Appendix A:

Life Cycle Cost Analysis Results for Individual Bridges

Introduction

This appendix provides a summary of the Life Cycle Cost Analysis (LCCA) results for the individual toll bridges in the Bay Area. For each bridge, the presented scenarios detail different potential strategies for managing the Bay Area toll bridges over the next 50 years, highlighting the tradeoffs between condition levels and costs. These bridge condition levels are based on the Federal Highway Administration (FHWA) National Bridge Inspection Standards (NBIS). A bridge condition rating is determined by element level inspections of bridges by Caltrans Bridge Maintenance Engineers, licensed by the State of California and certified for this work. The bridges are routinely inspected every two years in compliance with state and national standards. It is important to highlight the FHWA bridge condition ratings are not safety ratings and that a poor rating does not mean the bridge is unsafe. Safety determinations are made by Caltrans Bridge Maintenance Engineers who continuously monitor the bridges every day. Any safety deficiency is addressed at time of discovery. The FHWA bridge condition rating is a tool to help record and track deterioration and prioritize projects and funding. Accordingly, the recent Bipartisan Infrastructure Law utilized the bridge condition ratings in the National Bridge Inventory, including the Bay Area toll bridges, to apportion federal bridge funding to the states. The state of California recently provided supplemental funding to the toll bridges rehabilitation program to help address bridge needs identified through these ratings

The bridge component condition ratings are dynamic and anticipated to change over time. Even with preventive maintenance, bridge condition can be expected to deteriorate over time due to use, environmental exposure and normal wear and tear. Conversely, bridge component condition ratings may improve after component rehabilitation or replacement. The toll bridges are complex structures that are likely to include different structural types and systems. Inspections, observations, and ratings are performed at the element level across all the miles of bridges in the system. The element level inspection data is used as the basis for determining component condition ratings. The bridge components are the deck, superstructure, and substructure of each bridge. The overall condition rating for each bridge reflects the lowest of the three component ratings. FHWA's guidelines calls for rating the bridge components on a 0 to 9 scale. If the rating is greater than or equal to 7, the bridge is classified as Good; if it is less than or equal to 4, the classification is Poor. Bridges rated 5 or 6 are classified as Fair. In general, Good bridges are

typically newer with some minor defects that do not impact performance. Fair bridges may exhibit moderate defects; however, the strength and functionality of bridge components remain unaffected. Poor bridges tend to show more extensive or widespread deterioration that generally requires more monitoring and frequent maintenance to ensure continued safe operation.

This appendix presents the LCCA results for each toll bridge, including the defined bridge management scenarios, projected 50-year performance charts, and the present value of estimated agency costs for each scenario. In this appendix and other reports, the 50-year period is sometimes referred to as 'analysis period'.

Using the Antioch Bridge performance chart as an example, three maintenance strategies demonstrate different outcomes over the analysis period. Under the Spot Repair approach, maintenance is deferred until bridge elements are on the verge of very poor condition. This reactive strategy would keep the bridge in Good condition for only 10% (approximately 5 years) of the analysis period, Fair condition for 50% (25 years) of the analysis period, and Poor condition for 40% (20 years) of the analysis period, at a total agency cost of $140 million in present value. The Reduce Backlog strategy takes a more proactive approach by addressing bridge elements as needed to maintain Fair condition. This approach would keep the bridge in Good condition for 55% (27 years) of the analysis period and Fair condition for the remaining 45% (23 years), while reducing agency costs to $90 million in present value. The Accelerate Rehab strategy represents the most intensive approach, maintaining the bridge in Good condition for 60% (30 years) of the analysis period and Fair condition for 40% (20 years) of the analysis period, at a cost of approximately $120 million in present value. For many of the bridges, the differences in investment levels between the two scenarios are considerably greater with relatively modest improvements in condition ratings for a much higher investment.

