WASHINGTON CITY
TELEGRAPH ROAD & GREEN SPRINGS DRIVE
INTERSECTION STUDY

February 6, 2014

PREPARED BY:

SUNRISE ENGINEERING

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I. INTRODUCTION

A. STUDY BACKGROUND

The intersection of Telegraph Road and Green Springs Drive in Washington City is the major intersection responsible for traffic movement within the main commercial zone of the City. Currently, the intersection performs poorly during peak volumes and is expected to worsen as growth intensifies in the vicinity. The City is concerned about how this intersection should ultimately function, look and perform to satisfy future demand in the area.

In 2012, Washington City commissioned Sunrise Engineering, Inc. to conduct an intersection study for the Telegraph Road and Green Springs Drive intersection. As directed by the City, the specific objectives of this study were to analyze existing conditions, model the current traffic conditions, develop alternatives to improve the level of service of the intersection, model those alternatives, provide recommendations, and provide a cost analysis for each alternative. Sunrise Engineering and the City coordinated with the Dixie MPO to incorporate regional perspectives and traffic data.

B. PROJECT LOCATION

Washington City, Utah is located east of St. George City along I-15. The intersection that is being analyzed in this study is the Telegraph Road and Green Springs Drive intersection.

C. REASON FOR STUDY

As mentioned above, the Telegraph Road and Green Springs Drive intersection is the major intersection for the commercial area within Washington City. The main reason for conducting this study is to provide recommended solutions to improve movement and decrease travel time through the intersection for both existing and future travel demands in the area, while minimizing the impacts to surrounding businesses.

II. EXISTING CONDITIONS

A. STUDY AREA

The study area is displayed in Exhibit 1. It includes the intersection of Telegraph Road and Green Springs Drive, and the portions of roadway that lead up to the intersection from the north, south, east, and west. The study area extends to the north up until the on/off ramps from I-15. The study area extends to the south down to the driveways on either side of the roadway that enter into the Albertsons and the Home Depot parking lots. The study area extends to the east to the signalized intersection that provides access into the Wal-Mart parking lot and the Kohl's parking lot, 700 West. Finally, the study area extends to the west to the western most driveway that enters into the Albertsons parking lot.

B. EXISTING ROADWAY CONDITIONS

This section describes the existing streets, driveways, and intersections in the study area. The study area contains no driveways to the north, five driveways to the south, three driveways to the east, and nine driveways to the west of the intersection. The Telegraph Road and Green Springs Drive intersection is signalized, and the study area contains one other signalized intersection on the eastern boundary of the study area.

The Telegraph Road and Green Springs Drive Intersection has the following number of turn lanes.

Northbound – one dedicated left turn lane, two through lanes, and one dedicated right turn lane.

Southbound – two dedicated left turn lanes, two through lanes, and one dedicated right turn lane.

Eastbound – two dedicated left turn lanes, one through lane, and one through/right turn lane.

Westbound – two dedicated left turn lanes, two through lanes, and one dedicated right turn lane.

C. FACTORS AFFECTING LEVEL OF SERVICE

There are several factors that affect the current condition and level of service of the intersection. The most significant factor is the total volume of traffic moving through the intersection. As part of this study traffic counters were placed in several locations within the study area, hand and video traffic counts were taken for driveways, and traffic count figures provided by the Dixie MPO were compared with the data collected. Traffic counts were performed at the intersection to determine peak hour movements for both A.M. and P.M. time periods. The mainline counts, using traffic counters, were taken for a full week. The collected counts have been displayed in Exhibits 2, 3, and 4.

In addition to the total volume of traffic that the study area sees in a given day, there are other factors associated with the current configuration of the roadway and driveways that have an impact on the overall efficiency of the intersection and approach lanes. Many of these aspects have to do with access management, a subject that includes driveway offsets, driveways located in the area of influence of the intersection, shared turn lanes, the lack of deceleration lanes, driveways having close proximity to each other, etc.

In general, access management is the practice of coordinating the location, number, spacing, alignment, and design of driveways on a roadway to minimize conflicts and maximize the fluidity of the roadway. Proper access management not only maximizes capacity but also improves roadway safety. There are a number of issues associated with this intersection that could be addressed.

First, managing the number of driveways along a given roadway reduces the potential for conflicts between cars. Having adequate spacing between driveways also reduces the number of points a driver has to observe to properly navigate the roadway, which reduces potential conflicts. There are nine driveways to the west of the intersection of Telegraph Road and Green Springs Drive, with an average spacing of 120 feet. Correspondingly, there are five driveways to the south of the intersection of Telegraph Road and Green Springs Drive, with an average spacing of 165 feet. The preferred spacing for an un-signalized full movement intersection for this type of roadway is generally 500 feet.

Next, the center of an access should align with the center of the corresponding access on the opposite side of the road, particularly when those driveways share a median lane to enter and exit the roadway. If two accesses cannot be aligned directly across from one another, the center of one access to the center of the next access on the opposite side of the road should generally have a minimum offset of 200 to 300 feet. This distance allows for proper coordination in the shared median turn lane for both entering and existing in the driveway during left turning movements. To the west of the intersection, only two of the nine driveways are aligned directly across from one another, and the remaining seven have an average offset distance of 90 feet; well below the recommended 200 to 300 feet. Likewise to the south, only two of the five driveways are aligned directly across from one another, and the remaining three have an average offset distance of 125 feet.

Furthermore, medians are used to control and manage left turns and crossing movements from the different accesses along a roadway. By having medians and restricting driveway movements to right turn in and right turn out, it reduces the number of conflicts and potentially allows for additional driveways. Additional driveways can be allowed since the driveway spacing for right in/right out driveways is much less than spacing for full movement driveways, generally half the distance. Currently there are no medians being used, thus all driveways are essentially considered to be full movement.

Continuing on another subject, deceleration lanes and turn lanes improve traffic flow and roadway safety by ensuring that the traffic turning off the roadway into a driveway or side street does not interfere with the through movements. Currently, none of the driveways within the study area have deceleration lanes. Some turn lanes exist within the main intersection, but several movements do not have turn lanes incorporated into the existing configuration.

Likewise, left turn lanes can cause similar, if not more, conflicts if the storage lengths are not long enough. Often times vehicles will be backed up in the left hand turn lane to a point where the existing storage capacity is insufficient. At that point any cars attempting to enter the left hand turn storage lane will prevent through traffic from passing. There are no general lengths for storage distances for left turn lanes, but are sized on a case by case basis.

Lastly, driveways should be positioned far enough from the main intersection to ensure that traffic turning into these driveways do not interfere with the function of the intersection. Correctly positioning driveways a sufficient distance from the intersection improves traffic flow and safety. Currently, the northwest corner of the intersection has a single driveway approximately 50 feet from the corner while the southwest corner of the intersection has two driveways approximately 50 feet from the corner. The recommended distance from an intersection to the nearest driveway is generally 175 feet upstream from an intersection and 150 feet downstream from an intersection.

D. CRASH ANALYSIS

Over the past three years, the area in and directly around the study intersection has seen approximately 500 accidents of which 300 have been within the specified study area. This equates to be about 100 accidents per year. This many accidents reflects the need for additional access management within the study in order to decrease the number of potential conflicts a driver encounters while navigating through the study area.

III. DEVELOPMENT OF ALTERNATIVES

A. ALTERNATIVE DEVELOPMENT CONSIDERATIONS

Alternatives were developed to improve the overall function and capacity of the intersection while trying to minimize negative impacts and costs. The alternatives that have been developed are just for the intersection of Telegraph Road and Green Springs Drive. Therefore, these alternatives would be considered local alternatives.

First, this section evaluates the alternative where no improvements are made to the current conditions or configuration.

Secondly, this section assesses access management and proposes possible solutions. Access management improvements can be made independently or in conjunction with any of the next three alternatives in sub-sections D, E, and F. Although these improvements can be made in conjunction with other alternatives, it is recommended that improvements associated with access management be implemented as soon as possible.

The triple left turn, the thru-turn, the partial thru-turn, and the continuous flow intersection alternatives are discussed in sub-sections D, E, F, and G. These are local alternatives that were modeled under existing demands as well as future predicted demands at years 2020, 2030, and 2040. It is recommended that one of these alternatives be implemented around the time the existing conditions of the intersection fall below level of service D and no later than E. It is anticipated that the level of service at the intersection will drop to level D sometime between 2013 and 2014 and then to level E between 2018 and 2019. It should be noted that these levels of service could be met much sooner than predicted, and future growth and growth rates could end up being dramatically different than assumed.

On this subject, major considerations should be given to the commercial area to the south of Home Depot and Wal-Mart when discussing timeline for implementing different alternatives and when certain level of service bench marks are to be anticipated. The area to the south of Home Depot and Wal-Mart, according to St. George's general plan, will be an approximately 75 acre commercial development and will contribute a large traffic demand to the local vicinity and the study intersection.

A shopping center, which is the assumed future use, can range from as low as around 5,000 to a more average figure of 10,000 square feet of gross leasable area per acre. For a 75 acre development, that amounts to anywhere from 375,000 to 750,000 square feet of gross leasable total area. Applying these figures to the ITE manual for trip generation, the 75 acre shopping center during a weekday peak hour scenario would produce a total of 1,400 to 2,800 average trips.

Assuming that 60% of those trips will need to pass through the study intersection during peak weekday hour that amounts to approximately 840 to 1,680 vehicles. This study has assumed an average growth rate near 2%, but it's not unreasonable that this commercial development being developed in a very short period of time, "overnight". If this development were to go in overnight, traffic demands at the study intersections would be reaching peak hour turning movement volumes projected for years 2020 and 2030, assuming a 2% growth rate. Essentially, if the commercial development south of Home Depot and Wal-Mart were to be developed rapidly, the increase in traffic during the peak hour of the day would increase to demands projected for 2020 and 2030.

Local improvements can help to alleviate the problems occurring within the intersection, but it appears that the issues involving the Telegraph Road and Green Springs Drive intersection are not merely a local issue, but a regional one as well. In order to further alleviate the problems within the study area, additional measures should be taken within the region to do so. Regional considerations and possible regional/additional local alternatives are discussed in sub-sections H, I, J, and K.

B. NO IMPROVEMENTS

i. ALTERNATIVE DESCRIPTION

This option reflects no changes being made to the current conditions and configurations.

ii. ADVANTAGES

This option would have no direct costs associated with it. It would have the least impact on current businesses and drivers.

iii. DISADVANTAGES

The disadvantage of this option is it provides no relief to existing and predicted future congestion.

C. ACCESS MANAGEMENT IMPROVEMENTS

i. ALTERNATIVE DESCRIPTION

This option reflects changes and improvements to be made to enhance and improve the areas of access management that were deemed unsatisfactory in Section 2.C. Key attributes include the following:

1. The addition of a median on the north, east, and westbound approach lanes within the study area.
2. The eastbound approach lane would have three driveways closed.
3. The east and northbound approach lanes would each have one driveway moved farther from the intersection.
4. Increased left turn storage lane capacity.

Any of these components installed individually from the overall access management alternative would be beneficial and wouldn't be as costly as making all the improvements at once. For instance, installing just the medians would cost approximately $77,000 and would provide many of the advantages listed in the next paragraph. See appendix for the Engineer's Opinion of Probable Cost.

ii. ADVANTAGES

The access management improvements alternative may not have as significant an impact on the level of service of the intersection as some of the other options, but would have an impact on the efficiency of the intersection and the four approaching roadways. This alternative would greatly increase the safety of the intersection by decreasing left hand movements from driveways and the total number of driveways, thus significantly decreasing the number of possible conflicts in the area. We recommend that the components of this alternative be included with whichever alternative is selected.

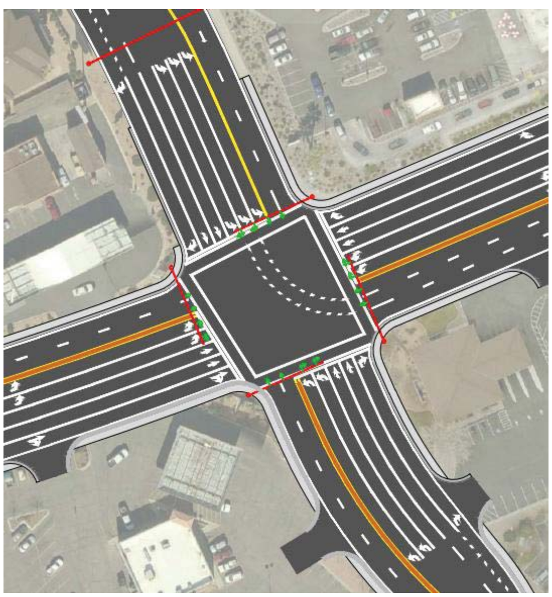
iii. DISADVANTAGES

The disadvantage of this option is that while this alternative increases safety and efficiency it may not meet the future capacity needs of the roadway. This alternative also impacts the local commercial area, since the number and frequency of driveways will be reduced. Also, with the medians in place, access into the different businesses in the area will be restricted to specific locations for all left turning movements.

D. TRIPLE LEFT TURN

i. ALTERNATIVE DESCRIPTION

This option, as its name implies, incorporates three left turn lanes for the southbound movements of the Telegraph Road and Green Springs Drive intersection.



The other key attribute to the triple left turn alternative would be to place a median on the east, west, and northbound lanes through the length of the study area. Other minor changes include two through lanes for eastbound movements, with an additional combination through/right lane. Eastbound left turn lanes would receive extra storage beyond the current configuration as well. Westbound would have its right turn lane storage extended. Northbound would receive an additional left turn lane, and both left turn lanes would receive extra storage. Northbound would also have its right turn lane storage extended.

The changes included in the access management improvements alternative would also be incorporated in with this alternative.

These changes result in a geometric design that can be seen in Exhibit 5.

ii. ADVANTAGES

This option represents the most conventional solution. It would be simpler for drivers to understand movements since the implemented changes associated with this alternative are subtle.

iii. DISADVANTAGES

The disadvantage of the triple left turn option is that it doesn't provide as much of an increase in capacity as the two thru-turn alternatives. This is true for all three time periods that were modeled. This alternative would also require additional right-of-way to be acquired, which is anticipated to have a significant impact on the overall cost of this alternative.

