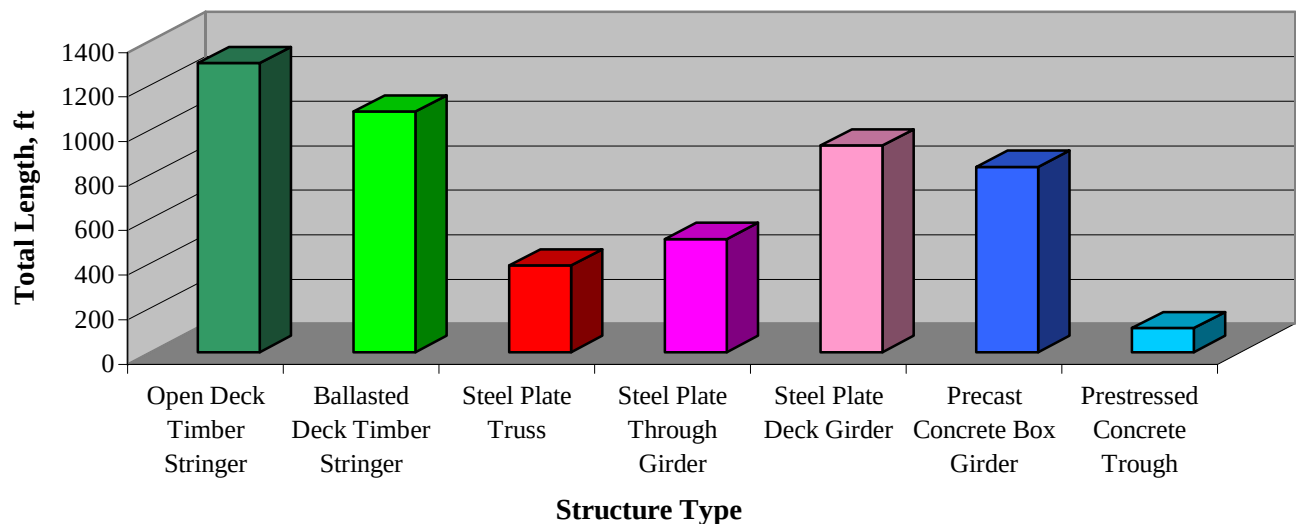
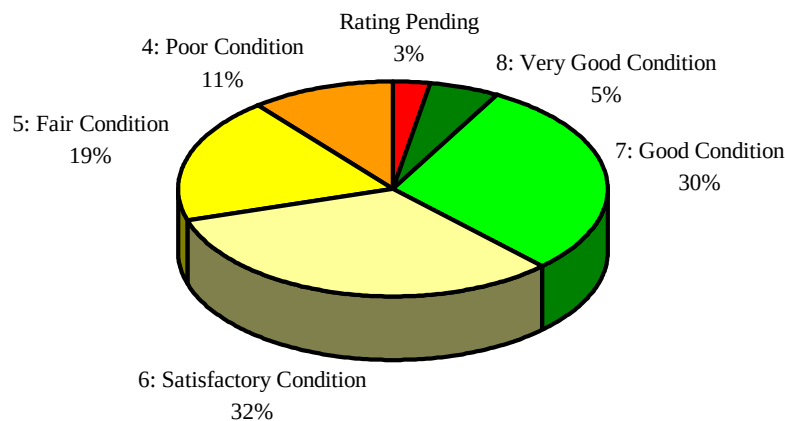


Figure 0-2: Railroad Bridges - Total Length by Type



A structural field review and preliminary structural assessment was performed on thirty-seven (37) of the thirty-eight (38) bridge structures. Structure conditions ranged from very good to poor, with the majority of the structures in fair to good condition. The assessment for one structure (MP 9.09, La Selva Trestle), is not complete, and is the subject of a supplemental report. The assessed structures appear to be suitable for continued freight operations with minimal anticipated capital investment. Figure 0-3 summarizes the condition ratings assessed for each of the existing Railroad Bridge Structures. (See Appendix D for complete Condition Rating Key). In general, a rating of 7 to 9 indicates Good Condition; a rating of 4 to 6 indicates Poor to Fair Condition; and a rating of 0 to 3 indicates Critical Condition.

Figure 0-3: Percent of Railroad Bridges by Rating



Continuance of Freight Service:

Overview:

Some near term capital investment is recommended for rehabilitation of several structures to improve structure safety and protect the RTC's long-term investment. Our preliminary assessment indicates that from a service load standpoint, the assessed Railroad Bridge Structures can continue to operate as they have with some level of near-term capital investment and a continued maintenance program. Replacement of damaged and/or deteriorated structural members represents the majority of the recommended near-term capital investment. Estimated near-term capital costs for the assessed Railroad Bridge Structures have been summarized at the end of this section (See Table 0-1: Estimated Potential Capital & Annual Maintenance Cost).

Seismic Considerations:

Given the number and relative ages of these structures, it is likely that several of the structures do not meet the current seismic design standard. This standard requires that the structure meet specific displacement ductility levels to prevent structure collapse under a Maximum Credible Seismic Event. Based on our experience and our overview of these structures, a large number of these structures can be seismically retrofitted and/or upgraded to meet the current seismic standard without significant capital cost. Retrofit costs for these structures can range from

approximately \$100 to \$2,000 per track foot of structure depending on the size, material, structure type and structure complexity.

There is evidence that several structures have received a Phase 1 type seismic retrofit in the past, including the retrofit of bridges over Route 1 that were designed by Biggs Cardosa Associates, Inc. Phase 1 retrofits are designed to prevent the loss of support of the superstructure. Phase 2 retrofits are designed to prevent collapse due to a substructure failure. A Phase 1 retrofitted structure does not necessarily mean that it meets the “no-collapse” criteria in the standard. A Phase 1 retrofit is simply a cost effective first step to implement a retrofit program that may reduce the overall risk of collapse. From the freight rail service standpoint, there is a low probability of a train passing over a bridge during a seismic event. The RTC may conclude based on a cost/benefit – risk analysis, that upgrading some or all of the bridge structures to meet the current standards is not economically feasible or practical. Based on an RTC cost/benefit – risk analysis, seismic vulnerability studies can be performed on an individual or a group of structures to identify potential seismic vulnerabilities, preliminary retrofit concepts and anticipated retrofit construction costs.

Short Line Operator Maintenance Responsibilities:

Routine maintenance operations will need to be performed by the short line operator, and should include periodic inspections of the structures and minor member replacements and rehabilitations. In order to protect the RTC’s long-term investment, a regular Inspection Program should be mandated and implemented to meet the specific needs of the Branch Line. The program should be tailored to consider the wide range of structural types, materials, relative age, importance, visibility and current condition of the structures. Estimated near-term short line operator maintenance costs for the Railroad Bridge Structures have been summarized at the end of this section (See Table 0-1: Estimated Potential Capital & Maintenance Cost).

Table 0-1: Estimated Potential Capital & Annual Maintenance Costs
(Railroad Bridge Structures)

Costs	Potential Capital Costs ⁽¹⁾		Potential Annual Maintenance Costs ⁽²⁾	
	Low	High	Low	High
Continuance of Freight Service Potential Costs	181,000	896,000	53,400	77,900

- (1) One-time, near term repair/rehabilitation cost (Does not include one-time costs for potential seismic retrofits which can typically range from \$100 to \$2,000 per track foot)
- (2) Recurring annual average cost
- All costs recommendations consist of planning level order of magnitude costs based on visual field review, limited historical data, readily available industry standards and recent project experience. Actual incurred costs may vary.
 - Anticipated costs can be further refined based on supplemental structural and/or seismic vulnerability studies recommended in section 8.

