FOX TUTTLE
TRANSPORTATION GROUP

TECHNICAL MEMORANDUM

To: Katie Allen

From: Bill Fox

Date: June 24, 2013

Project: Dillon Road/144th Avenue Traffic Forecast and Adjacent Roadway Impact Analysis

Subject: Summary of Findings and Recommendations

The Fox Tuttle / DEA team has completed our analysis of existing and projected traffic in the Dillon Road/144th Avenue corridor. This technical memorandum summarizes the results and provides recommendations for near term and long term roadway improvements in the corridor. In this analysis we have:

- documented and analyzed existing peak hour traffic;
- evaluated traffic "cutting through" Broomfield on Dillon Road/144th Avenue;
- completed peak hour travel time runs to document existing congestion in the corridor;
- projected Year 2035 daily traffic in the corridor with the existing 2/4 through lane geometry and with widening to 4 through lanes;
- projected the change in daily traffic on 144th, with / without the extension of South Boulder Road to 160th Avenue, and with /without the addition of new ramps onto the Northwest Parkway (to/from the west only) at Lowell Boulevard;
- projected Year 2035 peak hour traffic volumes and level of service (LOS)with corridor widening to 4 through lanes;
- projected future "cut-through" traffic in the corridor;
- developed a list of potential near term and long term intersection improvements to minimize peak hour congestion;

The findings of this analysis and our recommendations are summarized by topic below.

1. Existing and Near-Term Conditions

1.1 Traffic Volumes

The Dillon Road/144th Avenue corridor currently carries 15,000 to 18,000 vehicles per day (vpd) between the Northwest Parkway on the west and Zuni Street on the east. Figure 1 contains daily traffic volumes on the arterial roadway grid in this portion of Broomfield (blue numbers). The existing AM and PM peak hour traffic at the eight signalized intersections in the corridor is illustrated on Figure 2.

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1.2 Roadway Laneage

The existing roadway geometry and laneage along Dillon Road/144th Avenue varies significantly along the corridor today. On the west end there are two narrow through lanes with little or no paved shoulder width. There are other sections, such as just east of Sheridan Blvd., where there are 4 through lanes and on-street bicycle lanes. And there are still other sections, such as on either side of Lowell Blvd., where there are two eastbound lanes but only one westbound lane. On the east end of the corridor, between Lowell and Zuni Street, the cross-section narrows to a single lane in each direction. East of Zuni Street, in Westminster, there are 4 through lanes on Dillon Road/144th Avenue. The existing laneage on roadways in this area of Broomfield is illustrated on Figure 3.

The availability and number of auxiliary left and right turn lanes at key signalized intersections also varies throughout the corridor. Currently the 120th Street intersection has no eastbound left turn or westbound right turn lanes for example, while the Aspen, Sheridan, and Lowell intersections have a full set of left and right turn lanes on the approaches. (It should be noted that Broomfield is about to initiate a construction project at the Dillon Road/120th Street intersection to add an eastbound left turn lane and a westbound right turn lane.)

Clearly, with over 15,000 vpd in this corridor, the existing number of through lanes (2, 3, or 4 lanes) plays a significant role in accommodating peak period traffic demand. But it is the intersections along 144th Ave. on Broomfield's primary arterial grid (120th Street, Aspen Street, Sheridan Blvd., Lowell Blvd., and Zuni Street) that have the greatest impact on peak period traffic flow in the corridor today.

1.3 Traffic "Cutting Through" Broomfield

The amount of regional traffic that uses Dillon Road/144th Avenue to "cut through" Broomfield is of interest as City and County officials decide on future improvements to area roadways. Regional cut-through traffic is difficult to measure, and DRCOG regional travel models can only provide a mathematical estimate. Past DRCOG models used in the 2030 Broomfield Transportation Plan estimated that 60% of the traffic on Dillon Road/144th Avenue just west of Lowell Blvd. was cutting through the community. For this project we conducted a "select link" analysis with the current Year 2010 DRCOG regional travel model and determined that the model estimates that 52% of the traffic in the 144th corridor is cutting through (approximately 8,200 vpd). (Note that the existing condition analysis utilized the Year 2010 DRCOG model as this was the model used as the base year when developing the current Year 2035 model.)

One of the goals of this project has been to actually measure the amount of cut-through traffic on Dillon Road/144th Avenue. The methodology chosen was to monitor the use of Bluetooth devices at the ends of the corridor. We stationed "readers" and traffic counters just east of 120th Street and just west of Zuni Street. We also stationed a reader and counter on Sheridan Blvd. just south of SH 7 to allow us to determine if there was any diagonal cut-through pattern that utilized a portion of Dillon Road/144th Avenue. Each Bluetooth device transmits a unique signal, and by matching signals at both ends, a cut through trip could be documented. While only a small percentage of vehicles have active Bluetooth

devices on, we were able to monitor traffic for three days (Wed., Thurs., and Fri.) and capture a large enough sample for use in estimating the actual cut-through traffic volume.

A fundamental assumption was that Bluetooth device users are a reasonable representation of all corridor users. In researching the validity of this assumption we learned that:

- While using Bluetooth technology for traffic studies is a fairly new methodology, the manufacturer of the equipment used in this study (Traffax) has been utilizing this tool successfully in 30 to 40 detailed origin/destination studies in mid to large sized regions in the US in the past two years.
- Traffax is somewhat unique as a vendor in that it has a staff of professionals with over 120 years of combined experience in the transportation/traffic/ITS field.
- The technology is also widely used for travel time studies with excellent results.
- Another equipment supplier that we have interviewed has had their devices used in 1,300 installations for traffic related studies. So while this technology is new, it is gaining widespread use and popularity.
- A study in March, 2012 found that 88% of US adults own cell phones, and 46% own "smart phones". This study also found that Black and Hispanic populations have smart phone ownership percentages that are slightly higher than the national average. The only demographic group that has a noticeably lower level of smart phone ownership is the elderly (65+).
- Studies have shown that the vast majority of cell phones have been Bluetooth capable since 2009.

On this basis, there is no reason to believe that a Bluetooth sampling would not provide representative data for this cut-through study.

In the process of this cut-through study it was determined that:

- Approximately 5% of the vehicles traveling in the corridor have active Bluetooth devices on.
- In three days, over 5,500 Bluetooth devices were recorded.
- Approximately 28% of the vehicles with active Bluetooth devices on were matched at both ends of the Dillon Road/144th Avenue corridor (within a set maximum travel time) over the course of the three day study, indicating that they were cutting through the community.
- It was determined that this cut-through percentage is fairly constant between the AM and PM peak periods and over the entire day.
- There was a noticeable directional pattern to the cut-through traffic during the peak hours of the day.
- Approximately 1% or less of the traffic on 144th used Sheridan Blvd. to access SH 7

Clearly the cut-through percentage estimated by the DRCOG regional travel models (50% to 60%) is much higher than the actual measured cut-through percentage of 28%, indicating that the cut-through traffic is not as big an issue as previously believed. Possible reasons for this difference include:

- Regional DRCOG travel models utilize a "gravity equation" to define the distribution of trips from each traffic analysis zone (TAZ) to every other TAZ throughout the Denver region. At best this is a coarse approximation of how we as motorists make decisions on where to travel to and what route to take. The model is "calibrated", or forced to reproduce daily traffic volumes on roadways, but the underlying trip distribution (TAZ to TAZ) may not be well calibrated. This creates the potential for error when asking the model a very focused "cut-through" question. While the daily traffic assignment (traffic volume) may be well calibrated, the underlying trip length from TAZ to TAZ may not be well calibrated in this area, which can lead to cut-through estimates that are not representative.

- The accuracy of regional travel models tends to diminish with distance from the core of the region. In this case, the north end of Broomfield is fairly well removed from the core of the Denver region, increasing the chance of error in detailed corridor specific analysis. (That said, it is still the best tool we have, and we believe is still representative for daily volume projections, and testing of relative differences in this study corridor).

- At the micro level, regional travel models tend to be coarse tools. They utilize large traffic analysis zones (TAZs) and centroid connectors to represent a much more fine grained local street network and land use pattern. There is the potential for error in matching detailed localized trip patterns.

- The travel model assigns traffic to individual corridors based on the shortest calculated travel time from TAZ to TAZ. While this makes sense in theory, location specific congestion, such as exists in this study corridor today, may make motorists take other routes to bypass the congestion. This can easily account for why the model may overestimate the actual local cut-through traffic in the corridor.

Another way to approximate cut-through travel in the corridor is to utilize peak hour traffic counts at the signalized intersections (Figure 2). This method simply starts with the amount of traffic entering the corridor at one end, then subtracts any left or right turning traffic that exits the traffic flow at each "downstream" intersection. The remaining traffic at the end of the corridor represents an approximation of directional cut-through traffic. By definition, this method will result in an underestimation of cut-through traffic since any vehicles that enter the corridor at an internal intersection and then exits or turns off again before the end of the corridor will be subtracted from the original entering volume. This will result in an artificial reduction of the potential cut-through tally. That said however, it is worth using this method to provide a reality check to other methods of quantifying cut-through traffic. The results of this method are detailed in Table 1 below:

Table 1
Minimum Peak Hour Cut-Through Calculation (using traffic volumes in Figure 2)

Peak Hour	Travel Direction	A. Vehicles Entering the Corridor at the End (Zuni or 120th)	B. Vehicles Exiting the Corridor at an Interior Intersection	C. Minimum Cut-Through Vehicles (A minus B)	D. Minimum Cut-Through Percentage (C divided by A)
AM	Westbound	896 at Zuni	499	397	44%
AM	Eastbound	440 at 120th	531	0	0%
PM	Westbound	554 at Zuni	417	137	25%
PM	Eastbound	1,188 at 120th	905	283	24%

Given that these estimates are conservatively low by definition, the PM peak hour estimates compare favorably to the 28% daily Bluetooth estimate. The AM peak hour results differ from the daily Bluetooth averages, but seem reasonable given our time in the corridor during the AM peak hour. A closer look at the Bluetooth directional data in the AM peak hour supports the findings above, with a heavier westbound cut-through flow and a minimal eastbound cut-through flow. This approach to estimating cut-through traffic also indicates that the DRCOG regional travel models likely overestimate the actual traffic using Dillon Road/144th Avenue to cut all the way through Broomfield.

1.4 Origins/Destinations of Cut-through Traffic in the Dillon Road/144th Avenue Corridor

The origin or destination of traffic that cuts through this portion of Broomfield on Dillon Road/144th Avenue is also of interest to City and County staff. While it is illegal to utilize license plate or Bluetooth data to determine the home address of vehicles on the roadway, we were able to utilize the DRCOG travel model to run a "select link" procedure to estimate the origin and destination patterns of traffic entering and exiting the corridor. The results of this procedure are summarized in Table 2 for both the existing condition and the Year 2035 planning horizon. (Again, note that the existing condition analysis utilized the Year 2010 DRCOG model as this was the model used as the base year when developing the Year 2035 model.) Key findings include:

Of the traffic (either direction of travel) entering or exiting the west end of the corridor through the 120th Street intersection, and traversing the entire corridor through the Zuni Street intersection:

To/From:	Year 2010	Year 2035
Thornton	67%	61%
Westminster	12%	35%
I-25 North	19%	4%
I-25 South	2%	0%

Of the traffic (either direction of travel) entering or exiting the east end of the corridor through the Zuni Street intersection and traversing the entire corridor through the 120th Street intersection:

To/From:	Year 2010	Year 2035
US 287 North of Dillon Rd.	33%	26%
120th St. North of Dillon Rd.	15%	12%
Dillon Road West of US 287	29%	30%
US 36 West of Flatirons	1%	0%
Local Boulder County	10%	8%
Flatirons / Interlocken area	12%	24%

It can be seen that the City of Thornton is the primary trip origin or destination on the east end of the corridor. On the west end of the corridor the origins and destinations are more evenly dispersed between the major roadway corridors that feed Dillon Road/144th Avenue.