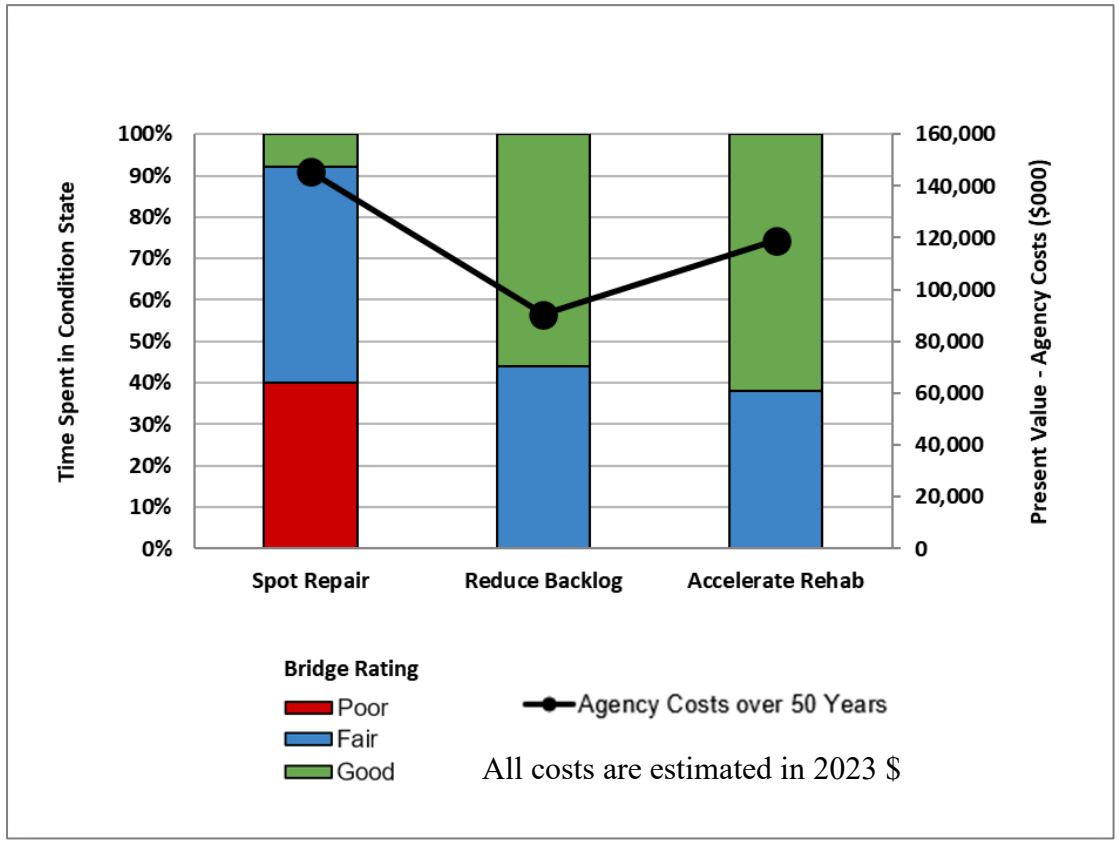
The overall analysis demonstrates that the Reduce Backlog strategy represents the most cost-effective approach for managing toll bridges in the Bay Area. This strategy provides a balanced maintenance strategy that preserves bridge conditions and extends service life while optimizing financial resources. The Accelerate Rehab scenario demonstrates that higher expenditures do not translate to proportionally better bridge performance over the analysis period. It is important to note that toll bridges are complex structures with unique elements that respond differently to

both maintenance interventions and external factors, which explains why each bridge performs differently under different scenarios.

Antioch Bridge

Scenario Definitions:

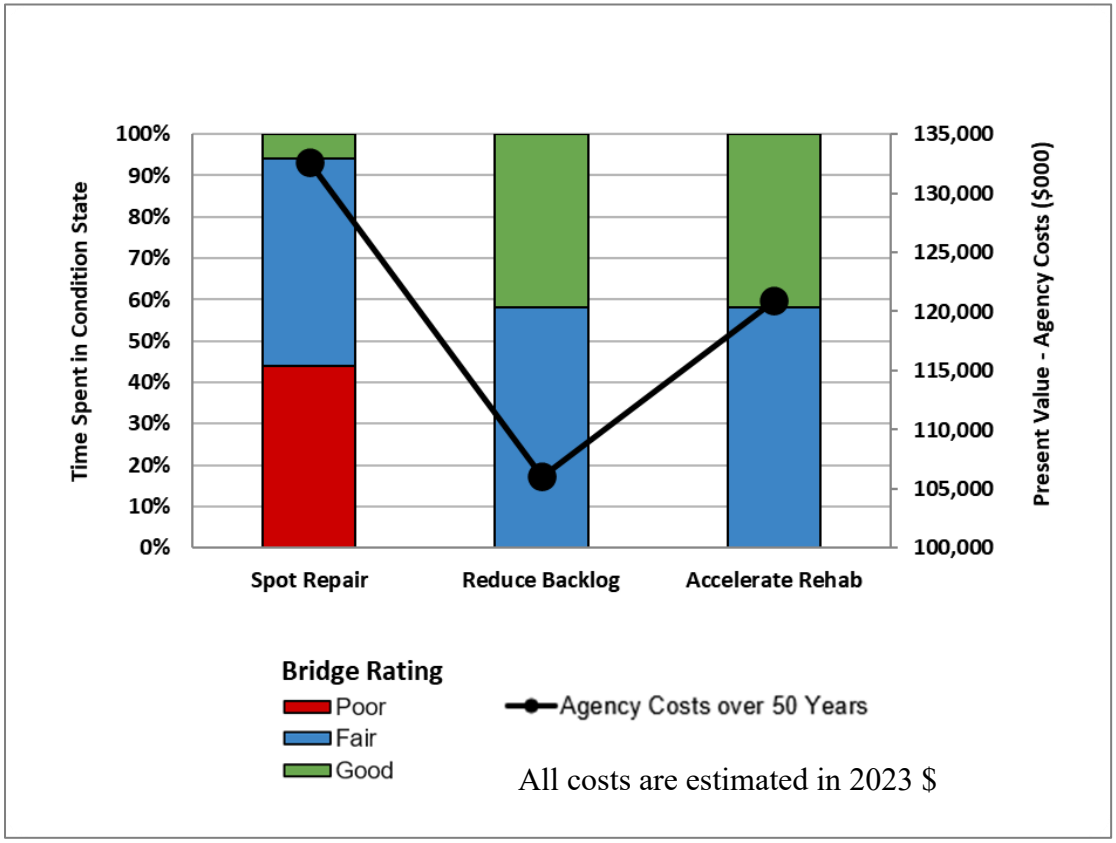
- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