Future Passenger Service:

Seismic Considerations:

Those structures that are suitable for continued freight service are anticipated to be suitable for the day-to-day service loads associated with any proposed passenger service. However, due to the increased frequency of trains and the increased number of individuals crossing these structures, the likelihood of a train being on or within stopping distance of a bridge structure during a seismic event increases significantly, and consequently the risk to public safety increases significantly. Due to the increased risk, detailed seismic vulnerability studies are recommended prior to implementation of any future passenger rail service for all of the Railroad Bridge Structures within the limits of any proposed passenger rail service to mitigate potential risks. This level of investigation may need to be performed for those structures that may be incorporated as part of any future trail project for the same reasons. As the San Lorenzo River Crossing (MP19.43) currently has a public walkway, seismic vulnerability should be considered a current concern.

Based on our experience and our overview of these structures, a large number of these structures can be seismically retrofitted and/or upgraded to meet the current seismic standard without significant capital cost. Retrofit costs for these structures can range from approximately \$100 to \$2,000 per track foot of structure depending on the size, material, structure type and structure complexity.

Short Line Operator Maintenance Responsibilities:

In general, the maintenance activities required for a future passenger service are essentially equivalent to those required for the freight operations. However, due to the increased frequency of loading to the structure, a reduction in the period between scheduled maintenance inspections may be warranted. Should separate short line railroads operate the freight and passenger rail service, a clear division of maintenance responsibility needs to be included in the contracts with both short line operators.

0.2.2 Highway Overhead Structures

The Branch Line is crossed by a total of six (6) highway, local road and/or private crossings. Excluding an amusement park ride belonging to the Santa Cruz Beach Boardwalk at MP 19.52 (Amusement Park Ride), the Highway Overhead Structures are comprised of four (4) distinct structural types as follows:

- Timber Through Truss
- Steel Deck Girder
- Concrete Tee Beam
- Concrete Slab

A structural field review and preliminary structural assessment was performed on all of the overhead structures (excluding the Amusement Park Ride). The overheads were generally in satisfactory to very good condition and appear to be suitable for continued freight operations to pass below with no appreciable capital costs currently anticipated. Maintenance responsibility

for the Highway Overhead Structures carrying public highways, streets and roads over the Branch Line is anticipated to be the primary responsibility of the associated public agency (Caltrans, County, City, etc). No appreciable capital or maintenance costs to the RTC associated with continuing freight operations under these structures is currently anticipated (subject to verification of standing maintenance agreements with the various agencies involved).

No appreciable additional capital or maintenance costs to the RTC associated with implementing passenger rail service is currently anticipated (subject to verification of standing maintenance agreements with the various agencies involved).

0.2.3 Culvert Structures

The Branch Line includes one hundred and two (102) culvert crossings passing under the track facilities, including twenty-four (24) major culvert crossings (diameter equal to or greater than 48"). The culvert crossings consist of numerous structural types of varying size and importance including:

- Concrete Arch Culverts
- Concrete Box Culverts
- Corrugated Metal Pipes (CMP)
- Reinforced Concrete Pipes (RCP)
- Rock Tunnels/ Stone Arch Culverts

A structural field review was performed on a portion of the major culvert crossings that were readily accessible and identifiable from the Branch Line right-of-way. The major culverts reviewed were generally in fair to good condition and appear to be suitable for continued freight operations with no appreciable capital costs currently anticipated. The Railroad maintained culverts should be incorporated into the regular structures maintenance program. Maintenance costs are currently estimated to be fairly minor and consist largely of clearing debris and vegetation.

No appreciable additional capital or maintenance costs associated with implementing passenger rail service are currently anticipated (subject to verification of standing maintenance agreements with the various agencies involved).

0.2.4 Retaining Wall Structures

Several Railroad and privately owned retaining wall structures of varying structural types, sizes and material composition occur intermittently along the Branch Line. These structures are outside of the contract scope of work. However, it is noted that there may be critical wall elements that may be important to review due to the potential for significant capital rehabilitation and/or maintenance costs, or the potential to impact rail operations should a failure occur. Of particular concern are the retaining walls adjacent to the La Selva Trestle, which appear to have some localized failures. Structural assessment of this section of retaining wall is recommended due to the potential risk to the trackway and interruption of freight service.

0.3 Supplemental Investigations

Based on review of the available as-built data and the results of the preliminary structural assessments, the following supplemental investigations are recommended to further assess the existing structural conditions, and refine estimates of potential capital improvement and annual maintenance costs:

- Supplemental Structural Studies
- Seismic Vulnerability Studies
- Verify Maintenance Responsibilities

0.3.1 Supplemental Structural Studies

Detailed Structural Assessments

Detailed structural assessments are recommended for selected structures as identified in the individual Field Review Reports (See Appendix E) due to a Poor Condition Rating, advanced age of the structure, importance/visibility of the structure, and/or potentially high capital and maintenance costs of the structure. These structures include:

MP 1.06	Pajaro River Crossing	Important river crossing
MP 10.45	Seascape Trestle	Condition Rating of 4: Poor Condition
MP 15.89	Capitola Crossing	Important highway and river crossing
MP 19.43	San Lorenzo River Crossing	Condition Rating of 4: Poor Condition and important river crossing
MP 23.54	Meder Creek Crossing	Condition Rating of 4: Poor Condition

Retaining Walls

Several Branch Line and private retaining wall structures of varying structural types and material composition were noted during the structural field review to occur intermittently along the Branch Line. Several of these structures may have the potential to require investment of capital and/or maintenance resources over the life cycle of the proposed project. Field review of the major retaining wall structures is recommended.

0.3.2 Seismic Vulnerability Studies

Prior to implementing a trail or initiating passenger service, on any of the existing Railroad Bridge Structures, detailed seismic vulnerability studies are recommended for the subject Railroad Bridge Structures, to mitigate potential risks. MP19.43 San Lorenzo River Crossing now has a public walkway on it, and so a seismic vulnerability study is recommended in the near term for this structure.

The RTC may also wish to conduct a risk assessment of all the major existing Railroad Bridge Structures to evaluate the costs of a seismic retrofit program against the risk of possible loss or damage of the structure, with associated freight service disruptions and costs of restoring the structures.

0.3.3 Maintenance Responsibility

Verification of the existing structure maintenance agreements and responsibility is recommended to further refine anticipated structure maintenance costs for the Branch Line.

1. INTRODUCTION

1.1 Background and Organization of Report

Biggs Cardosa Associates, Inc., in consultation with SYSTRA Consulting, Inc., is pleased to present this Santa Cruz Branch Line Structural Assessment to the Santa Cruz County Regional Transportation Commission (RTC) for its consideration. This Structural Assessment is based on the RTC's proposed acquisition of the 32-mile Santa Cruz Branch Line (Branch Line) from Union Pacific Railroad Company (UP), including UP's freight rail service on the Branch Line. In addition, this Structural Assessment assumes that the acquisition will be funded with a combination of State Transportation Improvement Program (STIP) funds, federal funds, and Proposition 116 funds, as provided in the RTC's current financial plan.

The Structural Assessment covers the following general areas of concern to the RTC:

- Summary of existing Branch Line Structures (Railroad Bridges, Highway Overheads and major drainage culverts), except for MP9.09 LaSelva Trestle, which is not complete and is the subject of a separate report
- Summary of Structural Assessment approach and methodology
- Summary of supplemental investigation recommendations
- Summary of issues and projected costs associated with continuance of freight rail service
- Summary of issues and projected costs associated with implementation of future passenger rail service
- Summary of potential historic structure issues
- Summary of potential seismic risks as they relate to continuance of freight service versus implementation of passenger rail service

While this Structural Assessment recognizes that there are potential structural issues related to the future Coastal Rail Trail, it does not include an assessment of the structural impacts of the construction or operation of the Rail Trail. For example, existing bridge walkways and railings may require upgrade to meet current standards. We understand that the RTC will address the Rail Trail project separately following acquisition and that a detailed analysis will be prepared at that time.

