Oregon Department of Transportation

POWELL BOULEVARD ROAD SAFETY AUDIT

20th Avenue to 33rd Avenue
September 2014

Prepared for:

ODOT Region 1 Traffic
123 NW Flanders
Portland, OR 97209
503.731.8220

Prepared by:

Kittelson & Associates, Inc.
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Oregon Department of Transportation

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

MOVINGFORWARDTHINKING™

Road Safety Audit Report

Powell Boulevard
Road Safety Audit (RSA)

20th Avenue to 33rd Avenue
Mile Point (M.P.) 1.76 to 2.49

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Project Principal: Brian L. Ray, P.E.

KAI Project Number: 17877.0

September 2014

THIS DOCUMENT IS PROTECTED UNDER THE PROVISIONS OF TITLE 23 UNITED STATES CODE SECTION 409 AS FOLLOWS:

Title 23 U.S.C. §409

Discovery and admission as evidence of certain reports and surveys

Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway-highway crossings, pursuant to sections 130, 144, and 148 of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

Technical Summary

PROJECT TITLE:

Powell Boulevard Road Safety Audit (RSA): MP 1.76 to 2.49

DATE:

June 3-6, 2014

RSA TEAM AND PARTICIPANTS:

- Hermanus Steyn, Pr. Eng., PE, Principal Engineer, Kittelson & Associates, Inc.
- Joel McCarroll, PE, ODOT Region 4 Traffic Manager
- Mike Coleman, PE, Port of Portland
- Jabra Khasho, PE, City of Beaverton
- Nate Young, Citizen Panelist, Hopworks
- Ashleigh Griffin, Transportation Analyst, Kittelson & Associates, Inc.

RSA RESOURCES

- Grant O'Connell, TriMet
- Sgt. Todd Davis, Portland Police Bureau (email)
- Andrew (Andy) Sullivan, Portland Bureau of Transportation
- Jamie Jeffrey, PE, Portland Bureau of Transportation
- April Bertelsen, Portland Bureau of Transportation
- Wendy Cawley, Portland Bureau of Transportation
- Kate Freitag, PE, Oregon Department of Transportation
- Jennifer Miles, Oregon Department of Transportation

PROJECT CHARACTERISTICS:

Description	Project Characteristic
Audit Type:	Planning Stage
Land Use Development Proposal:	No
Units of Measure:	U.S.
Adjacent Land Use:	Urban
Posted Speed (US in miles-per-hour [mph]):	35 mph
Opposite Flow Separation:	Two-way, left-turn lane
Service Function: • Highway Number • Route Number • Functional Classification • Oregon Highway Plan (OHP) Designation	 • 26 • US 26 • Urban Principal Arterial • Statewide Highway
Terrain:	Slight grade with steep section between 26th Ave-28th Pl
Climatic Conditions - Temperature:	Mild winter (rain with some freezing, icing possible), warm summer (sporadic hot days)
Climatic Conditions - Precipitation:	Rain during winter months

BACKGROUND

The study corridor is Powell Boulevard from approximately MP 1.76 to MP 2.49. Exhibit 1 illustrates the location and approximate extent of the study corridor.

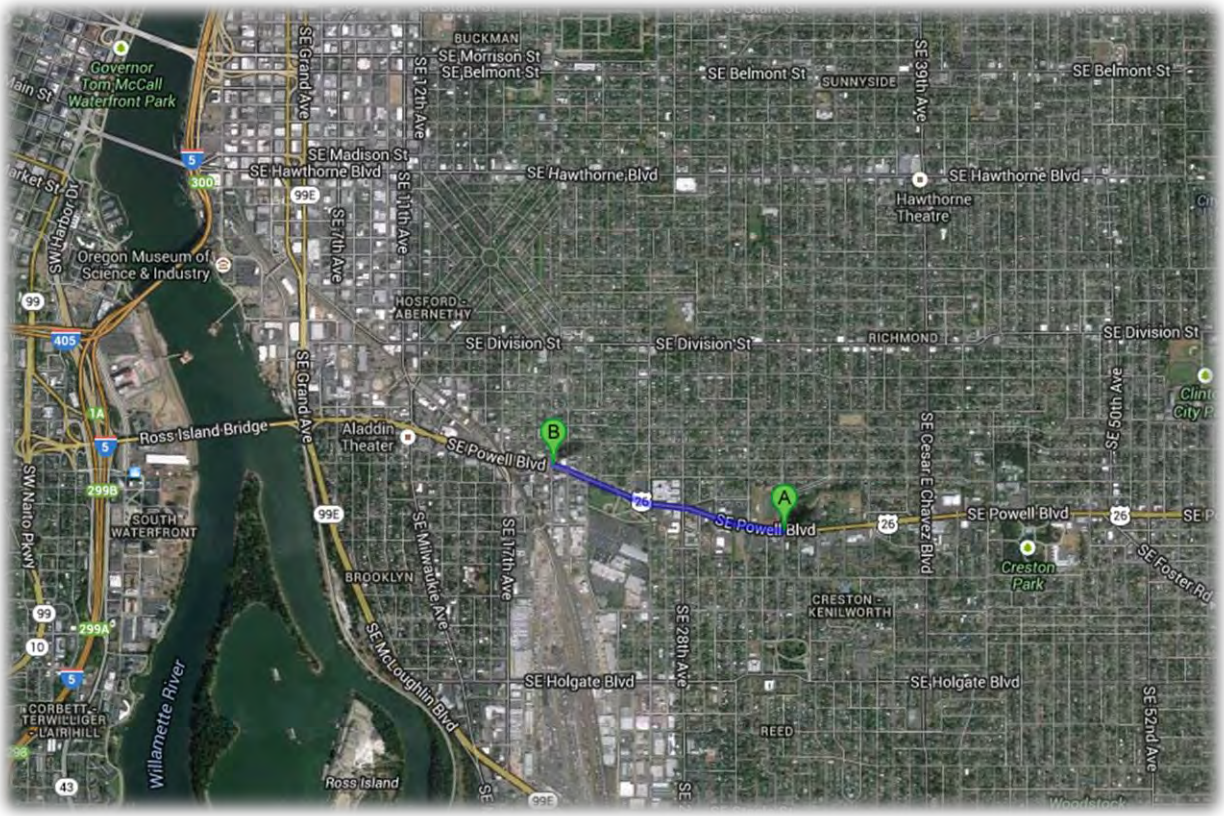

Exhibit 1 Vicinity Map of Powell Boulevard Study Segment in Portland, Oregon

Corridor Characteristics

KAI obtained reported crash data from Oregon Department of Transportation's (ODOT) online crash database for a period from January 2008 through September 2013. All graphs and/or reference to number of reported crashes reflect the data in the study area for the specific timeframe. The characteristics and crash trends observed within each study segment are summarized in the following sections. ODOT crash reports do not represent all incidents along these segments because crash reports are not completed for every crash. Oregon law requires drivers to complete a crash report when damages exceed $1,500.

Table 1 shows the study corridor has an average crash rate higher than both the statewide average for urban non-freeway principal arterials as well as a similar segment along a different section of Powell Boulevard.