Benicia-Martinez Northbound Bridge

Scenario Definitions:

- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition

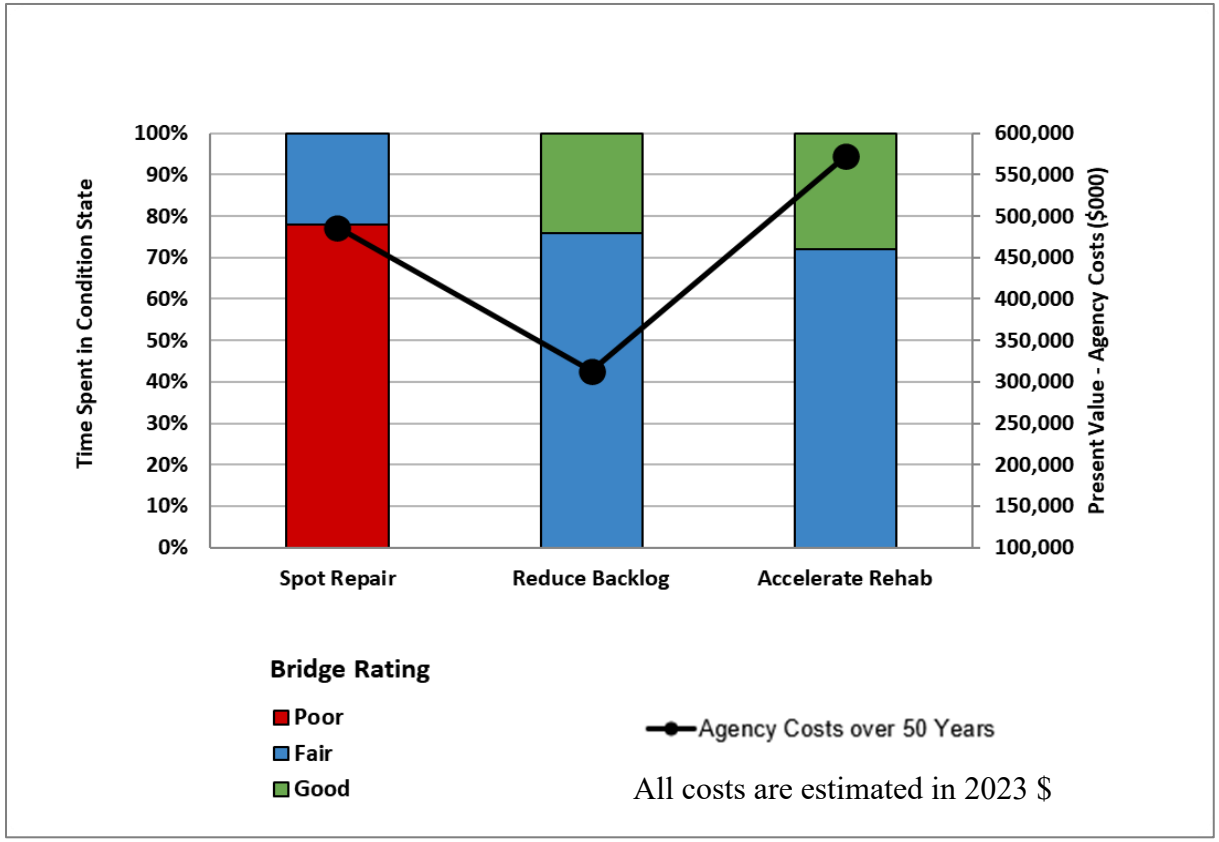


Benicia-Martinez Southbound Bridge

Scenario Definitions:

- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition

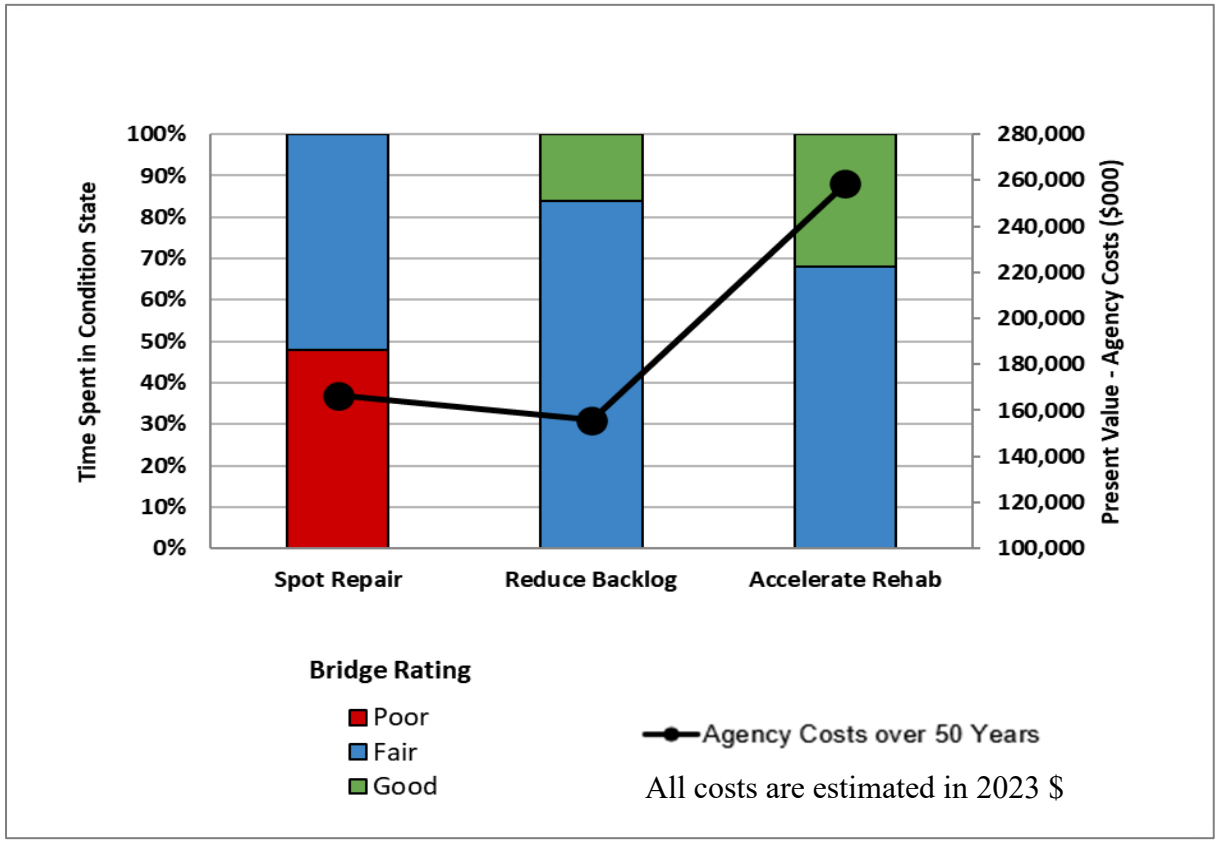
  Accelerate Rehab: Fix bridge elements as needed to increase time in good condition



Carquinez Eastbound Bridge

Scenario Definitions:

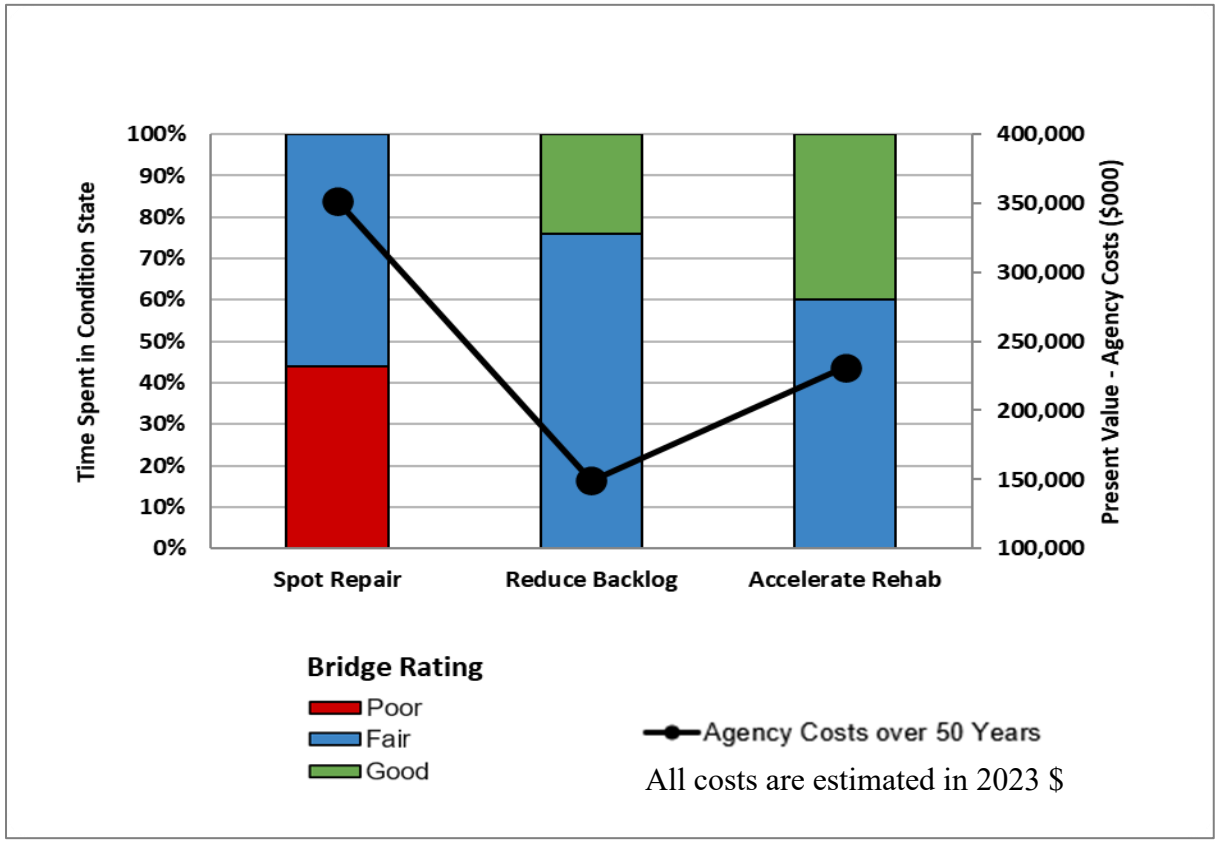
- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