1.5 Peak Hour Level of Service

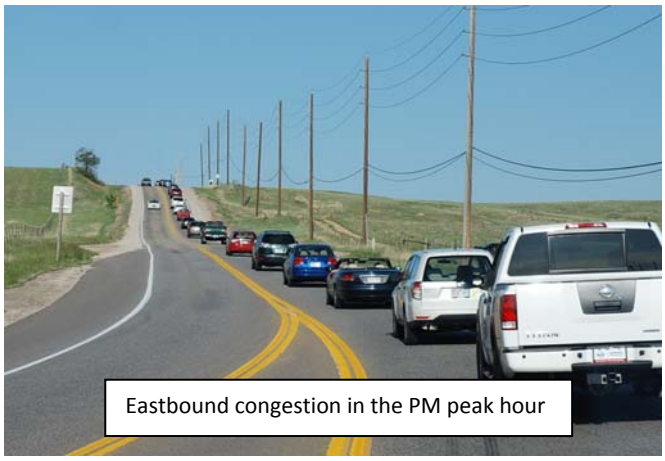
A peak hour level of service (LOS) model was set up for the signalized intersections in the corridor using the existing traffic illustrated on Figure 2, existing traffic signal timing information provided by Broomfield, and Synchro software that incorporates Highway Capacity Manual procedures. The AM and PM peak hours were analyzed and the LOS and delay results are detailed in Table 3. The detailed LOS calculation sheets are available in an Appendix under separate cover.

In general, this analysis concluded that the intersections all operate reasonably well in the A – D range overall, with some individual side street movements operating with more delay in the LOS E or F range. Unfortunately, the peak hour congestion calculated along Dillon Road/144th Avenue for east-west traffic was not nearly as bad as what was experienced in the field (see next section of this memo). Possible reasons are discussed below.

Westbound congestion in the AM peak hour

1.6 Peak Hour Travel Time

A series of travel time runs through the corridor between the Northwest Parkway and Zuni Street (3.5 miles) were completed during the existing AM and PM peak periods to observe the peak period traffic operations. The travel time runs were completed in September after the area schools were back in session. In the process we noted the following:


Eastbound congestion in the PM peak hour

- The posted speed limit is 40 mph in the west end of the corridor and 45 mph in the east end of the corridor.
- Traffic flow and congestion is heaviest in the westbound direction during the AM peak hour, and in the eastbound direction during the PM peak hour.
- During the AM peak:
  - The less congested eastbound trip took approximately 7 minutes at an average speed of 30 mph.
  - The very congested westbound trip took approximately 17 minutes at an average speed of 12 mph.
  - There was a rolling stop and go westbound vehicle queue that extended east from Aspen Street nearly to Lowell. At times traffic would sit at a green traffic signal with no room to move forward.
  - There was a long queue (20 plus vehicles) of northbound traffic on Aspen Street waiting to turn left onto 144th Ave during each signal cycle. It appeared that some motorists were using 136th Ave. to bypassing the congestion on 144th Ave.
- During the PM peak:
  - The less congested westbound trip took approximately 6 minutes at an average speed of 35 mph.

- In the eastbound direction, congestion was evident in the western end of the corridor between 120th Street and Sheridan Blvd. with a rolling stop and go vehicle queue. Congestion dissipated to the east of Sheridan where the additional eastbound through lane became available.
- The eastbound trip took over 10 minutes at an average speed of 20 mph.

The congestion and delay experienced during the AM and PM peak hours was significantly worse than the delay that was calculated using the Synchro LOS model described above. This difference appears, at least in part, to be a related to a cumulative increase in queue lengths that grew from signal cycle to signal cycle during the worst of the peak hour. Once the traffic at an intersection does not clear during a green signal phase, the problem grows each successive signal phase, and lengthy vehicle queues develop. When the queues extend back to and through the next upstream traffic signal, there is no chance for the system to recover until the peak is over and the traffic decreases significantly. Single through lanes with relatively high volumes and the lack of turn lanes in some areas all likely contribute to the problem.

1.7 Potential Near-Term Improvements to Facilitate Existing Traffic

The key to minimizing the peak period congestion described above is to provide the ability for select intersections to process more eastbound through vehicles in the PM peak and more westbound vehicles in the AM peak. While this is a fairly obvious answer, we believe the following improvements, illustrated conceptually on Figure 6, would have the most immediate benefit:

- Proceed with the planned implementation of improvements at the 120th Street intersection. Broomfield is currently moving forward on a project to add an eastbound to southbound left turn lane, and a westbound to northbound right turn lane. This will significantly reduce the congestion that occurs at this intersection today. (Note that we have included these improvements in the existing LOS analysis since they will be implemented soon.)

- The AM peak congestion appears to be most directly related to the inability for the signals at 120th Street and Aspen Street to process westbound through vehicles. Both intersections would benefit from the construction of a short auxiliary westbound through lane through the signal. These auxiliary lanes would begin say 400’ to 500’ prior to the intersection and taper back into the single westbound lane 800’ to 1,000’ downstream of the intersection. At the 120th Street intersection this additional through lane would be an extension of the new westbound right turn lane as illustrated on Figure 7. Figure 8 includes an illustration of a new westbound auxiliary through lane at the Aspen Street intersection. R.O.W. will likely be required on the north side of Dillon Road at both intersections, and a gas pipeline will need to be relocated at the Aspen Street intersection.

- AM peak congestion can also be mitigated in the near term by the construction of a westbound auxiliary through lane on Dillon Road at Sheridan Boulevard. The paved width necessary for the approach to the intersection already exists but is “striped out” since westbound Dillon Road/144th Avenue has two through lanes to the east of the Sheridan intersection. Widening

would be necessary to the west of the intersection to create the downstream portion of the auxiliary through lane as illustrated on Figure 9. It appears that there is adequate R.O.W. in this northwest quadrant of the intersection to allow this widening.

- Also in the AM peak hour, consideration might be given to reducing the length of the northbound left turn phase onto westbound 144th Ave. at the Aspen Street intersection. This would benefit 144th and would also likely discourage motorists from using 136th rather than Dillon Road/144th Avenue to travel westbound across Broomfield.

- The PM peak congestion in the western end of the Dillon Road/144th Avenue corridor appears to be most directly related to the inability of the traffic signal at Sheridan Blvd. to process eastbound traffic. At the same time, we observed that the dedicated eastbound to southbound right turn lane at this intersection appears to be underutilized. Therefore, a quick and inexpensive measure to take would be to convert the eastbound dedicated right turn lane into a shared through/right lane. Dillon Road/144th Avenue already has two eastbound lanes east of the intersection, so this change would simply let more traffic through the intersection on each green signal phase. (Note that it is our understanding that Broomfield staff has recently proceeded with this recommendation.) In the near term, the effectiveness of this additional through lane could be increased by extending the length of the shared through-right lane to the west of the Sheridan intersection. This will allow more vehicles to access it on each signal cycle.

1.8 Near-term Peak Hour Level of Service with Interim Improvements

The peak hour intersection LOS has been recalculated for the near-term or interim conditions in the Dillon Road/144th Avenue corridor using existing traffic volumes and assuming that the following set of improvements (described above) has been implemented:

- Complete the planned eastbound left and westbound right turn lanes at the 120th Street intersection;
- Add a westbound auxiliary through lane at the 120th Street intersection (an upstream and downstream extension of the new westbound right turn lane);
- Add a westbound auxiliary through lane at the Aspen Street intersection;
- Convert the existing eastbound right turn lane at the Sheridan Boulevard intersection into a shared through-right lane, and extend or lengthen this lane to the west;
- Construct a westbound auxiliary through lane at the Sheridan Boulevard intersection (paved width for the approach portion of this lane already exists).

Table 3 includes the results of this analysis (Note that the lane utilization of auxiliary through lanes was set at 25% and the existing through lane was set at 75%. This utilization split has been documented in a recent NCHRP publication[1]). The delay is reduced and the LOS is improved at all three of these intersections (all three intersections calculated to operate at LOS B or C). And given our on-site

[1] National Cooperative Highway Research Program Report 707, Guidelines on the Use of Auxiliary Through Lanes at Signalized Intersections, Transportation Research Board, 2011

observations during the peak commuting periods, we believe that the actual delay reductions will exceed the calculated reductions in the LOS model.

2. Projected Year 2035 Roadway and Traffic Conditions

2.1 Future Roadway Continuity and Widening

A number of roadway widening projects have been envisioned for this portion of Broomfield in previous planning efforts. For example, the Broomfield 2030 Plan assumed that Dillon Road/144th Avenue would be widened to 4 lanes from the Northwest Parkway to Zuni Street. That planning effort even tested the widening of 144th Ave. to 6 lanes west of Sheridan Parkway. The current DRCOG Year 2035 travel model also includes Dillon Road/144th Avenue as a 4 lane arterial roadway through Broomfield.

Both the Year 2030 Broomfield Plan and the DRCOG Year 2035 travel model included the extension of South Boulder Road to 160th Avenue, creating a parallel east-west corridor north of Dillon Road/144th Avenue. While this extension has been included in prior intergovernmental agreements, it is our current understanding that there is no financial support for this project from Broomfield, Lafayette, Boulder County, or DRCOG, and it is unlikely to be constructed by the Year 2035.

Figure 3 includes the potential roadway widenings and extensions that have been envisioned by the Year 2035.

For purposes of this study, the base case assumption has been that the South Boulder Road extension will not be constructed by the Year 2035. We then tested the effect of:

- widening Dillon Road/144th Avenue to 4-lanes throughout the Broomfield area, or
- leaving the existing sections of 2 and 3 through lanes in place.

The results of these alternatives are described below.

2.2 2035 Daily Traffic Volumes With 4-Lanes on Dillon Road/144th Avenue

It is projected that traffic in the Dillon Road/144th Avenue corridor will increase to between 33,000 and 38,000 vpd within Broomfield in the Year 2035 if the roadway is widened to 4 through lanes. This represents more than a doubling of existing traffic. Clearly there is a projected demand for increased east-west mobility in this part of Broomfield. The traffic on all other roadways in the study area is projected to increase as well, as is illustrated on Figure 1 (red numbers). Note that the traffic in the Sheridan Boulevard corridor is projected to increase significantly.

We did test the impact of the South Boulder Road extension to 160th Ave. on the traffic in the Dillon Road/144th Avenue corridor and concluded that it would cause a reduction in traffic of approximately 4,000 vpd along Dillon Road/144th Avenue (black numbers along 144th).

At the request of staff, we also tested the addition of two new ramps at the Lowell Boulevard/Northwest Parkway intersection. Currently there is no access between these two roadways. An eastbound off-ramp and a westbound on-ramp were added, as illustrated on Figure 1, to see what effect there would be on Parkway traffic, and the potential impact on Dillon Road/144th Avenue traffic. The Year 2035 planning horizon with 4-lanes on 144th Avenue/Dillon Road was used as the base model for this test. The results are summarized on Figure 1 and detailed in Table 4. It can be seen (compare red to orange on Figure 1) that the new ramps result in 2,000 more vehicles per day (+10%) on the Northwest Parkway west of Lowell Boulevard, with minimal impact on Dillon Road/144th Avenue traffic.

2.3 2035 Daily Traffic Volumes With Existing 2-Lane Sections of Dillon Road/144th Avenue

The daily traffic volume on Dillon Road/144th Avenue would be significantly less in the Year 2035 if no additional through lanes were added to the corridor. The projected daily volume, illustrated on Figure 1 (green numbers) range from 17,500 to 21,000 vpd (approximately a 25% increase relative to today). In this scenario, the traffic volume on parallel east-west arterials would increase by between 1,000 and 5,000 vpd to offset the lower capacity in the Dillon Road/144th Avenue corridor. For the most part it is projected that these parallel roadways will have adequate capacity to accommodate the shift in traffic, although congestion will increase proportionately in each if Dillon Road/144th Avenue is not widened to have four through lanes. Congestion will be most noticeable on the 2-lane portions of Midway Boulevard.

Given the significant congestion that exists today at peak times in the corridor, it is projected that delay will increase significantly to unacceptable levels by the Year 2035 if 4 continuous through lanes are not implemented between US 287 and Zuni Street. We do not anticipate that the near term or interim set of improvements described above will be able to mitigate the projected 25 percent increase in traffic.

2.4 Projected Future "Cut Through" Traffic

To estimate the future cut-through traffic in the Dillon Road/144th Avenue we reran the select link analysis for both the 4-lane and 2-lane scenarios. We then adjusted the cut-through projections based on the comparison, detailed above, between the existing model and the Bluetooth observations. On this basis it is projected that:

- If the roadway is widened to 4 through lanes, 27% of the traffic will be cutting through Broomfield from end to end on Dillon Road/144th Avenue. This is only slightly below existing levels.
- If the roadway is not widened, then only 23% of the traffic will be cutting through the community on Dillon Road/144th Avenue. Increased congestion in the corridor will likely result in cut-through traffic shifting to other corridors.