Appendix A includes a copy of the Powell Boulevard RSA Findings Presentation, which includes a summary of crash history and historic volumes.

Table 1 Crash Rate Comparisons

Segment	5-Year Average Crash Rate (Crashes per Million Vehicle Miles)
Study Segment Vicinity MP 1.61 to MP 2.91 (SE 39th Ave)	6.54
Similar Segment MP 2.91 (SE 39th Ave) to MP 3.45 (Foster Rd)	5.59
Statewide Urban Non-Freeway Principal Arterials	2.82

Source: ODOT Crash Rate Book 2012

RSA PROCESS

The purpose of the RSA is to identify potential issues contributing to crashes and suggest treatments for addressing those issues. The majority of the suggestions provided are engineering treatments; however, where appropriate, the RSA Team identified opportunities for public education and enforcement campaigns, which tend to be more effective at influencing certain types of driver behavior (e.g., aggressive driving).

The RSA Team initiated work on Tuesday, June 3, 2014 with a kick-off meeting at ODOT Region 1 offices in Portland, Oregon. The meeting was attended by:

- The RSA Audit Team;
- Kate Freitag, Jennifer Miles, Shelli Romero, Rich Watanabe, Bob Walker, Kate Riley, Sue D'Agnese, and Nate Scott from ODOT; and,
- Wendy Cawley, Jamie Jeffrey, and April Bertelsen from Portland Bureau of Transportation (PBOT).

Discussions at the kick-off meeting included the following topics:

- Background on the 20's Bikeway Plan and two preferred alternatives for the crossing of Powell Boulevard;
- Specific locations throughout the corridor:
    - Pedestrian volumes are likely higher at the crossing at 24th Avenue outside of the typical PM peak hours;
    - The TriMet Route 9 line is heavily used, and TriMet recently enhanced service along this route;
    - Light industrial uses are located south of Powell Boulevard (including the Fred Meyer headquarters), resulting in truck travel in the area;
    - Division Street to the north is undergoing a road diet, which may impact current travel patterns;
    - TriMet has considered enhancing the westbound bus stop at 28th Place to create a pedestrian plaza;

  - McDonald's will be closing a driveway as part of their site redevelopment; and,
  - The crosswalk at 31st Avenue experiences a different pedestrian peak.
- A summary of potential funding opportunities for these improvements: Highway Safety Funds (2016) and STIP Enhance Funds.

The team met throughout the week of June 3, 2014 at ODOT's Barlow office at 92nd Avenue and Powell Boulevard in Portland. The RSA Team schedule is summarized below:

Tuesday (Day 1)

- Morning
  - Pre-Audit/Kick-off meeting with RSA team, ODOT, PBOT, and Stakeholders
  - Project Start-up meeting with RSA team
- Afternoon and evening
  - Field visit to observe road user behavior and road characteristics during the afternoon hours (when school releases) and the PM peak hours
  - Evening field visit to observe road characteristics and user behavior after dark

Wednesday (Day 2)

- Morning field work during morning commute and school arrival period
- Review of supporting data (crash data, volumes, etc.)
- Discuss RSA team observations and issues

Thursday (Day 3)

- Prioritize issues observed
- Brainstorm mitigations
- Document findings and preliminary suggestions

Friday (Day 4)

- Presentation of preliminary findings

SUMMARY OF SAFETY ISSUES

The RSA Team identified and categorized system-wide and location-specific safety issues based on a qualitative risk scale. For the purposes of this RSA, risk is defined as a function of exposure, probability, and consequence. *Exposure* reflects the number of vehicles that could be influenced by the design feature. *Probability* reflects the likelihood of a crash influenced by the identified design feature. The *consequence* reflects the severity of a crash, if one occurs.

The qualitative risk rating of safety issues identified along Powell Boulevard within the study segments are assigned relative to all other issues observed. ***Category III*** issues have potentially the greatest risk compared to the other observed issues; they are associated with higher exposure, probability, and/or consequence than other issues. ***Category II*** issues indicate higher risk than some issues and lower risk relative to other observed safety issues. ***Category I*** issues indicate the least risk compared to the other observed issues; they are associated with lower exposure, probability, and/or consequence.

The RSA Team identified the following issues as Category III:

- Unpredictable yielding at pedestrian crossings
- Lack of protection for bicycle crossings

The RSA Team identified the following issues as Category II:

- Congestion and associated traffic signal queuing
- Permissive phasing and traffic signal conflicts

The RSA Team identified the following issues as Category I:

- Number of access points and types of land uses

Within the corridor, we reviewed individual locations and rated the locations based on the issues listed above at each location.

The RSA Team identified the following locations as Category III:

- Powell Boulevard/21st Avenue intersection safety issues
- Powell Boulevard/26th Avenue intersection safety issues
- Powell Boulevard/31st Avenue intersection safety issues
- Powell Boulevard/28th Avenue intersection safety issues
- Powell Boulevard/28th Place intersection safety issues

The RSA Team identified the following locations as Category II:

- Powell Boulevard/24th Avenue intersection safety issues
- Powell Boulevard/33rd Avenue intersection safety issues
- Powell Boulevard/29th Avenue intersection safety issues

The RSA Team identified the following issues as Category I:

- Powell Boulevard/20th Avenue intersection safety issues
- Powell Boulevard/22nd Avenue intersection safety issues

The qualitative rating of risk given to each observed safety issue and location is documented in further sections.

Road Safety Audit Findings

The RSA findings are organized into general segment-wide safety issues and safety issues by intersection between MP 1.76 and 2.49.

1) GENERAL STUDY-AREA SAFETY ISSUES

Issue: Unpredictable Yielding at Pedestrian Crossings

As shown in Exhibit 2, rear-end crashes were the most common collision types reported throughout the study corridor, accounting for 71 percent of reported crashes along the study segment. Exhibit 2 shows many of these crashes involved a pedestrian. This indicates a pedestrian stepping into the roadway or into the crosswalk may have contributed to a rear-end crash. In addition, 16 pedestrians have been directly involved in crashes along the corridor. Exhibit 3 shows the location of the pedestrian involved or pedestrian injured crashes throughout the corridor. This exhibit reveals the majority of pedestrian involved or injured crashes occurred between MP 2.15 – 2.24 and between MP 2.35 – 2.39, which correspond to the unmarked and marked crossings at 28th Avenue and 28th Place, as well as the marked crossing at 31st Avenue.

