PROJECT STUDY REPORT

(Calendar Poly Pomona Senior Project)

For

Conceptual Approval of an Interchange Improvement
And
Cooperative Agreement with The City of Lake Elsinore for completion of Project Approval and Environmental Documentation
On Interstate 15 at Railroad Canyon Road
Between Bundy Canyon Road and Main Street

APPROVAL RECOMMENDED:

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APPROVED

DISTRICT MANAGER

DATE
The Railroad Team would like to give special thanks to Dr. Xudong Jia from Cal Poly Pomona, and Jon Bumps and Du Lu from Caltrans District 8.
VICINITY MAP

Figure 1 – Site Location

ON INTERSTATE 15 AT RAILROAD CANYON ROAD
BETWEEN BUNDY CANYON ROAD AND MAIN STREET
INTERCHANGES IN RIVERSIDE COUNTY
This Project Study Report has been prepared under the direction of the following Project Managers, The Project Managers attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

________________________  _________________________
Mark D. Shisler, EIT       Brandon Wong

________________________
Date
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1. INTRODUCTION

Caltrans District 8 in partnership with the City of Lake Elsinore proposes to improve the existing interchange at Interstate 15 and Railroad Canyon Road in order to relieve existing and future traffic congestion (2040). These alternatives provide a solution that will greatly increase the capacity of the interchange to accommodate the future population growth of the city and vehicles utilizing the I-15. Pedestrians and bicyclists where given high priority to ensure they were given safe and accessible routes through the new interchange during the design process.

This Project Study Report is a complete review of four (4) project alternatives including the no build alternative. All alternatives were designed in accordance with the Highway Design Manual standards and other pertinent Caltrans and city documentation. The anticipated completion of construction of this improvement is 2020 (project base year). The design life of the new facility is twenty (20) years, which resulted in using projected 2040 traffic volumes.

The Railroad Interchange is owned, operated, and maintained by Caltrans. Railroad Canyon Road along with several other minor arterials affecting the operation of the interchange is owned by the City of Lake Elsinore. The city’s general plan for future road widening, along with the ultimate build-out of the I-15 was taken into consideration during the design process and is accommodated by each alternative.

This is a Category 3 Project per Caltrans Project Development Procedures Manual, as it will be along a previously constructed access controlled route, with no new route adoptions, and new right-of-way or may not be required.

<table>
<thead>
<tr>
<th>Table 1 – Project Category Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Limits: (Dist, CO., Rte., PM)</td>
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<tr>
<td>Number of Alternatives:</td>
</tr>
<tr>
<td>Alternative Recommended for Programming</td>
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<tr>
<td>Programmed or Proposed Capital Construction Costs:</td>
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<tr>
<td>Programmed or Proposal Capital Right-of-Way Costs:</td>
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<td>Funding Source:</td>
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<td>Type of Facility: (conventional, expressway, freeway):</td>
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<tr>
<td>Number of structures:</td>
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<td>Anticipated Environmental Determination/Document:</td>
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<td>Legal Description:</td>
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<td>Project Category</td>
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</table>
Figure 2 – Project Study Boundary

Figure 3 – Project Design Boundary
2. BACKGROUND

The design area lies in Riverside County, California, in the City of Lake Elsinore. More specifically, it focuses on the Railroad Canyon Road interchange off Interstate 15 and the local intersections in its immediate vicinity. The streets that will be affected include Railroad Canyon Drive, Grape Street, Auto Center Drive, and Lakeshore Drive.

Interstate 15 is a north-south running interstate highway that provides connections from Canada to San Diego County. It serves as a long-haul route for North American commerce, and passes through the adjacent counties of Riverside and San Bernardino as well as popular destinations such as Mountain High, San Diego, and even Las Vegas, Nevada. In Lake Elsinore, Interstate 15 is a 6-lane mixed flow freeway. Railroad Canyon Road is a five-lane east-west running urban arterial. Grape Street and Auto Center Drive are four-lane north-south running major arterials that intersect Railroad Canyon Road. Lakeshore Drive is a four-lane east-west running urban arterial as well. In the surrounding areas are multiple plazas that house local businesses. Future plans include widening and flow improvements to relieve congestion on the local streets.