Triple left turns would also have the same access disadvantages as those mentioned in the access management improvements alternative. There is also a concern that even though there are three turn lanes available for vehicles turning left, that the turn lanes won't be used efficiently. For example, drivers may choose only the outside lanes which would provide the easiest access to local businesses, thus possibly making the inside lane less effective.

The final disadvantage has to do with syncing and timing of this intersection and those intersections in the vicinity. Currently, the total phase time for the Telegraph Road and Green Springs Drive intersection is much longer than surrounding intersections due to the fact that the time for a pedestrian to cross the street is much longer. This is due to the fact that number of lanes in each approach to the intersection is greater, thus making the distance for a pedestrian to walk greater. This alternative would actually increase the distance and time a pedestrian would take to cross the street at this intersection. This in turn would require a longer signal cycle length which could lead to inefficiencies at the intersection.

iv. COSTS AND IMPACTS

The cost estimate, included in the appendix, estimates that the total cost of this project will be as follows:

1. Total Construction Cost - $3.4 Million
2. Total Engineering Cost - $0.8 Million
3. Total Right-of-Way Cost - $3.7 Million

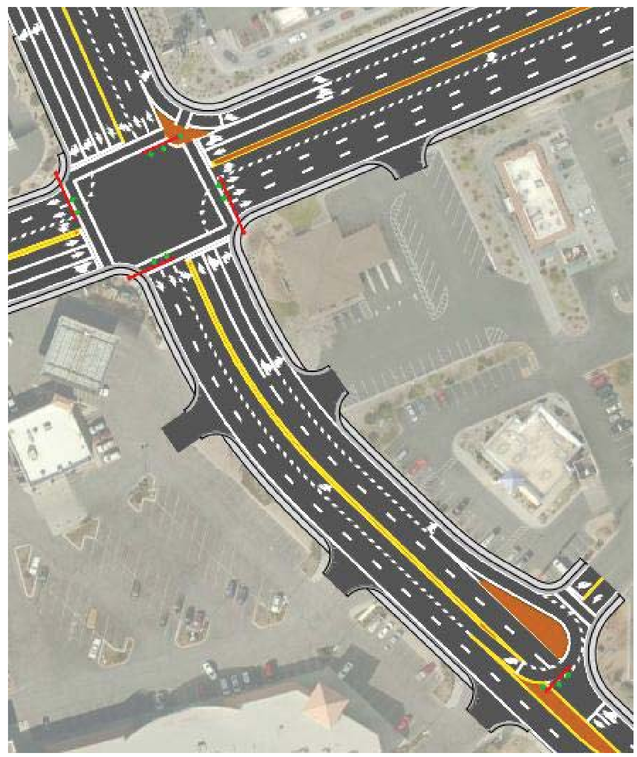
Total Cost - $7.9 Million

E. THRU-TURN

i. ALTERNATIVE DESCRIPTION

This option incorporates three u-turns that would be constructed in the east, west, and northbound approach lanes. The u-turns would be positioned approximately 570 feet from the intersection. This alternative removes all left turn lanes from the intersection, thus removing the ability to turn left at the intersection.

For an example, if a vehicle is approaching the intersection from the north it has a few options in order to turn east. With the first option, the vehicle would turn right, do a u-turn in the eastbound approach lane, and then proceed to go through the intersection heading east. The second option, the vehicle would go through the intersection and conduct a u-turn in the northbound approach lane and then turn right at the intersection to head east. Similar methods apply for all other approaches for vehicles needing to turn left.



Other changes associated with the thru-turn alternative include a dedicated u-turn lane for the east, west, and northbound approach lanes. The eastbound approach lane would have two through lanes and a single through/right turn lane. The northbound approach lane would have a single through lane, a through/right turn lane, and a dedicated right turn lane. The southbound approach lane would have two through lanes and two right turn lanes. The westbound approach lane would have a right turn lane dedicated for those entering I-15 northbound, a through/right turn lane for those turning right but not entering I-15 northbound, and a through lane.

The changes included in the access management improvements alternative would also be incorporated in with this alternative.

These changes result in a geometric design that can be seen in Exhibit 6.

Additionally, a variation to this alternative has also been included as Exhibit 6.1 in the appendix. This variation would allow for left turning movements out of the southern driveway for businesses such as The Home Depot, IHOP, Petco, etc.

ii. ADVANTAGES

The advantages of the thru-turn alternative would be that there are no left turns at the intersection, thus increasing mobility through the intersection. The left turns are no longer consuming time during the signal cycle. As discussed in the previous section, this alternative would actually improve the current situation with syncing the Telegraph Road and Green Springs Drive intersection with other intersection in the vicinity. This is because this alternative actually reduces the distance and time a pedestrian takes to cross the street at the intersection.

Thru-turns also consume less right-of-way than the triple left turn alternative. This alternative is one of the least cost alternatives between it and the triple left turn alternative.

iii. DISADVANTAGES

The disadvantage of this option is that this kind of intersection is unfamiliar to drivers within the area and the public would need to be educated in how to navigate the intersection.

Thru-turns would also have the same access disadvantages as those mentioned in the access management improvements alternative, but may be less severe than the triple left alternative since drivers would spend less time waiting at the signal.

iv. COSTS AND IMPACTS

The cost estimate, included in the appendix, estimates that the total cost of this project will be as follows:

1. Total Construction Cost - $3.1 Million
2. Total Engineering Cost - $0.7 Million
3. Total Right-of-Way Cost - $1.8 Million

Total Cost - $5.6 Million

F. PARTIAL THROUGH TURN

i. ALTERNATIVE DESCRIPTION

This option is very similar to the previous option, “Thru-Turn”, but eliminates the u-turn to the south of the study intersection, and includes some other minor adjustments. This option incorporates two u-turns that would be constructed in the east and west bound lanes. The u-turns would be positioned approximately 570 feet from the intersection. This alternative removes the left turn movements from the east and west bound lanes, but still allows left turn movements from the south and north bound lanes. This alternative also allows for left turns out of the northwest driveway for the Albertson’s parking lot.

Other changes associated with the thru-turn alternative include a dedicated u-turn lane for the east and west bound approach lanes. The eastbound approach lane would have two through lanes and a single right turn lane. The northbound approach lane would have two through lanes, a right turn lane, and two left turn lanes. The southbound approach lane would have two through lanes, a right turn lane, and two left turn lanes. The westbound approach lane would have a right turn lane dedicated for those entering I-15 northbound and two through lanes.

The changes included in the access management improvements alternative would also be incorporated in with this alternative.

These changes result in a geometric design that can be seen in Exhibit 6.2.

ii. ADVANTAGES

The advantages of the thru-turn alternative would be that there are no left turns at the intersection for the east and west bound lanes, thus increasing mobility through the intersection. The left turns for the east and west movements are no longer consuming time during the signal cycle. As discussed in the previous section, this alternative would actually improve the current situation with syncing the Telegraph Road and Green Springs Drive intersection with other intersection in the vicinity. This is because this alternative actually reduces the distance and time a pedestrian takes to cross the street at the intersection.

The advantage this alternative has over the other thru-turn alternative is this alternative provides left turning movements out of the major driveways for the Albertson's parking lot and the driveway to the west of Home Depot.

This alternative also represents the lowest cost solution, excluding the "no action" alternative.

iii. DISADVANTAGES

The disadvantage of this option is that this kind of intersection is unfamiliar to drivers within the area and the public would need to be educated in how to navigate the intersection.

Thru-turns would also have the same access disadvantages as those mentioned in the access management improvements alternative, but will be less severe than the other alternatives since many driveway movements are still allowed.

iv. COSTS AND IMPACTS

The cost estimate, included in the appendix, estimates that the total cost of this project will be as follows:

4. Total Construction Cost - $2.7 Million
5. Total Engineering Cost - $0.6 Million
6. Total Right-of-Way Cost - $1.6 Million

Total Cost - $4.9 Million

G. CONTINUOUS FLOW INTERSECTION

i. ALTERNATIVE DESCRIPTION

The continuous flow intersection moves the vehicles at an intersection that would be turning left and conflicting with through movements out of the main intersection. This is accomplished by having those vehicles turning left cross the path of the oncoming through traffic coming from the opposite direction several hundred feet upstream of the main intersection, by way of a signal. Once at the main intersection, the left turning vehicles then proceed on a separate lane which is outside of the opposing through lanes and at the same time as opposing through lanes. The intent of a continuous flow intersection is to eliminate a signal cycle by allowing left turning movements to proceed simultaneously with through movements, thus increasing the capacity of the intersection. The CFI movements would be implemented on the two opposing approaches on Telegraph Road. See Exhibit 6.3 in the appendix.

ii. ADVANTAGES

This type of intersection eliminates the left turn phase of the main intersection, which reduces average intersection delays and increases capacity. This type of intersection also has fewer conflict points compared to conventional intersections.

iii. DISADVANTAGES

This alternative does have some major disadvantages associated with it, particularly when trying to implement it into this location. A CFI has a larger footprint compared to a conventional intersection, and would require a lot of additional right-of-way. To apply a CFI to this location may require some business locations to be shutdown, while other businesses would lose parking, access, drive-throughs, etc. The right-of-way required would be too impactful to business and would be very costly to acquire. Access to local businesses would also be very restricted. Right turns in and out of several existing driveways would be eliminated where the left turning movements are moved to the opposite side of the roadway.

Due to significant negative impacts explained, this option was eliminated as a possible alternative and was not explored as fully as other options. In turn, this option does not have estimated costs or future capacity analyses.

H. INTERSECTION MOVED SOUTH

i. ALTERNATIVE DESCRIPTION

This option involves moving the intersection south, further from I-15, so that storage lengths and congestion involving I-15 are separated from the intersection.

ii. ADVANTAGES

Moving the intersection to the south would allow for more space for the intersection to be designed with the proper storage spacing, especially on the northern portion of the intersection. This alternative would also help to reduce the amount of conflicts a vehicle encounters as they exit I-15 since there would be more room to maneuver in the area.

iii. DISADVANTAGES

This alternative would require extensive work and expenses to acquire the required rights-of-way necessary to move the intersection further south, with not as many benefits as other alternatives would provide. This alternative would severely affect local businesses.

I. SIGNAL OPTIMIZATION

i. ALTERNATIVE DESCRIPTION

This alternative would include the equipment and installation of a signal optimization system. This equipment analyzes the number of vehicles entering the intersection and can change the lights to minimize travel time through the intersection. The equipment is generally mounted on the signal poles and cabinets, and would require no changes to the overall layout of the intersection itself.

Signal optimization would require coordination of nearby signals operated by UDOT and by St. George City.

ii. ADVANTAGES

The advantages of having signal optimization equipment installed at an intersection includes reduction of the side street delays, reduction of the off peak travel times, and reduction in mainline travel times. Although the signal optimization may not have as much of an effect during peak demand on the intersection it would however, reduce the amount of time the intersection took to recover from congestion caused by the peak demand.

One of the most favorable advantages of this option would be during those times that vehicles are required to wait for a timed light to turn green when no other vehicles are in the intersection. The signal optimization equipment has the capability to recognize no vehicles are entering the intersection and let the waiting vehicle pass through the intersection much earlier.

iii. DISADVANTAGES

A disadvantage of this option is the cost of the equipment and installation. The total cost is approximately $200,000. Another disadvantage is that it does not solve the intersection capacity issue.

J. SIGNAL COORDINATION

i. ALTERNATIVE DESCRIPTION

Portions of this alternative have already been implemented, while continued efforts are being made to improve signal coordination at the study intersection. Several upgrades that have already been made include the installation of additional signal heads, installation of additional car detection equipment, and a broken push button was fixed.

Matt Luker, with Utah Department of Transportation spent some time in February of 2013 working on signal operations issues. Included in the appendix is a document detailing the things that he observed and fixed. In summary of that document he wrote the following paragraph:

"Increase in cycle length during mid-day (weekdays and weekends) has improved operation during those times. Application of advanced controller features including "Actuated Coordinated Phase" has improved operation during most periods of the day on all days. But, during heaviest times of the day, especially PM peak and weekends, intersection at Green Spring

Drive & Red Cliffs/Telegraph is over capacity. Signal timing adjustments have helped some but the signal simply can't accommodate all of the demand. UDOT Signal Operations will continue to monitor the area from the Traffic Operations Center and through periodic site visits."

K. OPTIONS TO DECREASE VOLUME AT INTERSECTION

Another approach for improving performance at the study intersection would be to decrease the number of drivers who use the intersection. The majority of the previous alternatives develop methods for increasing the performance and capacity of the intersection itself, but most of these efforts have their limits and ultimately will not be able to fully alleviate existing and future demands on the study intersection. Providing alternative routes for drivers will need to be another factor to consider and explore in the future. The overarching intent of this subsection is to provide and explore options that would provide drivers alternative routes around the study intersection rather than needing to go through it.

i. MALL DRIVE UNDERPASS & DEDICATED CORRIDORS

Currently there are a significant number of drivers that are coming from St. George along Red Hills Parkway and heading east towards Washington Fields. Currently they have to pass under the freeway at Green Springs Drive. If an alternate route were available, then this would relieve pressure on the intersection.

An example of this would be to construct an under pass at Mall Drive in St. George as well as a dedicated corridor along 450 North. Exhibit 8 shows the current path that a driver might take to get to Washington Fields with the 450 North corridor alternative shown as well. By having the 450 North corridor constructed it actually reduces the overall travel distance by just less than a mile, and would decrease the amount of traffic required to go through the Telegraph Road and Green Springs Drive intersection.

A study prepared for the Dixie MPO was conducted to better estimate the reduction in the amount of traffic due to the future installation of the Mall Drive underpass and the 450 North corridor. In 2020, they estimated a 10% reduction in the traffic, and a 7% reduction in 2030. See Table 2 in the appendix for more information on those figures.

Another example along these same lines would include the same Mall Drive underpass and the Virgin River bridge at Mall Drive.

ii. 700 WEST TO 850 NORTH CONNECTOR ROAD

Another method for decreasing future demand at the study intersection is based on the importance of connectivity. Often time's roadways are built not just for large volumes and capacities, but to provide convenience and interconnectivity between those large capacity roadways. Another proposed option for alleviating congestion at the study intersection includes a connector road between existing 700 West and the proposed master planned road at 850 North as shown in Exhibit 9.

This option would require significant grading, a retaining wall for existing gas substation, and reworking of the existing parking lot for Home Depot and Wal-Mart. This alternative could also be either a "connection between parking lots" or as a roadway. This option would require specific coordination and involvement with St. George City.