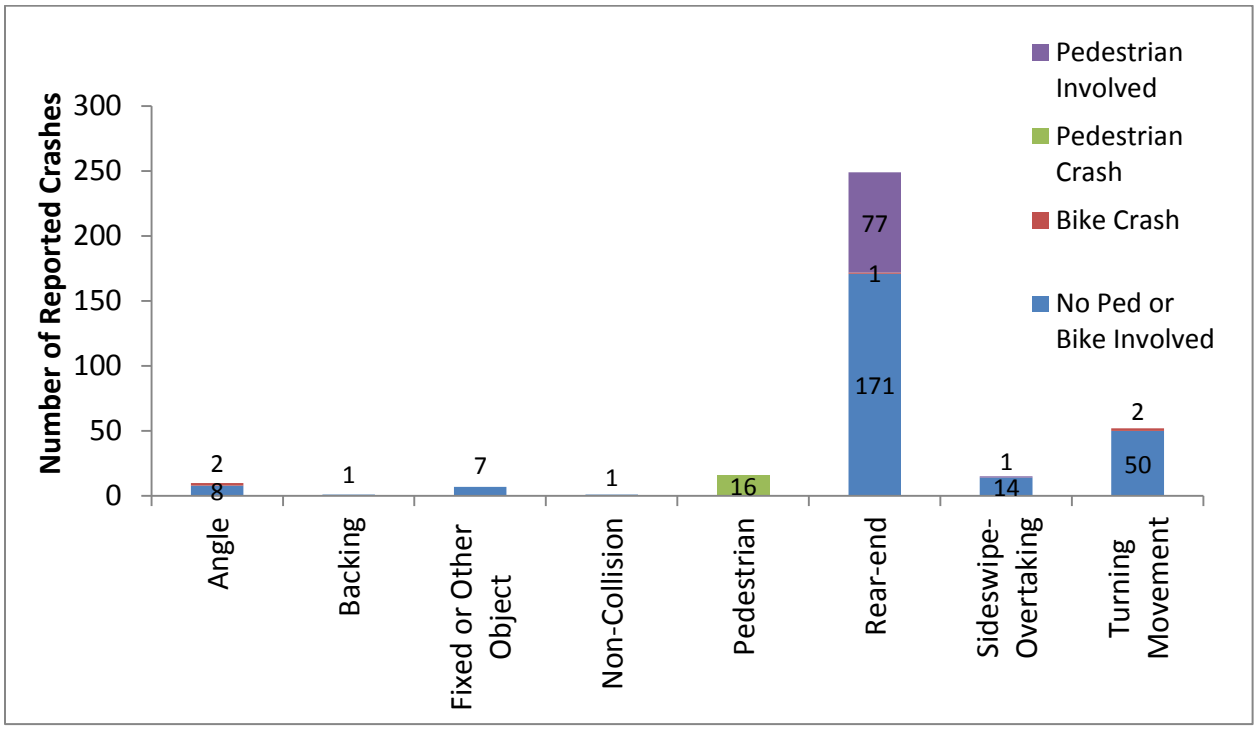

Exhibit 2 Crash Frequency by Collision Type (Powell Boulevard MP 1.76 – 2.49)

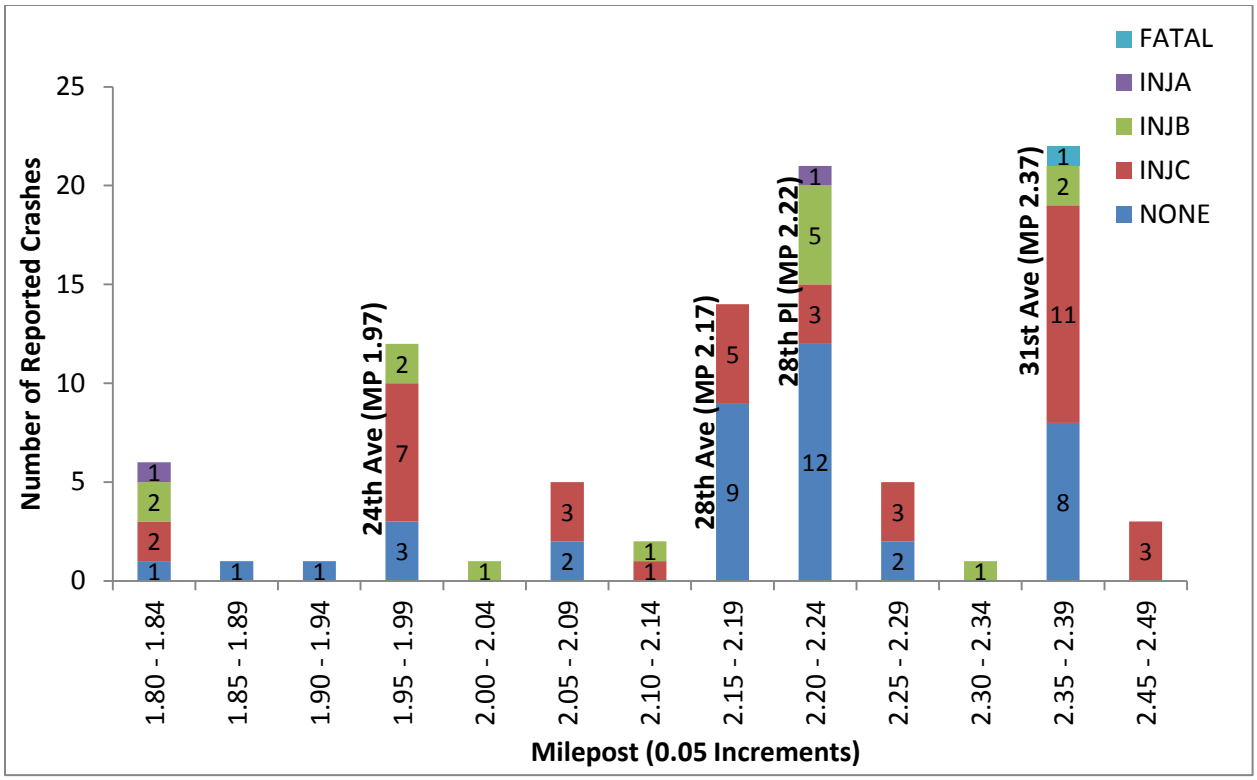

Exhibit 3 Locations of Crashes Involving Pedestrians (Involved or Injured)

Field review revealed drivers often do not see the pedestrian stepping into the crosswalk. Several times during field observations, the RSA team witnessed situations in which one driver yielded to the pedestrian but the second same-direction approaching driver failed to see the pedestrian and yield. In addition, subsequent approaching drivers often failed to understand why the first vehicle was stopped.

The RSA team identified the following issues contributing to pedestrian-involved and pedestrian-injured crashes:

- Location of pedestrian crossings
  - Several pedestrian crossings were located downstream from transit stops, as shown in Exhibit 4. This placement results in a stopped bus at the transit stop sometimes blocking a driver's view of a crossing pedestrian.
- Sign visibility
  - The visibility and reflectivity of signs, including pedestrian crossing signs, was restricted by street trees, as shown in Exhibit 5 and Exhibit 6. The tree canopies extend below the signs further restricting visibility of the signs. The limited visibility of signs may contribute to subsequent approaching drivers failing to see regulatory and/or warning signs and yield to the pedestrian.

- Sight lines
    - Sight lines between drivers and pedestrians are often restricted throughout the corridor by buildings, trees, and roadway curvature, as shown in Exhibit 7 and Exhibit 8. The trees have wide trunks and undergrowth reducing visibility from the roadway to the sidewalk and crossing locations.

- Crossings at traffic signals
    - Some of the pedestrian involved or injured crashes occurred at traffic signals with marked crossings. The signals at 21st Avenue and 33rd Avenue have unprotected left-turn phases on all movements. The signal at 26th Avenue has unprotected side street left-turn phases.