2.5 Projected Year 2035 Peak Hour Traffic and Level of Service

Year 2035 peak hour traffic volumes were estimated based on the projected increase in daily traffic and the related traffic growth factors in Tables 4 and 5, for both the 4-lane and 2-lane roadway scenarios. The projected peak hour traffic, assuming 144th has been widened to 4 lanes is illustrated on Figure 4. The projected peak hour traffic, assuming there are no additional continuous through lanes added, is illustrated on Figure 5.

Peak hour intersection LOS was calculated for each signalized intersection in the corridor for the 4-lane scenario only, using the Synchro model described above. The LOS and delay results are detailed in Table 3. The peak hour LOS for the Year 2035 2-lane/4-lane scenario was not included in this report because, as discussed above, the LOS model does not appear to accurately represent the cumulative delay in this corridor with only 2 through lanes, and, also as noted above, we do not believe the existing through lane geometry will be able to accommodate a 25% increase in through traffic.

Figure 6 illustrates the additional through lanes that have been included in the Year 2035 4-lane analysis. Also, a number of additional intersection turn lanes have been assumed to be in place to accommodate the projected peak hour traffic as follows:

- Aspen intersection — Add 2nd northbound left turn lane;
- Sheridan intersection — Add 2nd northbound, eastbound, and westbound left turn lanes; Add a westbound acceleration lane and a right turn island for southbound to westbound right turning traffic;
- Lowell intersection — Add 2nd northbound left turn lane;
- Zuni intersection — Add 2nd southbound lane to allow separate left and through-right movements

These lane additions are also illustrated in Figure 6.

In the Year 2035, if traffic in the corridor has doubled and the 4 through lanes and intersection improvements listed above are in place, most intersections in the corridor will operate in the LOS A-C range during peak hours as detailed in Table 3. However, the 120th Street intersection is projected to operate at LOS E during both peak hours of the day. The Sheridan intersection, which is the intersection of a major north-south arterial and a major east-west arterial, is projected to operate in the LOS F range, in part due to the large projected increase in traffic on Sheridan (4 or more times as much north-south traffic as exists today). While congestion will be noticeable, this does not imply traffic "gridlock". It just means that most vehicles will need to wait the equivalent of one traffic signal cycle to get through the intersection. It is likely that this congestion will result in some of the large increase in traffic on Sheridan Boulevard being redistributed to other north-south corridors such as Lowell Boulevard.

3. Summary and Recommendations

This analysis has documented existing and projected future traffic conditions in the Dillon Road/144th Avenue corridor to assist the City and County of Broomfield with near-term and long-term corridor planning. This information will be helpful in determining the magnitude and timing of needed roadway improvements. Significant findings and recommendations of this analysis are summarized as follows:

- Dillon Road/144th Avenue currently carries approximately 15,000 to 18,000 daily vehicle trips in this area of Broomfield between US 287 and Zuni Street. The daily capacity of a 2-lane arterial roadway is typically considered to be 15,000 to 20,000 vpd, depending on intersection treatments and laneage.
- The lack of 4 continuous through lanes in the corridor today between US 287 and Zuni Street has resulted in significant peak hour congestion and delay.
- It is estimated that approximately 28% of the east-west traffic in the corridor is "cutting through" or traveling all the way from end to end. This current estimate, based on the most recent Bluetooth technology, is less than the previous estimates of cut-through traffic generated by DRCOG regional travel models.
- A number of interim intersection improvements have been identified to help mitigate existing congestion in the corridor, including:

    - Implement Broomfield's planned eastbound left turn lane and westbound right turn lane at 120th Street
    - Add a westbound auxiliary through lane at 120th Street
    - Add a westbound auxiliary through lane at Aspen Street
    - Add a westbound auxiliary through lane at Sheridan Boulevard (pavement for approach portion already exists)
    - Lengthen the existing eastbound right turn lane at Sheridan Boulevard and convert it into a through-right lane to help move more eastbound traffic through the traffic signal. The receiving lane for this through movement already exists east of the intersection.

  These interim improvements would delay the need to widen the corridor to 4 continuous through lanes. The actual future traffic growth rate in this corridor will dictate when additional improvements or corridor widening is needed.
- The regional travel model predicts that traffic on Dillon Road/144th Avenue will approximately double by the Year 2035 to between 33,000 and 38,000 vpd. This projection assumes that the corridor is widened to have 4 continuous through lanes by Year 2035.
- 35,000 to 40,000 vpd is typically considered the capacity of a 4-lane arterial roadway, again depending on the intersection treatments and laneage.
- The travel model predicts that the extension or connection of South Boulder Road to 160th Avenue would only reduce the travel demand in the Dillon Road/144th Avenue corridor by 4,000 vehicle trips per day (a 10% to 12% reduction). It would not eliminate the need to widen this corridor to 4 through lanes.

- The travel model predicts that adding a ½ diamond interchange (west side only) at the Lowell Boulevard/Northwest Parkway crossing would increase the traffic on the Northwest Parkway to the west by approximately 2,000 vehicle trips per day (10%) in the Year 2035. This would have minimal impact on Dillon Road/144th Avenue traffic.
- It is projected that the percentage of cut-through traffic will decrease slightly by the Year 2035 as additional local traffic is added.
- If the corridor is not widened to have 4 continuous through lanes, the travel model predicts that the east-west traffic in the corridor will only increase by 25% by the Year 2035. In this scenario, unmet demand for east-west mobility will be shifted to parallel roadways in Broomfield, and congestion will increase proportionately in those corridors (such as 136th and Midway).
- We predict that congestion in the corridor will reach unacceptable levels by the Year 2035 if 4 continuous through lanes are not implemented, even if all of the interim improvements listed above are constructed.
- If funding availability results in the need for a phased approach to corridor widening, we recommend the following prioritized approach to phasing (generally from west to east):

  Phase 1: Complete the interim improvements identified above (auxiliary through lanes at 120th, Aspen and Sheridan)

  Phase 2: Widen the west end of the corridor to 4 continuous through lanes from just west of 120th to Sheridan

  Phase 3: Widen the middle segment to 4 continuous through lanes from Sheridan to Lowell

  Phase 4: Widen the eastern segment to 4 continuous through lanes from Lowell to Zuni

  If funding is available it may make sense to skip Phase 1 and go directly to Phase 2 and complete the entire west end from 120th to Sheridan. This will avoid any inefficiency or wasted effort that may result in a two step approach to widening this western end of the corridor.
- Even with corridor widening to 4 continuous through lanes, the following additional intersection improvements are recommended to accommodate future traffic:

-	Aspen intersection	Add 2nd northbound left turn lane;
-	Sheridan intersection	Add 2nd northbound, eastbound, and westbound left turn lanes; Add a westbound acceleration lane and a right turn island for southbound to westbound right turning traffic;
-	Lowell intersection	Add 2nd northbound left turn lane;
-	Zuni intersection	Add 2nd southbound lane to allow separate left and through-right movements

- If traffic does double by Year 2035 and the corridor is widened to 4 lanes, and Sheridan Boulevard traffic increases as projected, the Sheridan/Dillon/144th intersection will be the junction of two busy arterial roadways and will be called upon to serve over 70,000 vehicles per day. Even with all of the additional through and turning lanes described above, this major intersection will experience congested traffic conditions.

I hope this information is helpful. Please let me know if you have any questions or if I can provide additional information.

BF/

Attachments:

	Table 2	Origin or Destination of Traffic Traveling All The Way Through the Corridor
	Table 3	Intersection LOS Summary
	Table 4	144th/Dillon TCAD Model Forecasts
	Table 5	Year 2035 Turning Movement Volume Calculations
	Figure 1	Existing and Year 2035 Forecasted Daily Traffic Volumes
	Figure 2	Existing Intersection Volumes
	Figure 3	Existing and Future Laneage
	Figure 4	Year 2035 Intersection Volumes, 4-Lane Scenario
	Figure 5	Year 2035 Intersection Volumes, 2-Lane Scenario
	Figure 6	Signalized Intersection Laneage Recommendations
	Figure 7	Near-Term Interim Improvements – Dillon Rd & 120th St.
	Figure 8	Near-Term Interim Improvements – Dillon Rd & Aspen St.
	Figure 9	Near-Term Interim Improvements – Dillon Rd & Sheridan Blvd.

LOS calculation worksheets under separate cover

Table 2

Origin or Destination of Traffic Traveling All The Way Through the Corridor: 120th Street to Zuni[1]

Using DRCOG Regional Travel Models

Year:	2010		2035	
Daily Volume East of 120th Street:	15,500		38,000	
Traffic passing all the way through to Zuni:	**8,450**		**19,000**	
Percent passing all the way through:	55%		50%	
Traffic To/From the West: Origin or Destination East of Zuni:				
Thornton	5,650	66.9%	11,650	61.3%
Westminster	1,000	11.8%	6,550	34.5%
I-25 North of 144th Avenue	1,650	19.5%	800	4.2%
I-25 South of 144th Avenue	150	1.8%	0	0.0%
	8,450	100.0%	19,000	100.0%
Year:	**2010**		**2035**	
Daily Volume West of Zuni Street:	17,000		38,000	
Traffic passing all the way through to 120th Street:	**8,450**		**19,000**	
Percent passing all the way through:	50%		50%	
Traffic To/From the East: Origin or Destination West of 120th Street:				
US 287 North of Dillon Road	2,815	33.3%	5,020	26.4%
120th Street North of Dillon Road	1,285	15.2%	2,280	12.0%
Dillon Road West of US 287	2,470	29.2%	5,630	29.6%
US 36 West of Flatirons area	100	1.2%	0	0.0%
Local Trips - Boulder County	820	9.7%	1,520	8.0%
Flatirons / Interlocken area	960	11.4%	4,550	23.9%
	8,450	100.0%	19,000	100.0%

1. Based on adjusted DRCOG travel model data. 2010 Scenario utilizes existing roadway configuration.
   2035 scenario based on 4-lane configuraton without South Boulder Road Extension to 160th Avenue.

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Table 3 - Intersection Level of Service Summary