Finally, this Structural Assessment was prepared without the benefit of access to UP's detailed Branch Line maintenance records, as-built plans or records from its Branch Line freight rail operations (see Appendix B & C for available as-built data). In addition, supplemental investigations recommended in this report (if implemented by the RTC) may affect some of the conclusions concerning capital investments and annual expenses needed to continue freight operations and to institute recreational operations. The projections set forth in this Structural Assessment can be updated once that information is made available.

1.2 RTC Branch Line Acquisition

Using State of California Proposition 116 and other transportation funds, the RTC is considering acquisition of the Branch Line, so that existing and future uses of the Branch Line can be publicly and locally controlled.

UP currently provides freight service on the Branch Line. This report assumes that the RTC, through a contracted short line operator, would be responsible for the continuation of freight service upon acquisition.

The RTC may consider the potential for future recreational passenger rail service. The provision of passenger rail service is of no interest to UP and would be implemented under RTC ownership.

The RTC's long-range plan also includes as a priority project, construction of the Coastal Rail Trail within the Branch Line right-of-way next to the rail line. Because of cost and liability issues, a trail would be unacceptable to UP under its ownership, while it could be implemented under RTC ownership.

While under negotiations with UP for the acquisition of the Branch Line, the RTC is undertaking the preparation of this Structural Assessment to determine the conditions under which it can reasonably expect that:

- Freight services can continue profitably;
- Public ownership would not place an unreasonable financial burden on the RTC.

2. SCOPE AND OBJECTIVES

2.1 Scope

In general, the scope of services is as follows:

- Field review all bridge structures and approximately 20% of major culvert structures to assess existing condition and suitability for continued service. (Note: only 20% of major culvert structures were included in the scope of work due to the minor and repetitive nature of the culvert structures and the minimal potential cost impacts to the Branch Line)
- Prepare structural assessment of the bridge structures and selected culverts and provide recommendations associated with continuance of freight service and future passenger rail service, including potential historic significance and seismic risks
- Prepare range of conceptual level construction costs for the anticipated remediation associated with continuance of freight service.
- Prepare range of conceptual level maintenance costs associated with continuance of freight service.
- Identify any additional issues associated with the possible future implementation of passenger service.

2.2 Goal and Objectives

The overriding goal of this report is to provide the RTC with a structural assessment of all of the Railroad Bridge Structures, Highway Overhead Structures and a representative portion of the major Culvert Structures in connection with the RTC's due diligence investigation of the Branch Line.

The primary objectives of the structural assessment are four fold:

- Supply the RTC with a snap shot of existing structural conditions
- Identify potential structural issues and conceptual costs associated with continuance of freight operations by the RTC
- Identify potential structural issues associated with the possible implementation of future passenger rail service in addition to freight service
- Identify and recommend supplemental investigations and data collection to further define the issues, refine the conceptual costs and reduce potential risk.

3 SUMMARY OF STRUCTURES

3.1 General

The major structure facilities along and/or crossing the Branch Line can be classified into the following four broad categories:

- **Railroad Bridge Structures:** These structures include all of the existing Branch Line crossings carrying the railroad track facilities **over** obstructions such as rivers, creeks, drainage channels, State or County highways, local roads and/or other obstructions. Primary maintenance of these facilities is assumed to be by the UP.
- **Highway Overhead Structures:** These structures include all of the existing crossings carrying the Branch Line railroad track facilities **under** obstructions such as State or County highways, local roads and private facilities such as a Santa Cruz Beach Boardwalk Amusement Park ride. Primary maintenance of these facilities is assumed to be by the owning agency (public or private).
- **Culvert Structures:** These structures include all of the existing drainage facilities passing under the Branch Line such as piping, culverts and/or drainage tunnels. Several of these facilities extend beyond the branch line right-of-way with maintenance of these facilities anticipated to consist of a combination of UP, public agency and private ownership.
- **Retaining Wall Structures:** Branch Line and private retaining wall structures of varying structural types and material composition occur intermittently along the Branch Line. Maintenance of these facilities is anticipated to consist of a combination of UP, public agency and private ownership.

Summary maps of the Branch Line indicating the approximate milepost, structure type, approximate total length, approximate age, and structural condition rating associated with each Railroad Bridge Structure, Highway Overhead Structure and major Culvert Structures were prepared from the structural field reviews and from the Track Charts and confidential Structure Summary (Bridge Book) supplied by the UP to the RTC (See Appendix A). Data from the structural field reviews was also used to resolve/clarify discrepancies noted between the Track Charts and confidential Bridge Book.

3.2 Railroad Bridge Structures

The Branch Line includes a total of twenty-nine (29) Railroad Bridge Crossings. Several of these crossings are comprised of two or more distinct bridge structure type/facilities, resulting in a total of thirty-eight (38) bridge structures. (See Map 1; Appendix A). The Railroad Bridge Structures are comprised of seven (7) distinct structural types as follows:

Timber Structures:

- **Open Deck Timber Stringer:** The superstructure consists of sawn lumber timber stringer elements directly supporting the timber rail ties. The substructure typically consists of either timber piled bents (timber cap beam, piling and bracing) or timber-framed bents (timber cap beam, posts, bracing and grade beams).



- **Ballasted Deck Timber Stringer:** The superstructure consists of sawn lumber timber stringer elements overlain with timber deck planks supporting the ballast and timber rail ties. The substructure typically consists of either timber piled bents (timber cap beam, piling and bracing) or timber-framed bents (timber cap beam, posts, bracing and grade beams).



Steel Structures:

- **Steel Plate Truss:** The primary superstructure load bearing system consists of a steel truss comprised of steel chords, verticals and longitudinal and transverse bracing. The Branch Line either passes over the steel truss elements (Deck Truss type) or between the steel truss elements (Through Truss type).
- **Steel Plate Through Girder:** The primary superstructure load bearing system consists of built-up steel plate girders comprised of a steel web with steel flanges built-up from one or more steel plates. The Branch Line passes between the steel plate girders on either an open or ballasted deck supported by smaller transverse beams between the girders.
- **Steel Plate Deck Girder:** The primary superstructure load bearing system consists of built-up steel plate girders comprised of a steel web with steel flanges built-up from one or more steel plates. The Branch Line passes over the steel plate girders on either an open or ballasted deck supported by the girders.



Concrete Structures:

- **Precast Concrete Box Girder:** The primary superstructure load bearing system consists of two or more precast concrete box girders placed side-to-side supporting the ballast and timber rail ties.
- **Prestressed Concrete Trough:** The primary superstructure load bearing system consists of a prestressed concrete trough comprised of two deep, prestressed concrete girders connected by a continuous bottom flange supporting the ballast and timber rail ties. The Branch Line passes between the concrete girders.



A structural field review and preliminary structural assessment was performed on thirty-seven (37) of the thirty-eight (38) bridge structures included in the following summary table. The assessment of the LaSelva Trestle, is not complete and is the subject of a supplemental report.