Exhibit 4 Transit Stop Located Before Pedestrian Crossing

Exhibit 5 Signs Blocked by Trees

Exhibit 6 Signs with Limited Reflectivity

Exhibit 7 Restricted Sight Distance for Pedestrians

Exhibit 8 Limited Sight Distance Due to Trees on Horizontal Curve

The qualitative risk rating of Unpredictability of Yielding at Pedestrian Crossings within the study segment, relative to all other issues observed, is presented in Table 2.

Table 2 Qualitative Risk Rating of Unpredictability of Yielding at Pedestrian Crossing

Function	Classification	Reasoning
Exposure	Category III	High number of pedestrians crossing Powell Boulevard
Probability	Category III	High number of pedestrian crashes or pedestrian-involved crashes throughout corridor
Consequence	Category III	Pedestrians are vulnerable users
Overall	*III*	-

System-Wide Suggestions for Unpredictable Yielding at Pedestrian Crossings:

- Review bus stop locations relative to pedestrian crossings to determine if the stops located upstream from the crossings can be relocated downstream of the crossings.
- Upgrade unsignalized crossings to enhanced crossings with pedestrian refuge islands, visible advanced warning signage, "No Lane Change" striping, and rapid rectangular flashing beacons (RRFB), as shown in the concept in Exhibit 9. Exhibit 10 shows an example of a RRFB at a pedestrian crossing.
    - The median will allow a two-staged crossing for pedestrians.
    - Consistent crossing designs could be considered throughout the corridor (and similar roadways beyond the study area) to provide a consistent message for driver along the corridor.
- Provide pedestrian-scale lighting in advance of each unsignalized pedestrian crossing to illuminate the pedestrian in the crosswalk as illustrated in Exhibit 11. The illumination of

the pedestrian from this angle will cast light onto the pedestrian compared to locating lights directly above the crosswalk that does not provide light on the body of the pedestrian.

- Trim trees to provide clear height to make visible signs to drivers. This includes trimming the tree canopy as well as undergrowth at the base of the tree. Consider a minimum tree trimming height of 12 feet (typical height of sign assembly) to allow for visibility of all signs.
- Provide signing and striping improvements, which may include signs in Exhibit 12, to increase awareness of pedestrian crossings.
- Provide a leading pedestrian phase at signalized intersections to allow pedestrians to enter the intersection (increasing their visibility) before vehicles enter the intersection.
- Expand pedestrian landing areas on the corners of Powell Boulevard/26th Avenue to discourage pedestrians (e.g., students at Cleveland High School) from standing in the roadway.

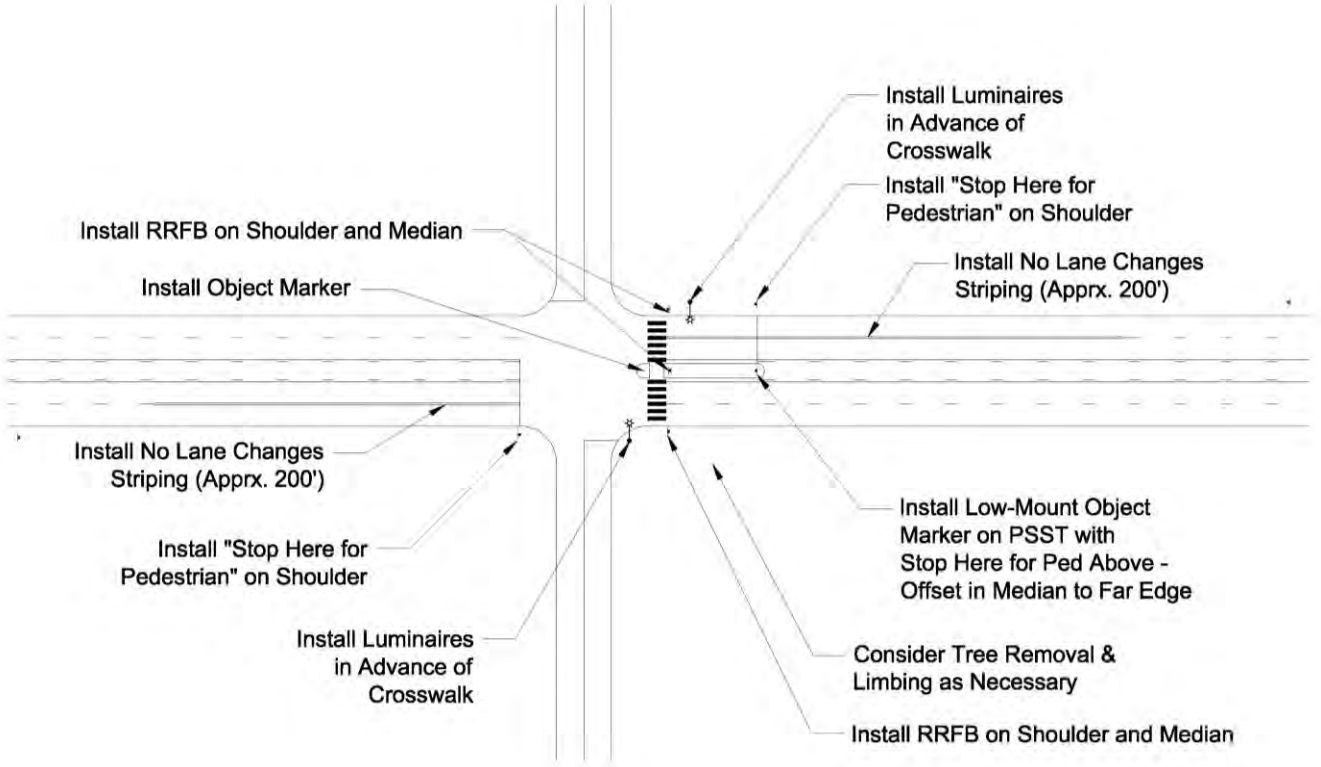

Exhibit 9 Concept of Enhanced Crossing (Shoulder mounted RRFB could also be considered approximately 350' in advance of crossing, on a case-by-case basis.)

Exhibit 10 Rectangular Rapid Flashing Beacons (RRFBs)

Figure 11. Drawing. Traditional midblock crosswalk lighting layout.

Figure 12. Drawing. New design for midblock crosswalk lighting layout

Exhibit 11 Example Lighting Placement at Pedestrian Crossing

Exhibit 12 Signs from MUTCD

Issue: Congestion and Associated Traffic Signal Queuing

As shown in Exhibit 2, 71 percent of reported crashes were rear-end crashes. While some of these crashes were associated with pedestrians, many were also associated with congestion throughout the corridor. Queues from traffic signals were observed to back-up to and sometimes beyond the next upstream signal during observed peak hours, as shown in Exhibit 13 and Exhibit 14. Visibility of signage (including information about the approaching intersection) was limited due to vegetation and reflectivity as previously discussed.

The signals cycle length also appeared to influence driver behavior along the corridor. The cycle observed at the signal at Powell Boulevard/26th Avenue during the afternoon peak hour appeared to allow approximately 30 seconds of green time, per cycle, to the east-west movements on Powell Boulevard. This congestion and observed cycle length appeared to lead to impatience among drivers; the RSA team observed drivers running the red lights at traffic signals to make it through the signal during the cycle. This impatience and cycle length may also contribute to the rear-end crashes along the corridor as drivers start to proceed forward and then have to stop sooner than they expect.