A study was conducted by Horrocks Engineers to estimate the impact this alternative would have on the study intersection under existing conditions, and in 2020 and 2040. The results showed an anticipated decrease in traffic in the north and west bound lanes of the study intersection, but no effect in east and south bound lanes. The percent decrease varies by year and location. For instance, the north bound lane showed a decrease of 35%, 26%, and 25% for existing, 2020, and 2040, respectively. The west bound lane didn't see quite the decease as the north bound lane, but showed a decrease of 6%, 7%, and 8% respectively for those study years. The study has been included in the appendix.

iii. NEW I-15 INTERCHANGE

Another option to alleviate congestion in the study intersection is a grade separated interchange. Two different locations were considered, the first one would be located at Main Street in Washington, and the second would be located at 300 East in Washington.

Both of these options would create an alternative route for traffic to enter Washington Fields over the Virgin River bridge that wouldn't require vehicles to pass through the Telegraph Road and Green Springs intersection.

300 East makes for a reasonable alternative since it represents the most straight forward alignment for entering Washington Fields, but would require a fair amount of work to overcome grade issues. Exhibits 10, 11, and 12 included in the appendix show different possible options for how the interchange could be configured.

The current configuration of I-15 and Main Street represents a potential alternative since there is already an existing underpass. Exhibit 13 included in the appendix shows and option for how the interchange could be configured.

A study was conducted by Horrocks Engineers to estimate the impact these alternatives would have on the study intersection under existing conditions, and in 2020 and 2040. Below is a table summarizing the percent decrease in traffic volumes.

Main Street Interchange Alternative			
Approach	**2010**	**2020**	**2040**
Northbound	0%	0%	0%
Southbound	8%	9%	7%
Eastbound	2%	2%	1%
Westbound	8%	12%	8%

300 East Interchange Alternative			
Approach	**2010**	**2020**	**2040**
Northbound	0%	0%	0%
Southbound	4%	6%	4%
Eastbound	1%	1%	0%
Westbound	6%	9%	4%

The study has been included in the appendix.

All the options discussed in this section are regional in nature and would require the involvement of the Dixie MPO and UDOT.

IV. ALTERNATIVE ANALYSIS RESULTS

A. INTRODUCTION

The purpose of this section is to provide the results of the models and simulations that were run for each scenario. As a base scenario, the no improvements alternative was modeled under existing conditions and then for years 2020 and 2030. The triple left and thru-turn scenarios were modeled for existing, 2020 and 2030. Once the results showed the thru-turn scenario was more effective, an additional model was run for to compare the thru-turn and partial thru-turn scenarios for 2020, 2030, and 2040. The access management alternative was not modeled since it was anticipated not to have a significant impact on the level of service of the intersection, and therefore was not included in this section's results.

B. TRAFFIC FORECAST

The analysis process generally consists of applying a growth percentage to the existing traffic volume counts to predict what future traffic volumes might be in order to model different scenarios under existing and future conditions. For this study, traffic volumes were predicted for 2020, 2030, and 2040 using figures determined in a previous study conducted by the Dixie MPO that was produced by Horrocks Engineering.

The Dixie MPO study showed results that reflected a 21% increase in traffic volumes from 2012 to 2020 and 31% increase in traffic volumes from 2012 to 2030. That equates to an annual increase from 2012 to 2020 of approximately 2.4% and an annual increase from 2012 to 2030 of 1.5%. See Table 2 in the appendix for the figures from the Dixie MPO study that was used as part of this study. The numbers to determine growth rates are those that represented the improvements in regional connectivity.

C. NO IMPROVEMENTS

Capacity analysis for the existing roadway geometrics and traffic volume was performed for the typical P.M. peak hour conditions. P.M. peak hour conditions were chosen since they are more extreme than the A.M. conditions. The existing conditions scenario was optimized for signal timing and phasing. Below is Table 3 that summarizes the results of this scenario.

Table 3 - Existing Condition

Year	LOS*	Delay (sec)
2012	C	32.0
2020	E	43.0
2030	F	56.1

* LOS - Level of Service

It's clear that the current configuration provides a less than ideal level of service in the near future. The next sub-sections discuss the three alternatives that are anticipated to have the most effect on alleviating future congestion.

D. TRIPLE LEFT TURN

Capacity analysis for the triple left turn scenario was performed for the typical P.M. peak hour conditions. The triple left scenario was optimized for signal timing and phasing. Below is Table 4 that summarizes the results of this scenario.

Table 4 - Triple Left

Year	LOS*	Delay (sec)
2012	C	29.8
2020	D	42.2
2030	D	52.7
2040	-	-

* LOS - Level of Service

E. THRU-TURN

Capacity analysis for the thru-turn scenario was performed for the typical P.M. peak hour conditions. The thru-turn scenario was optimized for signal timing and phasing. Below is Table 5 that summarizes the results of this scenario.

Eric Rasband, the Traffic Operations Analysis and Reporting Manager with Utah Department of Transportation made some minor modifications to this alternative. These modifications resulted in a lower delay for year 2040 compared with previous model results. A summary of the modifications that were made can be found in the appendix.

Table 5 - Thru-Turn

Year	LOS*	Delay (sec)
2012	B	19.6
2020	C	36.1
2030	D	38.8
2040	D (C**)	51.3 (26**)

* LOS - Level of Service
** Modified alternative results (UDOT)

F. PARTIAL THRU-TURN

Capacity analysis for the partial thru-turn scenario was performed for the typical P.M. peak hour conditions. The future predicted LOS for the partial thru-turn scenario received a predicted LOS C for year 2020 and LOS D for year 2030 and 2040. Below is Table 6 that summarizes the results of this scenario.

Eric Rasband, the Traffic Operations Analysis and Reporting Manager with Utah Department of Transportation also made some minor modifications to this alternative as well. The modifications included a change in lane utilization, but resulted in a similar level of service as previous model results. A summary of the modifications that were made can be found in the appendix.

Table 6 – Partial Thru-Turn

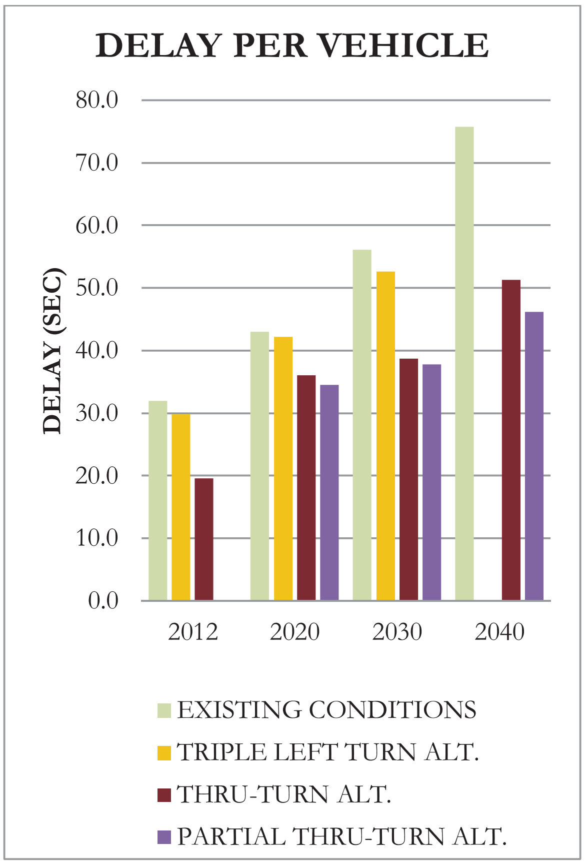
Year	LOS*	Delay (sec)
2012	-	-
2020	C	34.6
2030	D	37.8
2040	D (D**)	46.2 (46)

* LOS - Level of Service
** Modified Alternative Results (UDOT)

V. CONCLUSIONS AND RECOMMENDATIONS

A. ALTERNATIVE COMPARISON

The three alternatives that have been presented in this study have advantages and disadvantages associated with their implementation and performance. These have been covered in Section 3. From a performance standpoint, the following graph helps to illustrate the differences in mobility between the two alternatives with respect to existing conditions.



From this, it becomes apparent that the thru-turn and partial thru-turn alternatives provide the best performance and mobility. It should also be noted that the partial thru-turn scenario actually performs better than the thru-turn scenario.

From an impact standpoint, which is harder to quantify, the impact to the surrounding commercial entities would seem to be less with the triple left alternative than the thru-turn alternative, but about the same as the partial thru-turn.

The thru-turn and partial thru-turn alternatives aren't as intuitive and are therefore more complex to navigate, but the partial thru-turn appears to be a little more intuitive since traditional left hand turns can be made from two of the north and south bound approaches. Although they are not common, the triple left turn alternative, on the other hand, is intuitive and wouldn't likely have that kind of effect.

B. RECOMMENDED ALTERNATIVE

When deciding which alternative is the best solution for this particular intersection, it is important to take into consideration the operational benefits as well as the anticipated impacts to the surrounding businesses and cost implications.

It is recommended from a traffic mobility standpoint, the partial thru-turn alternative be constructed. This option also provides a significant reduction in commercial impact since left hand turns can be made out of each driveway from the Albertson's parking lot.

It is also recommended that the City continue to take an active role in promoting regional connectivity that would provide alternative routes for drivers merely passing through the area. This would essentially save the intersection capacity for drivers whose destination is the commercial and neighborhood areas around the intersection.

VI. COST ANALYSIS

A. COST ESTIMATES

Cost estimates were prepared for three alternatives, the triple left turn, the thru-turn and the partial thru-turn alternatives. These estimates reflect the entire pavement sections, as represented in the two alternative exhibits, as being replaced. Utilizing existing pavement could provide a cost savings but may not be an option depending on when and how improvements are constructed. In general, the cost estimate includes the following categories:

1. Utility replacement & relocation for
    a. Water,
    b. Stormwater,
    c. Wastewater, and
    d. Other miscellaneous utilities.
2. Asphalt placement, including
    a. Asphalt,
    b. Untreated base course,
    c. Pavement marking,
    d. ADA ramps,
    e. Median curbing and stamped concrete, and
    f. Curb and gutter and sidewalk.
3. Transportation related items including
    a. Signage and
    b. Signals.
4. Landscaping and lighting.
5. Engineering.
6. Right-of-way.

See the appendix for the itemized description of the cost estimates for each alternative.

EXHIBIT 1
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
STUDY AREA

SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 • FAX 435.652.8416
www.sunrise-eng.com

EXHIBIT 2
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
A.M. EXISTING COUNTS

SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 • FAX 435.652.8416
www.sunrise-eng.com

EXHIBIT 3
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
P.M. EXISTING COUNTS

SUNRISE
ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 • FAX 435.652.8416
www.sunrise-eng.com