For each structure a condition rating of 1-9 was assigned as noted below and in Appendix D:

- 9 EXCELLENT CONDITION
- 8 VERY GOOD CONDITION - no problems noted.
- 7 GOOD CONDITION - some minor problems.
- 6 SATISFACTORY CONDITION - structural elements show some minor deterioration.
- 5 FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling, decay, infestation or scour.
- 4 POOR CONDITION - advanced section loss, deterioration, spalling, decay, infestation or scour.
- 3 SERIOUS CONDITION - loss of section, deterioration, spalling, decay, infestation or scour have seriously affected primary structural components. Local failures are possible.
- 2 CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete, severe decay or infestation in timber or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
- 1 "IMMINENT" FAILURE CONDITION - major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put bridge back in light service.
- 0 FAILED CONDITION - out of service; beyond corrective action.

Table 3-1: Railroad Bridge Structures Summary

MP	Facility Carried	Struct. Length	Structure Type & Material	Approx. Year Built	Condition Rating ⁽¹⁾	Caltrans Br. No.
0.86	Branch Line	218 ft	14 span open deck timber stringer	1940	6	
1.06	Branch Line over Pajaro River	180 ft 300 ft 91 ft	13 span open deck timber stringer 5 span open deck steel thru plate girder 6 span open deck timber trestle	1950 1906 1950	6 6 6	
4.45	Branch Line over Watsonville Slough	60 ft	4 span open deck timber stringer	1932	7	
4.87	Branch Line over Harkins Slough	195 ft	13 span ballasted deck timber stringer	1909	6	
5.42	Branch Line	15 ft	1 span ballasted deck timber stringer	1904	5	
5.54	Branch Line	135 ft	9 span ballasted deck timber stringer	1923	7	
6.01	Branch Line	90 ft	6 span ballasted deck timber stringer	1926	7	
6.14	Branch Line	30 ft	2 span ballasted deck timber stringer	1926	6	
6.25	Branch Line	120 ft	8 span ballasted deck timber stringer	1909	5	
8.32	Branch Line	15 ft	1 span ballasted deck timber stringer	1916	6	
8.64	Branch Line over San Andreas Road	48 ft 112 ft	1 span ballasted deck PS concrete trough 8 span ballasted deck timber stringer	1975 1932	7 5	36C0082
10.45	Branch Line	240 ft	16 span ballasted deck timber stringer	1928	4	
11.16	Branch Line	240 ft	16 span ballasted deck timber stringer	1928	5	
12.30	Branch Line over State Route 1	89 ft	2 span steel beam with concrete deck	1947 (1996)	6	36-0003
12.34	Branch Line over Valencia Creek	218 ft	4 span open deck steel plate girder	1969	7	

MP	Facility Carried	Struct. Length	Structure Type & Material	Approx. Year Built	Condition Rating ⁽¹⁾	Caltrans Br. No.
12.39	Branch Line over Soquel Drive	60 ft	1 span open deck steel plate girder	1925	5	
12.71	Branch Line over Aptos Creek & Spreckles Dr.	160 ft 71 ft	2 span open deck steel plate girder 1 span open deck steel thru plate girder	1969 1929	7 7	36C0077
12.83	Branch Line over State Route 1	147 ft	2 span ballasted deck steel thru plate girder	1948 (1996)	6	36-0012
14.85	Branch Line over New Brighton Beach Road	52 ft	2 span PS concrete box	1971	7	36P0009
15.89	Branch Line over Capitola Ave., Soquel Creek and Wharf Road	120 ft 215 ft 148 ft 40 ft 60 ft	3 span PS concrete box 15 span open deck timber stringer 1 span open deck truss pinned 3 span open deck timber stringer 1 span PS concrete trough	1970 1904 1903 1904 1971	8 6 6 5 7	36C0111 36C0109
17.30	Branch Line over Rodeo Gulch	240 ft	8 span PS concrete box	1977	7	
18.84	Branch Line over Santa Cruz Small Craft Harbor (Woods Lagoon)	420 ft	7 span PS concrete box	1970	8	
19.43	Branch Line over San Lorenzo River	240 ft 60 ft	2 span open deck riveted thru truss 1 span open deck plate girder	1904 1904	4 4	
22.29	Branch Line over Moore's Gulch	330 ft	22 span open deck timber stringer	1928	5	
23.47	Branch Line over Wilder Creek	15 ft	1 span open deck timber stringer	1935	5	
23.54	Branch Line over Meder Creek	16 ft	1 span open deck timber stringer	1913	4	
26.09	Branch Line over Baldwin Creek	9 ft	1 span open deck timber stringer	1937	7	
26.55	Branch Line	10 ft	1 span open deck timber stringer	1937	6	

Notes:

(1) See Appendix D for Condition Rating Key. In general: Good Condition (7-9); Poor to Fair Condition (4-6); Critical Condition (0-3)

3.3 Highway Overhead Structures

The Branch Line is crossed by a total of six (6) highway, local road and/or private crossings. See Map 2; Appendix A).

Excluding the Amusement Park Ride, the Highway Overhead Structures are comprised of four (4) distinct structural types as follows:

Timber Structures:

- **Timber Through Truss:** The superstructure consists of sawn lumber timber stringers supporting the roadway with the main span load bearing system consists of two timber trusses comprised of timber chords, verticals and longitudinal bracing. The roadway passes between the timber trusses.



Steel Structures:

- **Steel Deck Girder:** The primary superstructure load bearing system consists of steel wide flange girders. The roadway passes over the steel girders on a concrete deck supported by the girders.



Concrete Structures:

- **Concrete Tee Beam:** The primary superstructure load bearing system consists of multiple cast-in-place concrete Tee beams with an integral concrete deck supporting the roadway.
- **Concrete Slab:** The primary superstructure load bearing system consists of a cast-in-place concrete slab supporting the roadway.



A structural field review and preliminary structural assessment was performed on five (5) of the six (6) overhead structures (excluding the Amusement Park Ride) as summarized in the following table. For each structure a condition rating of 1-9 was assigned (See Appendix D for complete Condition Rating Key) with a rating of 7 to 9 indicating Good Condition; a rating of 4 to 6 indicating Poor to Fair Condition; and a rating of 0 to 3 indicating Critical Condition.

Table 3-2: Highway Overhead Structures Summary

MP	Facility Carried	Struct. Length	Structure Type & Material	Approx. Year Built	Condition Rating ⁽¹⁾	Caltrans Br. No.	Remarks
2.73	State Route 1 (Dual) over Branch Line	255 ft 255 ft	Concrete T-beam Concrete T-beam	1967 1967	7 7	36-0083L 36-0083R	Caltrans reports that it has maintenance responsibility.
12.03	Rio Del Mar over Branch Line	85 ft	Steel plate girder	1953	6	36C0114	Functionally Obsolete per Caltrans. HBRR funding may be available for replacement by County. Santa Cruz County Public Works has assumed maintenance responsibility.
19.41	East Cliff Drive over Branch Line	69 ft	Concrete Slab	1990	7	36C0106	Verify maintenance responsibility.
19.52	Amusement Park Ride over Branch Line	N/A	Amusement Park Ride	1977	Not Rated		Maintenance responsibility of Santa Cruz Beach Boardwalk (assumed)
20.18	West Cliff Drive over Branch Line	190 ft	Timber Through Truss	1999	8	36C0127	City of Santa Cruz has assumed maintenance responsibility.

Notes:

(1) See Appendix D for Condition Rating Key. In general: Good condition (7-9); poor to fair condition (4-6); critical condition (0-3)

3.4 Culvert Structures

Based on review of the confidential Bridge Book, the Branch Line includes one hundred and two (102) culvert crossings under the track facilities. The culvert crossings consist of numerous structural types of varying size and importance. Only the major culvert crossings (diameter equal to or greater than 48”) were considered of structural significance and are considered herein. The Branch Line includes twenty-four (24) major culvert crossings under the track facilities. (See Map 2; Appendix A).

