City and County of Denver

Vision Zero Road Safety Audit

Chambers Road

SEPTEMBER 12 2020

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NOT FOR CONSTRUCTION – Recommendations contained in this document are intended ONLY for use by the local agency in determining possible future changes at the RSA location.

Information provided in this report does not reflect the opinion of any one team member. The recommendations reflect the collective suggestions of all team members based on their individual education, training, and experience.

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City and County of Denver RSA Process

The Denver Vision Zero Action Plan is a five-year plan to achieve zero traffic deaths and serious injuries by 2030. The Denver Vision Zero program provides traffic safety professionals a unique opportunity to work as part of a dedicated traffic safety improvement program by collaborating with law enforcement, first-responders, government officials, and other stakeholders. The Chambers Road Road Safety Audit (RSA) is the first of four RSAs and commences the City and County of Denver’s (CCD) formal Vision Zero RSA program.

The corridor of Chambers Road is part of Denver’s High Injury Network (HIN). The HIN has been identified in CCD as part of the Vision Zero initiative as the network of corridors with the highest number of fatal and injury crashes for all modes of travel. The choice of the four RSA corridors is driven by their proximity to the Equity Index Areas, i.e. areas of Denver where more vulnerable populations live. As stated in Denver’s Vision Zero statement, these areas are places with higher speeds, in closer proximity to schools and high school density, elderly populations, disability populations, and those with no vehicle ownership.

RSAs are formal examinations of selected roadway entities from a safety performance viewpoint. All RSAs are performed by an independent, multi-disciplinary team and are highly benefited by including one or more professionals trained in performing RSAs. An RSA qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. RSAs can be used in any phase of project development from planning and preliminary engineering, design and construction. RSAs can also be used on any sized project from a minor intersection and roadway retrofits to long corridors. The RSA team considers the safety of all road users, qualitatively estimates and reports on potential road safety issues and identifies opportunities for safety improvement. The RSA team reviews police crash reports and conducts field observations during different times of the day such as day/night and peak/non-peak hours.

Figure 1 Project Location Map
RSA Team

The independent, multi-disciplinary RSA team was led by Yung Koprowski of Y2K Engineering. The RSA team included:

- Yung Koprowski, Y2K Engineering (Chambers Road RSA Lead)
- Gaurav Vasisht, Felsburg Holt & Ullevig (CCD VZ RSA Consultant Team Leader)
- Charles Alexander, Fehr & Peers
- Patrick Picard, Fehr & Peers
- Chris Sobie, Y2K Engineering

On-site interviews were conducted with:

- Officer Kiarra Jenkins, Denver Police Department
- Assistant Chief Daniel Sadler, Denver Fire Department

The RSA team conducted this audit to the best of its abilities within the time allotted. The initial recommendations are based upon background information provided during the Kick-Off and Preliminary Findings Meeting, a limited evaluation of recent crash data, and both day and night field reviews, as discussed in the following paragraphs. This information assisted the RSA team identify potential opportunities to improve the safety performance of Chambers Road including intersections with 40th Ave, 46th Ave, Bolling Dr, Gateway Ave/Green Valley Ranch Blvd, 52nd Ave, 53rd Ave, Maxwell Pl, 56th Ave, and the 4800/5100 block. This information was initially presented to the group at the Preliminary Findings Meeting. While every attempt has been made to identify potential safety issues, the safety performance of the roadway remains the responsibility of the roadway owner and roadway users.

Background Information, Observations, and Recommendations

The following sections describe the background information, crash review, comments from the RSA Pre-Audit Meeting, observations from the field review, and recommendations for the Chambers Road corridor and for each study intersection. A comprehensive list of all recommendations including location, recommendation, observation addressed, crash modification factors, return on investment, and planning-level cost estimate is included in Appendix A.

Pre-Audit Meeting

The RSA team met with CCD staff Mike King (CCD Project Manager), Rolf Eisinger, David DiGiacomo, Alex Koupriievitch, and Dana Hoffman; DPD Lieutenant Robert Rock; and District 11 Council Aide Melissa Sotelo to discuss background information and the RSA schedule on Monday, July 20th, 2020, virtually on Microsoft Teams. The RSA Pre-Audit Meeting Presentations can be found in Appendix B. Information presented and discussed at the Kick-Off Meeting are included in this section under background information, crash review, and comments provided by City Staff and RSA stakeholders.

Observation Process

The RSA team began the observation period by driving the Chambers Road corridor in both directions in its entirety, followed by driving every approach to each intersection. The corridor wide observations are based on the general observations made by the RSA team during the windshield review and while conducting the walking field reviews. Observations included traffic signal operations, ADA facility conditions including ramps and sidewalks, bicycle infrastructure, spot speed measurements with a speed gun, lane and sidewalk widths with a measuring wheel, vertical elements with a tape measure, and windshield review.
Daytime field reviews were conducted on Monday, July 20, 2020, from 3:00 PM to 5:00 PM, and Tuesday, July 21, 2020 from 7:00 AM to 9:00 AM, and from 12:30 PM to 1:30 PM. Nighttime field inspection occurred on Monday, August 20, 2020, from 8:00 PM to 9:30 PM. The specific times of the site visits can be found on the RSA Intent Memorandum, a copy of which is located in Appendix C. The weather was clear with a mean high temperature of 85 degrees. The observation periods consisted of driving and walking the road and observing road users.

Information provided in this report does not reflect the opinion of any one team member.

Recommendation Process

The recommendations reflect the collective suggestions of all team members based on their individual education, training, and experience. The safety and mobility of all road users are considered. The recommendations listed below have been grouped into:

i. Short-term: (Less than 1 year) Denoted by a green circle
   
ii. Medium-term: (1 to 3 years) Denoted by a blue square
   
iii. Long-term: (More than 3 years) Denoted by a black diamond

The RSA team presented the preliminary findings to CCD staff Mike King (CCD Project Manager), Rolf Eisinger, David DiGiacomo, Alex Kouprievitch, and Dana Hoffman; DPD Lieutenant Robert Rock; and Council Aide Melissa Sotelo on Thursday, July 23, 2020, virtually on Microsoft Teams. Observations and potential opportunities for improvements were discussed during this meeting. The presentation slides from this meeting are provided in Appendix D.
Chambers Road Corridor

The following section provides background information, observations, and recommendations for the Chambers Road corridor as a whole including intersection geometry, user behavior, signal control, and multimodal infrastructure.

Background Information

Chambers Road is a north-south arterial consisting of three travel lanes in each direction south of Gateway Ave/Green Valley Ranch Blvd, and two travel lanes in each direction north of Gateway Ave/Green Valley Ranch Blvd. Throughout the project limits the posted speed limit on Chambers Road is 40 MPH. There are sidewalks on both sides of Chambers Road throughout the project limits. The sidewalk on the east side is buffered by a 10-foot landscape strip behind the curb line and the sidewalk on the west side is within a utility easement and varies from behind the curb to 75-feet from the curb. There are no bike lanes on Chambers Road. Annual Average Daily Traffic (AADT) varies within the project limits from 35,800 near the south end to 14,800 near the north end. There are three RTD transit routes that use Chambers Road within the project limits; 42, 45, and 121.
Crash Review

Between March 2017 and March 2020 there were a total of 294 crashes on Chambers Road within the RSA project limits:

- Four fatal crashes occurred on Chambers Road at Andrews Dr, 46th Ave, the 4800 Block, and the 4900 Block
- 17 reported fatal and serious injury (KSI) crashes
- Five crashes involved pedestrians or cyclists
- 39% Rear End
- 23% between 3 PM and 6 PM

![Crashes by Location (3/14/2017 to 3/15/2020)](image)

**Figure 4 Crashes by Location (3/14/2017 to 3/15/2020)**

Crash Data Summary

The following summarizes the corridor wide crash data and presents common trends at intersections and along segments.