EXHIBIT 4

TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY

24 HOUR EXISTING COUNTS

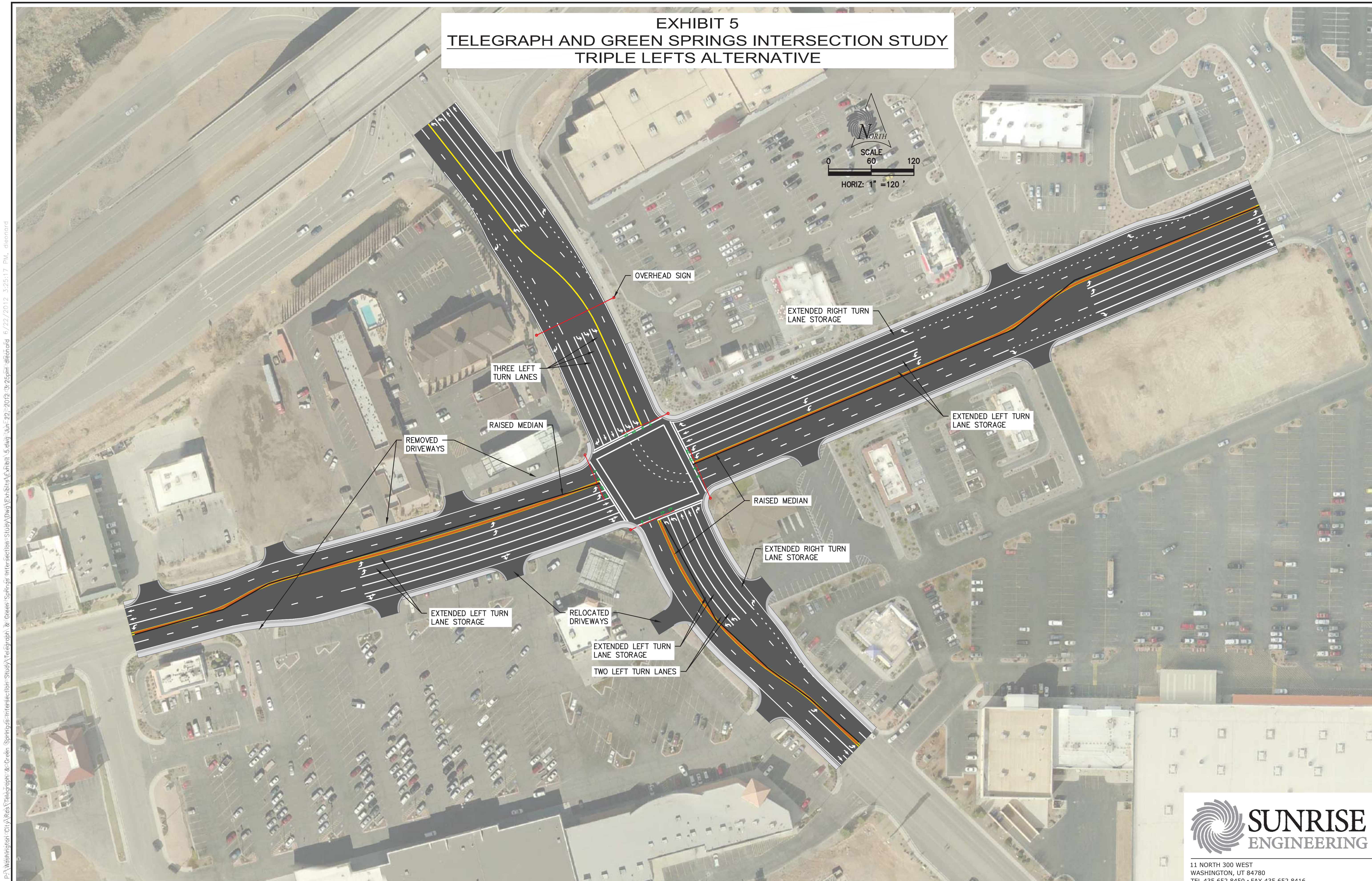
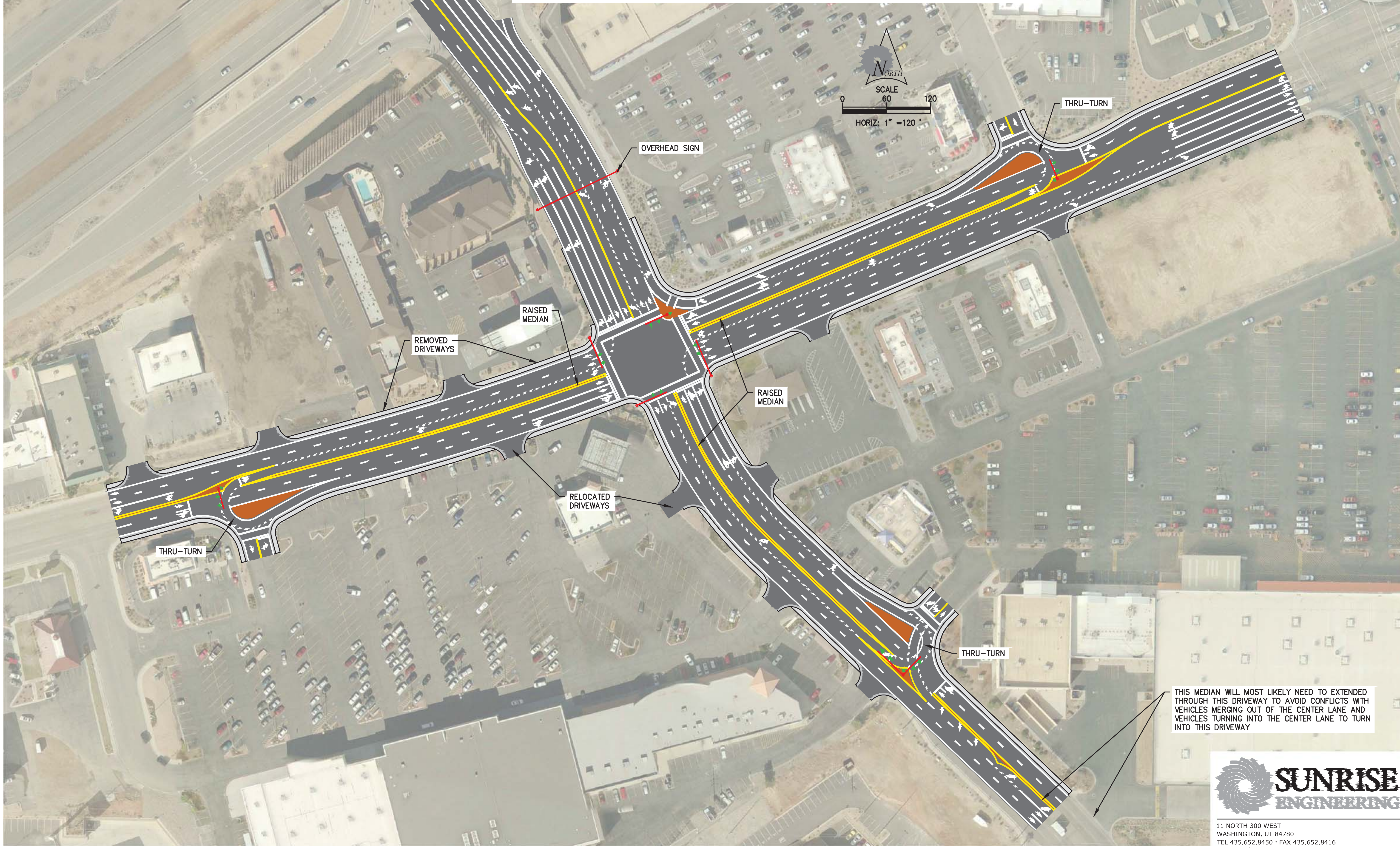


EXHIBIT 5
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
TRIPLE LEFTS ALTERNATIVE
NORTH
SCALE
0 60 120
HORIZ: 1" =120 '
OVERHEAD SIGN
EXTENDED RIGHT TURN LANE STORAGE
THREE LEFT TURN LANES
EXTENDED LEFT TURN LANE STORAGE
RAISED MEDIAN
REMOVED DRIVEWAYS
RAISED MEDIAN
EXTENDED RIGHT TURN LANE STORAGE
EXTENDED LEFT TURN LANE STORAGE
RELOCATED DRIVEWAYS
EXTENDED LEFT TURN LANE STORAGE
TWO LEFT TURN LANES
SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
www.sunrise-eng.com

EXHIBIT 6
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
THRU-TURN ALTERNATIVE

SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
www.sunrise-eng.com

EXHIBIT 6.1
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
THRU-TURN ALTERNATIVE - REV 1



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www.sunrise-eng.com

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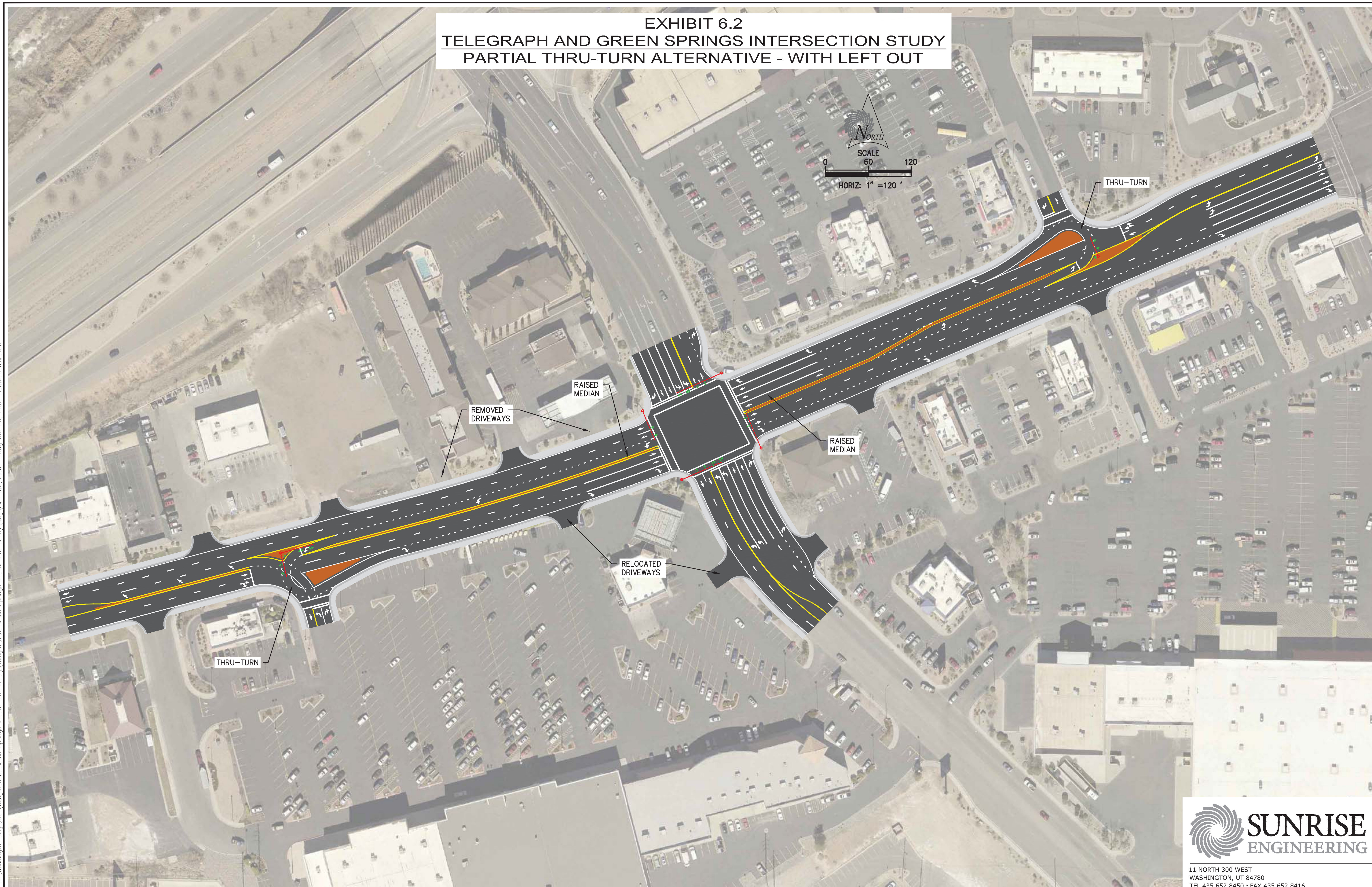

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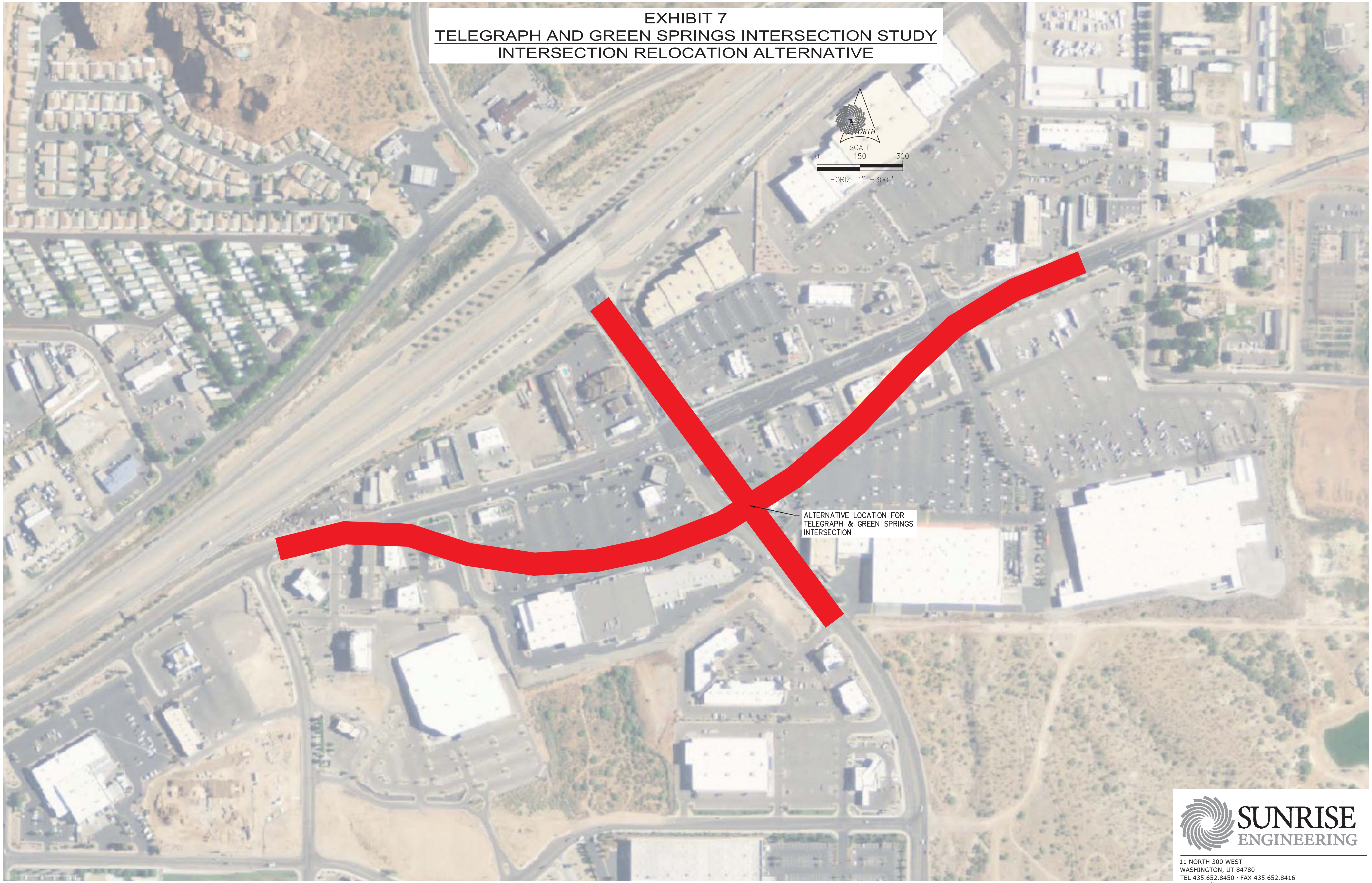
EXHIBIT 6.3
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
CONTINUOUS FLOW INTERSECTION

SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
www.sunrise-eng.com

EXHIBIT 7
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
INTERSECTION RELOCATION ALTERNATIVE



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WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
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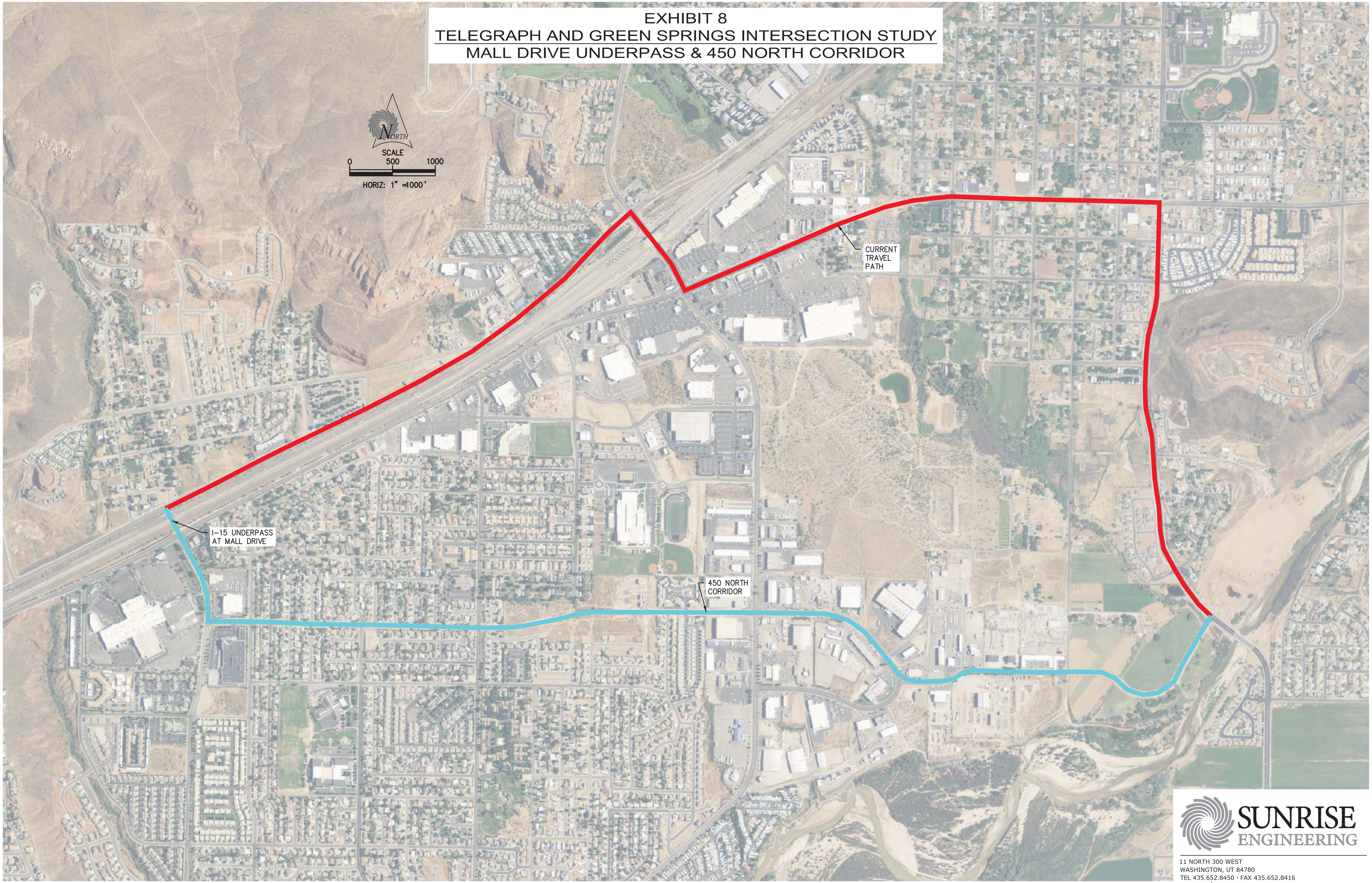
EXHIBIT 8
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
MALL DRIVE UNDERPASS & 450 NORTH CORRIDOR



SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
www.sunrise-eng.com

EXHIBIT 9
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
TELEGRAPH ST. TO 850 NORTH ST. CONNECTOR ROAD

SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
www.sunrise-eng.com

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EXHIBIT 10
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
300 EAST INTERCHANGE - OPTION A

THIS OPTION UTILIZES THE CURRENT NORTH BOUND LANES ALIGNMENT

SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
www.sunrise-eng.com

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EXHIBIT 11
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
300 EAST INTERCHANGE - OPTION B

THIS OPTION UTILIZES THE CURRENT SOUTH BOUND LANES ALIGNMENT

SUNRISE ENGINEERING
11 NORTH 300 WEST
WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416
www.sunrise-eng.com

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EXHIBIT 12
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
300 EAST INTERCHANGE - OPTION C

THIS OPTION UTILIZES THE CURRENT NORTH BOUND AND SOUTH BOUND LANES ALIGNMENT.
LEFT SIDE ON AND OFF RAMPS ARE NOT RECOMMENDED

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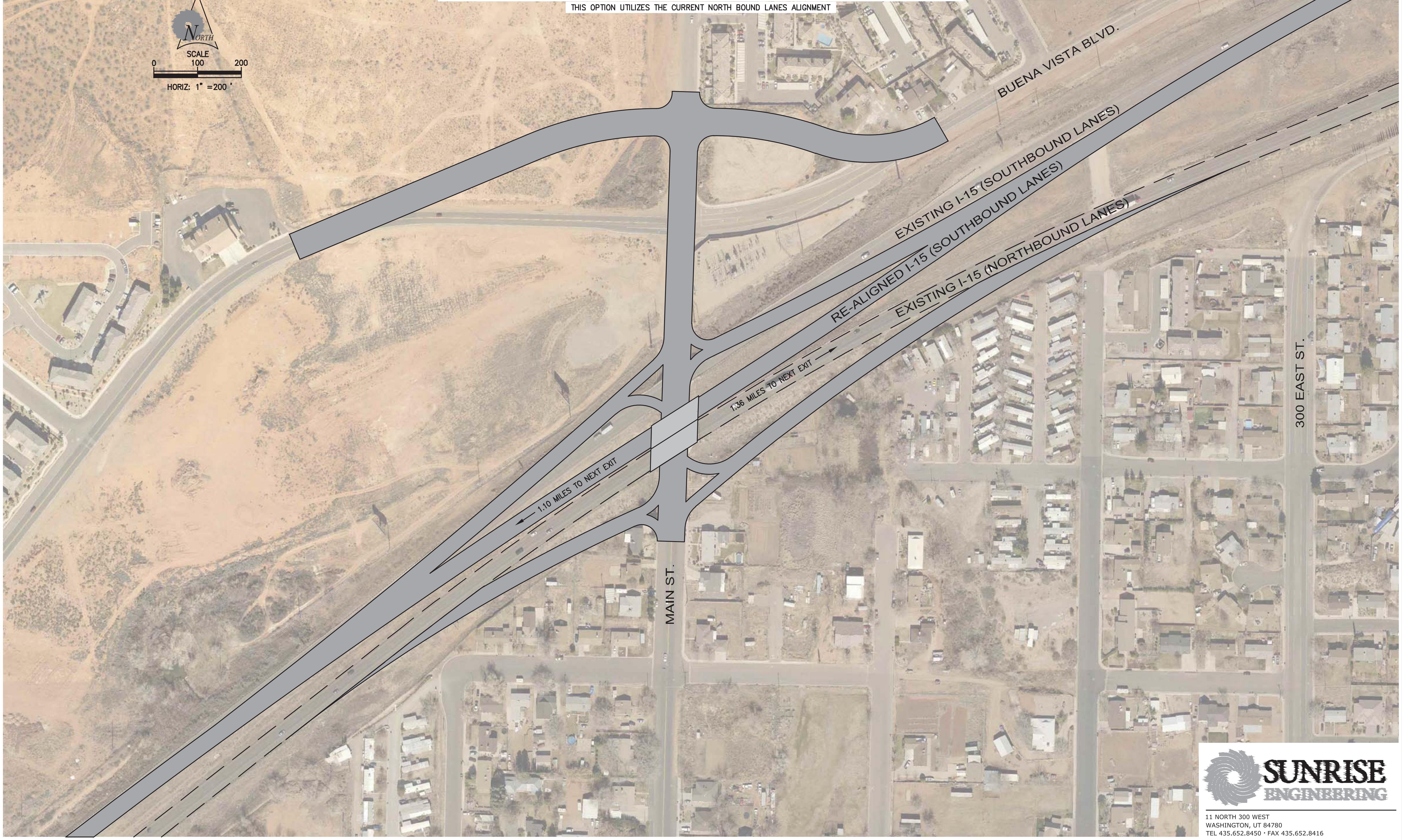
EXHIBIT 13
TELEGRAPH AND GREEN SPRINGS INTERSECTION STUDY
MAIN STREET INTERCHANGE

THIS OPTION UTILIZES THE CURRENT NORTH BOUND LANES ALIGNMENT



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WASHINGTON, UT 84780
TEL 435.652.8450 · FAX 435.652.8416

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SUNRISE ENGINEERING, INC.

11 North 300 West, Washington, Utah 84780
Tel: (435) 652-8450 Fax: (435) 652-8416

Engineer's Opinion of Probable Cost

Telegraph & Green Springs Intersection - Triple Left Turn Alternative 21-Jun-12
Washington City TJJ/rs

NO.	DESCRIPTION	EST. QTY	UNIT	UNIT PRICE	AMOUNT
GENERAL CONSTRUCTION					
1	Mobilization	7%	LS	$ 225,000.00	$ 240,000.00
2	Public Information Services	1	LS	$ 40,000.00	$ 40,000.00
3	Traffic Control	1	LS	$ 180,000.00	$ 180,000.00
4	Utilities Relocation / Replacement	1	LS	$ 25,000.00	$ 25,000.00
5	Infrastructure Removal	1	LS	$ 32,000.00	$ 32,000.00
6	Roadway Excavation	1	LS	$ 75,000.00	$ 75,000.00
7	Stormwater Infrastructure	1	LS	$ 150,000.00	$ 150,000.00
8	Driveway Approaches	1,650	SQFT	$ 4.00	$ 6,600.00
9	HMA - 8 inches	18,300	TON	$ 68.50	$ 1,253,550.00
10	Base Course - 12 inches	9,400	CUYD	$ 20.50	$ 192,700.00
11	Pavement Marking	1	LS	$ 8,000.00	$ 8,000.00
12	Concrete Curb and Gutter	3,870	LF	$ 9.50	$ 36,765.00
13	Concrete Sidewalk	2,400	SQYD	$ 22.50	$ 54,000.00
14	Signs	1	LS	$ 4,000.00	$ 4,000.00
15	Landscaping	1	LS	$ 125,000.00	$ 125,000.00
16	Sewer Line Replacement	1	LS	$ 100,000.00	$ 100,000.00
17	Water Line Replacement	1	LS	$ 20,000.00	$ 20,000.00
18	Retaining Walls	1	LS	$ 50,000.00	$ 50,000.00
19	Signals	1	EA	$ 130,000.00	$ 130,000.00
20	Lighting	1	LS	$ 161,000.00	$ 161,000.00
21	Overhead Sign	1	LS	$ 180,000.00	$ 180,000.00
22	ADA Ramps	26	EA	$ 500.00	$ 13,000.00
23	Median Curbing	5,050	LF	$ 5.25	$ 26,512.50
24	Stamped Conrete	444	SQYD	$ 25.00	$ 11,111.11
25					
26					
			SUBTOTAL		$ 3,114,238.61
			CONTINGENCY	10.0%	$ 311,400.00
			CONSTRUCTION TOTAL		**$ 3,425,638.61**
PROFESSIONAL SERVICES					
1	Pre-Construction Engineering			$ 411,000.00	$ 411,000.00
2	Construction Engineering			$ 343,000.00	$ 343,000.00
3	Right-of-Way			$ 3,680,000.00	$ 3,680,000.00
4					
			SUBTOTAL		$ 4,434,000.00
			TOTAL PROJECT COST		**$ 7,859,638.61**

In providing opinions of probable construction cost, the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as to the accuracy of such opinions compared to bid or actual costs.

SUNRISE ENGINEERING, INC.

11 North 300 West, Washington, Utah 84780
Tel: (435) 652-8450 Fax: (435) 652-8416

Engineer's Opinion of Probable Cost

Telegraph & Green Springs Intersection - Thru-Turn Alternative 21-Jun-12
Washington City TJJ/rs

NO.	DESCRIPTION	EST. QTY	UNIT	UNIT PRICE	AMOUNT
GENERAL CONSTRUCTION					
1	Mobilization	7%	LS	$ 220,000.00	$ 220,000.00
2	Public Information Services	1	LS	$ 40,000.00	$ 40,000.00
3	Traffic Control	1	LS	$ 180,000.00	$ 180,000.00
4	Utilities Relocation / Replacement	1	LS	$ 25,000.00	$ 25,000.00
5	Infrastructure Removal	1	LS	$ 32,000.00	$ 32,000.00
6	Roadway Excavation	1	LS	$ 75,000.00	$ 75,000.00
7	Stormwater Infrastructure	1	LS	$ 150,000.00	$ 150,000.00
8	Driveway Approaches	1,800	SQFT	$ 4.00	$ 7,200.00
9	HMA - 8 inches	12,136	TON	$ 68.50	$ 831,316.00
10	Untreated Base Course - 12 inches	9,300	CUYD	$ 20.50	$ 190,650.00
11	Pavement Marking	1	LS	$ 8,000.00	$ 8,000.00
12	Concrete Curb and Gutter	4,900	LF	$ 9.50	$ 46,550.00
13	Concrete Sidewalk	2,800	SQYD	$ 22.50	$ 63,000.00
14	Signs	1	LS	$ 4,000.00	$ 4,000.00
15	Landscaping	1	LS	$ 125,000.00	$ 125,000.00
16	Sewer Line Replacement	1	LS	$ 100,000.00	$ 100,000.00
17	Water Line Replacement	1	LS	$ 20,000.00	$ 20,000.00
18	Retaining Walls	1	LS	$ 50,000.00	$ 50,000.00
19	Signals	4	EA	$ 65,000.00	$ 260,000.00
20	Lighting	1	LS	$ 161,000.00	$ 161,000.00
21	Overhead Sign	1	LS	$ 180,000.00	$ 180,000.00
22	ADA Ramps	31	EA	$ 500.00	$ 15,500.00
23	Median Curbing	6,200	LF	$ 5.25	$ 32,550.00
24	Stamped Conrete	1,125	SQYD	$ 25.00	$ 28,125.00
25					
26					
			SUBTOTAL		$ 2,844,891.00
			CONTINGENCY	10.0%	$ 284,500.00
			CONSTRUCTION TOTAL		**$ 3,129,391.00**
PROFESSIONAL SERVICES					
1	Pre-Construction Engineering			$ 376,000.00	$ 376,000.00
2	Construction Engineering			$ 313,000.00	$ 313,000.00
3	Right-of-Way			$ 1,840,000.00	$ 1,840,000.00
4					
			SUBTOTAL		$ 2,529,000.00
			TOTAL PROJECT COST		**$ 5,658,391.00**

In providing opinions of probable construction cost, the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as to the accuracy of such opinions compared to bid or actual costs.

SUNRISE ENGINEERING, INC.