The Major Culvert Structures are summarized into five (5) distinct structural types as follows:

- Concrete Arch Culverts
- Concrete Box Culverts
- Corrugated Metal Pipes (CMP)
- Reinforced Concrete Pipes (RCP)
- Rock Tunnels/ Stone Arch Culverts

A structural field review was performed on a portion of the major culvert crossings that were readily accessible and identifiable from the Branch Line right-of-way as summarized in the following table. Many of the culvert structures extend well beyond the limits of the Branch Line right-of-way and/or are obscured by heavy vegetation.

For each structure a condition rating was assigned as noted below:

- GOOD: Culvert is limited to only minor problems.
- FAIR: Structural capacity of culvert is not affected by minor deterioration, section loss, spalling, cracking, decay, infestation or other deficiency.
- POOR: Structural capacity of culvert is affected or jeopardized by advanced deterioration, section loss, spalling, cracking, decay, infestation or other deficiency.
- Not Rated: Structure was inaccessible from Branch Line right-of-way and/or obscured by heavy vegetation.

Table 3-3: Culvert Structures Summary

MP	Facility Carried	Struct. Length	Structure Type & Material	Approx. Year Built	Condition Rating
4.01	Branch Line	70 ft	72" CMP	1968	Fair
5.05	Branch Line	60 ft	48" CMP	2004	Good
6.31	Branch Line	30 ft	48" CMP	1998	Not Rated ⁽¹⁾
9.54	Branch Line	44 ft	48" CMP	1998	Good
10.33	Branch Line	120 ft	4' x 3.5' concrete arch culvert	1915	Not Rated ⁽¹⁾
13.14	Branch Line	20 ft	60" CMP	1948	Not Rated ⁽¹⁾
13.84	Branch Line	90 ft	8' x 6' concrete arch culvert	1916	Not Rated ⁽¹⁾
14.23	Branch Line	93 ft	4' x 3.2' concrete arch culvert	1917	Fair
16.95	Branch Line	24 ft	60" CMP	1957	Fair
18.25	Branch Line	34 ft	10' x 8' concrete arch culvert	1904	Fair
18.36	Branch Line	102 ft	4' x 3' concrete arch culvert	1885	Not Rated ⁽¹⁾
20.21	Branch Line	40 ft	66" concrete pipe	1981	Good
20.22	Branch Line	40 ft	51" concrete box culvert	Unknown	Not Rated ⁽¹⁾
20.32	Branch Line	40 ft	66" concrete box culvert	1981	Not Rated ⁽¹⁾
23.55	Branch Line over Meder Creek	80 ft	10' x 8' stone arch culvert	1905	Not Rated ⁽¹⁾

MP	Facility Carried	Struct. Length	Structure Type & Material	Approx. Year Built	Condition Rating
25.31	Branch Line over Lombardi Creek	206 ft	11' x 10' stone arch culvert	1906	Not Rated ⁽¹⁾
26.08	Branch Line over Baldwin Creek	83 ft	9' x 7' stone arch culvert	1906	Not Rated ⁽¹⁾
27.13	Branch Line over Major's Creek	120 ft	15' x 12' stone arch culvert	1906	Not Rated ⁽¹⁾
28.18	Branch Line over Laguna Creek	110 ft	12' x 12' stone arch culvert	1906	Fair
29.09	Branch Line over Yellow Bank Creek	324 ft	9' x 7' stone arch culvert	1906	Fair
29.91	Branch Line over Liddell Creek	135 ft	6' x 8' stone arch culvert	1906	Fair
30.26	Branch Line	138 ft 40 ft	6' x 5' stone arch culvert 48" CMP	1906 1941	Not Rated ⁽¹⁾
30.83	Branch Line	130 ft	14' x 12' stone arch culvert	1906	Fair
31.10	Branch Line	315 ft	6' x 8' stone arch culvert	1906	Not Rated ⁽¹⁾

Notes:

(1) Inaccessible from Branch Line right-of-way and/or obscured by heavy vegetation, or duplicative of other culverts

3.5 Retaining Wall Structures

Several Branch Line and private retaining wall structures of varying structural types and material composition were noted during the structural field review to occur intermittently along the Branch Line. These structures are outside of the contract scope of work and were therefore not reviewed in depth in the field. However, it is noted that there may be critical wall elements that may be important to review due to the potential for significant capital rehabilitation and/or maintenance costs, or the potential to impact rail operations should a failure occur.

4 STRUCTURAL ASSESSMENT APPROACH

4.1 General

This section provides an overview of the approach to conducting the structural assessments. The assessments were performed in three phases:

- Phase 1: Data Collection
- Phase 2: Field Review
- Phase 3: Data Evaluation

4.2 Data Collection

Available structures data made available by the UP to the RTC was initially limited to the Santa Cruz Subdivision Track Chart (Track Chart) dated November 28, 2001 (See Appendix B). Structural data from the Track Charts was limited to the structure mileposts and a brief coded description of the bridge length and type, or culvert size.

Just prior to the initiation of field reviews, the UP provided the RTC with a confidential copy of their Structures Summary (Bridge Book) dated May 26, 2005, consisting of a brief summary of the Railroad Bridge Structures, Highway Overhead Structures and Culvert Structures. In general, Railroad Bridge Structure data was limited to milepost, number of spans, structure and span lengths, structure type, approximate year built, selected member sizes and truncated and coded summary results of previous field reviews.

Unfortunately, milepost and other data from the confidential Bridge Book were in conflict with that presented in the Track Charts. All mileposts contained within this report have been based on the milepost data presented in the confidential Bridge Book, which was in general conformance with milepost signs noted in the field.

The data UP provided was supplemented with Highway Overhead and Railroad Underpass data from Caltrans. Thirteen (13) of the Railroad Bridge Structures and Highway Overhead Structures are assigned a Caltrans Bridge Number. Data compiled included bridge logs and California Historic Bridge Inventory ratings.

Seismic retrofit plans previously prepared by Biggs Cardosa Associates for the Railroad Bridge Structures over State Route 1 in Aptos at mileposts 12.30 and 12.83 while under contract with Caltrans were also collected and reviewed.

4.3 Field Review Approach

Preliminary field reviews were conducted by a team of structural engineers to evaluate the conditions of the major structures (and channels as applicable). The primary inspections were performed between June 7, 2005 and June 23, 2005 on off-traffic days. The inspection team was supported by a UP provided flagman and Hy-Rail vehicle. On the first day of inspections, senior staff from Biggs Cardosa Associates, Inc. and SYSTRA Consulting conducted an overview inspection of the primary bridge structures along the Branch Line. Inspection teams were subsequently dispatched to conduct visual inspections, prepare photo logs of the structures, observe visible evidence of structure condition/ deterioration and prepare draft field review reports.

Since as built plans were unavailable, the following conventions pertaining to abutment/bent numbering were used:

- Railroad Bridge Structures: Looking up station along the Branch Line, the first abutment encountered was labeled Abutment 1 and first bent encountered labeled Bent 2, etc.
- Highway Overhead Structures: Looking up station along with the Branch Line, the right most abutment encountered was labeled Abutment 1. The bents were then numbered consecutively from right to left.

4.4 Structural Assessment Approach

Based on the findings of the fieldwork and data collection, structural assessments were made and the Field Review Reports finalized (See Appendix E). A panel of senior staff at Biggs Cardosa Associates, Inc reviewed the draft field reviews and photo logs and estimated existing structural condition and prepared structural assessment recommendations. Structural Condition Ratings were based on previously established Condition Rating Keys. In general, the condition rating can be grouped into three broad categories (see Appendix D for full break down of the Condition Rating Key).