Intersection and Lane Groups	Existing 2012				Existing w/ Interim Improvements				Year 2035 4-Lane Baseline Scenario				Year 2035 w/ Long-Term Improvements			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
120th St. & 144th/Dillon*	**19.0**	**B**	**17.8**	**B**	**13.7**	**B**	**17.0**	**B**	**60.9**	**E**	**70.1**	**E**	**67.6**	**E**	**66.5**	**E**
Eastbound Left	17.3	B	3.9	A	39.8	D	5.2	A	> 140.0	F	16.2	B	> 140.0	F	16.2	B
Eastbound Through	4.2	A	8.5	A	4.3	A	11.3	B	6.6	A	76.4	E	6.6	A	76.4	E
Westbound Through	18.5	B	2.5	A	---	---	---	---	74.9	E	31.5	C	84.3	F	13.6	B
Westbound Through+Right	---	---	---	---	7.9	A	3.6	A	---	---	---	---	---	---	---	---
Westbound Right	11.7	B	1.8	A	---	---	---	---	3.0	A	4.2	A	15.4	B	0.1	A
Southbound Left	58.5	E	89.3	F	57.9	E	67.3	E	> 140.0	F	48.6	D	> 140.0	F	48.6	D
Southbound Right	50.0	D	52.4	D	49.7	D	48.4	D	44.6	D	> 140.0	F	44.6	D	> 140.0	F
Aspen St. & 144th/Dillon	**31.4**	**C**	**49.5**	**D**	**18.8**	**B**	**21.5**	**C**	**69.2**	**E**	**35.1**	**D**	**20.1**	**C**	**34.4**	**C**
Eastbound Through	12.7	B	72.0	E	20.7	C	25.6	C	12.8	B	47.0	D	6.5	A	46.2	D
Eastbound Right	14.6	B	7.2	A	5.1	A	5.6	A	1.0	A	0.0	A	0.5	A	0.0	A
Westbound Left	9.2	A	46.4	D	11.9	B	69.9	E	12.0	B	77.2	E	2.2	A	90.9	F
Westbound Through	25.8	C	1.9	A	13.7	B	2.9	A	73.1	E	0.6	A	6.2	A	0.5	A
Northbound Left	70.3	E	43.2	D	32.9	C	54.8	D	> 140.0	F	80.4	F	82.9	F	66.3	E
Northbound Right	40.2	D	41.0	D	24.2	C	50.7	D	29.5	C	59.3	E	42.9	D	64.2	E
Sheridan Blvd. & 144th/Dillon (1)	**54.0**	**D**	**23.6**	**C**	**32.5**	**C**	**22.4**	**C**	**197.9**	**F**	**109.3**	**F**	**115.2**	**F**	**84.9**	**F**
Eastbound Left	41.9	D	5.5	A	35.3	D	5.2	A	113.1	F	40.5	D	66.3	E	54.4	D
Eastbound Through	54.0	D	11.6	B	---	---	---	---	27.1	C	> 140.0	F	45.8	D	91.2	F
Eastbound Through+Right	---	---	---	---	52.8	D	13.6	B	---	---	---	---	---	---	---	---
Eastbound Right	47.2	D	2.1	A	---	---	---	---	33.3	C	19.7	B	26.0	C	12.2	B
Westbound Left	52.1	D	71.8	E	10.4	B	26.4	C	27.2	C	> 140.0	F	23.6	C	131.3	F
Westbound Through	73.9	E	14.9	B	22.7	C	12.9	B	26.0	C	24.4	C	19.8	B	13.0	B
Westbound Right	110.6	F	8.2	A	0.9	A	1.0	A	3.6	A	11.1	B	3.5	A	5.9	A
Northbound Left	30.6	C	43.5	D	29.5	C	43.5	D	> 140.0	F	> 140.0	F	> 140.0	F	> 140.0	F
Northbound Through	36.2	D	46.3	D	34.1	C	46.0	D	56.4	E	109.6	F	68.2	E	122.7	F
Northbound Right	36.2	D	44.5	D	34.2	C	44.2	D	23.8	C	49.5	D	23.7	C	56.8	E
Southbound Left	35.0	C	45.5	D	35.0	C	45.5	D	85.3	F	> 140.0	F	100.6	F	> 140.0	F
Southbound Through	42.5	D	48.3	D	41.5	D	48.0	D	> 140.0	F	> 140.0	F	> 140.0	F	> 140.0	F
Southbound Right	40.5	D	45.9	D	39.6	D	45.5	D	> 140.0	F	49.3	D	1.4	A	0.2	A
Sheridan Blvd. & 144th/Dillon (2)					**26.5**	**C**	**22.0**	**C**								
Eastbound Left					33.0	C	5.0	A								
Eastbound Through					---	---	---	---								
Eastbound Through+Right					50.6	D	13.6	B								
Eastbound Right					---	---	---	---								
Westbound Left					11.4	B	26.4	C								
Westbound Through					17.1	B	10.1	B								
Westbound Right					0.9	A	1.0	A								
Northbound Left					21.1	C	43.5	D								
Northbound Through					25.9	C	46.0	D								
Northbound Right					26.3	C	44.2	D								
Southbound Left					25.6	C	45.5	D								
Southbound Through					31.2	C	48.0	D								
Southbound Right					30.4	C	45.5	D								

* Existing analysis performed with improvements currently under construction as complete (EB left-turn, WB right-turn)

(1) Analyzed with only eastbound auxiliary-through-lane in interim scenario

(2) Analyzed with both eastbound and westbound auxiliary-through-lane in interim scenario

Notes: Signal timing (splits) and intersection offsets are optimized for each scenario. Thus, some differences in movement delays from scenario to scenario may be due to both geometric changes and resulting changes to signal timings. In some cases, geometric/capacity improvements at one intersection may result in increased volumes and greater delay at a downstream intersection (removal of defacto "metering"). Movement delays > 140.0 seconds are not shown since the Synchro model does not accurately depict delays when V/C ratios are greater than 1.0

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Table 3 - Intersection Level of Service Summary (cont.)

Intersection and Lane Groups	Existing 2012				Existing w/ Interim Improvements				Year 2035 4-Lane Baseline Scenario				Year 2035 w/ Long-Term Improvements			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Holy Family & 144th/Dillon	**28.4**	**C**	**28.8**	**C**					**21.3**	**C**	**24.3**	**C**	**23.0**	**C**	**24.6**	**C**
Eastbound Left	24.8	C	30.2	C					50.3	D	25.4	C	52.8	D	26.9	C
Eastbound Through	20.1	C	30.1	C					5.8	A	11.2	B	6.2	A	14.3	B
Westbound Through	35.6	D	32.6	C					23.1	C	37.9	D	25.6	C	34.9	C
Westbound Right	22.8	C	25.2	C					7.5	A	27.1	C	10.2	B	24.7	C
Southbound Left+Right	22.3	C	10.0	A					51.8	D	22.5	C	51.8	D	24.7	C
Safeway & 144th/Dillon	**9.5**	**A**	**21.0**	**C**					**5.0**	**A**	**8.4**	**A**	**4.8**	**A**	**8.7**	**A**
Eastbound Through	9.8	A	26.9	C					1.7	A	6.3	A	1.5	A	6.6	A
Eastbound Right	24.9	C	10.5	B					0.9	A	0.4	A	0.7	A	2.0	A
Westbound Left	1.9	A	11.8	B					1.0	A	43.5	D	1.4	A	42.3	D
Westbound Through	2.7	A	11.1	B					2.5	A	0.5	A	2.2	A	0.7	A
Northbound Left	64.1	E	22.5	C					85.8	F	70.2	E	85.8	F	70.2	E
Northbound Right	57.5	E	22.1	C					62.6	E	66.3	E	62.6	E	66.3	E
Lowell Blvd. & 144th/Dillon	**30.7**	**C**	**21.5**	**C**					**41.1**	**D**	**28.2**	**C**	**33.3**	**C**	**27.0**	**C**
Eastbound Left	17.8	B	9.5	A					42.7	D	7.8	A	39.0	D	8.0	A
Eastbound Through	17.4	B	13.1	B					25.0	C	19.9	B	25.1	C	18.0	B
Eastbound Right	64.2	E	0.6	A					15.9	B	5.9	A	11.1	B	7.2	A
Westbound Left	14.3	B	56.5	E					53.4	D	77.0	E	41.3	D	76.2	E
Westbound Through	28.2	C	40.9	D					35.3	D	14.7	B	28.4	C	15.0	B
Westbound Right	18.0	B	26.4	C					11.3	B	8.4	A	12.9	B	9.5	A
Northbound Left	40.8	D	21.1	C					79.4	E	52.5	D	37.3	D	44.0	D
Northbound Through	44.6	D	21.6	C					47.2	D	63.7	E	58.3	E	63.3	E
Northbound Right	40.0	D	21.2	C					38.6	D	56.8	E	44.6	D	56.6	E
Southbound Left	46.6	D	18.1	B					50.6	D	53.9	D	44.4	D	53.3	D
Southbound Through+Right	46.1	D	22.7	C					84.2	F	63.2	E	51.3	D	57.6	E
McKay Park Dr. & 144th/Dillon	**14.4**	**B**	**9.5**	**A**					**7.0**	**A**	**4.4**	**A**	**8.1**	**A**	**4.0**	**A**
Eastbound Through	6.1	A	10.9	B					2.0	A	3.5	A	3.5	A	2.8	A
Eastbound Right	4.8	A	0.0	A					0.1	A	0.1	A	0.1	A	0.0	A
Westbound Left	3.9	A	3.8	A					4.9	A	18.4	B	6.0	A	17.9	B
Westbound Through	6.4	A	1.8	A					4.8	A	2.1	A	5.7	A	2.1	A
Northbound Left+Right	93.4	F	67.3	E					73.3	E	65.2	E	73.3	E	65.2	E
Zuni St. & 144th/Dillon	**22.6**	**C**	**11.7**	**B**					**34.2**	**C**	**13.5**	**B**	**30.8**	**C**	**13.0**	**B**
Eastbound Left	4.7	A	0.3	A					10.1	B	0.9	A	7.2	A	0.8	A
Eastbound Through	9.7	A	1.7	A					6.0	A	1.6	A	3.8	A	1.4	A
Eastbound Right	9.8	A	0.2	A					2.3	A	0.5	A	0.7	A	0.4	A
Westbound Left	4.5	A	2.9	A					122.6	F	55.4	E	106.4	F	44.8	D
Westbound Through	6.9	A	3.6	A					17.9	B	7.2	A	16.4	B	6.4	A
Westbound Right	3.2	A	2.3	A					8.3	A	4.7	A	7.7	A	4.2	A
Northbound Left	121.9	F	79.1	E					> 140.0	F	86.0	F	> 140.0	F	86.5	F
Northbound Through	52.4	D	58.2	E					38.1	D	48.8	D	39.6	D	50.6	D
Northbound Right	52.4	D	56.7	E					41.6	D	55.8	E	43.1	D	58.5	E
Southbound Left+Through+Right	56.1	E	61.0	E					42.1	D	51.7	D	---	---	---	---
Southbound Left	---	---	---	---					---	---	---	---	40.1	D	51.0	D
Southbound Through+Right	---	---	---	---					---	---	---	---	41.9	D	50.2	D

No Geometric Changes for Interim Scenario

Notes: Signal timing (splits) and intersection offsets are optimized for each scenario. Thus, some differences in movement delays from scenario to scenario may be due to both geometric changes and resulting changes to signal timings. In some cases, geometric/capacity improvements at one intersection may result in increased volumes and greater delay at a downstream intersection (removal of defacto "metering"). Movement delays > 140.0 seconds are not shown since the Synchro model does not accurately depict delays when V/C ratios are greater than 1.0

Table 4. 144th/Dillon TCAD Model Forecasts

East-West Road Segments			Existing Counts	2035 4-Lane 144th (No S Bldr Rd Conn)		2035 2-Lane 144th (No S Bldr Rd Conn)		2035 4-Lane 144th with New Ramps at Lowell/NW Parkway (No S Bldr Rd Conn)	
				2035 Forecast	% Annual Growth	2035 Forecast	% Annual Growth	2035 Forecast	Difference from 2035 4-Lane
Baseline / SH7	E County Line Rd	Lowell Blvd	20,000	41,500	3.2%	42,700	3.4%	42,000	500
	Sheridan Blvd	I-25	20,000	54,300	4.4%	55,000	4.5%	54,200	-100
Northwest Parkway	US287	Lowell Blvd	9,000	19,700	3.5%	24,600	4.5%	21,700	2,000
	Lowell Blvd	Sheridan Pkwy	9,000	19,700	3.5%	24,600	4.5%	18,100	-1,600
	Sheridan Pkwy	I-25	11,000	32,800	4.9%	34,600	5.1%	33,000	200
144th Ave / Dillon Rd	US287/NW Parkway	120th St	12,784	35,000	4.5%	19,000	1.7%	34,000	-1,000
	120th St	Aspen St/124th St	15,361	38,000	4.0%	19,500	1.0%	36,000	-2,000
	Aspen St/124th St	Sheridan Blvd	15,942	37,000	3.7%	19,600	0.9%	36,500	-500
	Sheridan Blvd	Lowell Blvd	15,332	33,000	3.4%	17,500	0.6%	33,500	500
	Lowell Blvd	Zuni St	16,969	38,000	3.6%	21,000	0.9%	38,000	0
136th Ave	Daphne St	Main St	5,881	8,000	1.3%	8,500	1.6%		
	Main St	Aspen St/124th St	8,164	12,800	2.0%	13,100	2.1%		
	Sheridan Blvd	Lowell Blvd	8,191	10,000	0.9%	12,500	1.9%		
	Lowell Blvd	Westlake Dr	11,834	10,600	-0.5%	13,300	0.5%		
	Westlake Dr	Zuni St	12,748	10,800	-0.7%	13,100	0.1%		
Midway Blvd / 124th Ave	US 287	Kohl St	13,731	17,000	0.9%	18,100	1.2%		
	Kohl St	Main St	8,783	13,400	1.9%	14,600	2.2%		
	Main St	Sheridan Blvd	13,029	22,000	2.3%	24,300	2.7%		
	Sheridan Blvd	Lowell Blvd	12,829	23,200	2.6%	25,100	3.0%		
	Lowell Blvd	Zuni St	10,269	17,100	2.2%	18,800	2.7%		
	Zuni St	Huron St	10,698	13,100	0.9%	13,000	0.9%		
120th Ave	Wadsworth Blvd	Main St	31,000	43,000	1.4%	44,600	1.6%		
	Main St	Sheridan Blvd	37,000	40,000	0.3%	41,400	0.5%		
	Sheridan Blvd	Lowell Blvd	33,000	37,200	0.5%	37,700	0.6%		