- Spot speed samples collected by the RSA team and comments provided by RSA stakeholders indicate motorist’s speed along the corridor is likely a factor contributing to left-turn related crashes at intersections, rear end crashes, and red light running (particularly at 40th Ave).
- Left-turn crashes at intersections accounted for 35% of KSI crashes in the corridor, which may be influenced by left-turn operation and intersection geometry.
- Pedestrian activity and crossing of Chambers Road represent 18% of KSI crashes in the corridor, particularly in the 4800/5100 Block of Chambers Road.
- The highest crash frequency occurred during afternoon peak hours and evenings.
- The highest crash frequency at intersections of Chambers Road occurred at 40th Ave, Andrews Dr, and Green Valley Ranch Blvd.

**Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting**

- Speeding is prevalent throughout the corridor. Residents have heard drag racing activity throughout the night.
- Red-light running is an issue especially at the three furthest south intersections.
- Many pedestrian mid-block illegal crossings throughout corridor. DPD has been noticing more conflicts with pedestrians and cyclists.
- Throughout the corridor permitted left-turns have been an issue.
Observations

The following section summarizes things well done along the corridor and general observations that apply to the project corridor as a whole.

Things Well Done

The RSA team noted several existing roadway features that appear to foster safer operations in the study area including:

- The raised medians and ¾ access points along the corridor provide good access control that promotes safety.
- Sidewalks are separated from the roadway with wide landscape buffers of ten feet or more. Trees planted in these buffers provide shade for non-motorized road users.
- There is a speed feedback sign for Chambers Road in the northbound direction near Bolling Dr.
- There is video-based vehicle detection that appears to be working for every intersection within the project limits.
- There are adequate RTD transit routes to serve the area residents.
- Side street pedestrian crossings at intersections rest in WALK.
- Most of the streetlights along Chambers Road were functional and provided consistent lighting.
- There are school crossing signs in advance of the intersections with crossings that serve the Montbello Recreation Center.
- The northbound lagging left turn operation at the intersection of Chambers Road/46th Ave cleared vehicles out of the intersection before the conflicting eastbound phase.
- Black contrast pavement markings were installed where concrete pavement sections existed.
- R4-7 Keep Right (symbol) signs were installed at the ends of all raised medians along Chambers Road.
- The R2-1 Speed Limit signs, R4-7 Keep Right (symbol) signs, and white pavement markings had good retroreflectivity at night.
- The following road users were observed along the corridor:
  - i. Vehicles
  - ii. Tractor Trailers
  - iii. School buses
  - iv. Motorcycles
  - v. Bicyclists
  - vi. Pedestrians
  - vii. RTD Buses

![Figure 5 Observed Road Users](image-url)
• Though a corridor speed study had not been conducted prior to this RSA, the RSA team observed several occurrences of motorists travelling at high speeds. Using a radar gun, the RSA team observed free flow speeds of 35 mph to 64 mph. Typical speeds likely exceed the 40-mph posted speed limit.
• Left-turn operation on the corridor varies. The RSA team observed permissive, permissive-protected, and protected-only operation at different locations on the corridor.
• Some signalized intersections on the corridor feature countdown pedestrian signals; however, others do not. The RSA team did not do a complete inventory of countdown pedestrian signals.
• Some signalized intersections on the corridor feature Opticom for emergency vehicle preemption; however, others do not. The RSA team did not do a complete inventory of Opticom devices. Staff from the Denver Fire Department specifically mentioned that due to the position of Opticom at westbound Green Valley Ranch Boulevard approaching Chambers Road they have difficulty triggering the system.
• The RSA team did not complete a detailed review of signal timings on the corridor. However, crash analysis revealed some crashes that may be addressed via changes to yellow change, red clearance, leading pedestrian intervals, and signal coordination via progression speed.

The Chambers Road RSA looked at pedestrian facilities at each intersection and along segments between intersections. Even though this audit was not a comprehensive ADA compliance audit, good ADA and pedestrian facility design practices and recommendations were kept in consideration. The following summarize some of the key aspects considered:
• Curb ramps widths: In general, the curb ramp widths were adequate and did not narrow excessively as compared to approaching sidewalk width.
• Curb ramp clear landing areas: Inadequate landing areas were noted at multiple intersection locations and channelizing islands along the corridor. These locations are identified in the following sections in the individual intersection sections.
• Push button location: In general, push button locations were in compliance with MUTCD requirements.
• Pedestrian signal visibility: Pedestrian signals had good visibility in general.
• Direction vs. diagonal curb ramps: Most of the curb ramps were diagonal ramps, which is not recommended. However, as required for ADA compliance, new construction in the corridor provide for directional ramps.
• Detectable warnings/truncated domes: Multiple locations along the corridor did not have adequate detectable warnings.
• Clearly defined conflict points: There was ambiguity associated at diagonal ramp locations that led to potential unsafe pedestrian-vehicle conflicts.
• Sidewalk condition, width and offset from roadway: Except for a few locations with noted concrete heaving, the sidewalks in the corridor were in good condition and were detached from the roadway providing for a positive pedestrian experience. Additionally, sidewalk width was noted to be generally adequate and no gaps in pedestrian facilities along either side of the Chambers Road were noted.

Recommendations

The following recommendations are based on the collaborative effort of the RSA multidisciplinary team and stakeholder interviews. Corridor wide recommendations are based on the team’s experience driving and walking the corridor.

1. The RSA team recommends a speed study on the corridor to understand existing operating speeds. This information can be used to inform left-turn operation and signal timings. The RSA team
recommends establishing signal coordination via the target operating speed but using actual operating speed to determine left-turn operation, yellow change intervals, and red clearance times.

2. The City has a draft Procedure Statement on left-turn arrows based primarily on crash history. However, this Procedure Statement does not address differences between permissive-only, permissive-protected, and protected-only operation. The RSA team recommends that the City develop, adopt, and apply more robust guidance for left-turn operation that is adapted to Vision Zero principles. The City of Boulder’s guidelines are a best-practice and account for number of lanes, bicyclist/pedestrian volumes, traffic volumes, operating speed, crash history, and Level of Service. As the City and County of Denver’s Procedure Statement is not formally approved, the RSA team applied the City of Boulder’s guidelines to intersections to prepare recommendations for this RSA.

3. Where changes to left-turn operation are recommended, the RSA team recommends four-section heads with flashing yellow arrows. Four-section heads allow the City to operate left-turns differently by time of day. Operating permissive-protected left-turns with a lagging protected phase can avoid the “yellow trap”.

4. The RSA team recommends that the City install Opticom at all signalized intersections. Additionally, the RSA team recommends that the City reposition the westbound Opticom receiver at the Green Valley Ranch Boulevard/Chambers Road intersection based on Denver Fire Department feedback.