There are mainly business that surround the interchange with numerous residential neighborhoods in nearby surrounding areas. Railroad Canyon Road is a direct access route for visitors and residents to the city’s large recreational lake. The future build-out of the I-15 is 3 mixed flow lanes and one HOV lane in each direction.

Agencies that are involved and support this project include Caltrans, the City of Lake Elsinore, the Riverside Transit Agency and the Cal Poly Pomona College of Engineering.

Figure 4 – Railroad Canyon Rd / Summerhill (looking east)
3. PURPOSE AND NEED

The purpose of this project is to reduce congestion, improve traffic operations and enhance safety at the Railroad Canyon Road Interchange and surrounding city intersections.

The I-15/Railroad Canyon Road interchange is experiencing operational problems caused by high peak periods of traffic volumes and a less efficient geometry of the current tight diamond interchange design. Additional delay is caused by the short spacing of signals along Railroad Canyon Road that are in close proximity to all on/off ramps. Bottlenecks are generated by high demands from westbound Railroad Canyon Road to northbound I-15 (AM), and southbound I-15 to eastbound Railroad Canyon Road (PM). Vehicle hours of delay, average speeds, travel times, safety, and other traffic performance measures will continue to degenerate as growth increases in the surrounding areas.

There is a need to accommodate for city development and growth for access to the I-15 interchange, account for the future widening of local streets and the I-15 corridor, all while providing safe access routes for pedestrians and bicyclists.
4. DEFICIENCIES

The deficiencies of the interchange at I-15 and Railroad Canyon include high congestion, substantial traffic delay, and lack of safe accessibility for pedestrians and bicyclists. As per the Highway Design Manual, the geometric design of new facilities or an improvement of a facility should accommodate 20 year projected traffic volumes. Following the guidelines set forth by the Highway Design Manual, all alternatives will accommodate a 20 year growth in traffic volumes.

The base year for the project is 2020 as that is the year that construction is predicted to be completed with a design life through the year 2040 (20 year design life). The existing, 2040 projected traffic volumes were provided by Caltrans as a preliminary traffic forecasting analysis was performed by a separate consultant.

A complete and detailed summary of all turning movements, mainline traffic volumes, and other traffic related documentation may be found in the appendix.

Figure five (5) depicts the existing level of service at I-15 and Railroad Canyon Road, with an F at all intersections.
The interchange at I-15 and Railroad Canyon Road is currently experiencing operational problems caused by periods of high traffic volumes. The combination of the current tight diamond geometry and closely spaced ramp and city street intersections produce congestion during morning and evening commute. Bottlenecks are generated by vehicles traveling from westbound Railroad Canyon Road to northbound I-15 (AM Peak), and southbound I-15 to eastbound Railroad Canyon Road (PM Peak). The back up on the southbound off-ramp overflows onto the I-15 causing not only operational delays to the freeway, but is also a safety hazard. Railroad Canyon is also experiencing high through traffic volumes that contribute to the congestion.

Lake Elsinore was the third-fastest growing city in the state of California last year. The population in the year 2000 was approximately 29,000, and the population today is roughly 55,000, that’s a The city had a 90% population increase in the last 14 years and the population of Lake Elsinore is projected to continue this trend through 2040.

The city general plan shows areas of future commercial, residential, industrial, recreational, and public institutional land development. The site specific areas colored in gray mainly contain plans for residential zoning.

Without improving the city and state’s transportation infrastructure; vehicle hours of delay, average speeds, travel times, safety, and other traffic performance measures will continue to degenerate if the situation is not properly mitigated.

Two Cal Poly Pomona senior project teams delivered a Project Study Report for their respective interchange projects which include the improvement of the existing interchange at Railroad Canyon, and the new interchange just north of Franklin Street. A PSR is an initial feasibility report that thoroughly investigates potential design alternatives that meet all project needs. Due to the close proximity of the two project locations and their impact on each other, both teams worked closely together.
5. ALTERNATIVES

After a completed analysis of numerous alternatives, and with consideration of project needs and existing constraints, it was determined that the following alternatives be selected as viable project alternatives:

- Alternative 1: No Build
- Alternative 2: Continuous Flow Interchange
- Alternative 3: Diverging Diamond Interchange
- Alternative 4: Single Point Urban Interchange

The only structure work needed for alternatives two (2) and three (3) is the removal of existing sloped paving and a retaining wall, and the construction of two (2) new retaining walls with tiebacks. The structure work required for alternative four (4) is extensive, and requires four (4) new bridge structures.