Exhibit 13 Queues Extend Signal to Signal

Exhibit 14 Queues at the Powell Boulevard/26th Avenue Signal

The qualitative risk rating associated with this safety issue, relative to other issues observed, is presented in Table 3.

Table 3 Qualitative Risk Rating of Congestion and Associated Traffic Signal Queues

Function	Classification	Reasoning
Exposure	Category III	High number of rear-ends in corridor (71% of all crashes)
Probability	Category II	Likelihood of rear-end crashes is high
Consequence	Category II	Potential for injury, but speeds are lower
Overall	*II*	-

System-Wide Suggestions for Congestion and Associated Traffic Signal Queuing:

- Consider signal timing modifications:
  - Consider reevaluating signal progression on Powell Boulevard.
  - Review the signal cycle lengths.

- Complete tree trimming to increase visibility of signs and approaching signals.
- Consider supplemental signal heads at near left side corner, as illustrated in Exhibit 15.
- Review sign placement and visibility. For example, consider using the back side of cantilever for the "Next Signal" sign for the eastbound approach to 26th Avenue as illustrated in Exhibit 16.

Exhibit 15 Potential Location for Supplemental Signal Head at Powell Boulevard/26th Avenue

Exhibit 16 Example of Using Cantilever for Next Signal Sign at Eastbound Approach to 26th Avenue

Issue: Permissive Phasing and Traffic Signal Conflicts

Exhibit 2 shows turning movement crashes were the second most common collision type. Turning movement crashes accounted for 15 percent of reported crashes. Together, turning movement and angle crashes accounted for 18 percent of reported crashes. Exhibit 17 shows the location of the turning movement and angle crashes throughout the corridor. The highest frequency of these crashes occurred at the three signalized intersections. Three of the five bicycle crashes reported on the corridor were turning movement or angle crashes and occurred at the Powell Boulevard/26th Avenue intersection.

The traffic signals at Powell Boulevard/21st Avenue and Powell Boulevard/33rd Avenue have permitted left-turn phases on all approaches. The signal at Powell Boulevard/26th Avenue has protected left-turn phases for Powell Boulevard and permitted left-turn movements for the 26th Avenue approaches. With these permitted left-turn phases, drivers may be concentrating on finding a gap in traffic to proceed through the intersection without looking at crossing pedestrians who may be in their path. The RSA team observed some drivers running red-lights after waiting through a cycle and not finding a gap in traffic.

In addition, several crashes involved vehicles turning from unsignalized cross streets and/or driveways. These crashes occurred at locations where sight distance was obstructed by buildings and horizontal curvature of the roadway.

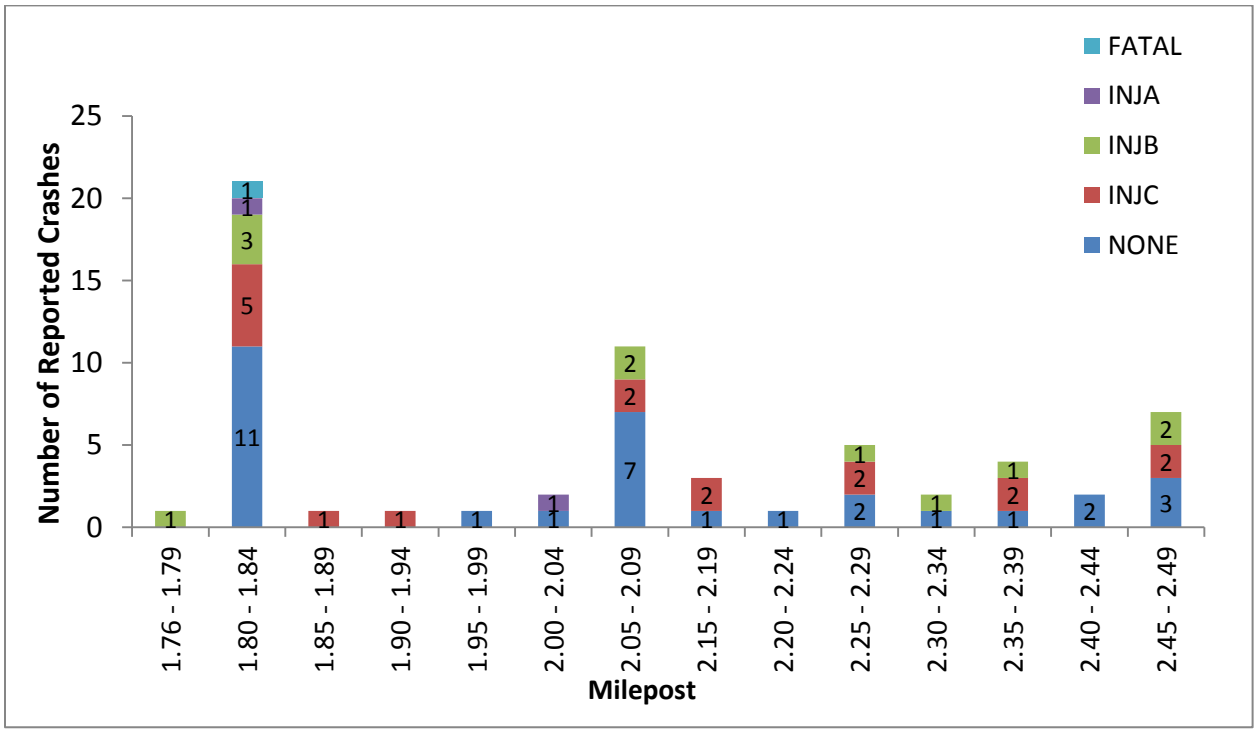

Exhibit 17 Turning Movement and Angle Crash Frequency by Milepost

The qualitative risk rating associated with this issue, relative to other issues observed, is presented in Table 4.

Table 4 Qualitative Risk Rating of Permissive Phasing and Traffic Signal Conflicts

Function	Classification	Reasoning
Exposure	Category II	High number of crashes at key intersections
Probability	Category II	Relatively high likelihood of turning movement crashes
Consequence	Category III	Angle and turning movement crashes may be severe
Overall	*II*	-

System-Wide Suggestions for Permissive Phasing and Traffic Signal Conflicts:

- Consider providing protected or protected/permitted left-turn phasing.
- Consider providing a leading pedestrian phase at signals when using protected/permitted left-turn phasing.
- Consider using the pedestrian function with the flashing yellow arrow (FYA) signals that will not allow a FYA to come up when a pedestrian call is placed. Exhibit 18 illustrates the FYA signal head.
- Consider prohibiting right turns on red at locations with:
    - A crash history involving right turning vehicles (21st Avenue) and/or involving pedestrians/bicyclists with right turning vehicles (26th Avenue), and/or
    - Limited sight distance (21st Avenue)