5. The City should address ADA compliance issues for curb ramps and landing areas per the existing city-wide process.

6. Left-turn offset is defined as the lateral distance between the left edge of a left-turn lane and the right edge of the opposing left-turn. If the right edge of the opposing left-turn lane is to the left of the left edge of the left-turn lane, the offset is defined as “negative”. If it is to the right, the offset is defined as “positive”. Throughout the Chambers Road corridor, most of the opposing left-turns would be defined as negative offset left-turns. Negative offset left-turns impose safety challenges as left-turning vehicles cannot see opposing through vehicles because opposing left-turning vehicles are blocking the line of sight. It is recommended the City investigate Chambers Road left-turn lanes throughout the corridor for negative offset left-turn challenges and reconstruct those challenge locations to have no or positive offset left-turns.

![Figure 6 Negative vs positive offset left-turns](image)

**Pavement and Sign Maintenance**

The review team drove Chambers Road and every approach of each study intersection. Northbound Chambers Road was recently repaved and was generally in good condition. Southbound Chambers Road, which is scheduled for repaving later this year, was in poor condition and will benefit from the paving project. Except for approaches with no striping or as noted in this report, the existing striping and pavement markings
throughout the project limits were in good condition. A night review of the corridor showed most signs have
good retroreflectivity. Sign maintenance is recommended at locations including the east leg of Chambers Road
and 40th Ave to turn R4-7 sign the other direction to face eastbound traffic, a missing S1-1 pedestrian crossing
sign before Gateway Rd/Green Valley Ranch Blvd, and a right-turn only regulation sign laying on the ground for
the northbound right-turn at Chambers Road and 56th Ave. It is recommended to post mount R3-7 Right Lane
Must Turn Right adjacent to and along the full width portion of dedicated right turn lanes. These signs would
replace any existing Mandatory Movement Lane Control word message signs. Mandatory Movement Lane
Control signs should be accompanied by lane-use arrow markings.
Chambers Road and 40th Ave

Background Information
At the intersection with 40th Avenue, northbound and southbound Chambers Road consists of three through lanes, one dedicated northbound left-turn lane, two southbound left turn lanes, sidewalks on both sides, and no bike facilities. The southbound left-turn operates as a protected-only left-turn. The northbound left-turn operates as protected/permitted left-turn controlled by a 5-section “doghouse” style signal head. There are marked pedestrian crossings across all legs except the south leg of the intersection. Chambers Road has a posted speed limit of 40 MPH and the average daily traffic is approximately 35,800 vehicles per day (vpd).

40th Ave is an arterial road. The profile of 40th Ave is different east of Chambers Road than west of Chambers Road. West of Chambers, 40th Ave consists of one through lane in each direction, a sidewalk only on the north side, no posted speed, and no bike facilities. East of Chambers Road, 40th Ave consists of two through lanes in each direction with a median, sidewalks on both sides, and a posted speed limit of 40 MPH. At the intersection with Chambers Road, the westbound approach consists of two left turn-lanes, one through lane, and one right turn-lane, while the eastbound approach consists of a shared through/right turn-lane and a left-turn lane. The westbound left-turn lane is operated as a protected-only and the eastbound left-turn lanes operates as a permissive left-turn.

Crash Review
Between March 2017 and March 2020 there were a total of 51 crashes at the intersection of Chambers Road and 40th Ave:

- There were zero KSI crashes
- 45% rear end crashes
- 32% caused by following too closely
- 29% broadside crashes (broadside crashes are left turn related caused by failing to yield right-of-way or careless driving)
- 17% caused by running the red light
- 50% of rear end crashes were southbound
Seven of the eight incidents involving red light running occurred in the southbound or northbound direction.

Table 1 Chambers Road and 40th Ave Crash Summary

<table>
<thead>
<tr>
<th>Harmful Event</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
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<tbody>
<tr>
<td>Total Crashes</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>45%</td>
<td>22%</td>
<td>8%</td>
<td>24%</td>
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<tr>
<td>Broadside</td>
<td>29%</td>
<td>-</td>
<td>-</td>
<td>43%</td>
<td>29%</td>
<td>7%</td>
<td>21%</td>
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<tr>
<td>Rear End</td>
<td>45%</td>
<td>-</td>
<td>-</td>
<td>50%</td>
<td>18%</td>
<td>9%</td>
<td>23%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>0%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Driver Action</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Followed Too Closely</td>
<td>32%</td>
<td>-</td>
<td>-</td>
<td>33%</td>
<td>20%</td>
<td>13%</td>
<td>33%</td>
</tr>
<tr>
<td>Failed to Yield ROW</td>
<td>4%</td>
<td>-</td>
<td>-</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>Ran Red Light</td>
<td>17%</td>
<td>-</td>
<td>-</td>
<td>50%</td>
<td>38%</td>
<td>0%</td>
<td>13%</td>
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<table>
<thead>
<tr>
<th>Movement</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Turn</td>
<td>12%</td>
<td>-</td>
<td>-</td>
<td>33%</td>
<td>50%</td>
<td>0%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting

- The pedestrian clearance time for the north leg crosswalk is not adequate to serve older persons coming from Sable Ridge Senior Residences which is located just west of the intersection.
- Pedestrians have been observed illegally crossing the south leg of the intersection which is closed and has no crossing signs posted.
- Hotels along 40th Avenue generate crowds of people crossing the intersection of Chambers Road and 40th Avenue, especially when conferences and conventions are in session.

Observations

The following observations were made by the RSA Team during the morning, afternoon, and evening field reviews.

- Queuing
  - Poor southbound lane utilization with traffic queuing in right-lane to enter a single I-70 westbound ramp entrance.
  - High volume rear end crashes and red-light running crashes, particularly southbound.
- Pedestrian Activity
  - Pedestrian crossing time across Chambers Road too short for senior walk pace (adjacent senior living facility).
  - High volumes of pedestrians reported when hotels have conventions.
  - No marked pedestrian crosswalk across Chambers Road on the south leg.
- Left Turn Operations
  - The signal phasing is confusing for eastbound left-turn movement as it occurs after the westbound left-turn phase and is not apparent to drivers in the eastbound direction that the westbound direction still has a green phase.
  - The alignment of the west leg makes it difficult to see the signal heads (see Figure 10).
  - Left-turn crashes at this intersection are associated primarily with the northbound left-turn and eastbound left-turn, both of which have permissive phases.
Recommendations

Making improvements to address the poor lane utilization southbound, enhance pedestrian crossings, and modify left-turn operations will improve the safety for all road users.

7. Lengthen the current walk time across Chambers Road (add time to flashing don’t walk phase – 9 seconds is observed to be available from the westbound phase following the westbound left-turn phase).

8. Adjust eastbound left-turn signal phasing by adding flashing yellow turn arrow or install a W25-1 sign.

9. Convert the northbound left-turn signal phasing to protected-only.

10. Add a traffic signal head for the eastbound approach on the back side of the near side signal pole (northwest corner).

11. Study pedestrian activity when normal hotel activity resumes to determine if there should be a crosswalk across the south leg of the intersection.

12. Study converting the I-70 westbound ramps to a 2-lane right turn from southbound Chambers Road.
Figure 13 Chambers Rd and 40th Ave Recommendation Map
Chambers Road and Andrews Dr

**Background Information**

At the signalized intersection with Andrews Dr, northbound and southbound Chambers Road consists of three through lanes, a dedicated left-turn lane, sidewalks on both sides, and no bike facilities. Both the northbound left-turn and southbound left-turn operate as a protected/permited left-turn controlled by a 5-section “doghouse” style signal head. In the vicinity of Andrews Dr, Chambers Road has a posted speed limit of 40 MPH and the average daily traffic is approximately 35,800 vpd.