North-South Road Segments			Existing Counts	2035 4-Lane 144th (No S Bldr Rd Conn)		2035 2-Lane 144th (No S Bldr Rd Conn)		2035 4-Lane 144th with New Ramps at Lowell/NW Parkway (No S Bldr Rd Conn)	
				2035 Forecast	% Annual Growth	2035 Forecast	% Annual Growth	2035 Forecast	% Annual Growth
US 287	SH 42	Northwest Pkwy	37,000	48,200	1.2%	46,700	1.0%		
	Miramonte Blvd	Midway Blvd	39,000	54,700	1.5%	54,500	1.5%		
Kohl St	Daphne St	Miramonte Blvd	6,047	7,800	1.1%	8,300	1.4%		
	Miramonte Blvd	Midway Blvd	1,548	2,500	2.1%	2,600	2.3%		
120th St	North of 144th Ave/Dillon Rd		2,827	11,100	6.1%	9,300	5.3%		
Main St	136th Ave	Miramonte Blvd	6,178	7,700	1.0%	7,700	1.0%		
	Miramonte Blvd	Midway Blvd	10,218	10,900	0.3%	11,900	0.7%		
	Midway Blvd	120th Ave	12,471	18,000	1.6%	18,100	1.6%		
Aspen St/124th St	Dillon Rd/144th Ave	136th Ave	4,325	7,200	2.2%	6,900	2.1%		
Sheridan Blvd / Sheridan Pkwy	Baseline Rd/SH7	160th Ave	2,547	18,800	9.1%	18,800	9.1%		
	Lowell Blvd	Feather Cir	4,502	36,100	9.5%	33,400	9.1%		
	Feather Cir	144th Ave	5,810	41,000	8.9%	38,000	8.5%		
	144th Ave	136th Ave	9,037	35,900	6.2%	35,400	6.1%		
	136th Ave	10th Ave	14,548	37,900	4.3%	36,900	4.1%		
	10th Ave	Midway Blvd	17,381	39,000	3.6%	39,000	3.6%		
	Midway Blvd	120th Ave	18,792	40,000	3.3%	40,000	3.3%		
Lowell Blvd	Spruce St	144th Ave	7,377	17,800	3.9%	17,800	3.9%		
	144th Ave	136th Ave	9,178	17,600	2.9%	17,400	2.8%		
	136th Ave	Midway Blvd	14,398	23,700	2.2%	24,000	2.2%		
	Midway Blvd	Highland Park/123rd	13,735	23,900	2.4%	24,200	2.5%		
	Highland Park/123rd	120th Ave	12,971	21,800	2.3%	22,100	2.3%		
Zuni St	149th Ave	144th Ave	1,114	2,000	2.7%	1,800	2.2%		
	144th Ave	136th Ave	6,660	12,200	2.7%	11,000	2.2%		
	136th Ave	Midway Blvd	11,649	22,500	2.9%	23,500	3.1%		
	Midway Blvd	120th Ave	13,000	16,100	0.9%	16,400	1.0%		

Table 5

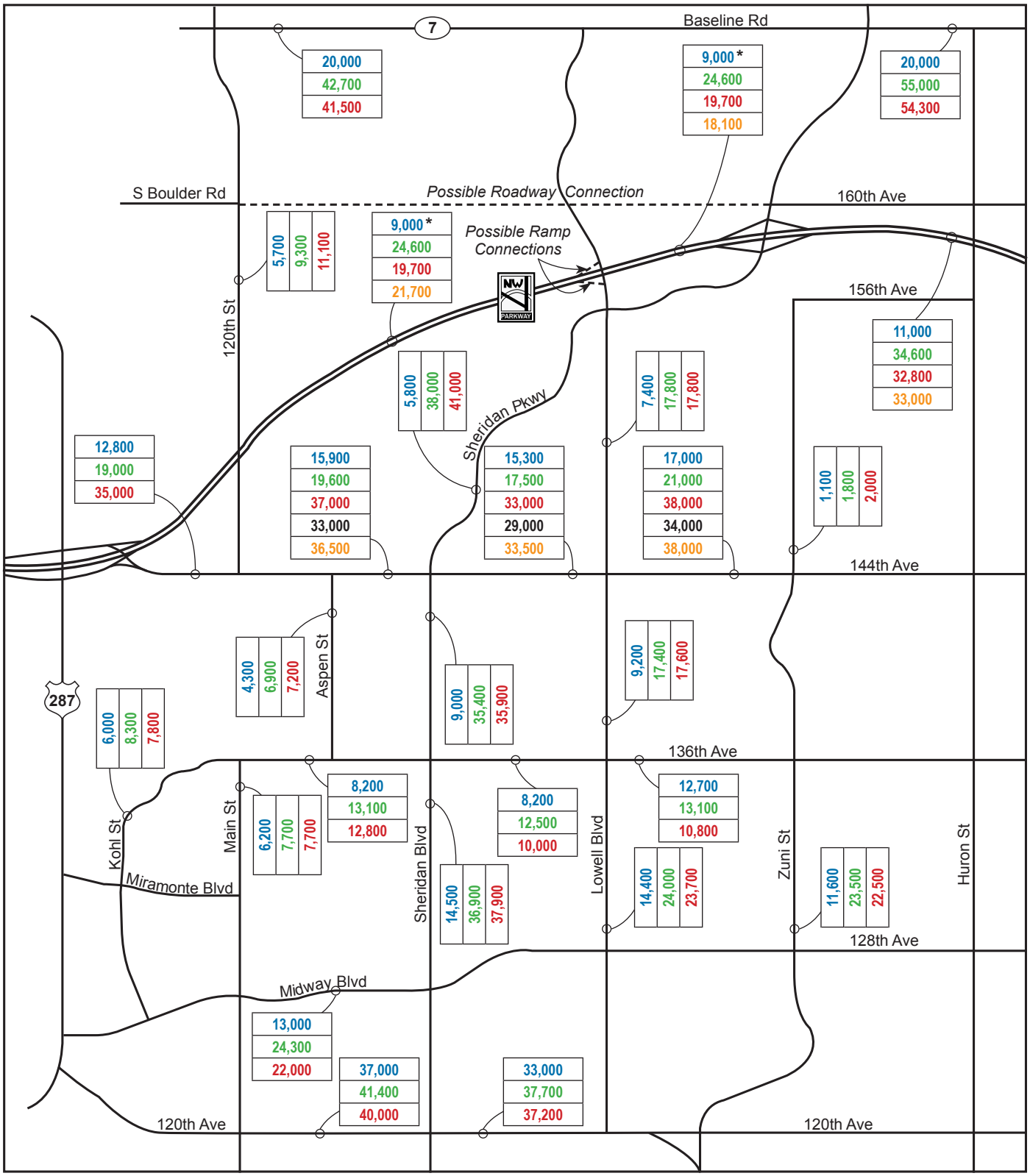
YEAR 2035 TURNING MOVEMENT VOLUME CALCULATIONS

		Existing 2012 Volumes		Annual Growth Factor		Projected 2035 Volumes			
						4-Lane		2-Lane	
		AM	PM	4-Lane	2-Lane	AM	PM	AM	PM
120th St	EB LT	67	70	5.3%	3.4%	220	230	143	149
	EB TH	317	979	4.3%	1.1%	826	2550	408	1259
	WB TH	927	347	4.3%	1.1%	2415	904	1192	446
	WB RT	296	116	5.1%	3.1%	919	360	591	232
	SB LT	123	209	5.1%	3.1%	382	649	245	417
	SB RT	82	66	5.3%	3.4%	269	216	175	141
Aspen St	EB TH	372	1182	3.9%	0.8%	887	2818	442	1404
	EB RT	64	143	3.1%	1.5%	129	289	89	199
	WB LT	13	38	3.0%	1.4%	25	74	18	52
	WB TH	917	416	3.9%	0.8%	2186	992	1089	494
	NB LT	342	65	3.1%	1.5%	690	131	476	91
	NB RT	16	36	3.0%	1.4%	31	70	22	50
Sheridan Blvd	EB LT	26	119	6.3%	4.6%	106	485	73	335
	EB TH	286	840	3.6%	0.7%	638	1874	332	975
	EB RT	62	192	5.0%	3.4%	188	583	134	414
	WB LT	121	114	4.8%	3.4%	356	335	258	243
	WB TH	672	337	3.6%	0.7%	1499	752	780	391
	WB RT	51	57	6.2%	4.6%	201	225	142	159
	NB LT	153	110	5.0%	3.4%	465	334	330	237
	NB TH	122	172	7.6%	7.3%	651	917	617	870
	NB RT	157	133	4.8%	3.4%	462	391	335	284
	SB LT	62	41	6.2%	4.6%	245	162	173	114
	SB TH	256	149	7.6%	7.3%	1365	795	1294	753
	SB RT	195	49	6.3%	4.6%	795	200	549	138
Holy Family	EB LT	161	58	0.0%	0.0%	175	75	175	75
	EB TH	415	494	3.4%	0.6%	895	1066	476	567
	WB TH	737	483	3.4%	0.6%	1590	1042	846	554
	WB RT	30	17	0.0%	0.0%	35	25	30	17
	SB LT	71	42	0.0%	0.0%	75	50	75	50
	SB RT	120	92	0.0%	0.0%	125	100	125	100
Safeway	EB TH	400	954	3.4%	0.6%	863	2058	459	1095
	EB RT	53	136	0.0%	0.0%	60	140	60	140
	WB LT	25	423	0.0%	0.0%	25	425	25	425
	WB TH	944	38	3.4%	0.6%	2037	82	1083	44
	NB LT	54	76	0.0%	0.0%	60	80	60	80
	NB RT	55	104	0.0%	0.0%	60	110	60	110
Lowell Blvd	EB LT	25	40	3.7%	2.3%	57	91	42	67
	EB TH	363	755	3.5%	0.8%	801	1666	431	897
	EB RT	84	167	3.2%	1.7%	171	341	124	246
	WB LT	146	84	3.3%	1.9%	305	175	223	128
	WB TH	710	368	3.5%	0.8%	1566	812	843	437
	WB RT	78	37	3.8%	2.4%	182	86	135	64
	NB LT	189	87	3.2%	1.7%	386	178	279	128
	NB TH	165	93	3.4%	3.4%	356	201	352	198
	NB RT	112	126	3.3%	1.9%	234	263	171	192
	SB LT	50	47	3.8%	2.4%	117	110	86	81
	SB TH	67	39	3.4%	3.4%	145	84	143	83
	SB RT	35	23	3.7%	2.3%	80	52	58	38
McKay Park Dr	EB TH	518	863	3.8%	0.9%	1208	2013	637	1060
	EB RT	56	50	0.0%	0.0%	60	55	60	55
	WB LT	35	32	0.0%	0.0%	40	35	40	35
	WB TH	900	517	3.8%	0.9%	2099	1206	1106	635
	NB LT	90	35	0.0%	0.0%	95	40	95	40
	NB RT	66	25	0.0%	0.0%	70	30	70	30
Zuni Street	EB LT	9	19	3.2%	1.6%	18	39	13	27
	EB TH	494	729	3.6%	0.9%	1114	1644	607	896
	EB RT	79	114	3.2%	1.6%	161	233	113	162
	WB LT	118	50	3.2%	1.6%	241	102	168	71
	WB TH	715	457	3.6%	0.9%	1613	1031	879	562
	WB RT	9	13	3.2%	1.6%	18	27	13	19
	NB LT	158	89	3.2%	1.6%	322	182	225	127
	NB TH	16	27	2.7%	2.2%	30	50	26	45
	NB RT	86	78	3.2%	1.6%	176	159	123	111
	SB LT	14	18	3.2%	1.6%	29	37	20	26
	SB TH	33	18	2.7%	2.2%	61	33	54	30
	SB RT	23	8	3.2%	1.6%	47	16	33	11

