Intersection Control Evaluation
Harden Parkway at McKinnon Street in Salinas, CA

INTRODUCTION

An Intersection Control Evaluation (ICE) was completed for the intersection of Harden Parkway and McKinnon Street (the "study intersection") in Salinas, California. The existing four-legged intersection operates as an all-way stop-control (AWSC). Continuous growth is expected to increase demand at the study intersection. The purpose of this ICE is to determine which intersection control will provide the greatest return-on-investment (ROI) over the design-life (20 years) for the study intersection. The current demand meets signal warrant 2 (four-hour) and warrant 3 (peak hour), as described in the California Manual on Uniform Traffic Control Devices (CAAMUTCD).

The following intersection control improvement alternatives were evaluated in this ICE Analysis:

- Existing AWSC (no improvements)
- Alternative 1: Traffic Signal
- Alternative 2: Roundabout

EXISTING CONDITION AND PROPOSED ALTERNATIVES

Existing Conditions

Harden Parkway is an east-west collector with North Main Street at the west end and El Dorado Drive at the east end. McKinnon Street in a north-south local road with East Alvin Drive at the south end and East Boronda Road at the north end. Harden Parkway has a left turn pocket and through, through/right approach lanes in both directions. McKinnon Street has a left turn pocket and a thru/right turn lane in both directions. Harden Parkway and McKinnon both have a posted speed limit of 35 mph. There are sidewalks on all four corners and bicycle lanes on each approach and exit. There is residential housing on the north-west, south-west, and south-east corners and McKinnon Park on the north-east corner.

Design Year Scenarios

- Existing Conditions (2021)
  - Traffic counts were taken on Thursday May 6, 2021.
- Future Conditions (2041)
  - The existing counts were grown out 20 years using a linear growth rate of 1.7%.

See **Appendix A** for the intersection traffic volumes and heavy vehicle percentages that were used for the intersection analysis.

Existing AWSC Operations

The Existing AWSC is projected to operate at LOS F for the peak 2035 design year, with a maximum delay of 110.1 seconds and a maximum 95th percentile queue of 875 feet on WB approach. **Table 1** below summarizes the operations for the Existing AWSC. See **Appendix B** for existing traffic signal synchro operational analysis worksheets.

Table 1: Existing AWSC Operations

	AM			PM		
Design Year	LOS	Delay (s)	95% Queue (ft) (approach)	LOS	Delay (s)	95% Queue (ft) (approach)
2021	B	11.8	75 (SB)	C	23.9	150 (SB)
2041	C	16.6	150 (SB)	F	89.8	475 (SB)

Proposed Intersection Control Alternatives

Two intersection control alternatives were ultimately considered in the ICE Analysis for the intersection of Harden Parkway and McKinnon Street. See **Appendix C** and **Appendix D** for the operational analysis worksheets for each alternative.

Alternative 1: Traffic Signal

This alternative includes adding traffic signal heads to the intersection. The lane configuration would remain the same as the existing conditions. See **Table 2** below for a summary of Alternative 1 operations analysis.

Table 2: Traffic Signal Operations

	AM			PM		
Design Year	LOS	Delay (s)	95% Queue (ft) (approach)	LOS	Delay (s)	95% Queue (ft) (approach)
2021	A	6.2	50 (SB)	A	7.9	75 (SB)
2041	A	6.9	75 (SB)	B	10.6	150 (NB)

This alternative would replace the Existing AWSC with a roundabout. See **Table 3** below for a summary of Alternative 2 operations analysis.

Alternative 2: Roundabout

Table 3: Roundabout Operations

	AM			PM		
Design Year	v/c	Delay (s)	95% Queue (ft) (approach)	v/c	Delay (s)	95% Queue (ft) (approach)
2021	0.246	5.2	50 (SB)	0.565	9.6	150 (EB)
2041	C0.289	5.7	50 (SB)	0.585	11.9	150 (EB)

SUMMARY OF KEY PERFORMANCE MEASURES

Four performance metrics are evaluated at the study intersection to calculate the Benefit Cost (B/C) Ratio which measures the expected return on investment for each proposed intersection control. The performance measures used to calculate the ***benefits*** of the proposed improvement compared to the existing condition, or no project alternative are:

- ***Safety Benefit*** (of the proposed intersection control type)
- ***Delay Reduction Benefit*** (of the proposed intersection control type)

Performance measures used to calculate the conceptual level ***costs*** of the proposed intersection control improvement compared to the existing condition, or no project alternative are:

- ***Operations and Maintenance (O&M) Cost*** (added costs of the proposed intersection control type)
- ***Initial Capital Cost*** (added costs of the proposed intersection control type)

Refer to **Appendix E** for a detailed description of each performance measure and the Cal B/C 2020 Value Comparison Table[1] that were used in this B/C Analysis.