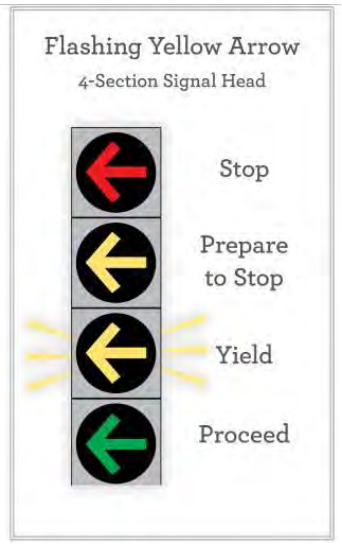

Exhibit 18 Flashing Yellow Arrow (FYA)

Issue: Number of Access Points and Types of Land Uses

The study corridor is surrounded by a mixture of land uses including a high school, residential areas, fast food restaurants, a brewery, hotel, and a bowling alley. There are many access points for these businesses along the corridor. Some parcels have multiple access points onto Powell Boulevard. Some of these access points overlap with pedestrian crossing medians, as illustrated in Exhibit 19. There is a two-way, left-turn lane located throughout the length of the study area. The RSA team observed difficulty for drivers making left-turns from driveways and side streets due to limited sight distance (due to horizontal curves, vertical curves, and buildings), as shown in Exhibit 20, as well as the approaching grades on side streets.

The crash history revealed 13 of the 351 crashes along the corridor occurred at a driveway and/or alley. However, the distraction of drivers caused by many access points in conjunction with pedestrian crossings, pedestrians on the sidewalk, and bicycles on the sidewalk or roadway, as illustrated in Exhibit 21, may contribute to the rear-end crashes in the vicinity of the driveways.

Exhibit 19 Example of Driveways Located Adjacent to Pedestrian Crossings

Exhibit 20 Example of Limited Sight Distance from Access Point

Exhibit 21 Example of Potential Bicycle/Pedestrian/Vehicle Conflict at Commercial Driveway

The qualitative risk rating associated with this issue, relative to all other issues observed, is presented in Table 5.

Table 5 Qualitative Risk Rating of Number of Access Points and Types of Land Uses

Function	Classification	Reasoning
Exposure	Category I	The majority of reported crashes did not involve vehicles turning in or out of driveways
Probability	Category I	Relatively few crashes reported with a driveway roadway character
Consequence	Category II	Turning movement and angle crashes at driveways have potential for injuries
Overall	*I*	-

System-wide Suggestions for Number of Access Points and Types of Land Uses:

- Although the data does not show a strong correlation between crashes and driveways within the study segment, future development and growth in the area may impact safety and operations at driveways. Consider developing an access management plan for Powell Boulevard (with emphasis between 29th Avenue and 31st Avenue) that may:
    - Prioritize for access review those locations with access points overlapping with pedestrian refuge islands as candidates; and,
    - Consider developing and implementing a policy to consolidate access points upon redevelopment.
- Consider providing zoning guidance on access and building orientation for the properties along the corridor.

Issue: Lack of Protection for Bicycle Crossings

There were five reported crashes involving a bicyclist between January 2008 and September 2013. Of these crashes, one was a rear-end, two were turning-movement crashes, and two were angle crashes. One occurred near the Powell Boulevard/21st Avenue intersection and four occurred at the Powell Boulevard/26th Avenue intersection; 26th Avenue has three-foot-wide striped bicycle lanes and bike boxes in the northbound and southbound directions. The majority of bike crashes involved bicyclists traveling through the intersection (north or south) and a vehicle making a turning movement. Powell Boulevard has limited right-of-way available for providing bicycle facilities, and few bicyclists were observed riding east-west along Powell Boulevard; some rode on the sidewalks to get to their destinations on Powell Boulevard from the north-south bike routes. Bicyclists must cross Powell Boulevard while traveling north-south in the area. While bicyclists were observed crossing at signalized intersections, some used the unsignalized pedestrian crossings due to their origin-destination routes (shortest paths) that have limited protection. Exhibit 22 shows

an example of bicyclists crossing Powell Boulevard at 21st Avenue. Location-specific treatments will be discussed in the next section of the report; this Issue summarizes general treatments that can be considered for bike crossings of Powell Boulevard within the study area.

Exhibit 22 Example of Bicyclists Crossing the Intersection of Powell Boulevard/21st Avenue

The qualitative risk rating associated with this issue, relative to all other issues observed, is presented in Table 6.

Table 6 Qualitative Risk Rating of Lack of Protection for Bike Crossings

Function	Classification	Reasoning
Exposure	Category II	Cyclists observed crossing Powell Boulevard
Probability	Category III	Cyclists are crossing at signals or unsignalized crossings. The signals often have permissive left-turn movements with through bicycle heavy traffic
Consequence	Category III	Bicyclists are vulnerable users, with the potential for higher crash severity
Overall	*Category III*	-

System-wide Suggestions for Lack for Protection for Bike Crossings:

- Install bike boxes at signalized intersections, as shown in Exhibit 23.
- Use bike detection at signalized intersections. This could be designed to have an indicator informing bicyclists when they are detected.
- Consider installing bike lanes on cross-streets heavily traveled by bicyclists (21st Avenue, 26th Avenue (wider), and 33rd Avenue). In some situations, it may be appropriate to add bike lanes at the intersection approaches to lead the bicyclists to the new bike boxes and/or bike detection.

- Consider installing sharrows on lower volume, lower speed streets to inform drivers to share the lane with bicyclists and/or inform cyclists of a potential bike route. Exhibit 24 illustrates the lane marking for sharrows.

Exhibit 23 Example of a Bike Box at Powell Boulevard/26th Avenue

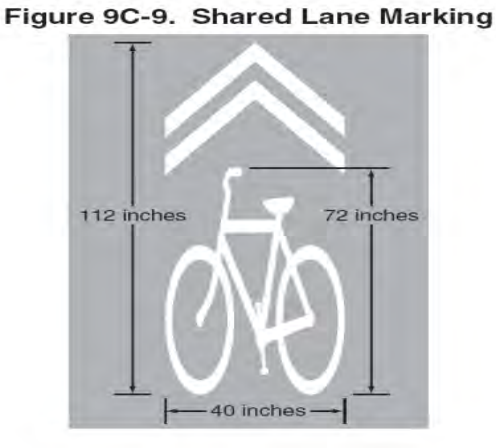

Exhibit 24 Sharrows Marking

2) INTERSECTION SAFETY ISSUES

Location: Powell Boulevard & 20th Avenue

The Powell Boulevard/20th Avenue intersection has a center median separating the eastbound and westbound traffic. Side streets are restricted to right-in, right-out movements, as illustrated in Exhibit 25. The northbound approach has limited sight distance to the west, as shown in Exhibit 26. The northbound and southbound approaches lack one-way signing and right-turn only pavement markings to inform drivers of the allowed movements, as illustrated in Exhibit 27 and Exhibit 28.

Exhibit 25 Intersection Illustration

Exhibit 26 Illustration of Limited Sight Distance (Northbound Approach) to the West

Exhibit 27 Lack of Right Turn Only Pavement Marking

Exhibit 28 Lack of One Way Signage Directly in Front of Approach

The qualitative risk rating associated with the safety issues at the intersection of Powell Boulevard/20th Avenue, relative to the issues observed at other intersections, is presented in Table 7.