11 North 300 West, Washington, Utah 84780
Tel: (435) 652-8450 Fax: (435) 652-8416

Engineer's Opinion of Probable Cost

Telegraph & Green Springs Intersection - Partial Thru-Turn Alternative 9-Oct-13
Washington City TJJ/rs

NO.	DESCRIPTION	EST. QTY	UNIT	UNIT PRICE	AMOUNT
GENERAL CONSTRUCTION					
1	Mobilization	7%	LS	$ 220,000.00	$ 220,000.00
2	Public Information Services	1	LS	$ 40,000.00	$ 40,000.00
3	Traffic Control	1	LS	$ 180,000.00	$ 180,000.00
4	Utilities Relocation / Replacement	1	LS	$ 25,000.00	$ 25,000.00
5	Infrastructure Removal	1	LS	$ 32,000.00	$ 32,000.00
6	Roadway Excavation	1	LS	$ 65,000.00	$ 65,000.00
7	Stormwater Infrastructure	1	LS	$ 125,000.00	$ 125,000.00
8	Driveway Approaches	1,650	SQFT	$ 4.00	$ 6,600.00
9	HMA - 8 inches	9,800	TON	$ 68.50	$ 671,300.00
10	Untreated Base Course - 12 inches	6,900	CUYD	$ 20.50	$ 141,450.00
11	Pavement Marking	1	LS	$ 6,000.00	$ 6,000.00
12	Concrete Curb and Gutter	4,530	LF	$ 9.50	$ 43,035.00
13	Concrete Sidewalk	2,800	SQYD	$ 22.50	$ 63,000.00
14	Signs	1	LS	$ 4,000.00	$ 4,000.00
15	Landscaping	1	LS	$ 125,000.00	$ 125,000.00
16	Sewer Line Replacement	1	LS	$ 90,000.00	$ 90,000.00
17	Water Line Replacement	1	LS	$ 20,000.00	$ 20,000.00
18	Retaining Walls	1	LS	$ 50,000.00	$ 50,000.00
19	Signals	2	EA	$ 65,000.00	$ 130,000.00
20	Lighting	1	LS	$ 161,000.00	$ 161,000.00
21	Overhead Sign	1	LS	$ 180,000.00	$ 180,000.00
22	ADA Ramps	26	EA	$ 500.00	$ 13,000.00
23	Median Curbing	3,100	LF	$ 5.25	$ 16,275.00
24	Stamped Conrete	750	SQYD	$ 25.00	$ 18,750.00
25					
26					
			SUBTOTAL		$ 2,426,410.00
			CONTINGENCY	10.0%	$ 242,600.00
			CONSTRUCTION TOTAL		**$ 2,669,010.00**
PROFESSIONAL SERVICES					
1	Pre-Construction Engineering			$ 320,000.00	$ 320,000.00
2	Construction Engineering			$ 267,000.00	$ 267,000.00
3	Right-of-Way			$ 1,600,000.00	$ 1,600,000.00
4					
			SUBTOTAL		$ 2,187,000.00
			TOTAL PROJECT COST		**$ 4,856,010.00**

In providing opinions of probable construction cost, the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as to the accuracy of such opinions compared to bid or actual costs.

SUNRISE ENGINEERING, INC.

11 North 300 West, Washington, Utah 84780
Tel: (435) 652-8450 Fax: (435) 652-8416

Engineer's Opinion of Probable Cost

Telegraph & Green Springs Intersection - Raised Median Curbing 4-Feb-14
Washington City TJJ/rs

NO.	DESCRIPTION	EST. QTY	UNIT	UNIT PRICE	AMOUNT
GENERAL CONSTRUCTION					
1	Mobilization	1	LS	$ 4,000.00	$ 4,000.00
2	Public Information Services	1	LS	$ 2,000.00	$ 2,000.00
3	Traffic Control	1	LS	$ 5,000.00	$ 5,000.00
4	Median Curbing	5,050	LF	$ 5.25	$ 26,512.50
5	Paint Removal	1	LS	$ 2,000.00	$ 2,000.00
6	Micro Surfacing	700	SY	$ 7.00	$ 4,900.00
7	Pavement Marking	1	LS	$ 6,000.00	$ 6,000.00
8	Pavement Message	1	LS	$ 1,500.00	$ 1,500.00
9	Construction Staking	1	LS	$ 2,500.00	$ 2,500.00
10					
			SUBTOTAL		$ 54,412.50
			CONTINGENCY	10.0%	$ 5,400.00
			CONSTRUCTION TOTAL		**$ 59,812.50**
PROFESSIONAL SERVICES					
1	Pre-Construction Engineering			$ 8,000.00	$ 8,000.00
2	Construction Engineering			$ 7,000.00	$ 7,000.00
3	Design Survey			$ 2,000.00	$ 2,000.00
			SUBTOTAL		$ 17,000.00
			TOTAL PROJECT COST		**$ 76,812.50**

In providing opinions of probable construction cost, the Client understands that the Engineer has no control over costs or the price of labor, equipment or materials, or over the Contractor's method of pricing, and that the opinion of probable construction cost provided herein is made on the basis of the Engineer's qualifications and experience. The Engineer makes no warranty, expressed or implied, as to the accuracy of such opinions compared to bid or actual costs.

TABLE 2 - DIXIE MPO STUDY FIGURES

Green Springs Dr/Telegraph St Intersection PM Peak Hour Turning Movement Volumes

Year		2010	2012	2020				2030				2040			
Scenario		Base	Base	1	2	3	4	1	2	3	4	1	2	3	4
Green Springs Northbound	Left	130	120	140	170	100	120	140	160	130	110	200	190	120	130
	Thru	590	590	630	630	790	790	740	740	900	920	750	760	930	950
	Right	180	220	370	430	280	300	360	330	220	310	320	440	280	310
Green Springs Southbound	Left	600	470	730	630	980	890	830	670	920	1070	680	760	1160	1070
	Thru	580	530	570	560	690	720	650	630	760	800	650	650	790	870
	Right	290	310	180	170	220	240	220	210	380	260	290	210	310	310
Telegraph Eastbound	Left	290	340	210	200	300	330	240	410	390	300	290	260	400	410
	Thru	680	600	980	1050	860	950	940	1010	730	760	960	1180	970	1040
	Right	120	110	140	180	110	140	140	230	110	100	170	190	120	160
Telegraph Westbound	Left	320	250	510	620	440	480	520	530	350	460	520	600	410	470
	Thru	570	510	620	680	510	570	640	640	660	550	840	740	600	630
	Right	440	510	460	420	700	650	560	540	730	770	530	510	810	760
Intersection Turning Movement Total		4790	4560	5540	5740	5980	6180	5980	6100	6280	6410	6200	6490	6900	7110
% Change Over No-Build Scenario #4		-	-	-10%	-7%	-3%	0%	-7%	-5%	-2%	0%	-13%	-9%	-3%	0%

Scenario #1 - Telegraph and Green Springs Volumes with Mall Drive Underpass and 450 North Corridor constructed.

Scenario #2 - Telegraph and Green Springs Volumes with only the Mall Drive Underpass constructed

Scenario #3 - Telegraph and Green Springs Volumes with only the 450 North Corridor constructed

Scenario #4 - Telegraph and Green Springs Volumes without the Mall Drive Underpass and 450 North Corridor constructed

Green Springs/Telegraph Vissim Analysis Summary

Green Springs/Telegraph 2020 P.M. Peak Traffic Analysis

Approach	Movement	Base		Partial ThrU-Turn		Full ThrU-Turn	
		Delay (sec/veh)	Level of Service	Delay (sec/veh)	Level of Service	Delay (sec/veh)	Level of Service
Green Springs Dr: Eastbound	EBL	67.1	E	45.9	D	42.7	D
	EBR	18.2	B	4.3	A	11.1	B
	EBT	31.9	C	33.9	C	28.3	C
Telegraph St: Southbound	SBR	13.9	B	19.9	B	19.3	B
	SBT	41.9	D	22.5	C	25.2	C
	SBL	56.9	E	65.2	E	59.1	E
Red Cliffs Dr: Northbound	NBT	44.6	D	27.8	C	22.4	C
	NBL	76.9	E	67.9	E	68.8	E
	NBR	46.9	D	25.9	C	24.7	C
Green Springs Dr: Westbound	WBR	14.4	B	12.5	B	43.8	D
	WBT	39.6	D	48.8	D	52.3	D
	WBL	71.7	E	45.4	D	96.1	F
Avg Sum		**43.0**	**D**	**34.6**	**C**	**36.1**	**D**

NOTE: 2020 analysis assumes that the I-15 crossing at Mall Dr and 450 N extension are in place.

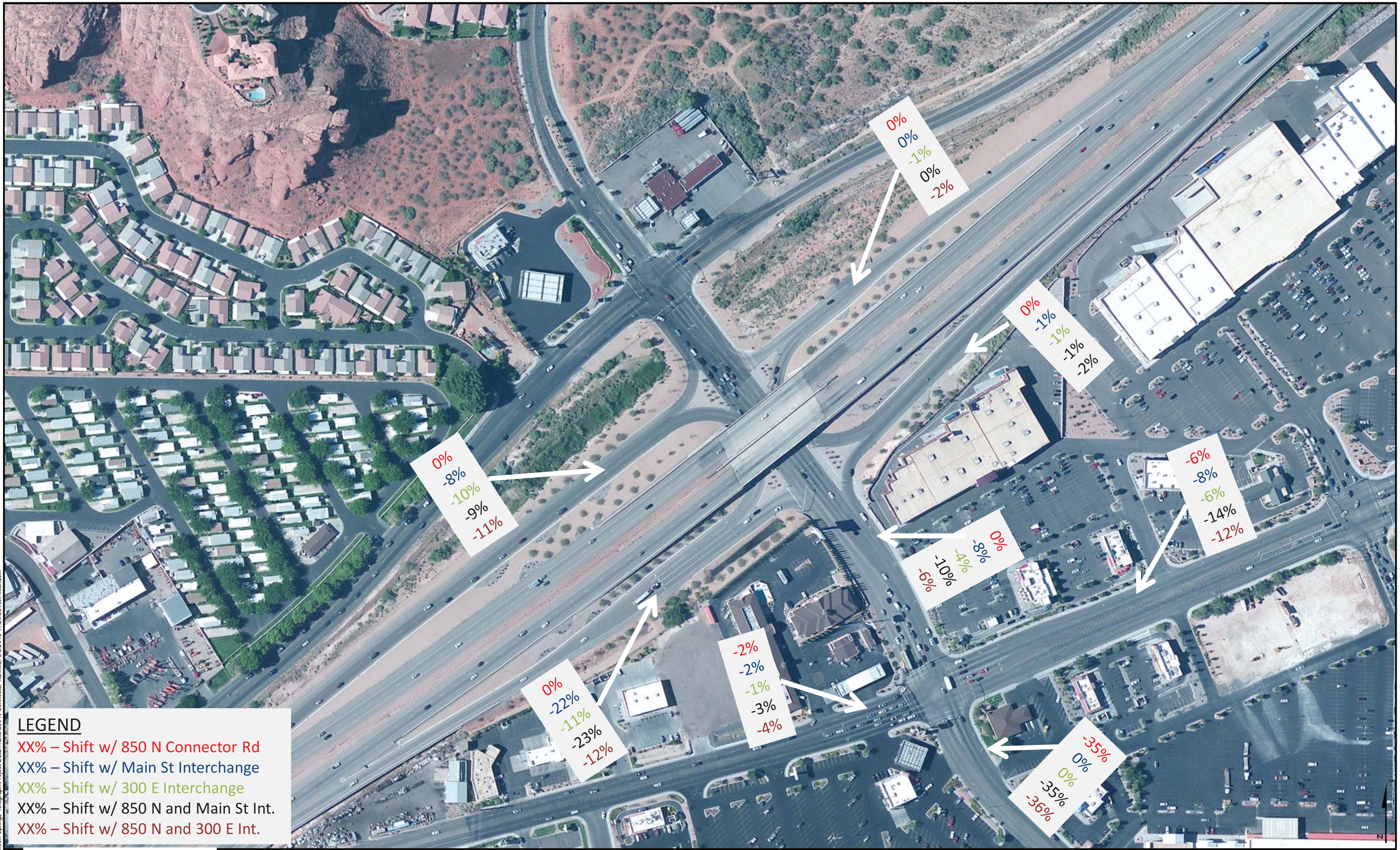
Green Springs/Telegraph 2030 P.M. Peak Traffic Analysis

Approach	Movement	Base		Partial ThrU-Turn		Full ThrU-Turn	
		Delay (sec/veh)	Level of Service	Delay (sec/veh)	Level of Service	Delay (sec/veh)	Level of Service
Green Springs Dr: Eastbound	EBL	100.1	F	47.7	D	48	D
	EBR	26	C	5.2	A	12.8	B
	EBT	40.4	D	34.3	C	26.8	C
Telegraph St: Southbound	SBR	22.6	C	22.8	C	20.4	C
	SBT	45.3	D	26.6	C	26.3	C
	SBL	89.7	F	83.6	F	64.1	E
Red Cliffs Dr: Northbound	NBT	67.7	E	28	C	24.7	C
	NBL	77.4	E	68.7	E	79.5	E
	NBR	72.1	E	32.9	C	27.3	C
Green Springs Dr: Westbound	WBR	18.1	B	23.7	C	49.8	D
	WBT	43.5	D	46.6	D	47.9	D
	WBL	70.7	E	55	D	110.5	F
Avg Sum		**56.1**	**E**	**37.8**	**D**	**38.8**	**D**

NOTE: 2030 analysis assumes that a Interchange at 300 East and I-15 is in place in addition to a connector road that extends between the Walmart/Home Depot siganl at 850 North.