The City’s General Plan classifies Railroad Canyon Road as an urban arterial with an ultimate widening of 3 lanes in each direction.

The proposed improvements of the interchange at I-15 and Railroad Canyon Road are consistent with the ultimate build-out of both the city and I-15. Each alternative accommodate the ultimate facility as described in detail earlier in the report.
a) Alternative 1: No Build

Alternative one (1) is the No Build alternative that consists of keeping the current interchange configuration with no improvements.

The No Build alternative was used as the base for comparing the other three (3) alternatives in terms of the increased intersection level of service that the remaining alternatives provide. Figure six (6) displays the current interchange layout with the projected 2040 AM/PM peak hour level of service for each intersection.

![Figure 6 – No Build Layout with 2040 Projected LOS](image)

The largest advantage of the alternative is the no construction cost as the definition of the No Build alternative means no construction for improvement will be needed; however, without improvement, there will be high congestion, inadequate and unsafe access routes for pedestrians and bicyclists, and not meeting the public’s needs of the facility.

The level of service (LOS) of each intersection using the projected 2040 traffic volumes results in an F at all intersections. The combination of the current tight diamond geometry and closely spaced ramp and city street intersections produce congestion during morning and evening commute. In the evening, vehicles back up along the southbound off ramp and overflow on the freeway causing delays to the I-15 and it’s a major safety hazard. The current sidewalks for pedestrian and bicyclists, but enhancements in design will increase safety.
b) Alternative 2: Continuous Flow Interchange

Alternative two (2) is the Continuous Flow Interchange. The alternative reduced congestion by decreasing traffic delay, and provides pedestrians and bicyclists safe accessibility, while improving overall safety. Figure seven (7) displays the layout with the blue lines highlighting the proposed horizontal alignment.

![Figure 7 – Alternative 2 Layout](image)

There is lane addition on the northbound off ramp and southbound on ramp, and lane addition in each direction along Railroad Canyon Road. This new lane addition along Railroad Canyon will serve as the left-turn pocket for the cross-over movement so vehicles can make a yielded left onto the freeway without having to wait at an additional intersection.

The reduction of the additional delay at the intersection allows a complete removal of a phase, increasing the level of service of not only the individual intersection, but the entire roadway network.

Proper striping and signage will be used to assist drivers as they make this new movement through the interchange. A concrete barrier will be used to separate the crossover left vehicles and opposing traffic. This is to ensure safety to the possibility of head on collisions with opposing vehicles.
All turning radii were checked using AutoTURN to ensure that STAA semi-trailer trucks can make all movements on and off the interstate safely. Pedestrian and bicycle access is provided on the northerly side of Railroad Canyon and all designs within DIB 82-5 standards.

The projected 2040 intersection level of service for the alternative is summarized in an alternative comparison table after the discussion of each alternative.
c) Alternative 3: Diverging Diamond Interchange

Alternative three (3) is the Diverging Diamond Interchange. This alternative reduced congestion by decreasing traffic delay, and provides pedestrians and bicyclists safe accessibility, while improving overall safety. Figure eight (8) displays the layout with the blue lines highlighting the proposed horizontal alignment.

There is lane addition on the northbound off ramp and southbound on ramp, and lane addition in each direction along Railroad Canyon Road. This design is similar to the CFI; however, instead of a single lane crossing opposing traffic, there is a braiding of all through movements at the intersection prior to the entrance to the freeway. This movement provides a yielded left on the interstate, not having to wait at an additional intersection before turning left onto the I-15.

Proper striping and signage will be used to assist drivers as they make this new movement through the interchange. A large median will be in the center of Railroad Canyon to ensure safety.
The reduction of the additional delay at the intersection allows a complete removal of a phase, increasing the level of service of not only the individual intersection, but the entire roadway network.

All turning radii were check using AutoTURN to ensure that STAA semi-trailer trucks can make all movements on an off the interstate safely. Pedestrian and bicycle access is provided on the northerly side of Railroad Canyon and all designs within DIB 82-5 standards.