Carquinez Westbound Bridge

Scenario Definitions:

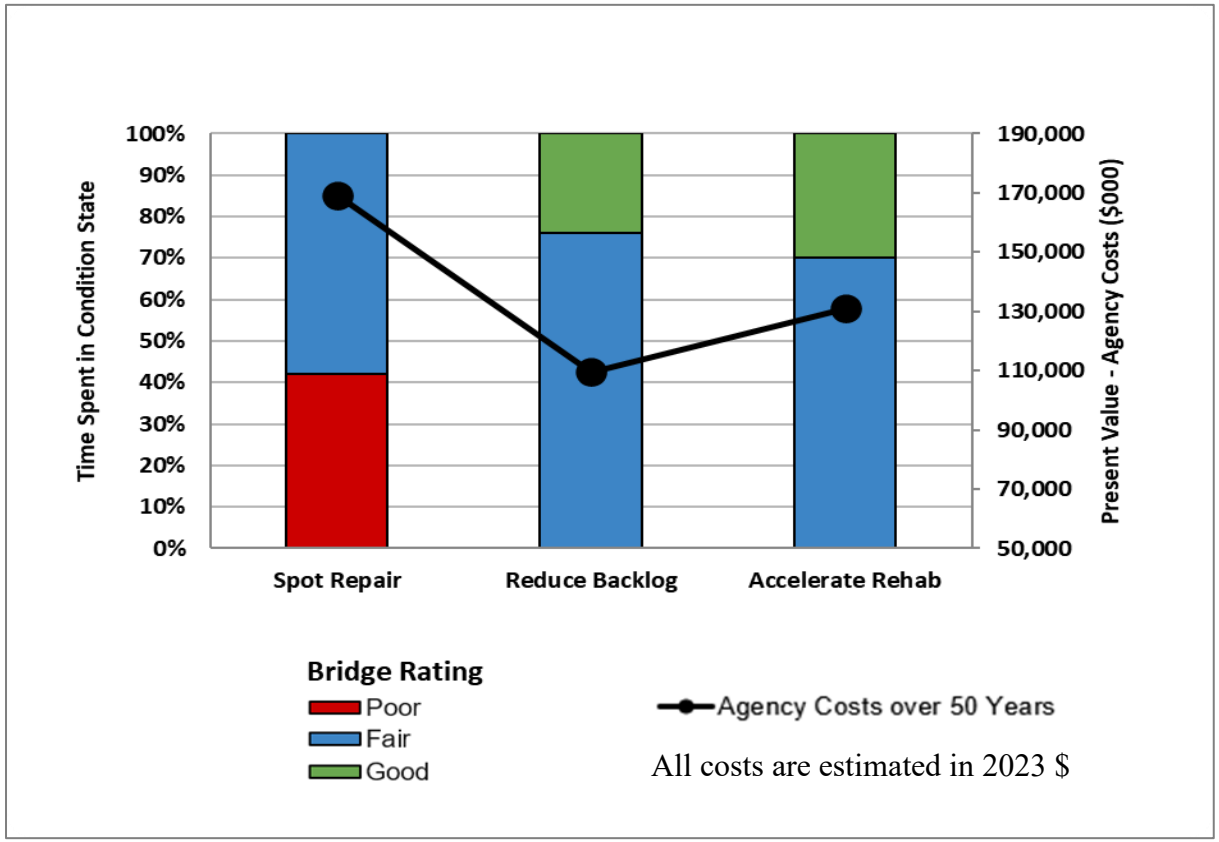
- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