	Annual Growth Factor	
	4-Lane	2-Lane
W-Leg	4.5%	1.4%
E-Leg	4.0%	0.8%
S-Leg		
N-Leg	6.1%	5.3%
W-Leg	4.0%	0.8%
E-Leg	3.7%	0.7%
S-Leg	2.2%	2.1%
N-Leg		
W-Leg	3.7%	0.7%
E-Leg	3.4%	0.6%
S-Leg	6.2%	6.1%
N-Leg	8.9%	8.5%
W-Leg	3.4%	0.6%
E-Leg	3.4%	0.6%
S-Leg		
N-Leg	Round Up	Round Up
W-Leg	3.4%	0.6%
E-Leg	3.4%	0.6%
S-Leg	Round Up	Round Up
N-Leg		
W-Leg	3.4%	0.6%
E-Leg	3.6%	0.9%
S-Leg	2.9%	2.8%
N-Leg	3.9%	3.9%
W-Leg	3.6%	0.9%
E-Leg	3.9%	0.9%
S-Leg	Round Up	Round Up
N-Leg		
W-Leg	3.6%	0.9%
E-Leg	3.6%	0.9%
S-Leg	2.7%	2.2%
N-Leg	2.7%	2.2%

Figure 1

Existing and Year 2035 Forecasted Daily Traffic Volumes



LEGEND

XX 2012 Daily Traffic

2035 Daily Traffic Forecasts:

XX 2-Lane 144th Ave

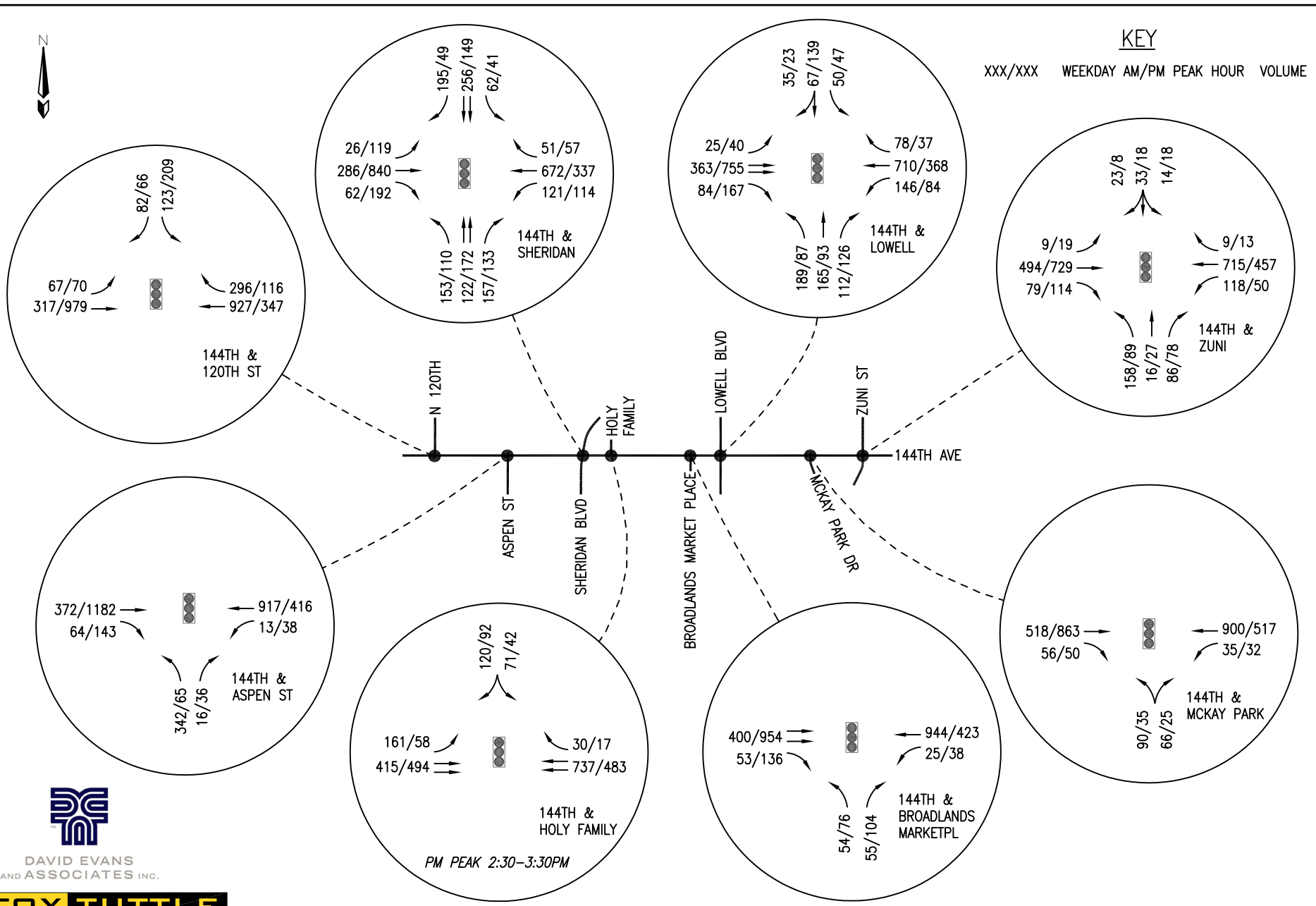
XX 4-Lane 144th Ave

XX 4-Lane 144th Ave with S Boulder Rd Extension

XX 4-Lane 144th Ave with Lowell Blvd/Northwest Parkway Ramp Connections

Note: * Estimated Existing Volume

N



DAVID EVANS AND ASSOCIATES INC.