The projected 2040 intersection level of service for the alternative is summarized in an alternative comparison table after the discussion of each alternative.
d) Alternative 4: Single Point Urban Interchange

Alternative four (4) is the Single Point Urban Interchange. This alternative reduced congestion by decreasing traffic delay, and provides pedestrians and bicyclists safe accessibility, while improving overall safety. Figure nine (9) displays the layout with the blue lines highlighting the proposed horizontal alignment.

![Figure 9 – Alternative 4 Layout](image)

The main advantage of the Single Point Urban interchange design, is that is has a central intersection for all movements on and off the freeway. This not only increases intersection spacing but also completely eliminates an intersection along Railroad Canyon Road.

Lane additions for all ramps provide capacity for projected volumes, and all merging zones are within Caltrans standards to ensure safety.

The largest con of this design is that it requires extensive new bridge work. Unlike the CFI and DDO that can be constructed with only minimal structure work, the SPUI requires four (4) new bridge structures. There are two new bridges that span over Railroad Canyon Road and two new ramp bridges crossing the San Jacinto River just north of the interchange. Due to the
complete redesign of the interchange, the construction staging is complex and impacts the I-15 severely.

![Figure 10 – Single Point Urban Interchange Traffic Flow Diagram](image)

All turning radii were check using AutoTURN to ensure that STAA semi-trailer trucks can make all movements on an off the interstate safely. Pedestrian and bicycle access is provided on the northerly side of Railroad Canyon and all designs within DIB 82-5 standards.

The projected 2040 intersection level of service for the alternative is summarized in an alternative comparison table after the discussion of each alternative.
Alternatives Level of Service Summary

Table 2 – Summary of Alternatives LOS (2040)

<table>
<thead>
<tr>
<th>Continuous Flow Interchange</th>
<th>Intersection</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>AM Peak</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>PM Peak</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>C</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diverging Diamond Interchange</th>
<th>Intersection</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM Peak</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>PM Peak</td>
<td>D</td>
<td>C</td>
<td>C</td>
<td>E</td>
<td>E</td>
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<table>
<thead>
<tr>
<th>Single Point Urban Interchange</th>
<th>Intersection</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td>AM Peak</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>PM Peak</td>
<td>D</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

As shown in the table above, the Single Point Urban interchange produces the greatest increase in the intersection level of service. This is largely contributed the complete elimination of an intersection along Railroad Canyon Road, and the reduction of signal phases.

The Continuous Flow and Diverging Diamond interchange alternatives produce similar increases in intersection level of service, with the Continuous Flow providing slightly better results. The intersection level of service will serve as the base for the benefit analysis of each alternative.
8. COSTS

A preliminary cost estimate and complete benefit analysis of each alternative was performed. The main purpose of the cost-benefit analysis is to quantify the total benefits of alternative compared to the total cost. To ensure the comparison was valid, all monetary values are in 2014 dollars.

The cost of each alternative was separated into several main categories which include: roadway, structure, right-of-way, design, construction and administration, and contingencies. Table three (3) is a summary of the costs of each alternative in 2014 dollars.

Table 3 – Alternative Cost Summary

<table>
<thead>
<tr>
<th>Item</th>
<th>CFI</th>
<th>DDI</th>
<th>SPUI</th>
</tr>
</thead>
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<tr>
<td>Roadway</td>
<td>16.7</td>
<td>16.7</td>
<td>37.5</td>
</tr>
<tr>
<td>Structure</td>
<td>0.7</td>
<td>0.7</td>
<td>42.2</td>
</tr>
<tr>
<td>R/W</td>
<td>5.4</td>
<td>5.4</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>22.8</strong></td>
<td><strong>22.8</strong></td>
<td><strong>87.4</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Support</th>
<th>CFI</th>
<th>DDI</th>
<th>SPUI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design (10%)</td>
<td>2.3</td>
<td>2.3</td>
<td>8.7</td>
</tr>
<tr>
<td>Const. &amp; Admin. (20%)</td>
<td>4.5</td>
<td>4.5</td>
<td>17.5</td>
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<tr>
<td>Contingencies (25%)</td>
<td>5.7</td>
<td>5.7</td>
<td>22.0</td>
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<tr>
<td><strong>Total:</strong></td>
<td><strong>13.4</strong></td>
<td><strong>13.4</strong></td>
<td><strong>48.2</strong></td>
</tr>
</tbody>
</table>

*All values are in Millions (2014)

The benefits of each alternative were calculated using Synchro V8 measures of effectiveness. The total benefit was based on the reductions of vehicle stops, vehicle delay, fuel used, and carbon dioxide emissions compare to the No Build alternatives. These reductions were assigned a monetary value using projected market rates for the facility’s 20 year design life, and a present worth calculation was performed to calculate the total benefit of each alternative in 2014 dollars.