- Rating 7-9: Good Condition
- Rating 4-6: Poor to Fair Condition
- Rating 0-3: Critical Condition

Brief summary assessment recommendations were also prepared and included in the field review reports. Structural assessment recommendations were two fold:

- Structural recommendations pertaining to issues and/or suitability for continuance of freight service
- Recommendations for supplemental structural investigations, studies, research and/or data collection

5 CONTINUANCE OF FREIGHT SERVICE

5.1 General

The UP currently operates freight service on the Branch Line consisting of approximately 4,000 carloads per year with vehicle loads restricted to 286,000 pounds each. Per discussions with maintenance personnel assigned as flagmen for the preliminary field review portion of the project, current level of service typically consists of three scheduled trains per week (one Monday, one Wednesday & one Friday). The primary loads, consisting of cement, coal and lumber, are typically carried in 100-ton capacity railcars and all service along the Branch Line is limited to 10 miles per hour (FRA Excepted Track).

Upon acquisition of the Branch Line, the RTC plans to continue current freight service through a contracted short line operator. The following recommendations pertain to continuance of freight operations and distinguish between capital costs (rehabilitation/upgrades) that would likely be born by the RTC and maintenance costs (on-going/routine) that would likely be born by the short line operator.

5.2 Railroad Bridge Structures Issues and Costs

5.2.1 Potential Capital Costs and Issues

In general, the majority of the assessed structures appear to be suitable for continued freight operations with minimal anticipated capital investment. However, some near term capital investment is recommended for rehabilitation of several structures to improve structure safety and protect the RTC's long-term investment. Additionally, the near term investment may have the added benefit of reducing the short line operator's associated ongoing operations and maintenance costs. The August 2004 Business Plan (Table 5-11) assumed that no capital investment would be necessary to structures.

Structure Rehabilitation:

Replacement of damaged and/or deteriorated structural members represents the majority of the recommended near-term capital investment. Estimated near-term capital costs for the Railroad Bridge Structures have been summarized at the end of this section (See Table 5-2: Estimated Freight Rail Potential Capital & Maintenance Cost). An order of magnitude, high/ low range of potential capital costs has been included based on past project experience, the results of the preliminary field reviews, structural assessments and review of the minimal as-built data available, designated historic significance and current industry standards. Seismic retrofit costs are not included. These potential costs can be further refined after implementation of the supplemental investigations recommended in Section 8.

From a service load standpoint, the Railroad Bridge Structures can continue to operate as they are now with some level of a continued maintenance program. Given the number and relative ages of these structures, it is likely that several of the structures do not meet the current seismic design standard. This standard requires that the structure meet specific displacement ductility levels to prevent structure collapse under a Maximum Credible Seismic Event. Based on our experience and our overview of these structures, a large number of these structures can be seismically retrofitted and/or upgraded to meet the current seismic standard without significant

capital cost. Retrofit costs for these structures can range from approximately \$100 to \$2,000 per track foot of structure depending on the size, material, structure type and structure complexity.

There is evidence that several structures have received a Phase 1 type seismic retrofit in the past, including the retrofit of bridges over Route 1 that were designed by Biggs Cardosa Associates, Inc. Phase 1 retrofits are designed to prevent the loss of support of the superstructure. Phase 2 retrofits are designed to prevent collapse due to a substructure failure. A Phase 1 retrofitted structure does not necessarily mean that it meets the “no-collapse” criteria in the standard. A Phase 1 retrofit is simply a cost effective first step to implement a retrofit program that may reduce the overall risk of collapse. From the freight rail service standpoint, there is a low probability of a train passing over a bridge during a seismic event. The RTC may conclude based on a cost/benefit – risk analysis, that upgrading some or all of the bridge structures to meet the current seismic standards is not necessary as long as the structure is only used for freight. Seismic vulnerability studies can be performed on an individual or a group of structures to identify potential seismic vulnerabilities, preliminary retrofit concepts and anticipated retrofit construction costs. (See Section 8.3: Seismic Vulnerability Studies).

5.2.2 Potential Maintenance Costs and Issues

Routine maintenance operations will need to be performed by the short line operator, and should include periodic inspections of the structures and minor member replacements and rehabilitations.

In order to protect the RTC’s long-term investment, a regular Inspection Program should be mandated and implemented to meet the specific needs of the Branch Line. The program should be tailored to consider the wide range of structural types, materials, relative age, importance, visibility and current condition of the structures. Based on this regular information, timely and specific maintenance operations can be undertaken to correct situations that could otherwise lead to more extensive future repair or replacement. A typical inspection program for the Branch Line structures would likely be on a 2 –5 year recurring basis with actual rates for each structure tailored based on the factors listed above.

Structure maintenance should include minor member replacement identified during the regular inspection program. Examples of routine structure maintenance would include but not be limited to replacement of isolated members such as broken braces, failed bolts/rivets, broken railing or walkway panes and damaged ties, repair of split timbers, cracked welds, spalled concrete and exposed reinforcing, spot cleaning and painting, localized applications of preservatives, maintaining fire breaks, clearing debris and silt build-up, and maintaining approach slopes. In general, routine maintenance would exclude such items as complete structure painting, sandblasting or the global application of wood preservatives, unless otherwise addressed in the short line operator’s contract. Estimated maintenance costs (recurring annual average costs) for the Railroad Bridge Structures have been summarized in Table 5-2 below.

The August 2004 Business Plan (Table 5-1) assumed that maintenance of way (MOW) costs would be \$231,000, or \$7,000 per track mile. This includes \$2,000 to \$3,000 per track mile dedicated to structure maintenance, which is higher than average to reflect the large number of significant structures on this line. Nationally, short line MOW costs average about \$4,000 per track mile.

Table 5-2: Estimated Freight Rail Potential Capital & Annual Maintenance Costs

MP	Potential Capital Costs ⁽¹⁾		Potential Maintenance Costs ⁽²⁾		Remarks
	Low	High	Low	High	
0.86	15,000	30,000	2,400	3,000	
1.06a	0	0	2,000	2,700	
1.06b	0	100,000	3,600	5,200	
1.06c	0	0	1,000	1,400	
4.45	0	0	700	800	
4.87	5,000	10,000	2,100	2,800	
5.42	5,000	20,000	500	700	
5.54	2,000	10,000	1,500	1,900	
6.01	2,000	10,000	1,000	1,300	
6.14	2,000	10,000	500	700	
6.25	5,000	20,000	1,300	1,900	
8.32	0	0	500	700	
8.64a	0	5,000	500	700	
8.64b	5,000	20,000	1,200	1,700	
10.45	40,000	100,000	2,600	4,600	
11.16	20,000	60,000	2,600	4,200	
12.30	0	0	1,100	1,300	
12.34	0	0	2,600	3,600	
12.39	0	0	700	1,000	
12.71a	0	0	1,900	2,400	
12.71b	0	0	900	1,100	
12.83	0	0	1,600	2,100	
14.85	0	2,000	500	700	
15.89a	0	22,000	1,200	1,900	Historical significance ⁽³⁾
15.89b	20,000	77,000	2,400	4,000	Historical significance ⁽³⁾
15.89c	0	110,000	1,800	3,000	Historical significance ⁽³⁾
15.89d	10,000	44,000	500	800	Historical significance ⁽³⁾
15.89e	0	11,000	600	900	Historical significance ⁽³⁾
17.30	0	0	2,400	3,300	
18.84	0	0	2,000	3000	
19.43a	20,000	120,000	2,900	5,200	
19.43b	5,000	40,000	700	1,300	
22.29	20,000	60,000	3,600	5,200	
23.47	0	0	500	700	
23.54	5,000	10,000	500	700	
26.09	0	0	500	700	
26.55	0	5,000	500	700	
Total	181,000	896,000	53,400	77,900	

Table 5-2 Notes:

- (1) One-time, near term repair/rehabilitation cost (Does not include one-time costs for potential seismic retrofits which can typically range from \$100 to \$2,000 per track foot)
 - (2) Recurring annual average cost
 - (3) Capitola Crossing structures are part of an existing historic district. High costs include an associated 10% premium.
- All costs recommendations consist of planning level order of magnitude costs based on visual field review, limited historical data, readily available industry standards and recent project experience. Actual incurred costs may vary.
 - Anticipated costs can be further refined based on supplemental structural and/or seismic vulnerability studies recommended in section 8.
 - Table includes assessed structures only.