[1] *Cal B/C 2020 Value Comparison Table*, Caltrans, January 2020.

PERFORMANCE MEASURE SUMMARY

The following figures show the cost of key performance measures for each control types at the intersection of Harden Parkway and McKinnon Street assuming 20-years of intersection operations to calculate life-cycle costs. Table 4 below summarizes the costs associated with each alternative.

Table 4: Performance Measure Summary

PERFORMANCE MEASURE LIFE CYCLE COST (NET PRESENT VALUE)			
Safety			
	No-Build (AWSC)	**Signal**	**Roundabout**
Annual Cost of Collisions	$149,578	$206,261	$95,628
Discounted Life Cycle Cost of Collisions	$2,128,120	$2,975,714	$1,380,111
Delay			
	No-Build (AWSC)	**Signal**	**Roundabout**
Annual Quantity (hours)	10348	1936	2066
Annual Cost	$128,990	$25,520	$27,331
Total Discounted Life Cycle Cost	$2,708,784	$535,913	$573,947
Operations and Maintenance			
	No-Build (AWSC)	**Signal**	**Roundabout**
Annual O&M Costs	$300	$6,700	$2,833
Discounted Life Cycle O&M Costs	$4,377	$97,755	$41,332
Discounted Pavement Rehab Costs	$96,444	$96,444	$57,033
Total O&M Costs	$100,821	$194,199	$98,365
Initial Capital			
	No-Build (AWSC)	**Signal**	**Roundabout**
High Approximation	$0	$1,000,000	$2,000,000
Low Approximation	$0	$850,000	$1,500,000
Average for Both Ramps	**$0**	**$925,000**	**$1,750,000**

Benefit Performance Measure Summary

Safety

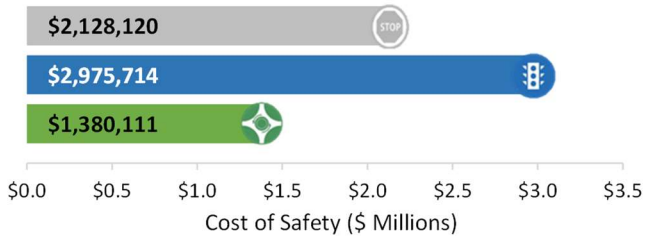

Figure 1: Lifecycle Cost of Safety

Preferred Alternative:

Based on the lowest predicted life-cycle cost for safety, the preferred intersection control type for this intersection is a roundabout. See Appendix F for the Interactive Highway Safety Design Manual (IHSDM)'s KABCO values used for the safety analysis.

Delay

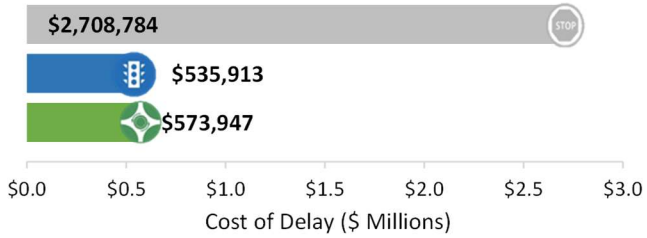

Figure 2: Lifecycle Cost of Delay

Preferred Alternative:

Based solely on the lowest predicted life-cycle cost for delay, the preferred intersection control type for this intersection is a traffic signal.