FOX TUTTLE TRANSPORTATION GROUP

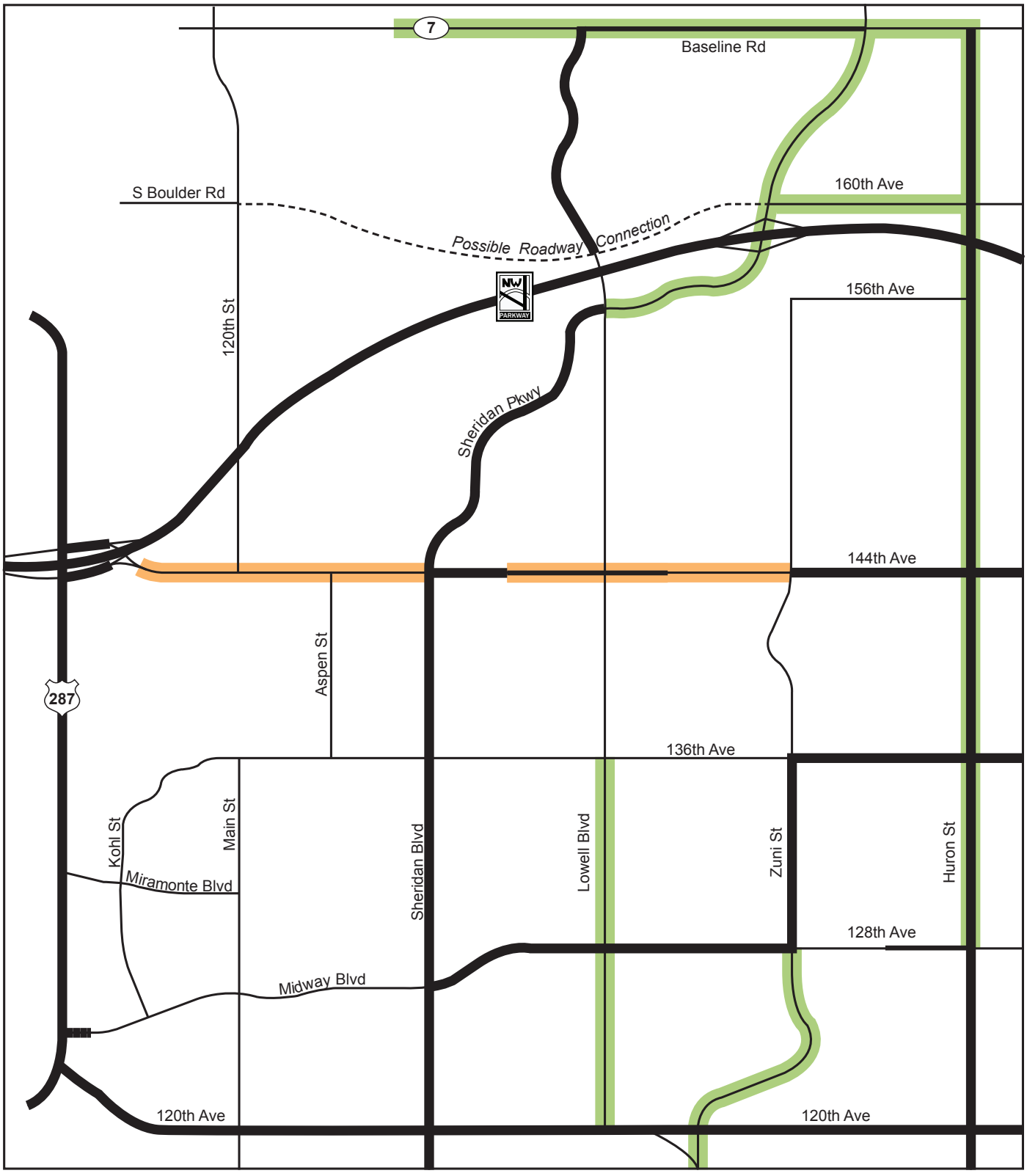
144TH AVENUE CORRIDOR STUDY

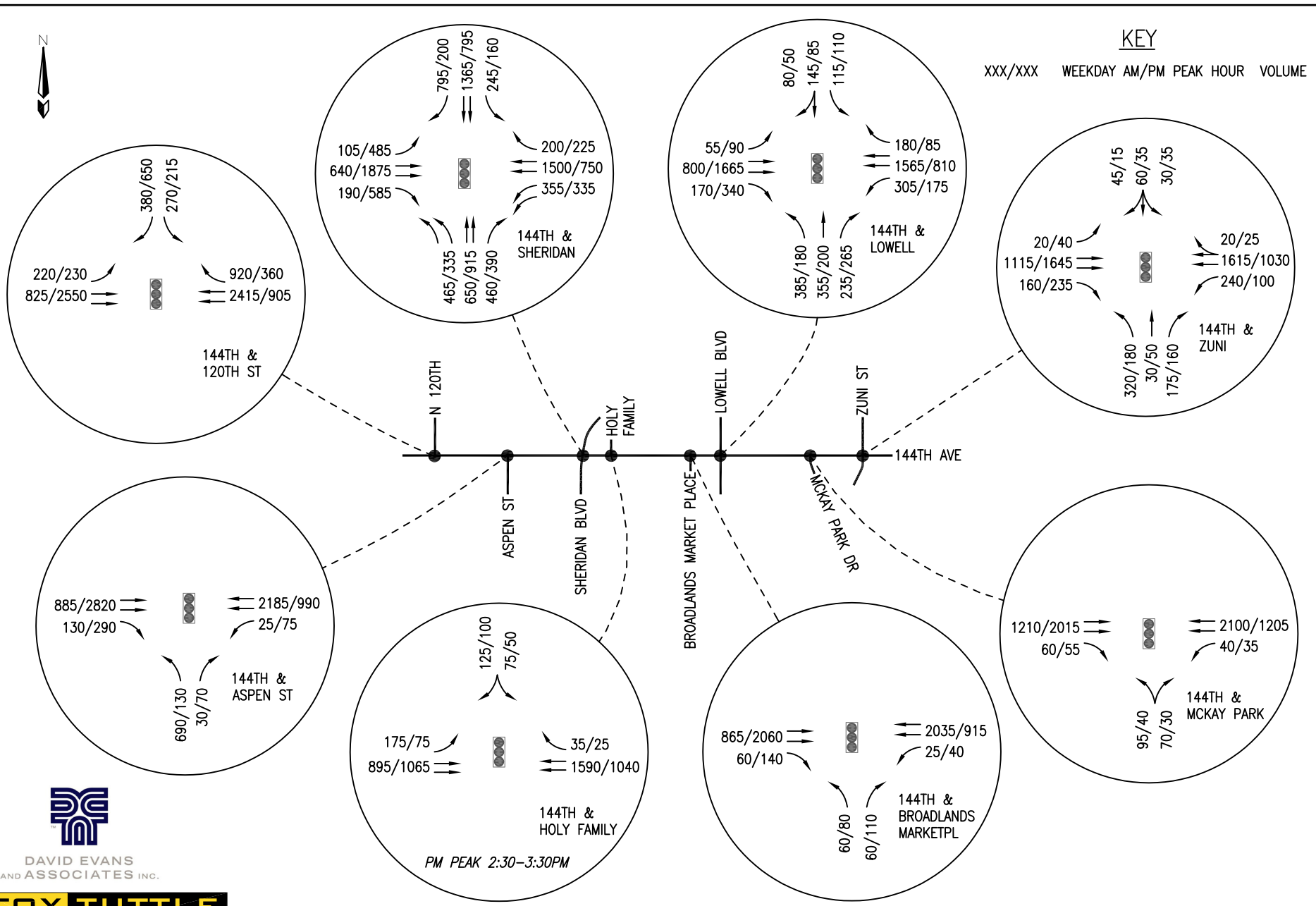
EXISTING (2012) INTERSECTION VOLUMES

FT Project #	12024	Original Scale	NTS	Date	12/17/12	Drawn by	SGT	Figure #	2

Figure 3

Existing and Future Laneage





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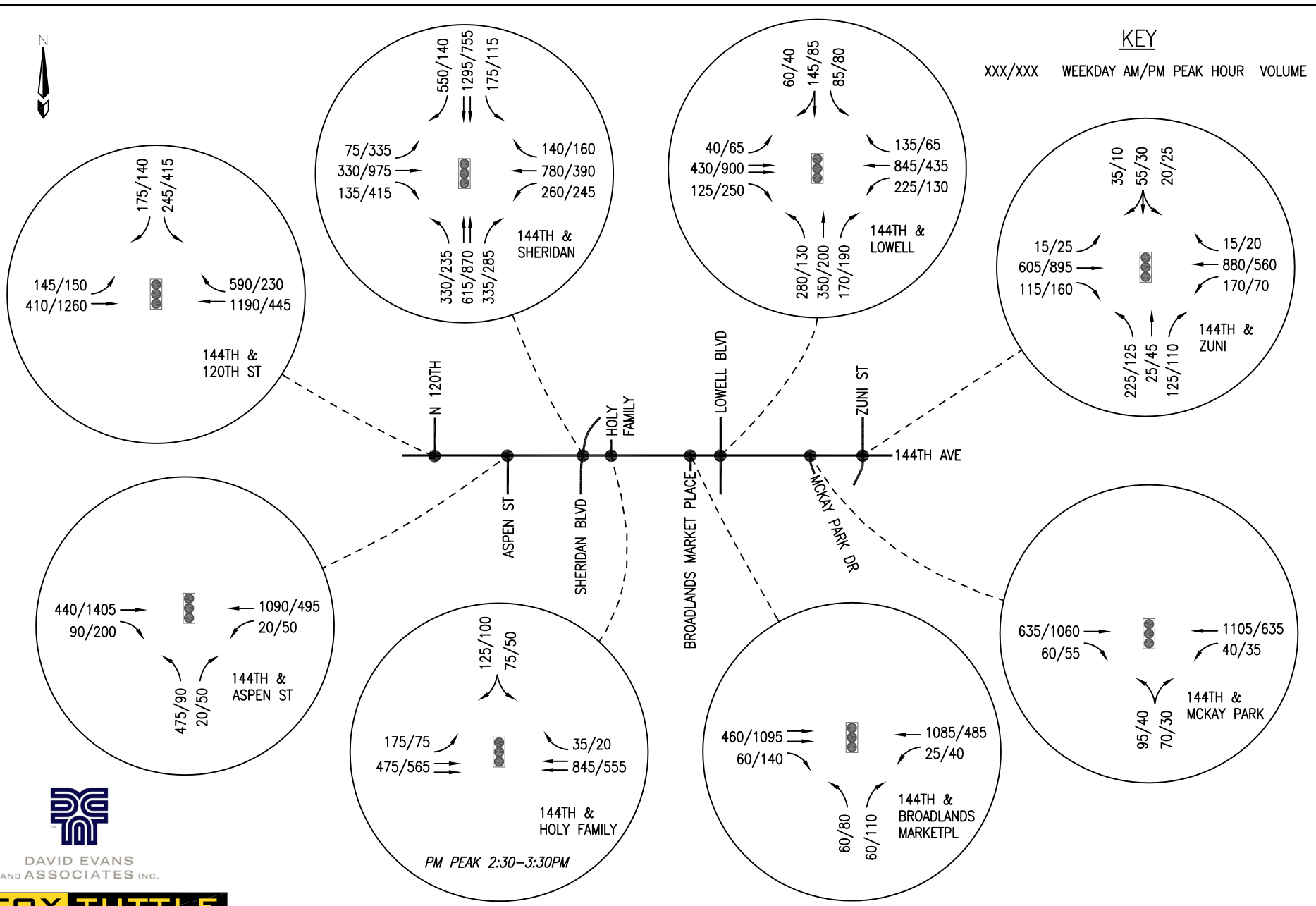
FOX TUTTLE TRANSPORTATION GROUP

144TH AVENUE CORRIDOR STUDY

YEAR 2035 INTERSECTION VOLUMES, 4-LANE 144TH SCENARIO

FT Project #	12024	Original Scale	NTS	Date	12/17/12	Drawn by	SGT	Figure #	4



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FOX TUTTLE TRANSPORTATION GROUP

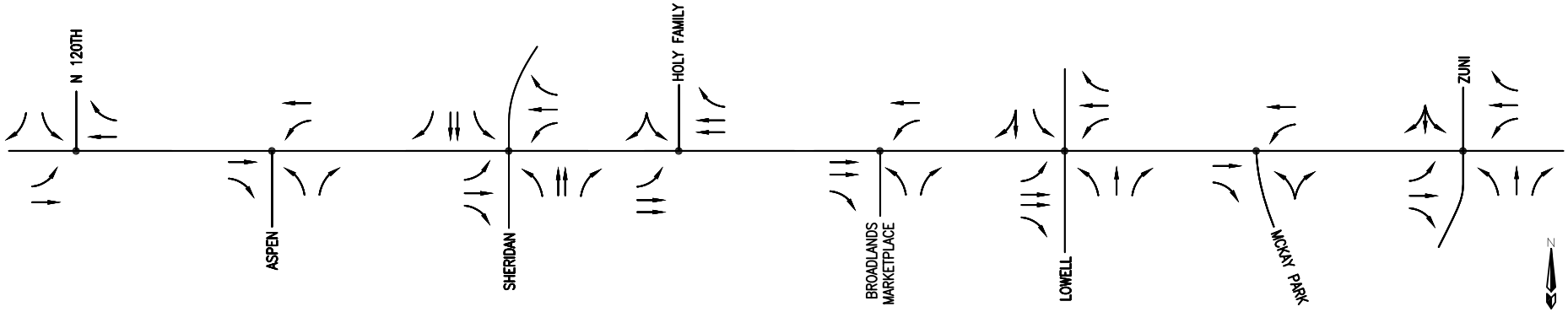
144TH AVENUE CORRIDOR STUDY

YEAR 2035 INTERSECTION VOLUMES, 2-LANE 144TH SCENARIO

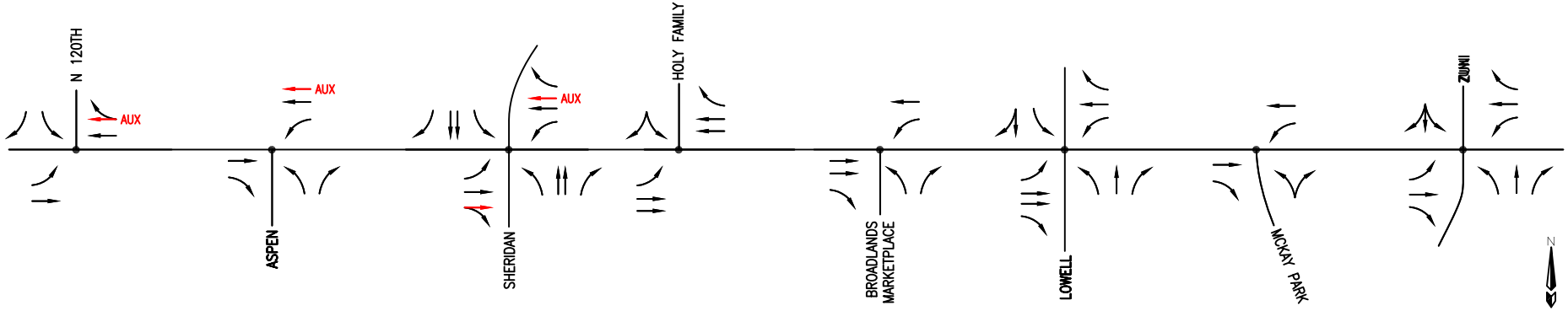
FT Project #	12024	Original Scale	NTS	Date	12/17/12	Drawn by	SGT	Figure #	5

EXISTING

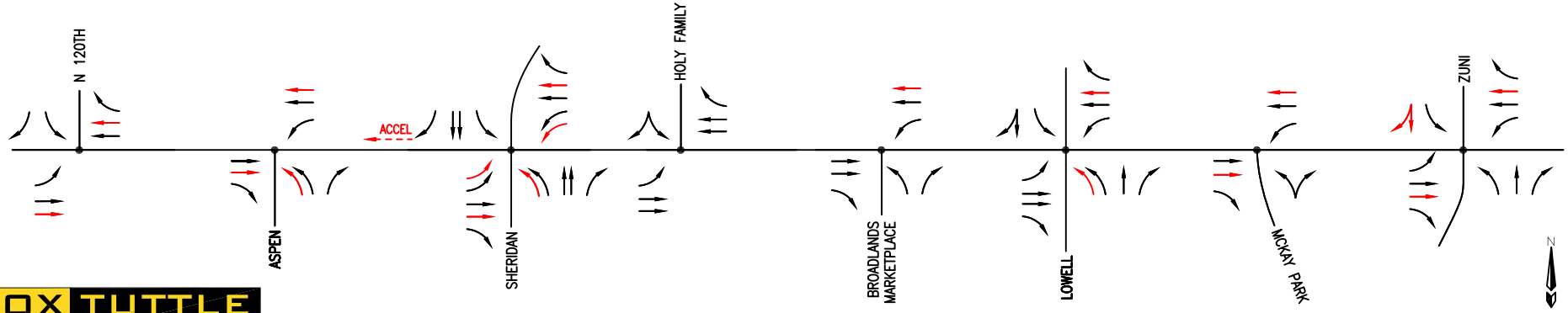
AUX = AUXILIARY THROUGH LANE (TERMINATES DOWNSTREAM OF INTERSECTION)