5.3 Highway Overhead Structures Issues and Costs

Maintenance responsibility for the Highway Overhead Structures carrying public highways, streets and roads over the Branch Line is anticipated to be the primary responsibility of the public agency (Caltrans, County, City, etc). No appreciable capital or maintenance costs to the RTC associated with these structures is currently anticipated (subject to verification of standing maintenance agreements with the various agencies involved).

5.4 Culvert Structures Issues and Costs

Primary maintenance for the Culvert Structures within the Branch Line right-of-way is anticipated to be the responsibility of the Branch Line owner. Ownership and maintenance responsibility for the Culvert Structures that extend beyond the Branch Line right-of-way is not clear and is anticipated to consist of a combination of UP, public agency and private ownership.

Based on the initial field review, the major culvert structures are generally in fair to good condition and appear to be suitable for continued freight operations with no appreciable capital costs currently anticipated. The Railroad-owned culverts should be incorporated into the regular structures maintenance program and be covered under the MOW cost range previously included in the business plan. Maintenance costs are currently estimated to be fairly minor and consist largely of clearing debris and vegetation.

6 FUTURE PASSENGER RAIL SERVICE

6.1 General

Recreational rail service is not currently proposed on the Santa Cruz Branch Line. The following recommendations pertain to potential structural issues associated with the existing structures should passenger service be established in the future. Issues not directly pertaining to the existing branch line structures, such as station structures, are outside of the project scope and are not considered herein.

6.2 Railroad Bridge Structures Issues and Costs

6.2.1 Potential Capital Costs and Issues

Future passenger service is assumed to be low cost recreational in nature, and operating speeds will be confined to the FRA Class 1 maximum of 15 mph. Passenger service rolling stock and service loads are anticipated to be lighter than those induced by the freight service. Therefore, those structures that are suitable for continued freight service are anticipated to be suitable for the day to day service loads associated with any proposed passenger service.

The primary structural issue associated with implementing passenger service on these existing Branch Line structures is risk management. Due to the increased frequency of trains and the increased number of individuals crossing the structures, the likelihood of a train being on or within stopping distance of a bridge structure during a seismic event increases significantly, and consequently the risk to the public increases significantly. Due to the increased risk, detailed seismic vulnerability studies are recommended prior to initiating service for all of the Railroad Bridge Structures within the limits of any proposed passenger rail service to mitigate potential risks (See Section 8.3: Seismic Vulnerability Studies). This level of investigation may also need to be performed for those structures that may be incorporated as part of the future trail project for the same reasons. MP19.43 San Lorenzo River Crossing now has a public walkway on it, and so a seismic vulnerability study is recommended in the near term for this structure.

Based on past project experience, current industry standards and the results of the preliminary field reviews, estimated seismic retrofit capital costs associated with initiating passenger rail service can range from approximately \$100 to \$2,000 per track foot of structure depending on the size, material, structure type and structure complexity. These costs would be in addition to any rehabilitation capital costs recommended in Section 5 for continuance of freight service. These potential costs can be further refined after implementation of supplemental seismic vulnerability studies listed in Section 8, which are recommended to be undertaken only if passenger service is contemplated in the future.

6.2.2 Potential Maintenance Costs and Issues

In general, the maintenance activities required for any future passenger service are essentially equivalent to that required for the freight operations. However, due to the increased frequency of loading to the structure (and the potential increase of pedestrian use of the structure walkways should a trail be implemented), a reduction in the period between scheduled maintenance inspections may be warranted. Should separate short line operators be contracted for the freight and passenger rail service, clear division of maintenance responsibility needs to be included in

the contracts with both short line operators. It is assumed that the primary maintenance responsibility will fall to the freight service short line operator, with the passenger service short line operator paying a maintenance premium as part of their operating contract.

Any required seismic retrofits should be considered part of the capital costs for initiating passenger service. If seismic upgrades are constructed, they may have the potential added benefit of reducing the short line operator's associated ongoing operations and maintenance costs.

6.3 Highway Overhead Structures Issues and Costs

No significant issues or appreciable capital or maintenance costs associated with these structures due to a future passenger service are anticipated beyond that which is required for continued freight operations (subject to verification of standing maintenance agreements with the various agencies involved).

6.4 Culvert Structures Issues and Costs

No significant issues or appreciable capital or maintenance costs associated with these structures due to a future passenger service is anticipated beyond that which is required for continued freight operations (subject to verification of standing maintenance agreements with the various agencies involved).

7 POTENTIAL HISTORIC STRUCTURES ISSUES

7.1 Potential Issues

This report does not include a detailed Historic Structure assessment of the existing facilities along the Branch Line. It is our understanding from the RTC, that only the Capitola Crossing structures (MP 15.89a through 15.89e) are currently identified as being part of an existing historical district.

Based on previous project experience, historic significance can have an impact on potential capital improvements and maintenance requirements for the structure. A common rule of thumb is to increase estimated structure costs by approximately 10% to account for potential supplementary code requirements, and/or restrictions on design and materials for capital improvements. Actual costs and impacts may vary on a case by case basis.

Potential impacts of a historical significance rating on the potential replacement or significant modification of a structure may include one or more of the following mitigations:

- No additional impacts
- Detailed research and documentation of structure prior to replacement/ modification
- Construction of information plaque on the site of the demolished or modified structure
- Construction of the structure replacement/ modification utilizing a similar structural type and detailing as the original structure
- Construction of a new railway structure along a parallel alignment with closure of the existing structure to both rail and pedestrian traffic. Existing structure to remain in place.
- Replacement not allowed. Rehabilitation of existing structure required.

Other structures that are over 50 years old may be classified as historic. Evaluation of structures for historical significance is triggered by the particular environmental review requirements of the funding source.

8 SUPPLEMENTAL INVESTIGATIONS

8.1 General

Preliminary structural assessments were based on overview field surveys with the focus on identifying the general structure conditions, issues and potential order of magnitude capital and maintenance expenditures associated with acquiring the Branch Line. The preliminary field review scope also included identification and recommendation of required and/or cost effective supplemental investigations.

Based on review of the available as-built data and the results of the preliminary structural assessments the following supplemental investigations are recommended to further assess the existing structural conditions, and refine estimates of potential capital improvement and annual maintenance costs. Three categories of proposed supplemental investigations have been identified as follows:

- Supplemental Structural Studies
- Seismic Vulnerability Studies
- Confirm Maintenance Responsibility

A Supplemental Study Summary Table has been compiled at the end of this section summarizing recommendations for supplemental studies.