Andrews Dr is a collector with one travel lane in each direction, sidewalks on both sides, a posted speed limit of 25 MPH, and no bike facilities. At the intersection with Chambers Road, both the westbound and eastbound approaches consist of a shared through-right lane and a dedicated left-turn lane. Both left-turn lanes operated as permitted left-turns which are controlled by a 3-section signal head.

![Figure 14 Chambers Road and Andrews Dr](image)

**Crash Review**

Between March 2017 and March 2020 there were a total of 62 crashes at the intersection of Chambers Road and Andrews Dr:

- Six reported KSI crashes and one reported fatal crash
- Four of the six KSI crashes were left-turn crashes caused by failing to yield right-of-way
- The other two KSI crashes were rear-end crashes in the southbound direction
- Five incidents involved red light running in the southbound direction
- 40% rear end crashes
- 33% broadside crashes
- 27% caused by failing to yield right-of-way
- 25% caused by following too closely

Table 2 Chambers Road and Andrews Dr Crash Summary

<table>
<thead>
<tr>
<th>Harmful Event</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Crashes</td>
<td>61</td>
<td>6</td>
<td>1</td>
<td>38%</td>
<td>36%</td>
<td>19%</td>
<td>7%</td>
</tr>
<tr>
<td>Broadside</td>
<td>33%</td>
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<td>100%</td>
<td>40%</td>
<td>30%</td>
<td>20%</td>
<td>10%</td>
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<tr>
<td>Rear End</td>
<td>40%</td>
<td>33%</td>
<td>0%</td>
<td>33%</td>
<td>46%</td>
<td>17%</td>
<td>4%</td>
</tr>
<tr>
<td>Head On</td>
<td>10%</td>
<td>33%</td>
<td>0%</td>
<td>33%</td>
<td>17%</td>
<td>33%</td>
<td>17%</td>
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<td>Pedestrian</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Driver Action</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Followed Too Closely</td>
<td>25%</td>
<td>17%</td>
<td>0%</td>
<td>33%</td>
<td>40%</td>
<td>27%</td>
<td>0%</td>
</tr>
<tr>
<td>Failed to Yield ROW</td>
<td>27%</td>
<td>50%</td>
<td>100%</td>
<td>13%</td>
<td>38%</td>
<td>31%</td>
<td>19%</td>
</tr>
<tr>
<td>Ran Red Light</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

| Movement | Left Turn | 32% | 67% | 100% | 21% | 47% | 16% | 16% |

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting

- There are long wait times for drivers making permissive left-turns from Andrews Dr onto Chambers Road in both the eastbound and westbound direction.
- There are persistent conflicts between westbound left-turns and eastbound right-turns most likely due to current signal operations and driver impatience.
- Vehicles have been observed making left-turns from Andrews Dr several seconds into the all-red phase.
- Drivers have a difficult time judging gaps when making a left off Chambers Road as opposing drivers are exceeding 45 MPH, particularly in the southbound direction.
- Traffic queues will sometimes extend past the northbound left turn lane leading drivers to erratically weave around the congestion and turn left at 46th Ave.

Observations

The intersection of Chambers Road and Andrews Dr has gas stations on the northeast and southeast corner with access driveways just north, east, and south of the intersection. Paired with the neighborhood access served by the west leg of the intersection, there were many turning vehicles and lane changes observed at this intersection.

- Vehicles were observed red light running, specifically in the southbound direction.
- Drivers are hesitant to make the permitted westbound left-turn movement due to the potential conflict with eastbound through vehicles, although most eastbound vehicles were making a right turn.
- There is a southbound lane imbalance resulting in queuing in the curb lane due to drivers positioning to access I-70 westbound.
- The northbound left-turn queue was observed spilling back outside of the storage bay length.
- Vehicles were observed leaving the driveway just south of the intersection and crossing all three travel lanes to access the northbound left-turn lane.
- The northbound and southbound left turns have a negative offset contributing to sight distance issues.
Recommendaions

The intersection appeared to be at capacity and due to the current lane assignment recommendations are focused on capacity that are expected to contribute to safer operations.

13. Retime the intersection to improve coordination among 40th Ave, Andrews Dr, and 46th Ave.
15. Change the lane configuration by restriping the west leg to have an exclusive right-turn lane, through lane, and exclusive left-turn lane.
16. Pull back medians and add carrot striping to remove negative offset for the northbound left-turn and southbound left-turn lanes.
Figure 18 Chambers Road and Andrews Dr Recommendations Map and Illustration
Chambers Road and 46th Ave

Background Information

The intersection of Chambers Road and 46th Ave is a three-legged signalized intersection with 46th Ave only having an eastbound approach. This intersection is approximately 550 feet north of the intersection of Chambers Road and Andrews Dr. In the vicinity of 46th Ave, Chambers Road consists of three travel lanes in both directions, sidewalks on both sides, and no bike facilities. The northbound approach consists of three through lanes and a dedicated left-turn lane that operates as a permitted/protected left-turn controlled by a 5-section “doghouse” style signal head. The southbound approach consists of two through lanes and a shared through/right-turn lane. Chambers Road has a posted speed limit of 40 MPH and average daily traffic of approximately 35,800 vpd.

46th Ave is a collector with two travel lanes in each direction which are separated by a 40-foot wide median. At the intersection with Chambers Road, the eastbound approach consists of a dedicated left-turn lane and a dedicated right-turn lane. 46th Ave serves as a corridor for the RTD Transit Line 42, has a posted speed limit of 25 MPH, and a 2011 average daily traffic of 4,800 vpd. There are sidewalks on both sides of 46th Ave but there are only marked crosswalks across the west and south legs. There are no bicycle facilities on 46th Ave.

Crash Review

Between March 2017 and March 2020 there were a total of 22 crashes at the intersection of Chambers Road and 46th Ave:

- All reported crashes involved drivers on Chambers Road in the northbound or southbound direction
- There were two KSI crashes and one fatality
- The fatal crash was a southbound rear end crash
- One reported crash involved a pedestrian crossing Chambers Road outside of the crosswalk
- All broadside crashes were left-turn related caused by red light running, failing to yield, or speeding
- 35% rear end crashes
- 30% broadside crashes
- 22% caused by following too closely
- 17% caused by red light running

**Table 3 Chambers Road and 46th Ave Crash Summary**

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
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<td>Total Crashes</td>
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<td>43%</td>
<td>0%</td>
<td>17%</td>
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<tr>
<td>Broadside</td>
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<td>14%</td>
<td>43%</td>
<td>0%</td>
<td>43%</td>
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<tr>
<td>Rear End</td>
<td>35%</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>4%</td>
<td>50%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Driver Action</th>
<th>Followed Too Closely</th>
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<th>0%</th>
<th>60%</th>
<th>40%</th>
<th>0%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Failed to Yield ROW</td>
<td>17%</td>
<td>0%</td>
<td>0%</td>
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<td>25%</td>
<td>0%</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>Ran Red Light</td>
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<td>0%</td>
<td>50%</td>
<td>25%</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>Movement</td>
<td>Left Turn</td>
<td>26%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>0%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting

- The timing interval for eastbound may be short as vehicles have been observed in the intersection during the all red phase.

**Observations**

The three-legged intersection of Chambers Road and 46th Ave has a 40 foot median on the left leg which results in a long travel path to clear the intersection for northbound left-turning vehicles

- Northbound left-turning vehicles were observed waiting approximately 80 feet past the stop bar waiting to complete their permitted left-turn movement.
- The northbound left-turn operates as a lagging left-turn which was observed to adequately clear vehicles from the intersection before the conflicting eastbound phase begins.
- There are only crosswalks on the west and south legs of the intersection.