Green Springs/Telegraph 2040 P.M. Peak Traffic Analysis

Approach	Movement	Base		Partial ThrU-Turn		Full ThrU-Turn	
		Delay (sec/veh)	Level of Service	Delay (sec/veh)	Level of Service	Delay (sec/veh)	Level of Service
Green Springs Dr: Eastbound	EBL	113.5	F	50.9	D	53.8	D
	EBR	26.5	C	5.9	A	18.1	B
	EBT	44	D	39.2	D	38.2	D
Telegraph St: Southbound	SBR	45.7	D	25.6	C	24.8	C
	SBT	63.4	E	27.4	C	33.3	C
	SBL	80.9	F	81.2	F	72.6	E
Red Cliffs Dr: Northbound	NBT	125.1	F	28.9	C	28.4	C
	NBL	102	F	73.3	E	105.7	F
	NBR	131.4	F	37	D	32	C
Green Springs Dr: Westbound	WBR	30.2	C	56.3	E	73.2	E
	WBT	53.5	D	88.8	F	77.6	E
	WBL	82.8	F	60.3	E	159	F
Avg Sum		**75.8**	**E**	**46.2**	**D**	**51.3**	**D**



HORROCKS ENGINEERS

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Green Springs/Telegraph Traffic Study

2010 Shift in Traffic

DATE 5/8/2013

DRAWN

Figure 1

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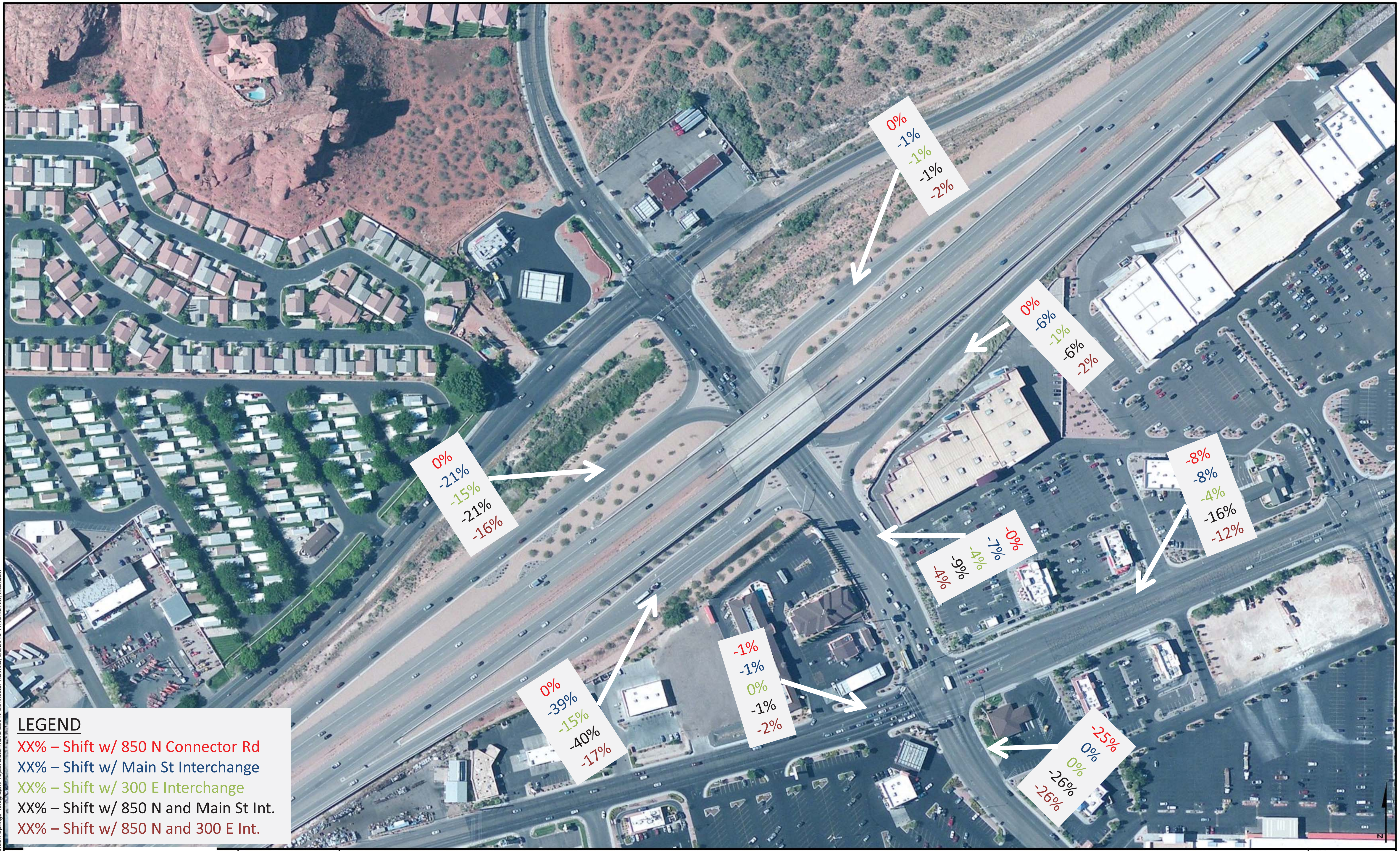
Green Springs/Telegraph Traffic Study

2020 Shift in Traffic

DATE 5/8/2013

DRAWN

Figure 2



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Green Springs/Telegraph Traffic Study

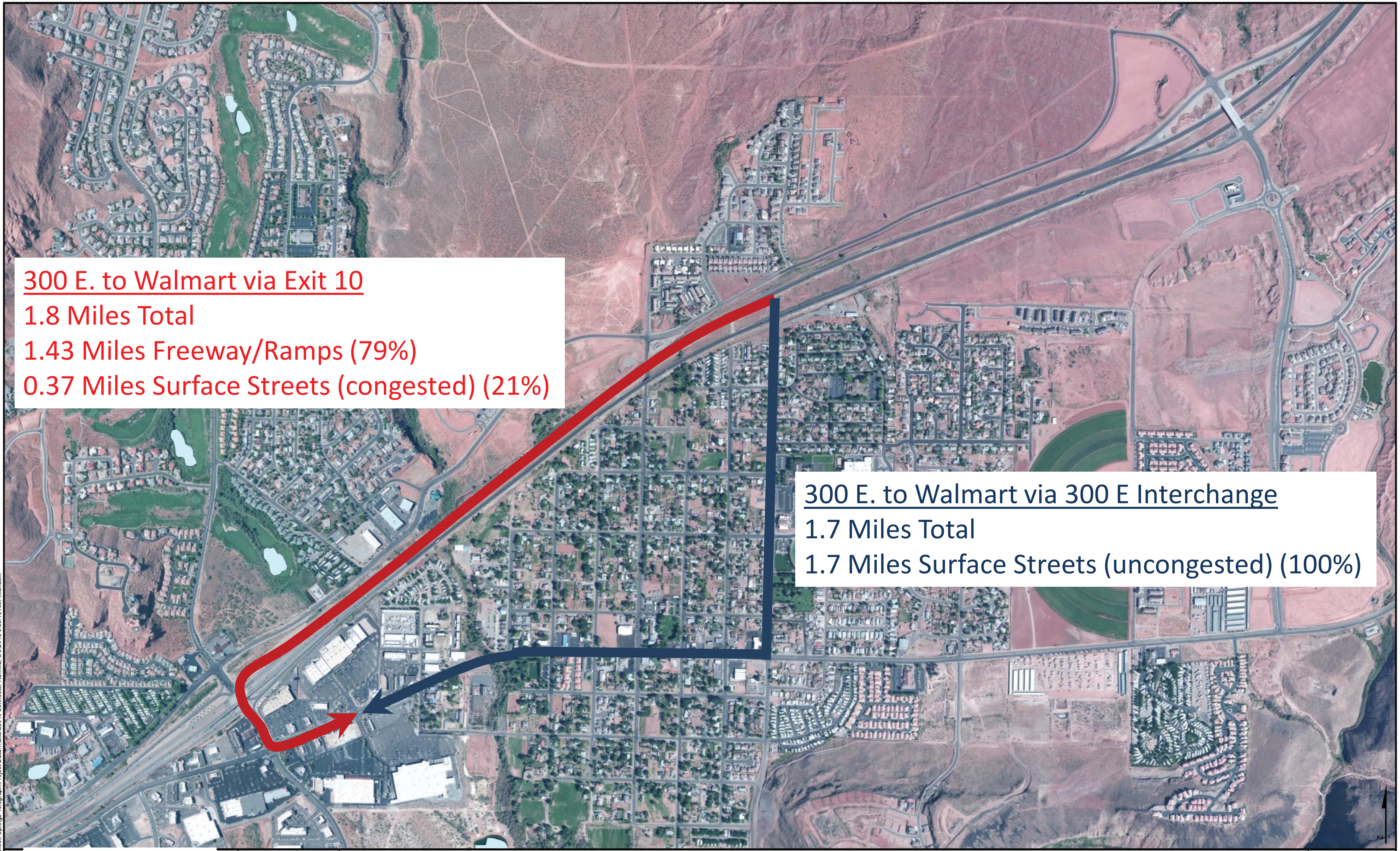
2040 Shift in Traffic

DATE 5/8/2013

DRAWN

Figure 3

H:\2013\SG-482-1303 Green Springs-Telegraph\Project Data\Traffic\850 N Connector Rd.mxd, 5/8/2013 11:45:42 AM, michaelh



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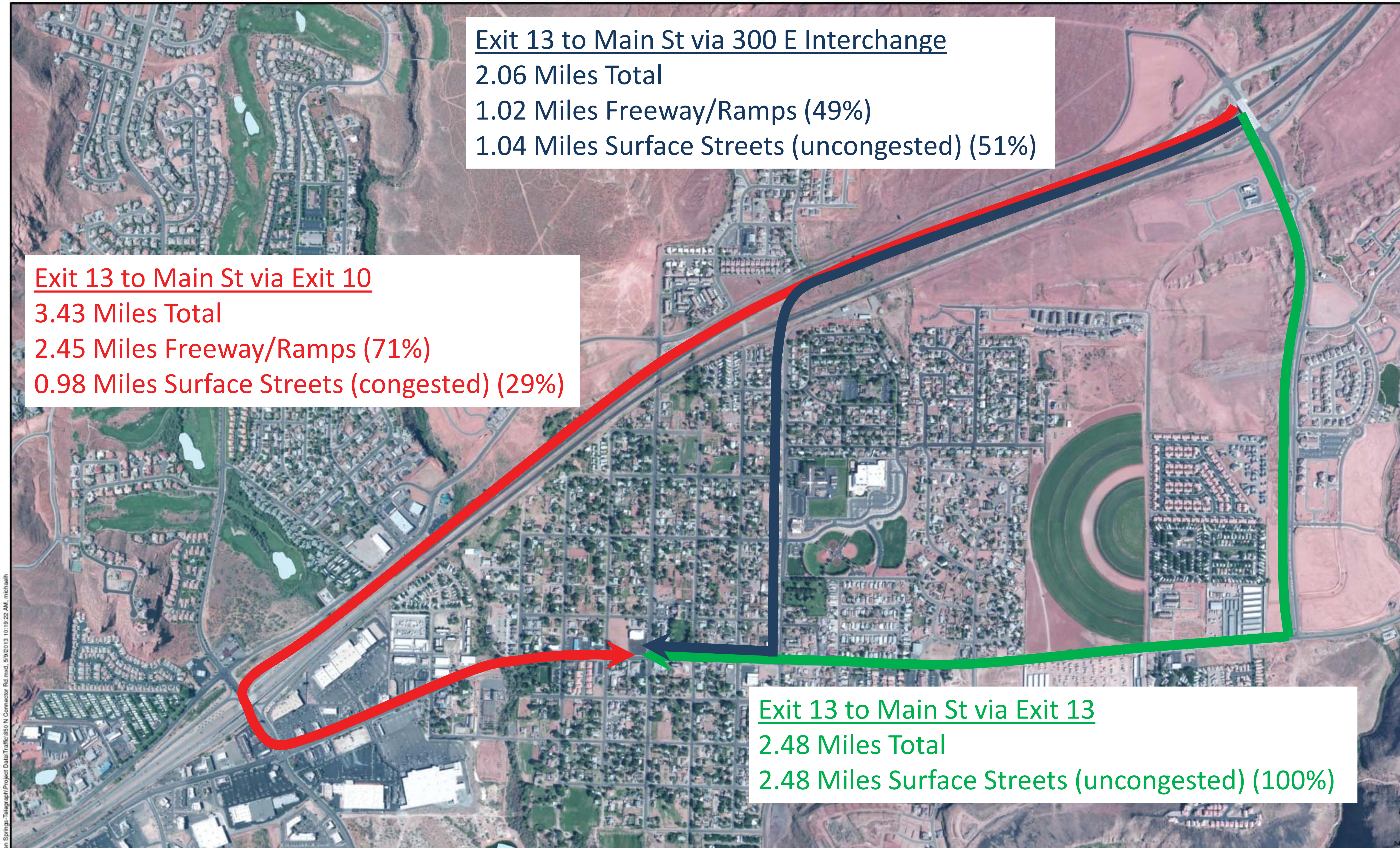
Green Springs/Telegraph Traffic Study

O-D Comparison

DATE 5/9/2013

DRAWN

Figure 4



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Green Springs/Telegraph Traffic Study

O-D Comparison #2

DATE 5/9/2013

DRAWN

Figure 5

Green Spring Drive Traffic Signal Coordination
February 2013 – M. Luker, UDOT

Background

Green Spring Drive (formerly SR-212) is a busy area with three closely-spaced intersections, centered on the SPUI at I-15. The signals were last retimed by UDOT in March 2010 and the area has experienced growth since then, resulting in increased congestion. At the moment UDOT continues to maintain signal timing in this area as part of the jurisdictional transfer agreement, and UDOT continues to own the SPUI.

The Situation

Of the three intersections, the busiest is at Green Spring Drive & Telegraph Street/Red Cliffs Drive. This intersection is the "controlling" one, determining the cycle length that is required at the others. During peak times, all movements at this intersection are busy and are near or over capacity. Pedestrians are frequent, even during winter, and crossing times dictate the minimum split that can be given to the through movements. Leftover cycle time is allocated to the left turns, but this is often not enough time to clear all of the waiting vehicles. All of the left turn movements, except the NB-to-WB movement, have two lanes, but lane use is not balanced—in some cycles I observed, *all* waiting vehicles used only *one* of the two lanes, leaving the other empty. Addition of more lanes has been suggested but I recommend against it, since use of the new lane would be poor and it would increase the intersection width and thus the pedestrian crossing times. Many drivers have been observed running red lights at the end of the left turn phases because of their frustration.

Both the SPUI and the northern intersection, Green Spring Drive & Red Hills Parkway/Buena Vista, are under capacity but do experience congestion as a result of their close spacing to each other and the capacity problems at Telegraph Street. There is unused green time as a result of the cycle length being dictated by Telegraph, which contributes to the perception of poor timing.

Concerns have been raised about the following movements being congested in all time periods except the middle of the night and Sundays:

- EB-to-NB left turn from Red Cliffs Drive toward I-15.
- NB I-15 off-ramp, turning right to go South toward Telegraph/Red Cliffs.
- Traffic going NB on Green Spring trying to turn left onto SB I-15.
- SB traffic coming from Green Spring development and from Red Hills Parkway, trying to get through the SPUI to Telegraph/Red Cliffs.
- WB-to-NB right turn from Telegraph toward I-15.
- Through traffic on Telegraph/Red Cliffs.
- NB traffic coming from 3050 East toward I-15 and turning onto Red Cliffs.