8.2 Supplemental Structural Studies

8.2.1 Detailed Structural Assessments

Detailed structural assessments are recommended for selected structures as identified in the individual Field Review Reports (See Appendix E) due to a Poor Condition Rating, advanced age of the structure, importance/ visibility of the structure, and/or potentially high capital and maintenance costs of the structure. These structures include:

MP 1.06	Pajaro River Crossing	Condition Rating of 6: Satisfactory Condition; Important river crossing (~300 ft long), approximately 100 years old with potentially high rehabilitation cost
MP 10.45	Seascape Trestle	Condition Rating of 4: Poor Condition; Major crossing (~ 240 ft long), approximately 80 years old, with moderate to severe decay of timber bracing elements
MP 15.89	Capitola Crossing	Condition Rating varies with low of 5: Fair Condition; Important highway and river crossing (~580 ft long thru Downtown Capitola), over 100 years old, located in historic district with potentially high rehabilitation cost
MP 19.43	San Lorenzo River Crossing	Condition Rating of 4: Poor Condition; Important river crossing (~300 ft long), over 100 years old with potentially high rehabilitation costs
MP 23.54	Meder Creek Crossing	Condition Rating of 4: Poor Condition; over 90 years old

The recommended supplemental studies have been grouped into two priority classes as noted in Table 8-1: Supplemental Investigation Summary. Priority Group 1 studies are recommended to

be conducted within 0 to 3 years on structures receiving a Poor Condition Rating to confirm structure integrity and suitability for continued freight service and identify any areas potentially requiring rehabilitation (MP 10.45; MP 19.43; MP 23.54). The RTC may desire to have this group of assessments performed prior to acquisition of the Branch Line. Priority Group 2 studies are recommended to be conducted within 0 to 5 years on the remaining important crossings to verify structure load rating and identify any areas potentially requiring rehabilitation (MP 1.06; MP 15.89). The proposed supplemental structural assessments are recommended to include the following:

- Thorough review of available as-built data, including as-built structure plans (original, retrofit, rehabilitation) and complete maintenance reports
- Detailed structural element field surveys, including a member by member review of current condition and estimated section loss
- Service load structural analysis of the structure, accounting for current member conditions and measured section loss.

8.2.2 Retaining Walls

Retaining wall structures were not included in the confidential Bridge Book or Track Charts provided by UP to the RTC. As a result, a comprehensive list of Branch Line retaining wall structures is not currently available. At a minimum, visual field review and condition rating of the following three (3) retaining wall structures noted during the preliminary field review is recommended:

- Steel soldier pile and lagging retaining wall located between Watsonville Slough (MP 4.45) and Harkins Slough (MP 4.87)
- Steel rail pile and lagging wall located between San Andreas Road (MP 8.64) and Leonard Gulch (La Selva Trestle) (MP 9.09). This structure is of particular concern due to the potential risk to trackway and continuation of freight service should localized failure occur.
- Timber crib wall located north of Leonard Gulch (La Selva Trestle) (MP 9.09)

8.3 Seismic Vulnerability Studies

If passenger service is going to be pursued in the future, or if any existing structures are to be used for a future trail, detailed seismic vulnerability studies are recommended prior to initiating service for all of the Railroad Bridge Structures located within any proposed limits of future passenger rail service to mitigate potential risks. The seismic vulnerability studies are recommended to include the following:

- Thorough review of available as-built data, including as-built structure plans (original, retrofit, rehabilitation) and complete maintenance reports
- Detailed structural element field surveys, including a member by member review of current condition and estimated section loss

- Geotechnical investigation including preliminary structure foundation assessments and seismic design criteria recommendations.
- Seismic vulnerability structural analysis of the structure, accounting for current member conditions and measured section loss.

Studies will identify seismic vulnerabilities, preliminary retrofit concepts and anticipated retrofit construction costs.

MP19.43 San Lorenzo River Crossing now has a public walkway on it, and so a seismic vulnerability study is recommended in the near term for this structure. It is included in Table 8-1 as a Priority 1 recommendation.

RTC may also wish to conduct a risk assessment of the major existing Railroad Bridge Structures outside of the proposed passenger rail service or trail limits to evaluate the costs of a seismic retrofit program against the risk of possible loss or damage of the structure, with associated freight service disruptions and costs of restoring the structures.

8.4 Maintenance Responsibility

Primary maintenance for the Railroad Bridge Structures is anticipated to be the responsibility of the Branch Line owner or short line operator. However, maintenance of the Underpass Structures (Mileposts 8.64, 12.30, 12.39, 12.71, 12.83, 14.85, 15.89a, and 15.89e) carrying freight traffic over public highways, streets and roads may be shared between the Branch Line owner and the governing public agency (Caltrans, County, City, etc). Based on past experience while working with Caltrans on seismically retrofitting the structures at Mileposts 12.30 and 12.83 over State Route 1, Caltrans was responsible for maintaining the substructure elements and the UP was responsible for maintaining the superstructure elements (including the bearings). Per the confidential Bridge Book, a similar arrangement exists at Milepost 12.39 with Caltrans maintaining the substructure and the UP maintaining the superstructure.

Maintenance responsibility for the Highway Overhead Structures carrying public highways, streets and roads over the Branch Line is anticipated to be the primary responsibility of the public agency (Caltrans, County, City, etc).

Primary maintenance for the Culvert Structures and Retaining Wall Structures within the Branch Line right-of-way is anticipated to be the responsibility of the Branch Line owner. Maintenance responsibility for the Culvert Structures and Retaining Wall Structures that extend beyond the Branch Line right-of-way is anticipated to consist of a combination of UP, public agency and private ownership. The maintenance costs for the Railroad maintained culverts/ retaining walls are anticipated to be minor and should be covered under the MOW cost range previously included in the business plan.

Verification of the existing structure maintenance agreements and responsibility is recommended to further refine anticipated structure maintenance costs for the Branch Line.

Table 8-1: Supplemental Investigation Summary

MP	Detailed Structural Assessment	Seismic Vulnerability Study	Verify Maintenance Responsibility
0.86	-	-	-
1.06a	-	-	-
1.06b	Yes (2)	-	-
1.06c	-	-	-
4.45	-	-	-
4.87	-	-	-
5.42	-	-	-
5.54	-	-	-
6.01	-	-	-
6.14	-	-	-
6.25	-	-	-
8.32	-	-	-
8.64a	-	-	Yes
8.64b	-	-	-
10.45	Yes (1)	-	-
11.16	-	-	-
12.30	-	-	Shared (4)
12.34	-	-	-
12.39	-	-	Shared (4)
12.71a	-	-	-
12.71b	-	-	Yes
12.83	-	-	Shared (4)
14.85	-	-	Yes
15.89a	Yes (2)	-	Yes
15.89b	Yes (2)	-	-
15.89c	Yes (2)	-	-
15.89d	Yes (2)	-	-
15.89e	Yes (2)	-	Yes
17.30	-	-	-
18.84	-	-	-
19.43a	Yes (1)	Yes (3)	-
19.43b	Yes (1)	Yes (3)	-
22.29	-	-	-
23.47	-	-	-
23.54	Yes (1)	-	-
26.09	-	-	-
26.55	-	-	-

Notes: (1) Priority 1 assessment due to Poor Condition Rating
 (2) Priority 2 assessment due to importance and/or potentially high rehabilitation costs
 (3) Priority 1 assessment due to existing public walkway on structure
 (4) Maintenance Responsibility Shared: Superstructure maintained by UP;
 Substructure maintained by Agency

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APPENDIX A:
SUMMARY MAPS

APPENDIX B:
TRACK CHARTS

APPENDIX C:
(NOT USED)

APPENDIX D:
CONDITION RATING SYSTEM
(See Volume 2)

APPENDIX E:
FIELD REVIEW REPORTS
(See Volume 2)