The total reductions in the factors previously described are shown in Figures eleven (11) through thirteen (13). These reductions are directly related to the increased intersection level of service provided by each alternative.
Figure 2 – CFI Total Benefit

Figure 12 – DDI Total Benefit
A Cost-Benefit analysis is a systematic process for calculating and comparing the costs and benefits of a project. It has two purposes: one, to determine if a project is a sound investment and two, to provide a basis for comparing project alternatives. A benefit-cost ratio is a representation of how much the benefits of a project outweigh its cost. Table four lists the cost, benefit, and benefit-cost ratio for each alternative.

**Table 4 – Benefit-Cost Analysis Results**

<table>
<thead>
<tr>
<th>Alternative</th>
<th>CFI</th>
<th>DDI</th>
<th>SPUI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>36.2</td>
<td>36.2</td>
<td>135.6</td>
</tr>
<tr>
<td>Benefit</td>
<td>69.0</td>
<td>49.0</td>
<td>124.0</td>
</tr>
<tr>
<td>B/C Ratio</td>
<td>1.90</td>
<td>1.35</td>
<td>0.91</td>
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</table>

*Values are in millions (2014)*

As you can see, the CFI produces the greatest benefit with the least cost with a B/C ratio of 1.90, and the SPUI’s benefit doesn’t outweigh its cost with B/C ratio a 0.91. The cost and benefit are two main design factors used when selecting the recommended alternative for project implementation.
9. RECOMMENDED ALTERNATIVE SELECTION

It is not customary to recommend an alternative during the Project Study Report stage in the project; however, this team would like to take a step forward and make a formal recommendation for the alternative selected for project approval.

We decided to select our recommended alternative by using a weighted decision matrix as shown in Table five (5). We started by listing design factors, such as “Local Circulation”, “Freeway Operations”, “Benefit”, and “Cost” and then put them in the order we deemed most important based on Caltrans, City, and Community needs.

*Table 5 – Weighted Decision Matrix*

<table>
<thead>
<tr>
<th>Importance</th>
<th>Design Factor</th>
<th>CFI Score</th>
<th>DDI Score</th>
<th>SPUI Score</th>
<th>Weight</th>
<th>CFI Weighted Score</th>
<th>DDI Weighted Score</th>
<th>SPUI Weighted Score</th>
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<tbody>
<tr>
<td>1</td>
<td>Local Circulation</td>
<td>8</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>64</td>
<td>48</td>
<td>72</td>
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<tr>
<td>2</td>
<td>Freeway Operations</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>49</td>
<td>35</td>
<td>56</td>
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<tr>
<td>3</td>
<td>Benefit</td>
<td>5</td>
<td>3</td>
<td>9</td>
<td>6</td>
<td>30</td>
<td>18</td>
<td>54</td>
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<td>4</td>
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<td>9</td>
<td>4</td>
<td>5</td>
<td>45</td>
<td>45</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>Ease of Construction</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>32</td>
<td>32</td>
<td>12</td>
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<tr>
<td>6</td>
<td>Maintainability</td>
<td>7</td>
<td>8</td>
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<td>21</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>Adaptability</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>12</td>
<td>12</td>
<td>4</td>
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<td>8</td>
<td>Ped./Bike Friendliness</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>6</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

We then scored each alternative from 1 to 10, as to how well they met each factor. For an example of our scoring methodology, “Local Circulation” was based on the average intersection level of service in 2040. From our data we gave the CFI an 8, the DDI a 6, and the SPUI a 9.

After giving a score to each alternative, we assigned numerical weights to each factor, giving the most important the highest weight. We then multiplied these weights by the scores, to get “weighted scorings”.

After totaling these weighted scores, the CFI had a total of 259, the DDI, 222, and the SPUI, 231. From these totals we selected the CFI as our recommended alternative.
10. APPENDIX

Please visit http://www.railroad-franklini15project.com/ for all supporting documentation. This website is a complete review of the interchange improvement at I-15 and Railroad Canyon Road in the City of Lake Elsinore.