Table 7 Qualitative Risk Rating of Safety Issues at Powell Boulevard/20th Avenue

Function	Classification	Reasoning
Exposure	Category I	Low number of crashes at intersection, relative to others
Probability	Category I	Low right turn volume
Consequence	Category II	Vehicles can be traveling at higher speeds on the ends of the corridor, leaving to more severe turning movement crashes
Overall	*I*	-

Suggestions for Powell Boulevard/20th Avenue:

- Add right-turn arrow pavement markings on the northbound and southbound approaches; and,
- Add one-way signage for the northbound and southbound approaches.

Location: Powell Boulevard & 21st Avenue

Powell Boulevard/21st Avenue is a signalized intersection with a predominant southbound left turn movement and relatively high bicycle volumes traveling northbound and southbound during the commute hours. There are relatively high pedestrian crossing volumes. The southbound left-turning vehicles conflict with bicycle and pedestrian crossings. The visibility of the crosswalk delineation (at this signal) was limited due to pavement wear.

21st Avenue has single lane approaches and lacks bicycle lanes, as shown in Exhibit 29. Dented signal poles, as shown in Exhibit 30, reveal vehicles that are likely trucks that have struck the poles while making turning maneuvers.

The signal has permitted left-turn phases and field observations revealed drivers having difficulty finding a gap, as well as looking for pedestrians in the crosswalk to make a left turn from Powell Boulevard. In addition, the southbound and/or northbound left-turns block sight distances for oncoming traffic, which also makes it difficult to find a gap. Although there are bicycle detection symbols in the pavement on the north and south approaches, the RSA team could not determine whether the bicyclists triggered the signal every time. Crash data revealed a high number of turning movement crashes occurred at this intersection, with many of those involving eastbound left-turning vehicles. Several pedestrian crashes occurred with turning vehicles. In addition, several crashes were northbound right-turning vehicles colliding with eastbound through vehicles, potentially due to limited sight distance and right-turns on red.

Exhibit 29 Bicyclists Sharing the Lane with Vehicles on 21st Avenue at Powell Boulevard

Exhibit 30 Example of Dented Pole

The qualitative risk rating associated with the safety issues at the Powell Boulevard/21st Avenue intersection, relative to the issues observed at other intersections, is presented in Table 8.

Table 8 Qualitative Risk Rating of Safety Issues at Powell Boulevard/21st Avenue

Function	Classification	Reasoning
Exposure	Category III	High number of crashes, relative to other intersections in study
Probability	Category II	High number of turning movement crashes which suggestions may address
Consequence	Category III	Crash history shows high severity at the intersection
Overall	*III*	-

Suggestions for Powell Boulevard/21st Avenue:

- Restripe the north- and south-bound approaches to include left-turn lanes, as illustrated in Exhibit 31.
    - Remove some parking on 21st Avenue to accommodate the turn lanes.
    - Investigate the feasibility of allowing right-turns on red with shared through/right lane closer to curb. The existing sight distance is restricted at this intersection due to building locations and the intersection angle. The addition of a left-turn lane may further restrict the sight distance by requiring the shared through/right lane see pass the left-turn queue. Right-turns on red should not be permitted without adequate sight distance. The turning radius for right-turn movements should also be evaluated to ensure sufficient space to complete a right-turn maneuver from the lane closer to the curb (compared with existing turning maneuver).

- Provide protected or protected/permissive left-turn phasing for all approaches. Signal phasing adjustments should include a capacity implication analysis during project planning stages.
- Consider restricting rightturn onred for the northbound approach using signage, as illustrated in Exhibit 32.
- Install supplemental signal heads to increase awareness of approaching intersection as discussed under the "Congestion and Associated Traffic Signal Queuing" section.
- Rebuild signal with mast arm street name signs to increase visibility. Consider placing signal poles to accommodate truck movements in the new design.
- Consider a queue detection and warning system to detect queues on Powell Boulevard associated with 21st Avenue signal.

Exhibit 31 Conceptual Design for Powell Boulevard/21st Avenue

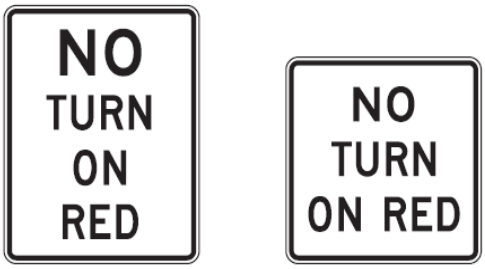

Exhibit 32 MUTCD No Turn on Red Signs

Location: Powell Boulevard & 22nd Avenue

The Powell Boulevard/22nd Avenue intersection is an offset, unsignalized intersection. The RSA team observed angle parking on the east side of 22nd Avenue (north of Powell Boulevard) being used incorrectly, as illustrated in Exhibit 33. Vehicles park in a southbound direction on the east side of the street rather than in a northbound direction, with the flow of traffic. Although this is unconventional, there appears no issue related to the existing parking configuration. The northbound stop bar is placed back from the assumed crosswalk and appears to restrict sight distance.

Exhibit 33 Example of Incorrectly-Used Angle Parking on 21st Avenue, North of Powell Boulevard

The qualitative risk rating associated with the safety issues at the Powell Boulevard/22nd Avenue intersection, relative to the issues observed at other intersections, is presented in Table 9.

Table 9 Qualitative Risk Rating of Safety Issues at Powell Boulevard/22nd Avenue Intersection

Function	Classification	Reasoning
Exposure	Category I	Lower side street volumes and no pedestrian or bicycle crossing at this location
Probability	Category I	Relatively lower number of crashes at this intersection, compared to others in corridor
Consequence	Category I	Reported crashes at this location were not severe
Overall	*I*	-

Suggestions for Powell Boulevard/22nd Avenue:

- Install a curb extension on the Southeast corner; and,
- Move the stop bar on northbound approach closer to intersection to increase sight distance.

Location: Powell Boulevard & 24th Avenue

The Powell Boulevard/24th Avenue intersection is a three-leg, unsignalized intersection. It has a marked crosswalk on the east side of the intersection connecting to the park on the south side of Powell Boulevard. The crosswalk was difficult to see at night due to the placement of lighting; as shown in Exhibit 34. An eastbound bus stop located prior to the crosswalk restricts the line of sight between pedestrians and drivers when occupied by a bus. The majority of crashes at this intersection are rear-end crashes. Two of the crashes were pedestrian crashes. During the RSA field work, the intersection was blocked by queues from nearby signals during both the AM and PM peak hours, as shown in Exhibit 35.

Exhibit 34 Pedestrian Crossing is Dark at Night

Exhibit 35 Queues blocking intersections

The qualitative risk rating associated with the safety issues at the Powell Boulevard/24th Avenue intersection, relative to the issues observed at other intersections, is presented in Table 10.