*Figure 20 Northbound left-turning vehicle waiting 80 feet past the stop bar*
**Recommendations**

To ease driver frustration, the traffic signal at Chambers Road and 46th Ave should be timed in coordination with Chambers Road/Andrews Dr and Chambers Road/40th Ave.

17. Double yellow and white channelizing striping should be applied past the end of the south median to help delineate the waiting position for the northbound left-turn movement.

18. Install a dashed stripe for northbound left-turn guidance.

*Figure 21 Chambers Road and 46th Ave Recommendations Map and Illustrations*
Chambers Road and Bolling Dr

Background Information

Bolling Dr is classified as a collector roadway, consists of one travel lane for both the eastbound and westbound directions, is stop controlled, has sidewalks on both sides of the street, and no bicycle facilities are present. This 3/4 access intersection has a median in the middle which only allows right-out, right-in, and left-in movements. The posted speed limit on Bolling Dr is 25 MPH. The east leg of Bolling Dr was built in 2018 to accommodate a new residential development and terminates approximately 0.80 miles to the east of Chambers Road. The west leg of Bolling Dr serves residential homes and schools. Approximately 0.75 miles from Chambers Road, Bolling Dr provides access to Maxwell Elementary School, STRIVE prep, Noel Community Arts School, and Montbello Central Park. The road increases from one lane in each direction to two lanes in each direction with a center median west of 51st Ave.

![Figure 22 Chambers Road and Bolling Dr](image)

Crash Review

Between March 2017 and March 2020 there were a total of nine crashes at the intersection of Chambers Road and Bolling Dr.

- The primary types of collisions at this intersection are associated with making a northbound left-turn
- 38% rear end crashes
- 33% caused by failing to yield right-of-way
- 25% broadside crashes
- 22% caused by lane violation (defined as an instance where any tire of a straight moving vehicle touches the road surface marking in the mid-block segment).
Table 4 Chambers Road and Bolling Dr Crash Summary

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Crashes</td>
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<td>0</td>
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<td>71%</td>
<td>14%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>Broadside</td>
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<td>-</td>
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<td>100%</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>Rear End</td>
<td>38%</td>
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<td>-</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>0%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Driver Action</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Followed Too Closely</td>
<td>17%</td>
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<td>-</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Failed to Yield ROW</td>
<td>33%</td>
<td>-</td>
<td>-</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Movement</td>
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<tr>
<td>Left Turn</td>
<td>29%</td>
<td>-</td>
<td>-</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting

- Vehicles have been observed making an illegal left-turn from eastbound Bolling Dr to northbound Chambers Road.
- There is a planned new development on the east side of Chambers Road. The new development may be responsible for a traffic signal warrant study at the intersection of Chambers Road/Bolling Dr.

Observations

The intersection of Chambers Road and Bolling Dr provides access to residents to the east and west. This partial ¾ intersection prohibits left turns from Bolling Dr onto Chambers Road thereby forcing residents east of Chambers Road to take Kittredge St to complete their desired movements toward I-70 to the south or 56th Ave to the north.

- There was damage to the median island which indicates drivers are making illegal eastbound left-turns.
- There were several observed northbound to southbound U-turns.
- There is no stop bar for the eastbound approach. Drivers were observed rolling the stop sign.
- One near miss was observed between an eastbound right turning vehicle and a bicyclist crossing from south to north on the west side of Chambers Road.
- The northbound left turn vehicle path does not align with the west leg receiving lane.
- The intersection was well lit at night.
- There are no crosswalks or facilities to facilitate safe crossing across Chambers Road for pedestrians.
- East of Chambers, residents must currently route to the north or south to make their way to the interstate.
Recommendations

Maintaining the striping, signing, and raised median will make the intersection stand out to drivers in both the day and night. Greater awareness of stop lines, medians, and crosswalks will improve safety for all road users.

19. Add eastbound and westbound stop bars.
20. Add crosswalk across the west leg of the intersection.
21. Add raised pavement markers to the top of the median.
22. Bring northbound and southbound turns closer together so the northbound left aligns better with west leg. Add supplemental flex posts to prevent illegal left turns.
23. Reduce curb radius on the southwest corner.
24. Further study converting current stop-controlled intersection to a Z-style partial signal or pedestrian hybrid beacon.
25. Study Overall access to southwest Gateway Ave/Green Valley Ranch Blvd and perform a signal warrant analysis at Chambers Road and Bolling Dr, and Kittredge St and Green Valley Ranch Blvd.
Figure 26 Chambers Road and Bolling Dr recommendation map

Figure 27 Partial signal concept

Figure 28 Access control for new development
Chambers Road and Gateway Ave/Green Valley Ranch Blvd

Background Information

At the signalized intersection with Gateway Ave/Green Valley Ranch Blvd, Chambers Road has two travel lanes in the northbound direction and three travel lanes in the southbound direction. The southbound direction transitions from two travel lanes to three travel lanes approximately 150 feet north of the intersection. The northbound approach consists of a dedicated left-turn lane, two through lanes, and a dedicated right-turn lane. The dedicated right-turn lane is a lane-drop that begins approximately 340 feet south of the intersection. The southbound approach consists of a dedicated left-turn lane, two through lanes, and shared through/right-turn lane. Both the northbound left-turn and southbound left-turn operate as a protected/permitted left-turns and are controlled by 5-section “doghouse” style signal heads. There are sidewalks on both sides of Chambers Road on both the northbound and southbound approach. There are currently no bicycle facilities present on Chambers Road or Gateway Ave / Green Valley Ranch Blvd. Chambers Road has a posted speed limit of 40 MPH and an average daily traffic of approximately 25,500 vpd.

The west leg of the intersection is Gateway Ave and the east leg of the intersection is Green Valley Ranch Blvd. Gateway Ave is a collector with two travel lanes in both directions, a posted speed limit of 30 MPH, and sidewalks on both sides. The approach to Chambers Road includes a dedicated left-turn lane, a through lane, and a shared through/right-turn lane. The left-turn lane operates as a protected/permitted left-turn controlled by a 5-section “doghouse” style signal head. Gateway Ave serves as a corridor for RTD transit route 45. Green Valley Ranch Blvd is an arterial with two travel lanes in both directions, a posted speed limit of 40 MPH, and sidewalks on both sides. At the approach to Chambers Road, Green Valley Ranch Blvd has two dedicated left-turn lanes, two through lanes, and a dedicated right-turn lane. The left-turn lanes operate as protected/permitted left-turns controlled by a 5-section “doghouse” style signal head. The 2017 average daily traffic on Green Valley Ranch Blvd was 11,800 vpd.