Dumbarton Bridge

Scenario Definitions:

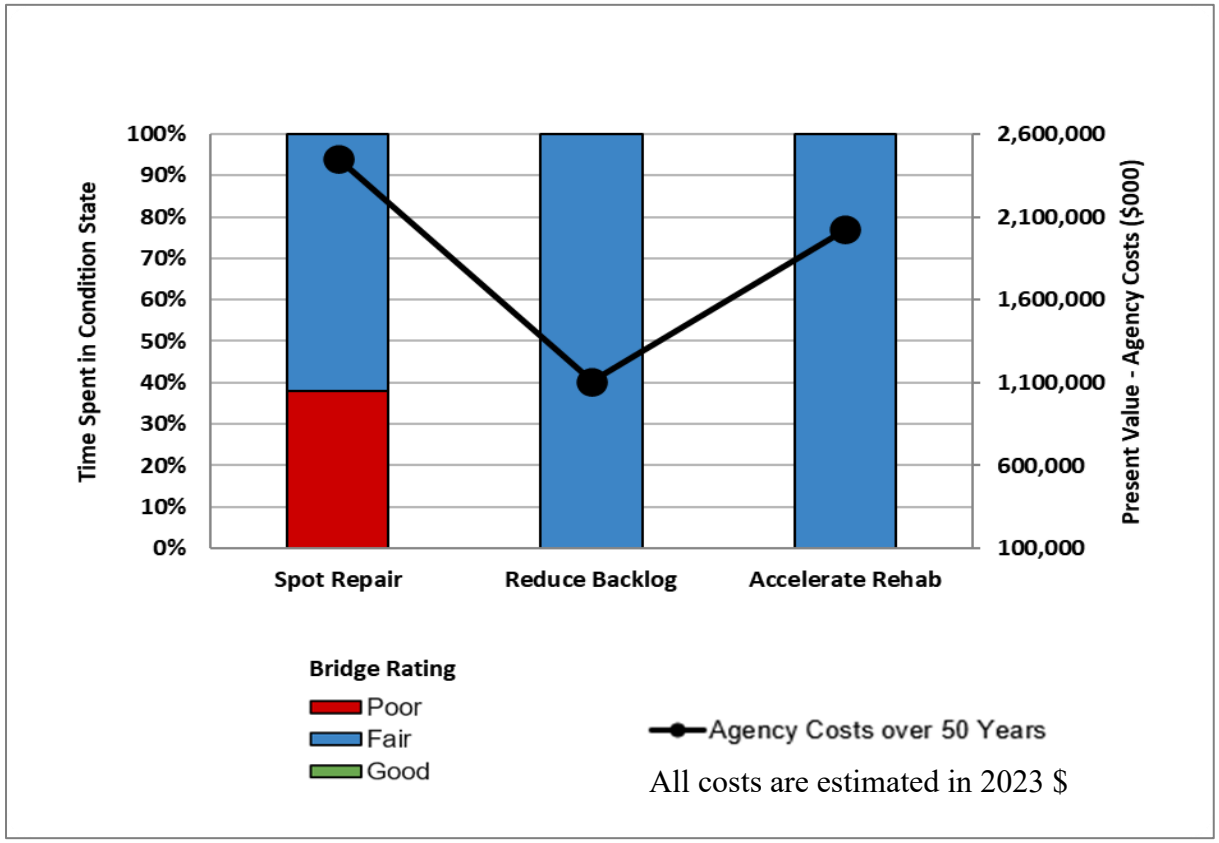
- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



Richmond-San Rafael Bridge

Scenario Definitions:

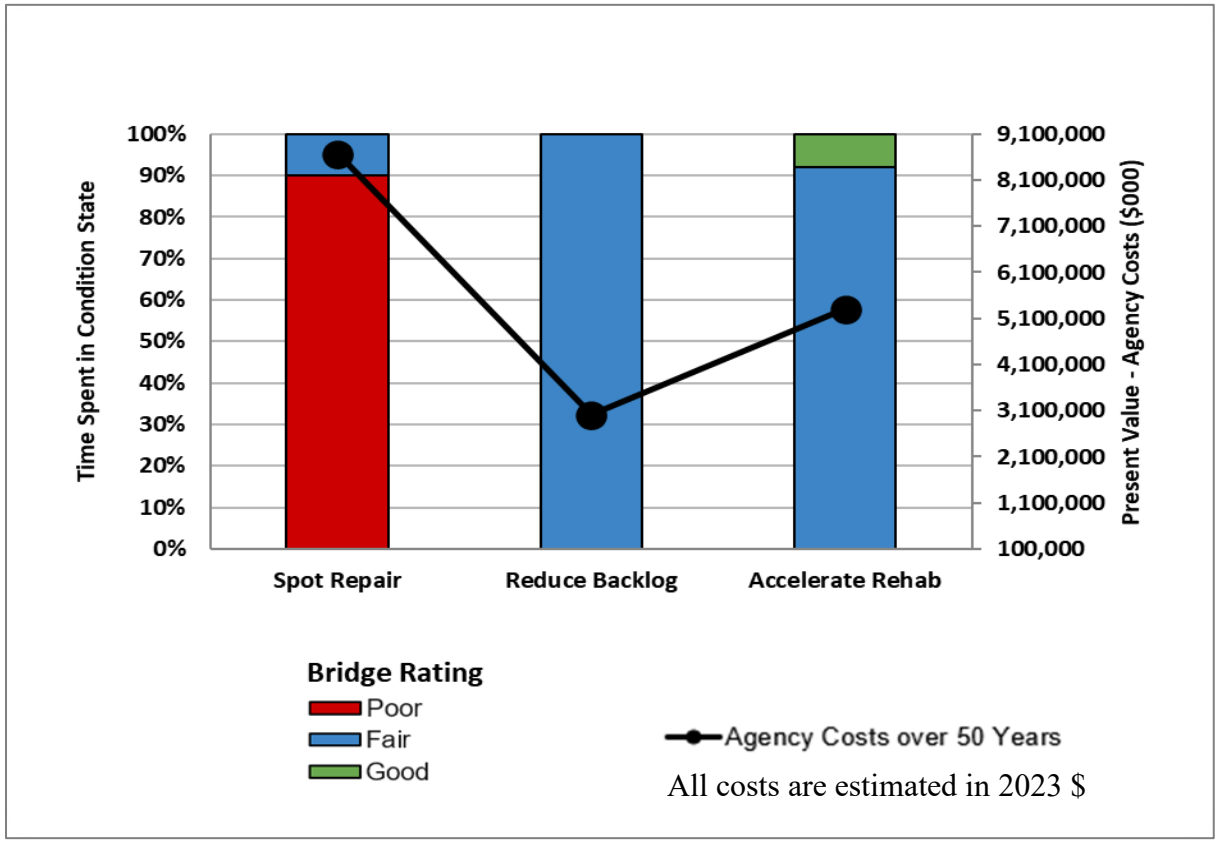
- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



San Francisco-Oakland Bay Bridge West Span

Scenario Definitions:

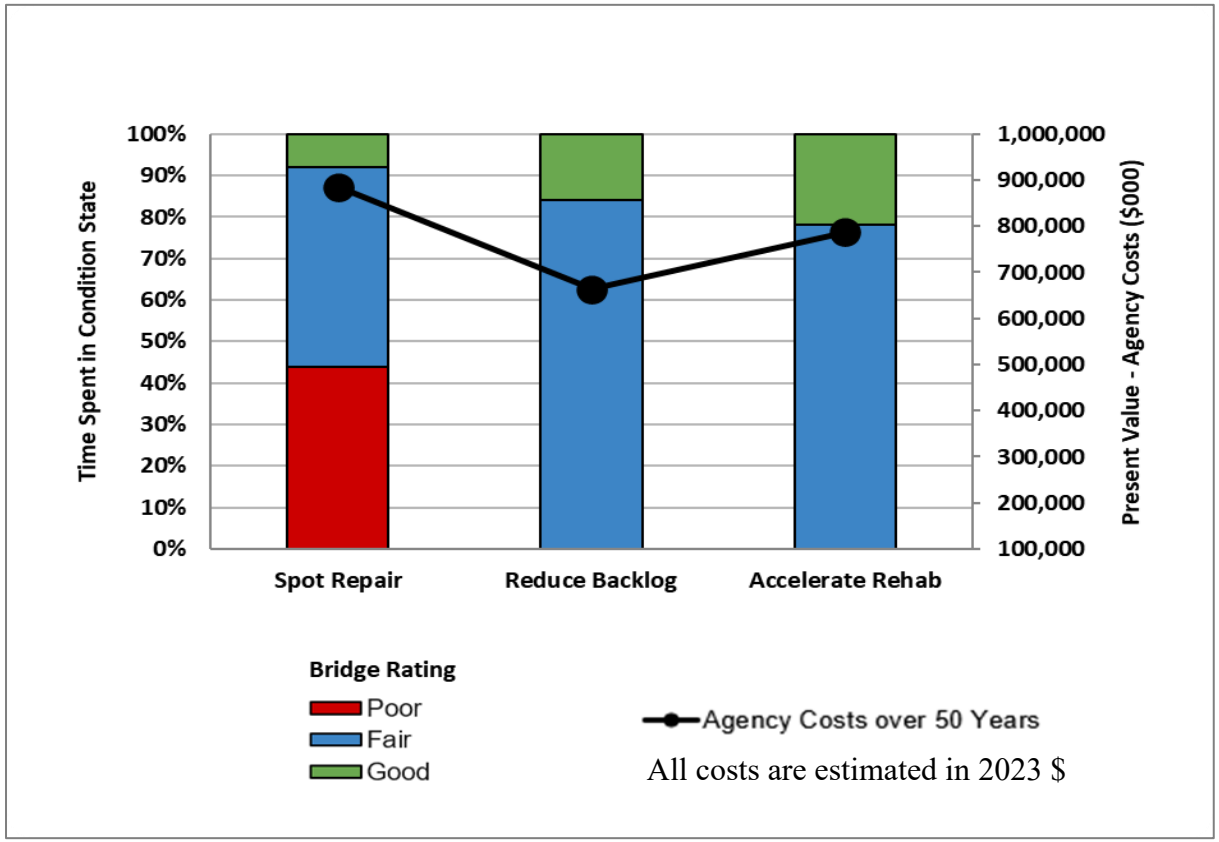
- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