Cost Performance Measure Summary

Operations and Maintenance (O&M)

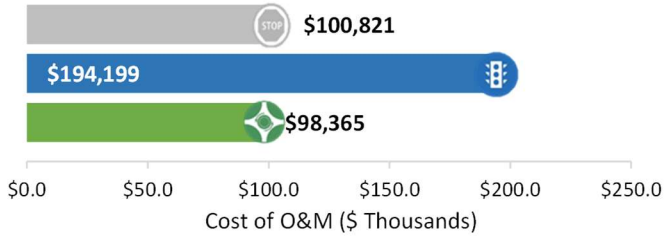

Figure 3: Lifecycle Cost of O&M

Preferred Alternative:

Based solely on lowest expected annual O&M costs, the preferred intersection control type for this intersection is a roundabout.

Initial Capital Costs

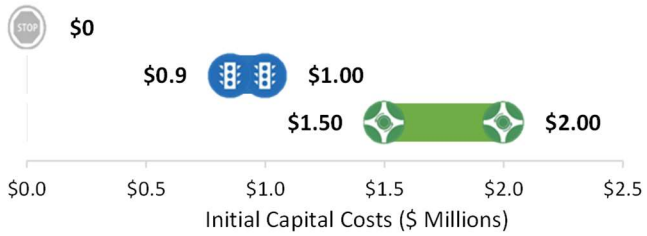

Figure 4: Initial Capital Costs

Preferred Alternative:

Of the two proposed alternatives, the traffic signal would have a lower initial capital cost.

B/C ANALYSIS SUMMARY

B/C Ratio Scoring

The following equation illustrates the B/C ratio and Table 5 provides the description of B/C ratio scoring:

$$\mathbf{B/C}\ \text{Ratio Score} = \frac{\sum \textbf{Benefit Performance Measures}}{\sum \textbf{Cost Performance Measures}}$$

Table 5: Description of B/C Ratio Scoring

B/C Ratio Score	Description
B/C = 1.00	A B/C ratio of 1.00 is a neutral rating. This indicates that the ROI for existing signal is equal to improved signal/roundabout.
B/C < 1.00	A B/C ratio less than 1.00 indicates that the existing signal will provide a better ROI when compared to improved signal/roundabout.
B/C > 1.00	A B/C ratio greater than 1.00 indicates that improved signal/roundabout provides a better ROI when compared to the existing signal.
The B/C score is based on the net present value using a discount rate of 4% through the life-cycle duration of 20 years for each of the five performance measures.	

Note: ROI=Return of Investment

The summary results of the stage 1 B/C analysis at the study intersection are summarized in Table 6. The stage 1 B/C analysis compares the proposed signal and roundabout alternatives to the Existing AWSC. Both the traffic signal and the roundabout have B/C ratios greater than 1.0, which indicate that they are both cost-effective intersection control types when compared to the Existing AWSC.

Table 6: Summary of Life-Cycle B/C Analysis – Stage 1 B/C Ratios

TOTAL PROJECT LIFE CYCLE SUMMARY FOR 20 YEARS			
Total Benefits (B)			
Added Benefits Compared to No-Build (AWSC)	**No-Build (AWSC)**	**Signal**	**Roundabout**
Safety	$ -	$ (847,594)	$ 748,008
Delay	$ -	$ 2,172,871	$ 2,134,838
Total Benefits	**$0**	**$1,325,277**	**$2,882,846**
Total Costs (C)			
Added Cost Compared to Existing Conditions	**No-Build (AWSC)**	**Signal**	**Roundabout**
O&M	$ -	$ 93,378	$ (2,456)
Initial Capital	$ -	$ 925,000	$ 1,750,000
Total Costs	**$0**	**$1,018,378**	**$1,747,544**
B/C Ratio Compared to Existing Conditions	**N/A**	**1.30**	**1.65**

A second stage of the B/C analysis was performed to determine the preferred alternative intersection control type between the traffic signal and a roundabout. The stage 2 B/C analysis compares the roundabout to the traffic signal alternatives. The roundabout has a B/C ratio greater than 1.0, which indicates that the roundabout will have a greater ROI compared to the traffic signal. Table 7 shows a summary of the stage 2 B/C results.