Figure 29 Chambers Road and Gateway Ave/Green Valley Ranch Blvd
Crash Review
Between March 2017 and March 2020 there were a total of 45 crashes at the intersection of Chambers Road and Gateway Ave/Green Valley Ranch Blvd:

- Four reported KSI crashes and no reported fatal crashes
- KSI crashes involved left-turns, rear ends, and one bicycle
- 44% broadside crashes
- 31% rear end crashes
- 28% caused by failing to yield right-of-way
- 20% caused by careless driving

Table 5 Chambers Road and Gateway Ave/Green Valley Ranch Blvd Crash Summary

<table>
<thead>
<tr>
<th>Harmful Event</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
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<tbody>
<tr>
<td>Total Crashes</td>
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<td>14%</td>
<td>47%</td>
<td>28%</td>
<td>12%</td>
</tr>
<tr>
<td>Broadside</td>
<td>44%</td>
<td>25%</td>
<td>-</td>
<td>24%</td>
<td>47%</td>
<td>18%</td>
<td>12%</td>
</tr>
<tr>
<td>Rear End</td>
<td>31%</td>
<td>25%</td>
<td>-</td>
<td>0%</td>
<td>67%</td>
<td>25%</td>
<td>8%</td>
</tr>
<tr>
<td>Bicycle</td>
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<td>25%</td>
<td>-</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Driver Action</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
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</thead>
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<tr>
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<td>-</td>
<td>0%</td>
<td>57%</td>
<td>29%</td>
<td>14%</td>
</tr>
<tr>
<td>Failed to Yield ROW</td>
<td>28%</td>
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<td>-</td>
<td>27%</td>
<td>45%</td>
<td>9%</td>
<td>18%</td>
</tr>
<tr>
<td>Ran Red Light</td>
<td>5%</td>
<td>0%</td>
<td>-</td>
<td>50%</td>
<td>0%</td>
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</table>

<table>
<thead>
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<th>Movement</th>
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<th>Fatal</th>
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<th>Northbound</th>
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<th>Westbound</th>
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<td>Left Turn</td>
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<td>-</td>
<td>45%</td>
<td>36%</td>
<td>9%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting

- The awkward geometry of this intersection, especially the westbound approach, can make it confusing to navigate.
- This intersection serves existing bike trails crossing.
- The Opticom sensor for the westbound approach is poorly aimed and does not usually pick up fire trucks unless they intentionally angle their trucks at the sensor.

The intersection of Chambers Road and Gateway Ave / Green Valley Ranch Blvd is one of the busier intersections for vehicles and pedestrians within the project limits. In addition, several bus routes pass through the intersection to the north, west, and south. The primary concerns at this intersection include the number of pedestrian crossings between the two shopping centers and the east and west approach alignment.

Observations

- The eastbound and westbound left-turns feature atypical geometry. This geometry limits sight distance for some drivers and may be confusing for some drivers.
- On all intersection approaches negative offset left-turns limit sight distance for drivers.
- Pedestrian activity was observed to be relatively high across all legs of this intersection given the land use context.
- All approaches to this intersection operate with protected/permissive left-turn operation.
- Standing water was observed on the intersection’s southeast corner. Passing vehicles spray water on the adjacent transit stop furniture.
• There is a stub out on the mast arm for a signal head for the eastbound approach.
• In the northbound direction south of Green Valley Ranch Boulevard, there is an AHEAD plaque missing its associated S1-1 sign.
• As stated in the general recommendations, the Denver Fire Department commented that the westbound Opticom receiver currently located on the mast arm at the southeast corner of the intersection does not work well for them.

![Figure 30 Missing S1-1 pedestrian crossing sign](image)

![Figure 31 Ponding on the southeast corner](image)

**Recommendations**

The recommendations for Chambers Road and Gateway Ave/ Green Valley Ranch Blvd are focused on providing safe passage for pedestrians and maximizing safety for vehicle users.

26. Convert all the intersection’s left-turns to protected-only operation.
27. Add an additional signal head for the eastbound approach.
28. Investigate the standing water observed on the intersection’s southeast corner and respond accordingly.
29. Consider implementing a Leading Pedestrian Interval at this intersection. High pedestrian crossing volumes were observed across the west and north legs; however, counts may reveal that the east and south legs have similar pedestrian volumes.
30. Install the missing S1-1 sign in the northbound direction south of Green Valley Ranch Boulevard.
31. Relocate the westbound Opticom receiver from the pole/mast on the southeast corner to the pole/mast on the northwest corner.
32. Design and restripe the westbound left-turn lanes with more typical left-turn geometry.
Figure 32 Chambers Road and Gateway Ave/Green Valley Ranch Recommendations Map

Figure 33 Restripe east leg and implement leading pedestrian interval illustration
Chambers Road 4800/5100 Block

Background Information

The 4800/5100 Block of Chambers Road is the mid-block area located between the intersection with Green Valley Ranch Blvd and 52nd Ave, which is a distance of about 1,500 feet. In this section Chambers Road has two travel lanes in each direction with a landscaped median and wide sidewalks on both sides. There are no bicycle facilities present. There are two large shopping centers on either side of Chambers Road with driveway access onto Chambers about 470 feet north of the intersection with Green Valley Ranch Blvd. The driveway access is configured to allow three-quarter turn movements, including right-turn in, right-turn out and left-turn in, but prohibits left-turn out from the shopping center to Chambers Road. There are three bus stops along this stretch of Chambers Road, including two on the northbound direction and one in the southbound direction. Based on boarding and alighting data, these bus stops have the highest bus activity in the corridor. There are no pedestrian crossings across Chambers Road. The posted speed on Chambers Road is 40 MPH and the average daily traffic is about 14,800.

Crash Review

Between March 2017 and March 2020 there were a total of 13 crashes in the 4800/5100 Block of Chambers Road (note: 4800 represents east side addresses and 5100 represents west side addresses):

- Two reported KSI crashes, both involving pedestrians, both occurred at night, including one fatality
- One KSI crash involved a pedestrian crossing Chambers not at an intersection
- Other KSI crash was a fatality where a pedestrian stepped in front of an RTD bus before it came to a complete stop
- All three broadside crashes resulted from drivers heading west out of driveway (including two right-turn and one left-turn)
- 29% broadside crashes
- 14% pedestrian-involved crashes
- In 31% of crashes drivers were cited for careless driving
Table 6 Chambers Road 4800/5100 Block Crash Summary

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Crashes</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>43%</td>
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<td>43%</td>
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<td>0%</td>
<td>0%</td>
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<tr>
<td>Rear End</td>
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<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Pedestrian</td>
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<td>100%</td>
<td>100%</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>Driver Action</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failed to Yield ROW</td>
<td>21%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
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<td>100%</td>
</tr>
<tr>
<td>Pedestrian Enter not at Intersection</td>
<td>7%</td>
<td>50%</td>
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<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Movement</td>
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<td></td>
<td></td>
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<tr>
<td>Left Turn</td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
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<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting
- There are pedestrian making midblock crossings throughout the day which is attributed to the shopping centers and bus stops on either side of Chambers Road.
- Potential to move RTD station to the south near the intersection with Green Valley Ranch Blvd so bus passengers will be more likely to use the signal to cross.