NEAR TERM IMPROVEMENTS



YEAR 2035 with 4-LANES



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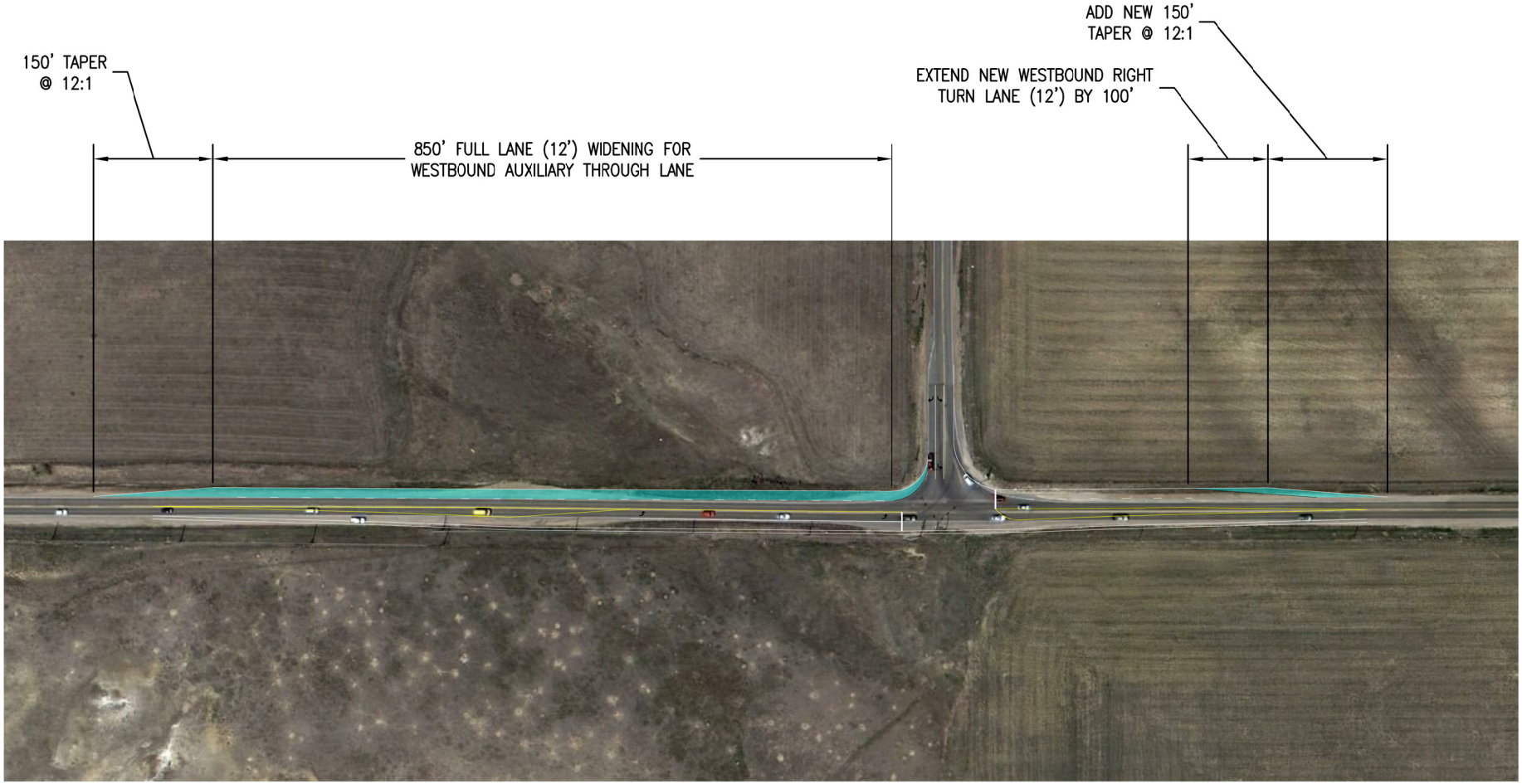
144TH AVENUE CORRIDOR STUDY

SIGNALIZED INTERSECTION LANEAGE RECOMMENDATIONS

DAVID EVANS AND ASSOCIATES INC.

FT Project #	12024	Original Scale	NTS	Date	12/18/12	Drawn by	SGT	Figure #	6



RECOMMENDED IMPROVEMENTS:

- ADD WESTBOUND AUXILIARY THROUGH LANE

N

0 50 100 200

SCALE IN FEET

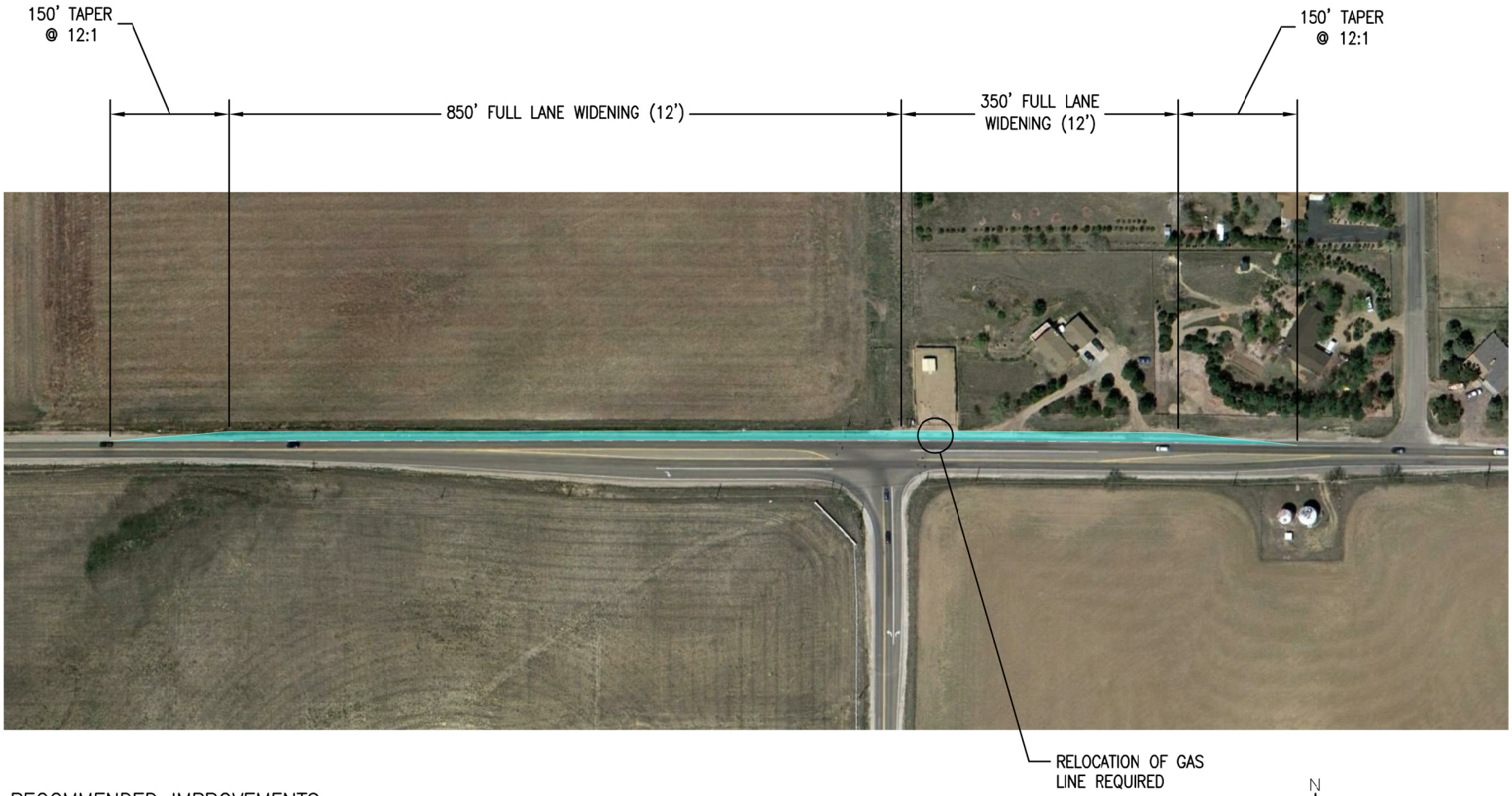
FOX TUTTLE
TRANSPORTATION GROUP

144TH AVENUE CORRIDOR STUDY

NEAR TERM INTERIM IMPROVEMENTS - DILLON RD & 120TH ST

DAVID EVANS AND ASSOCIATES INC.

FT Project #	12024	Original Scale	1"=200'	Date	12/17/12	Drawn by	SGT	Figure #	7



RECOMMENDED IMPROVEMENTS:

- ADD WESTBOUND AUXILIARY THROUGH LANE

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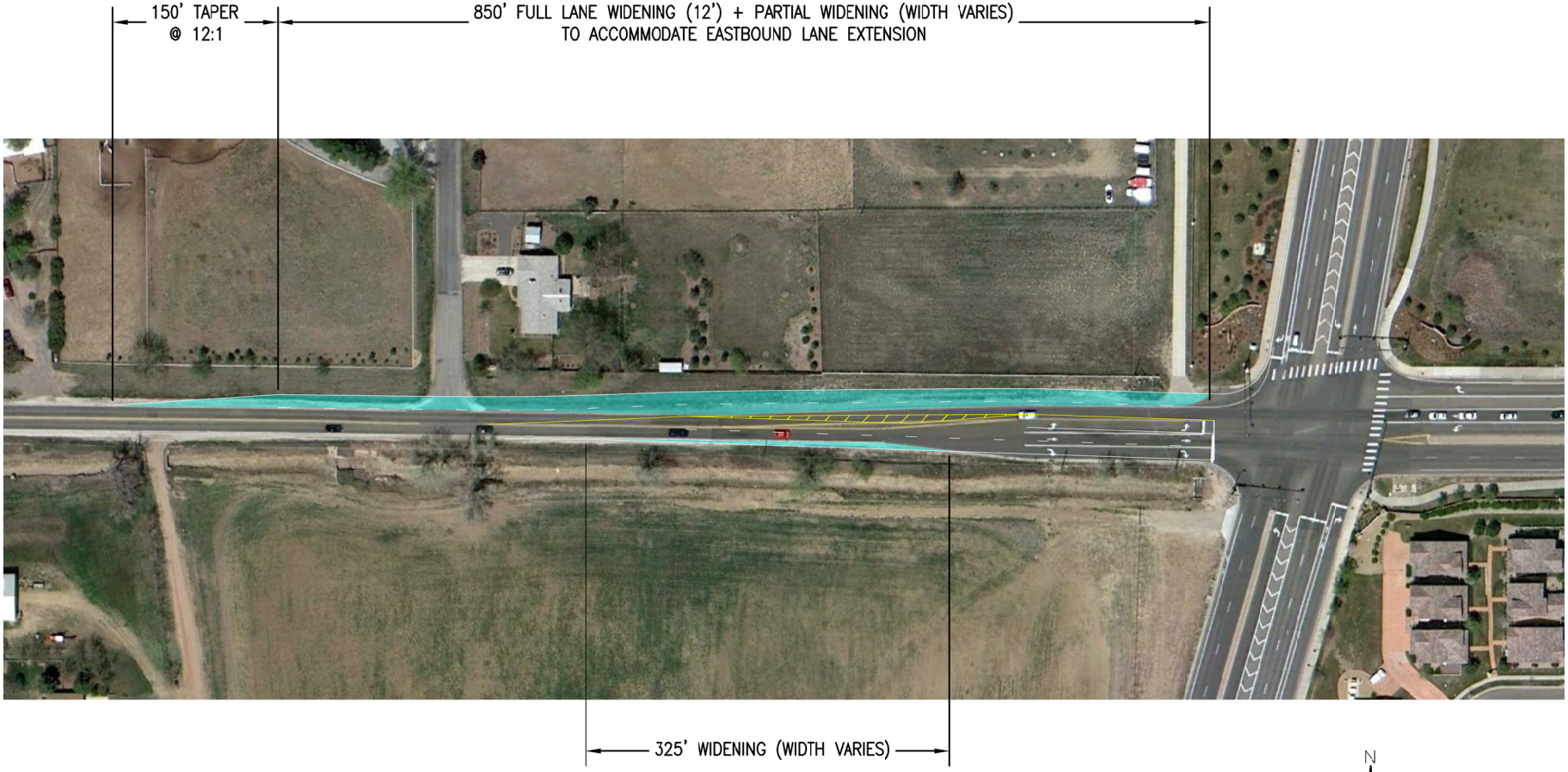
144TH AVENUE CORRIDOR STUDY

NEAR TERM INTERIM IMPROVEMENTS - DILLON RD & ASPEN ST

DAVID EVANS AND ASSOCIATES INC.

FT Project #	12024	Original Scale	1"=200'	Date	12/17/12	Drawn by	SGT	Figure #	8



RECOMMENDED IMPROVEMENTS:

- ADD WESTBOUND AUXILIARY THROUGH LANE (ONLY FAR-SIDE WIDENING REQUIRED)
- ADD EASTBOUND AUXILIARY THROUGH LANE (ONLY NEAR-SIDE WIDENING REQUIRED)

N

0 75 150

SCALE IN FEET

FOX TUTTLE TRANSPORTATION GROUP

144TH AVENUE CORRIDOR STUDY

NEAR TERM INTERIM IMPROVEMENTS - 144TH AVE & SHERIDAN PKWY

DAVID EVANS AND ASSOCIATES INC.

FT Project #	12024	Original Scale	1"=150'	Date	12/17/12	Drawn by	SGT	Figure #	9