Table 7: Summary of Life-Cycle B/C Analysis – Stage 2 B/C Ratios

TOTAL PROJECT LIFE CYCLE SUMMARY FOR 20 YEARS		
Total Benefits (B)		
Added Benefits Compared to Signal	**Signal**	**Roundabout**
Safety	$ -	$ 1,595,602
Delay	$ -	$ (38,034)
Total Benefits	**$0**	**$1,557,568**
Total Costs (C)		
Added Cost Compared to Existing Conditions	**Signal**	**Roundabout**
O&M	$ -	$ (95,834)
Initial Capital	$ -	$ 825,000
Total Costs	**$0**	**$729,166**
B/C Ratio Compared to Existing Conditions	**N/A**	**2.14**

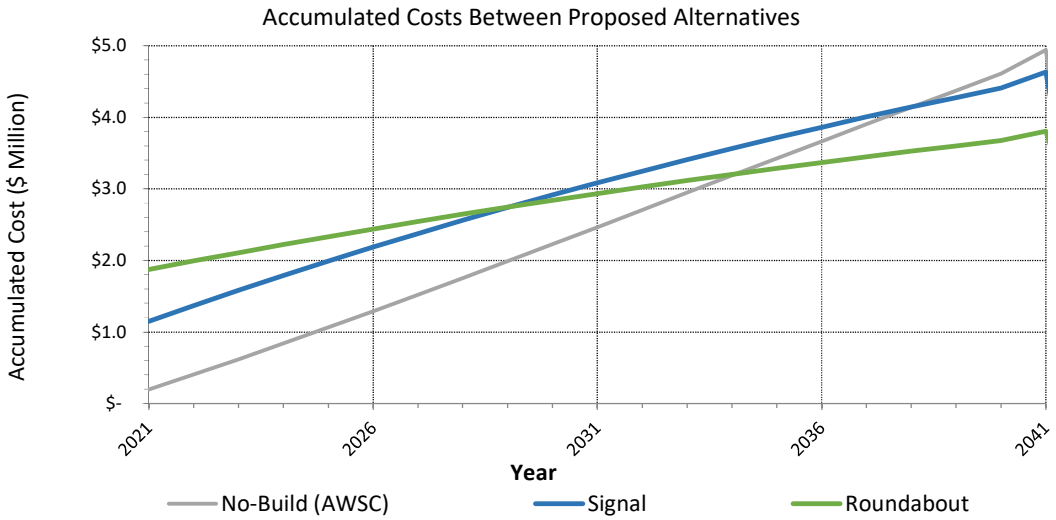

Figure 5: Lifecycle Accumulated Costs

Figure 5 shows the accumulated costs of all four performance measures for the AWSC and each proposed alternative. The roundabout starts with the largest accumulated cost in year 2021 because of the high initial capital cost. However, because the roundabout has low safety, delay, and O&M costs, the accumulated cost for the roundabout is the lowest in year 2041. The roundabout and AWSC lines intersect near year 2034 (13 years) – this is when the roundabout would have a positive ROI that will continue to grow. The roundabout is the preferred intersection control type for the entire 20-year analysis time period.

CONCLUSION AND RECOMMENDATIONS

An analysis of the estimated benefit and cost performance measures indicate that, when forecast traffic volumes are considered for a minimum 20-year service life, **a roundabout-controlled intersection is the preferred alternative** at the intersection of Harden Parkway and McKinnon Street.

- The Existing AWSC will have the longest delays and queue lengths out of all the intersection control alternatives at the study intersection.
- The traffic signal and roundabout would have similar operations.
- The roundabout alternative has the lowest lifecycle societal cost on safety.
- The Existing AWSC and the roundabout have similar lifecycle O&M costs.
- Both the proposed traffic signal and roundabout would have a ROI compared to the Existing AWSC over the lifecycle of the intersection.
- The proposed roundabout would have a ROI compared to the proposed traffic signal over the lifecycle of the intersection.
- The City of Salinas will start to see a positive ROI from the roundabout after 13 years.

Appendix

Appendix A – Traffic Volumes
Appendix B – Existing AWSC Synchro Operational Analysis
Appendix C –Traffic Signal Synchro Operational Analysis
Appendix D – Roundabout SIDRA Operational Analysis
Appendix E – Description of Benefit Cost Performance Measures and Caltrans Cal B/C 2020 Value Comparison Table
Appendix F – HSM Predictive Method Safety Analysis IHSDM KABCO Values