Observations

The 4800/5100 Block of Chambers Road is between the intersection with Green Valley Ranch Blvd and 52nd Ave. This location has a high volume of pedestrian activity and turning vehicles associated with the large shopping center on both sides of Chambers Road.
- High Pedestrian Activity
  o High volume of pedestrians crossing mid-block, particularly in the afternoon and evening, both to the bus stops and to get to the shopping center (within the small sample observed – about 30 minutes – a pedestrian was observed crossing an average of about every three minutes during the afternoon and evening)
  o High bus activity – over 200 boardings and alightings per day at the three bus stops combined within this block
  o There are two closely spaced bus stops northbound (less than 500 feet apart)
  o There is vegetation in the median which makes it difficult to see pedestrians crossing between the bus stops.
  o There are conflicts between left-turning vehicles entering the shopping center from Chambers Road and pedestrians crossing the driveway, particularly on the east side of Chambers Road
  o Two pedestrian-involved crashes resulting in serious injury or death occurred in this block during the three-year crash review period
• Three Quarter Access to the Shopping Center
  o Several signs in the median have been knocked down
  o Left-turns are not allowed out of the driveways, but it’s not clearly marked and difficult to see the delineation between the concrete pavement and raised median, which may cause confusion for drivers unfamiliar with the area
  o Due to the vertical curvature of the road, there is limited sight distance when making a northbound left-turn. Opposing vehicles also block the view for turning drivers in either direction due to geometry of the turn lanes.
  o The northbound right-turn lane from Chambers Road to the shopping center driveway is unclear, poorly marked, and has excess pavement width which may cause confusion as to which lane drivers should be in to continue straight or make a right turn. This situation also contributes to confusion for drivers exiting the driveway westbound. Crash history exists involving drivers making a westbound movement exiting the driveway onto Chambers Road.
  o Nighttime illumination was observed to be poor in the vicinity of the 3/4 access.
  o There is a high volume of turning vehicles using the 3/4 access.
  o The east leg driveway is wide and there is no crosswalk marking or stopbar.
**Recommendations**

Recommendations for Chambers Road 4800/5100 Block will provide safe passage for pedestrians between the transit stops and the two major shopping centers. Additionally, modifying the median island will provide better guidance and sight distance for drivers trying to access the shopping centers.

33. Restripe the northbound right-turn lane and add an object marker to the curb extension on the north side of the driveway.

34. Add well-positioned signs and edge-line striping to the median at the ¾ access. The Bolling Dr intersection is a good example.

35. Trim or remove brush vegetation from the median so the view of pedestrians is not blocked.

36. Temporarily consolidate and move the bus stops to the north side of the intersection with Green Valley Ranch Blvd.

37. Add a longitudinal island in the east driveway (designed to not impede pedestrian movements across the driveway) to promote slower speeds turning into the driveway, paint high visibility crosswalks across driveways, and replace STOP bar and STOP stencil.

38. Install a pedestrian hybrid beacon near the existing bus stops adjacent to Walmart, north of the ¾ access.

39. In conjunction with the installation of the pedestrian hybrid beacon, consolidate the bus stops between the 4800/5100 Block and 52nd Ave to a location adjacent to the pedestrian crossing.

40. Reconstruct the ¾ access to correct geometric and sight distance issues.

*Figure 37 Chambers Road 4800/5100 Block Recommendations Map*
Figure 38 Bus stop relocation, lane striping, crosswalk striping, and median striping

Figure 39 Driveway island types from NCHRP 151

Figure 40 Long-term improvements including realigning turn lanes, reconstructing median, and crosswalks
Chambers Road and 52\textsuperscript{nd} Ave

Chambers Road and 52\textsuperscript{nd} Ave is a three-legged stop-controlled intersection. 52\textsuperscript{nd} Ave serves the local neighborhood and has relatively low volumes. This intersection was not identified as a key intersection and was not discussed in the Pre-Audit RSA Meeting. However, the RSA team made observations and recommendations.

**Observations**

- There is an old 3-foot sidewalk on the east side of Chambers Road directly back of the curb. The old sidewalk includes non-ADA compliant curb ramps. A new 4-foot sidewalk exists 8 feet behind the old sidewalk.
- The intersection has unmarked crosswalks on all three legs.
- The north leg median nose is broken.

![Figure 41 North leg median nose broken](image1.png)

![Figure 42 Non-ADA compliant curb ramp without path to new sidewalk](image2.png)

**Recommendations**

Although not identified as a key intersection, Chambers Road and 53\textsuperscript{rd} Ave has several pedestrian enhancements that will promote safety for pedestrians.

1. Add eastbound stop bar.
2. Add crosswalk across the west leg of the intersection.
3. Connect ramp on southeast corner of the intersection to the new sidewalk.

![Figure 43 Chambers Road and 52nd Ave recommendations map and illustrations](image3.png)
Chambers Road and 53rd Ave

Background Information

At the signalized intersection with 53rd Ave, Chambers Road has two travel lanes in both the northbound and southbound direction. The northbound and southbound approaches consist of a dedicated left-turn lane, a through lane, and a shared through-right turn lane. Both the northbound left-turn and southbound left-turn operate as a permitted left-turn which are controlled by 3-section signal heads. The posted speed limit for Chambers Road is 40 MPH, there are sidewalks on both sides of the road, no bicycle facilities present, and the average daily traffic is approximately 14,800 vehicles per day.

53rd Ave is a collector with two travel lanes in each direction which are separated by a 40-foot wide median. At the intersection with Chambers Road, the eastbound approach consists of shared through-left turn lane and a shared through-right turn lane. The westbound approach consists of a dedicated left-turn lane and a shared through-right lane. The east leg of 53rd Ave serves as a corridor for the RTD Transit Line 45, has a posted speed limit of 25 MPH, and has crosswalks on both sides of the road. There are no bicycle facilities present on 53rd Ave.

Figure 44 Chambers Road and 53rd Ave

Crash Review

Between March 2017 and March 2020 there were a total of 14 crashes at the intersection of Chambers Road and 53rd Ave:

- No reported KSI crashes
- 50% rear end crashes, majority in northbound direction
- 36% broadside crashes
- 21% are left turn crashes from failing to yield right-of-way
Table 7 Chambers Road and 53rd Ave Crash Summary

<table>
<thead>
<tr>
<th>Harmful Event</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
<th>Westbound</th>
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</thead>
<tbody>
<tr>
<td>Total Crashes</td>
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<td>0</td>
<td>21%</td>
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<td>14%</td>
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<tr>
<td>Broadside</td>
<td>36%</td>
<td>-</td>
<td>-</td>
<td>20%</td>
<td>40%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Rear End</td>
<td>50%</td>
<td>-</td>
<td>-</td>
<td>29%</td>
<td>57%</td>
<td>14%</td>
<td>0%</td>
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<tr>
<td>Driver Action</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Followed Too Closely</td>
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<td>-</td>
<td>0%</td>
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<td>0%</td>
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<tr>
<td>Failed to Yield ROW</td>
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<td>-</td>
<td>-</td>
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<td>33%</td>
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<tr>
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<td>100%</td>
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<tr>
<td>Movement Left Turn</td>
<td>21%</td>
<td>-</td>
<td>-</td>
<td>33%</td>
<td>33%</td>
<td>0%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting - none

The intersection of Chambers Road and 53rd Ave serves as the primary southern crossing for citizens accessing the Montbello Recreation Center. In addition, there is an RTD transit route that makes a westbound left-turn from 53rd Ave to Chambers Road.

Observations

- There is a bush on the nose of the east leg median that obstructs sight distance for eastbound left-turning vehicles.
- The 40-foot-wide median adds additional challenges for eastbound and westbound left-turning vehicles.
- Neither the eastbound approach or the westbound approaches have lane markings delineating lane assignment or separation between lanes.
- There is a leading pedestrian interval (LPI) in operation only for the south leg crosswalk.
- The southbound left-turn bay and northbound left-turn bay striping are not direct.
- The west leg crosswalk is skewed and may present a challenge for visually impaired pedestrians.
- The sidewalk on the southeast corner is heaving.

Recommendations

The median landscaping made sight distance challenging for the RSA team during the windshield review. Additionally, the lack of lane delineation causes driving confusion for the eastbound and westbound approaches.