Also, concerns have been raised about unnecessarily long red lights for through traffic on Red Hills/Buena Vista, while no traffic is using the NB green light.

Essentially every movement suffers some delay and congestion, indicating that there is little or no excess capacity to be reallocated using signal timing. Improvements to one movement must necessarily come at the expense of another. Further refinements to the signal timing will not cure the root problem: traffic demand exceeds capacity. **Reductions in congestion will require either an increase in capacity, a reduction in demand (such as by encouraging alternate routes), or a combination of the two.**

Changes Made February 12-14, 2013

All of these changes were made using these assumptions of priority, which were also in use when the timing was last done in 2010:

1. Pedestrians must be accommodated at all intersections. There are enough pedestrians to make using an "oversized pedestrian" infeasible. (An "oversized pedestrian" is when the time for a movement is normally

set shorter than is needed for a pedestrian to cross the street; when a pedestrian pushes the button, the pedestrian times override the normal times and the intersection leaves the coordinated cycle to accommodate the pedestrian. Afterwards it takes a few cycles to get back "in-step" with the other intersections).

2. The most important movements to keep clear are those under the freeway. If backing is allowed to accumulate there, it will prevent other movements from serving and could impact operations on the freeway as well. Vehicles can be stored outside of this area but not in it.
3. Wasted green time is to be avoided as much as possible when there are other movements waiting to use the intersection.

My initial observations indicated that the 108-second cycle that was being used from 07:00 to 15:30 and 18:30 to 20:00 on weekdays (and all day Saturday and Sunday) was too short and did not provide enough time for left turns. The 120-second cycle, which was being used from 15:30 to 18:30, was better at handling traffic. **I changed the time-of-day schedule to use the 120-second cycle more often,** including on weekends. This will not solve the underlying capacity problem but should make some improvement.

The old and new time-of-day schedules are:

OLD	NEW
M-F 07:00 108-s Cycle	M-F 07:45 108-s Cycle
M-F 15:30 120-s Cycle	M-F 10:34 120-s Cycle
M-F 18:30 108-s Cycle	M-F 18:30 108-s Cycle
M-F 20:00 Free	M-F 20:00 Free
Sat 08:00 108-s Cycle	Sat 08:30 108-s Cycle
(120-s Cycle was not used on Saturdays before)	Sat 10:20 120-s Cycle
	Sat 18:30 108-s Cycle
Sat 20:00 Free	Sat 20:00 Free
Sun 10:00 108-s Cycle	Sun 10:00 108-s Cycle
(120-s Cycle was not used on Sundays before)	Sun 11:20 120-s Cycle
	Sun 18:30 108-s Cycle
Sun 20:00 Free	Sun 20:00 Free

I also found that while traffic is generally heavy, it is sporadic enough that there was occasionally wasted green time, even at the "controlling" intersection (Green Spring & Telegraph/Red Cliffs). This is a typical side-effect of signal coordination. To minimize this, **I implemented a controller feature called "Actuated Coordinated Phase"** which allows the signal to shorten the coordinated phase when there is no demand for it at the end of the cycle. Except during the busiest hour of the day, I found that extra time existed on the coordinated phase at least every few cycles, and this time could be given to the other movements. In many cycles, all movements could clear on the first green. I implemented this same feature at the other two intersections, which will help them to appear more responsive to traffic.

At Green Spring & Telegraph/Red Cliffs, I also **changed the phase order during the 120-second cycle** to allow the EB-to-NB left turn to follow, or lag, the opposing (WB) through phase. Unused green time on the through phase can now be picked up by the left turn phase.

I **changed the splits at Green Spring & Telegraph/Red Cliffs** to provide 2 more seconds of time for the EB-to-NB left turn, at the expense of the WB through. No additional split time is available to improve that movement.

I found that the SPUI was providing more time than necessary for the left-turn onto NB I-15. This tended to cause congestion south of the freeway. By using the "Actuated Coordinated Phase" setting, wasted time is reduced and more time is provided for the left-turn onto SB I-15, and the through phase to go toward Red Hills Parkway.

At Green Spring & Red Hills/Buena Vista, the signal was providing more green time than necessary for the NB-to-WB left-turn, to head toward St. George. This was hurting the SB movement coming out of the Green Spring development. **I changed the coordinated phase assignment** there to give more time to the through phase.

At all of the intersections, **I re-evaluated the "Vehicle Extension" time, and reduced it for most phases**. This will allow the controllers to "gap-out" earlier when demand is light. (A "gap-out" occurs when the signal senses, through its detectors, that the gap between arriving vehicles is too large and that the queue has been cleared out; the signal's timing program would allow for more green but the signal turns yellow, anyway, and moves to the next phase).

I also **increased the all-red time after the left turn phases** from 1.5 seconds to 2.0 seconds at both Green Spring & Telegraph/Red Cliffs and Green Spring & Red Hills/Buena Vista. This is consistent with the time it takes vehicles to clear the intersection and will tend to reduce the number of vehicles still in the intersection when the next phase turns green. (All-red time for left turns at the SPUI remains at 4.0 seconds and is longer there because of the larger turn radius).

I **did not implement any cycle lengths above 120 seconds** because that would tend to increase queue length on all approaches. There is no available storage, especially under the freeway, for additional queued vehicles. Research has shown that cycle lengths above 120 seconds do not necessarily increase capacity. I do not believe there would be any advantage to using a longer cycle length.

In downtown Washington City, **I changed the coordination at Telegraph & Main Street and at Telegraph & 300 East** to run a much shorter, 60-second cycle throughout most of the day. The signal spacing works well at that cycle length to provide excellent two-way progression. At 300 East, the NB and SB left turn phases are "lagged" so that the green arrow follows the flashing yellow arrow. In the afternoon, left turn demand on the NB-to-WB left turn becomes too great to be accommodated with the 60-second cycle, so this signal switches to a 120-second cycle with the left turns leading. Main Street does not use lagging left turns but has very light traffic on all movements except EB and WB through, so the 60-second cycle worked well all day there.

I also **upgraded firmware** on all of the signal controllers in the area, which will allow the Traffic Operations Center to begin collecting some automatic performance measures to assist in future timing work.

Observations After Making Changes

The biggest improvement came from implementing the longer, 120-second cycle length earlier in the day. Lunchtime queuing was reduced significantly; in fact, throughout most of the day, all approaches at all intersections cleared within the first cycle. This is an improvement over prior operation with the 108-second cycle.

On Wednesday (2/13), there was a period of approximately 1 hour, between about 16:00 and 17:00, when the intersection at Green Spring/Telegraph was over capacity on several movements. This condition appeared again on Thursday (2/14) but lasted longer than 1 hour; traffic was probably heavier that day because of Valentine's Day and the number of restaurants in the area. Unfortunately I was not able to remain in town for the weekend on this trip, but observations by Mark Taylor on Presidents' Day (Monday, 2/18) found the area quite congested, particularly the EB-to-NB left turn. However, he reported that the area under the freeway was not gridlocked and that traffic was not backing onto the freeway.

Recommendations for the Future

As stated above, the root problem in this area is a lack of sufficient roadway capacity. But, there are a few things which could improve operations at a relatively low cost:

1. **Add a right-turn overlap for WB-to-NB traffic at Green Spring & Telegraph/Red Cliffs.** This overlap would provide a green arrow for right-turning traffic from Telegraph toward I-15, while the left-turn phase from I-15 onto Telegraph Street is green. U-turns would need to be prohibited from that approach, but I don't believe that would cause any impacts. The increased capacity for the right-turn movement would not affect any other movements and would alleviate some congestion in that lane. The expense of the new signal head would be minimal and the existing control equipment is already capable of operating it.

2. **Improve vehicle detection.** All of the vehicle detection in this area is older video-based equipment, and it has reliability issues. UDOT and our consultants have done a good job of maintaining this equipment and it is working pretty well for video detection, but the technology itself has limitations that affect operations here. I observed several cases of calls being missed, and other cases of the signal holding on when traffic had already cleared. I recommend installation of newer technology, such as radar, to increase the reliability of the detection. This will allow the signal controller to much more accurately distribute the green time where it is needed most.
3. **Lane-by-lane detection should be considered** on critical approaches. This would allow the signal controller to evaluate when to gap out on a lane-by-lane basis, rather than for an entire approach. This would minimize cases of randomly-arriving traffic holding a signal green longer than is needed to clear out the initial queue. However, this strategy could result in early gap-outs and resulting longer queues in the next cycle.
4. **Consider Flashing Yellow Arrows for single-lane left turn approaches.** At Green Spring & Red Hills/Buena Vista, there is a single SB-to-EB left turn lane but it is protected-only. Demand for that movement is light but delay could be reduced by using an FYA. The NB-to-WB left turn at Green Spring & Telegraph/Red Cliffs is also a single lane and could possibly benefit from an FYA, but there will be more demand for the left turn and fewer opposing gaps.
5. **Traffic adaptive or traffic responsive signal control may be beneficial.** Traffic adaptive systems adjust splits and cycle lengths each cycle, to adapt the signal timing to actual traffic. Traffic responsive systems are much less sophisticated but do allow the cycle lengths to be selected based on traffic conditions rather than a simple time-of-day clock. Neither type of system will be able to overcome the lack of capacity during peak hours but they may help with reducing unneeded queuing or wasted green times during periods of lighter traffic, and they can help with weekends, holidays, special events, and other times when traffic may peak at different times. The benefit from these systems will occur almost exclusively during periods where traffic is already moving OK and the cost should be weighed carefully against the fact that significant improvements during the worst times of day are not likely. Such systems also generally require more maintenance than the current time-based system, which would increase ongoing operational costs.
6. **Plan for capacity improvements and/or travel demand management.** Ultimately congestion will continue until roadway capacity exceeds travel demand. Capacity improvements should be carefully evaluated as some of the traditional methods may not work well here. This is particularly true of adding additional lanes. Due to the large number of closely spaced intersections and business accesses, lane use is very unbalanced even with only two lanes per approach. Travel demand management could include promoting increased use of Exit 13.
7.

---------- Forwarded message ----------
From: **Matt Luker** <mluker@utah.gov>
Date: Thu, Dec 12, 2013 at 12:33 PM
Subject: Fwd: Exit 10 - Black Friday observations
To: Dana Meier <danameier@utah.gov>

Dana,

Horrocks Engineers were tasked to observe and respond to traffic during Black Friday shopping. Their report is below. Please contact me if you have any questions.

Regards,

Matt Luker, P.E.
Statewide Signal Engineer
Utah Department of Transportation

Traffic Operations Center
2060 S 2760 W
Salt Lake City, UT 84104
Phone: 801-887-3627
Email: mluker@utah.gov
Signal Operations Desk: 801-887-3702

---------- Forwarded message ----------
From: **Michael Merkley** <mmerkley@utah.gov>
Date: Wed, Dec 11, 2013 at 4:17 PM
Subject: Re: Exit 10 - Black Friday observations
To: Matt Luker <mluker@utah.gov>
Cc: "Noall, Troy" <troyn@horrocks.com>, Devin Squire <dsquire@utah.gov>

Matt,

I apologize not getting your these comments sooner. When we watched Green Springs we found that traffic was saturated from all directions. The major bottleneck was at the 700 West signal. The current pm peak plans lag the NB left out of Walmart. With the saturate conditions this resulted in there being no place for the NB lefts to go on Telegraph which is turn caused the vehicles to block the intersection resulting in the heavy EB left into the north shopping area not to be able to turn when their light went green. We set the signal FREE to allow the signal to lead all the left turns which resulted in the NB left being able to clear the intersection allowing the EB lefts to be able to make their left turn.

Another problem area was the signal at Telegraph and Green Springs. Traffic was heavy on all approaches. During the PM peak plans the SB left from Green Spring (coming from the freeway) is the coordinated phase. At times this phase was lighter than other phases resulting in unused time on the coordinated phase. Troy and I tried to run the signal FREE but around 12 pm the traffic coming from Red Hills Pkwy and the SPUI was heavy which favored running the coordination plans to keep vehicles from backing through the SPUI. Later in the day volumes coming from Red Hills Pkwy dropped off and running the Telegraph and Green Springs signal FREE worked better. After watching all the signals in the area we thought that setting the SPUI and Red Hills Pkwy FREE along with Telegraph might have worked well but with traffic being so heavy we weren't able to get to the cabinets to test running them FREE. When we ran coordination at Telegraph and Green Springs the EB queue almost reached 2450 East, WB queue was to the 700 West signal, and SB queue was to the SPUI. Running the signal FREE the EB queue was able to reduce significantly without impacting the other directions.

Please let me know if you have any questions.

Thank you,

Mike Merkley, P.E., **ITS Engineer**
HORROCKS ENGINEERS

2162 W. Grove Parkway, Suite 400 | Pleasant Grove, Utah 84062
Work 801 763 5164 | **Fax** 801 763 5101 | **Mobile** 801 369 7898
Horrocks Email michaelm@horrocks.com | **UDOT Email** mmerkley@utah.gov

2040 LEVEL OF SERVICE ADJUSTMENTS (ERIC RASBAND UDOT)

Hello all,

Three leg Thru Turn Intersection:
We were able to modify the VISSIM models provided by Horrocks looking at the full thru turn concept on 3 legs of Telegraph/Red Cliffs/Green Springs intersection. We modified the location of the thru turn to line up with the main access to the Albertson's and Home Depot. This configuration will require some changes to the accesses to line up between IHOP and Home Deport and the Albertson's access. Year 2040 Level of Service under this alternative results in **LOS C with 26 seconds of delay** through the intersection. The signal cycle length under this alternative is a 60 second cycle.

Two Leg Thru Turn Intersection:
We then looked at the two leg through turn concept. We modified the lane utilization to represent field observations in relation to the SB left turning vehicle wanting to access the Home Depot and Wal Mart develop on the SE quadrant of the intersection. Year 2040 Level of service under this alternative results in **LOS D with 46 seconds of delay** through the intersection. The signal cycle length under this alternative is a 90 second cycle.

Rick, will you please provide me with a sample of the simulation you've previously been supplied? This will help us to capture a similar simulation for your discussion.

Eric Rasband
Utah Department of Transportation
Traffic Operations Analysis and Reporting Manager
(801) 608-8870