San Francisco-Oakland Bay Bridge East Span

Scenario Definitions:

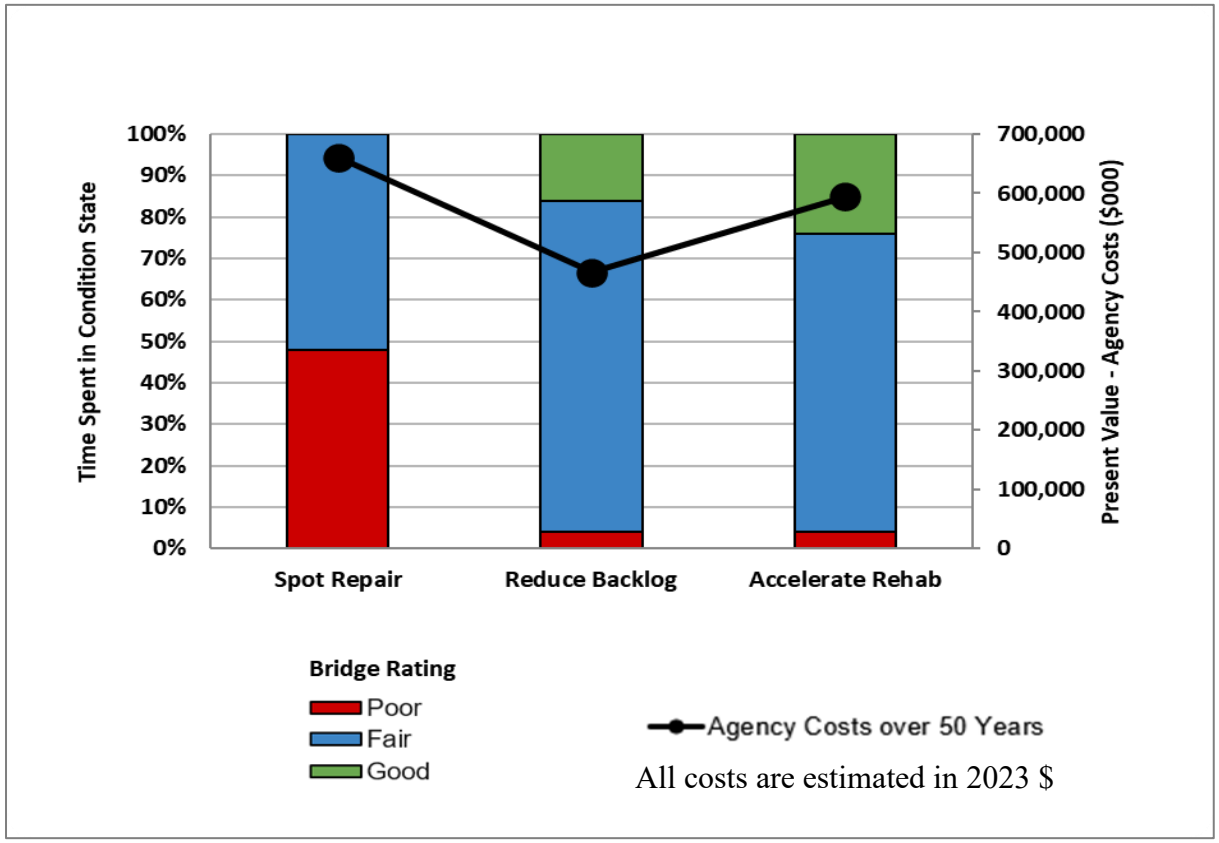
- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



San Mateo-Hayward Bridge

Scenario Definitions:

- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition



Yerba Buena Crossing Tunnel

Scenario Definitions:

- **Spot Repair:** Fix bridge elements before they fall into very poor conditions
- **Reduce Backlog:** Fix bridge elements as needed to sustain fair condition
- **Accelerate Rehab:** Fix bridge elements as needed to increase time in good condition