44. Trim landscaping on the east leg median nose to improve sight distance.
45. Provide eastbound and westbound approach lane striping.
46. Consider protected eastbound left-turn operation.
47. Justify use of LPI. If justified, use LPI with audible pedestrian signal.
48. Restripe northbound left-turn and southbound left-turn bays for improved line of sight.
49. Install dual directional curb ramp on the northwest corner and straighten crosswalk.

Figure 47 Heaved sidewalk

Figure 48 Skewed crosswalk

Figure 49 Chambers Road and 53rd Ave Recommendations Map
Chambers Road and Maxwell Pl

Background Information

The traffic signal at Chambers Road and Maxwell Pl was built in 2018. At this intersection, Chambers Road has two travel lanes in each direction. The northbound and southbound Chambers Road approaches consist of a dedicated left-turn lane, through lane, and a shared through/right-turn lane. The left-turns operate as permitted left-turns controlled by a 3-section signal head. There are sidewalks on both sides of the roadway, no bicycle facilities, and there is a dirt path on the southeast corner leading to the Montbello Recreation Center. At this location, Chambers Road has a posted speed limit of 40 MPH and an average daily traffic of 14,200 vpd.

Maxwell Pl is a collector consisting of one travel lane in each direction and a posted speed limit of 25 MPH. The eastbound and westbound Maxwell Pl approaches consist of one dedicated left-turn lane and a shared through-right lane. The left-turn movements operate as permitted left turns controlled by 3-section signal heads. There are sidewalks on both sides of Maxwell Pl but no bicycle facilities.

Crash Review

Between March 2017 and March 2020 there were a total of nine crashes at the intersection of Chambers Road and Maxwell Pl:

- Two reported KSI crashes and no reported fatal crashes
- One KSI crash involved a motorcycle rear ending into stopped vehicles
- One KSI crash involved a northbound left turn into the signal pole
- All broadside crashes were left turn related
- 63% broadside crashes
- 22% caused by careless driving
- 38% caused by failing to yield

Figure 50 Chambers Road and Maxwell Pl
Table 8 Chambers Road and Maxwell Pl Crash Summary

<table>
<thead>
<tr>
<th>Harmful Event</th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
<th>Eastbound</th>
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<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>40%</td>
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<tr>
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<td>-</td>
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<tr>
<td>Pedestrian</td>
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<td></td>
<td></td>
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<td>0%</td>
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<td>-</td>
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<td>-</td>
<td>13%</td>
<td>50%</td>
<td>0%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting

- New signal that was installed in 2018.
- The community has expressed interest in the installation of protected left-turns for Maxwell Pl.

The intersection of Chambers Road and Maxwell Pl was installed in 2018. This intersection serves as the north entrance primary crossing for citizens accessing the Montbello Recreation Center.

Observations

- The southbound and northbound left-turns are currently operating as permitted left-turns. This may present a safety issue due to higher speeds observed in the vicinity of the intersection on Chambers Road.
- The northbound and southbound left-turn striping is not direct.
- The pedestrian signal for the south crossing is not functional. The signal timing for east and west concurrent phases reflects that the pedestrian walk and clearance time are in operation, but the pedestrian signals maintain the DON’T WALK indication.
- There are no pavement lane markings indicating lane movement on any approach.

Recommendations

As this intersection serves as a primary access point to Montbello Recreation Center, it is paramount that the south leg pedestrian crossing is functional.

50. Repair south leg crossing pedestrian signal.
51. Restripe the northbound and southbound left-turn bays to be more directional.
52. Implement pavement lane markings for Chambers Road left-turns and Maxwell Pl left-turns.
53. Consider protected northbound and southbound left-turn signals.
54 Consider protected/permitted eastbound and westbound left-turn operation, where the protected phase is only called when at least three cars are present (the detection zone would be 60 – 75 feet upstream of the stop bar).

Figure 52 Chambers Road and Maxwell PI recommendations map and illustrations
Chambers Road and 56th Ave

Background Information

The intersection of Chambers Road and 56th Ave is a three-legged intersection with Chambers Road only having a northbound approach. The northbound Chambers Road approach consists of a dedicated left-turn lane and a dedicated right-turn lane. The two lanes are separated by a 15-foot painted gore area. In the southbound direction, on the south leg, Chambers Road consists of two travel lanes with the inside lane measuring approximately 24 feet and tapering to 12 feet approximately 950 feet south of the intersection. At this intersection Chambers Road has a posted speed limit of 40 MPH, average daily traffic of 14,200 vpd, sidewalks on both sides, but no bicycle facilities.

56th Ave is an arterial consisting of one travel lane in both directions and a posted speed limit of 45 MPH. The eastbound 56th Ave approach consists of one shared through/right-turn lane and the westbound approach consists of a dedicated left-turn lane and a through lane. The left-turn movements operate as a permitted/protected left-turn controlled by a 5-section “doghouse” signal head. There is a sidewalk along the south side of 56th Ave but no bicycle facilities. The north side of 56th Ave is a dirt area with overhead utilities where roadside vendors park and sell their goods. This signalized intersection is currently span wire and has been identified for future improvements. 56th Ave had a 2017 average daily traffic of 17,000 vpd.

Crash Review

Between March 2017 and March 2020 there were a total of 14 crashes at the intersection of Chambers Road and 56th Ave:

- No reported KSI crashes
- 93% of crashes in the eastbound or westbound direction
- 50% rear end crashes
- 21% are collision with object (two with light post, one with tree)
Table 9 Chambers Road and 56th Ave Crash Summary

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>KSI</th>
<th>Fatal</th>
<th>Southbound</th>
<th>Northbound</th>
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<td>100%</td>
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<tr>
<td>Rear End</td>
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<td>-</td>
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<td>57%</td>
<td>29%</td>
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<td></td>
<td></td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Comments provided by City Staff and RSA Stakeholders during Pre-Audit Meeting - none

Observations

The intersection of Chambers Road and 56th Ave is a three-legged intersection with the majority of traffic traveling on 56th Ave.

- One northbound left-turning vehicle was not detected because they did not pull forward to the detection zone.
- There are no pedestrian crosswalks on the west leg or east leg.
- The single eastbound shared through-right lane experienced long queues when pedestrians were crossing the south leg.
- There is a steep pavement drop off and no shoulder on the northeast corner of the intersection.
- The northbound right-turn only sign was on the ground leaning against the signal pole.
- There are many poles on the north side of the roadway which do not have object markers.
- The inside southbound departure lane is approximately 24 feet at the intersection and tapers to 12 feet approximately 950 feet south of the intersection.
- There is a manhole on the northwest corner of the intersection which rises 6 inches above the ground.

Figure 54 Pavement drop off on the northwest corner
Recommendations

The City indicated that the intersection of Chambers Road and 56th Ave will receive improvements in the future. The following recommendations provide short-term improvements that will increase safety for both vehicles and pedestrians.

55. Remount northbound right-turn only sign.
56. Add object markers to poles along the north side of 56th Ave.
57. Add tapered painted hatch markings on the southbound inside lane to narrow lane to 12 feet.
58. Add safety edge on the northwest side of 56th Ave.
59. Fix manhole to be flush with adjacent surface or install barrier around manhole.
Figure 59 Narrow inside southbound lane with striping and install safety edge.
Appendix A: Chambers Road RSA Recommendations Table
Appendix C: RSA Intent Memorandum
Appendix D: Preliminary Findings Presentation