Table 10 Qualitative Risk Rating of Safety Issues at Powell Boulevard/24th Avenue Intersection

Function	Classification	Reasoning
Exposure	Category II	Pedestrian crossing volumes are lower than other crossings during peak hours of the day
Probability	Category II	Relatively high number of crashes
Consequence	Category III	Pedestrians are involved (possibly causing the rear-end crashes, but not often injured) in many of the crashes, and pedestrians are vulnerable users
Overall	*II*	-

Suggestions for Powell Boulevard/24th Avenue:

- Consider adding an RRFB and pedestrian scale lighting in advance of the crosswalk, as shown in Exhibit 36.
- Consider removing select tree(s) to increase visibility of crossing, signage, and pedestrians. Consider eliminating or relocating eastbound TriMet stop downstream of the crosswalk. The spacing between this stop and the next stop at 26th Avenue should be considered in the decision.

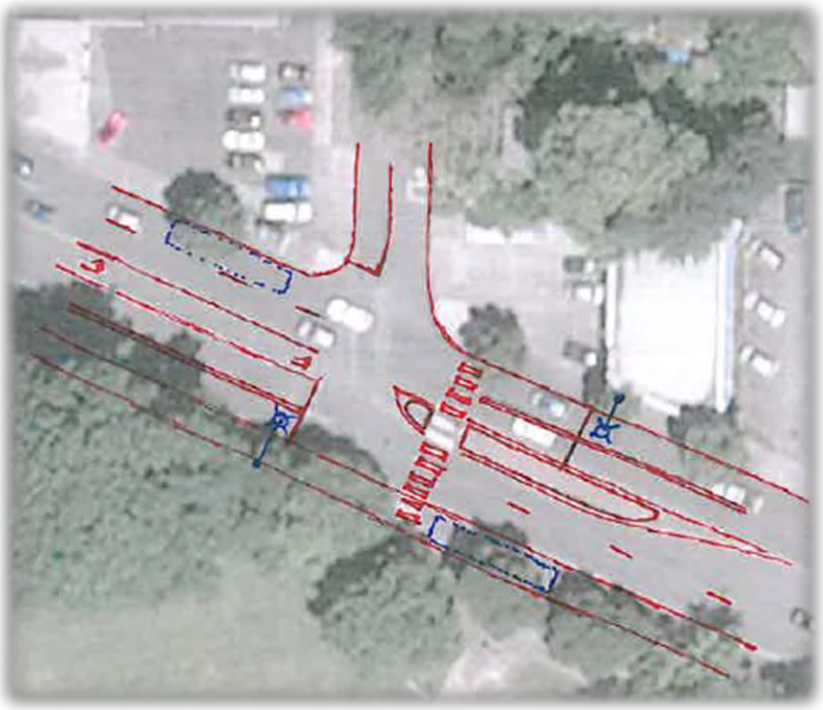

Exhibit 36 Concept of Crossing Improvements at Powell Boulevard/24th Avenue

Location: Powell Boulevard & 26th Avenue

Powell Boulevard/26th Avenue is a signalized intersection with relatively heavy north-south bike and pedestrian crossing volumes. The limited intersection cross-section allows for three-foot wide bike lanes in the north and south directions. Cleveland High School is located northeast and Powell City Park is located southwest of the intersection. A residential driveway is located on the southeast corner of the intersection. The faculty parking lot is located on the west side of 26th Avenue, across from the school. The RSA team observed midblock crossings between this parking lot and the school, as shown in Exhibit 37.

The intersection is a transfer point between the east-west TriMet routes along Powell Boulevard and the north-south routes along 26th Avenue. The RSA team observed buses unloading a group of students who crossed the intersection as a group and were unable to fit on the sidewalks on the corner, as shown in Exhibit 38. Students were observed standing in the street. In addition, there is a

tree conflicting with the westbound bus stop that prohibited students from using the back door to the bus on some occasions, as shown in Exhibit 39.

The intersection crash history showed a combination of rear-end crashes and turning movement crashes. Several crashes involved pedestrians and bicyclists.

Some of the intersection conflicts may be associated with the signal timing and signal cycle lengths. The RSA team observed cycle lengths of approximately 60 seconds during the afternoon peak hours that appear undesirable compared to similar corridors within the metropolitan area. In addition, the team observed vehicles running the red lights at the end of left-turn phases on the east-west mainline movements, likely due to impatience associated with the long queues. Powell has protected left-turning movements, but the side streets have permitted left-turn movements. Trucks were observed having difficulty making right-turns at the northeast and southwest corners of the intersection without encroaching on the curb and sidewalk, as shown in Exhibit 40. When the curb is filled with students from the TriMet buses, the trucks' inability to make the turning movement without encroaching on the curb presents conflicts between pedestrians and trucks.

In addition to the intersection turning movement conflicts, the crash data indicates a trend toward rear-end crashes. We observed that it was difficult to see the "Next Signal" informational signs, so drivers may be unaware of their location relative to the signal or be unaware what intersection they are approaching.

Exhibit 37 Midblock Crossing

Exhibit 38 Pedestrians Wait in the Street

Exhibit 39 Conflict between Bus Drop Off and Tree

Exhibit 40 Tight Turn Radius

The qualitative risk rating associated with the safety issues at the Powell Boulevard/26th Avenue intersection, is presented in Table 11.

Table 11 Qualitative Risk Rating of Safety Issues at Powell Boulevard/26th Avenue Intersection

Function	Classification	Reasoning
Exposure	Category III	Busy intersection for all modes
Probability	Category III	Crash history showed high numbers of reported crashes and conflicts between modes
Consequence	Category III	High number of vulnerable users at intersection (pedestrians and bicyclists)
Overall	*III*	-

Suggestions for Powell Boulevard/26th Avenue:

- Review and consider modifying signal timing:
  - Review and consider lengthening cycle lengths;
  - Consider providing protected/permissive phasing for northbound and southbound left-turn phases; and
  - Consider using leading pedestrian intervals.
- Consider a queue jump for eastbound buses.
- Consider installing a new signal, with the following considerations:
  - Modify the pole locations and curb radii to accommodate turns; and,
  - Expand pedestrian refuge area on corners.
- Consider working with Cleveland High School and Portland Public Schools to create a pedestrian plaza in front of the high school.
- Consider closing residential driveway on the southeast corner.
- Consider the following two options to accommodate bikes crossing Powell Boulevard:
  - Widen both sides by removing the landscape strip and moving the bus stop to accommodate wider bike lanes on both sides, as shown in the concept in Exhibit 41.
  - Remove the bike lanes, as shown by the concept in Exhibit 42, and replace with a bike crossing further east on Powell Boulevard. The eastern crossing options will be discussed in more detail in the following sections of the report.

Exhibit 41 Concept to Accommodate Wider Bike Lanes on Both Sides of 26th Avenue

Exhibit 42 Concept to Remove Bike Lanes at Intersection

Location: Powell Boulevard & 31st Avenue

The Powell Boulevard/31st Avenue intersection is an unsignalized intersection with a pedestrian crossing located on the east side of the intersection. There is no pedestrian refuge median in the crossing. The high school's athletic fields are located in the northeast corner of the intersection, the bowling alley is located in the northwest corner of the intersection, and a motel is located south of the intersection. The motel's exit-only access point forms the southern leg of the intersection, although the lack of pavement markings and standard signage makes it difficult for drivers to determine it is an exit-only driveway.

Crash history revealed that this location had the highest number of reported pedestrian or pedestrian involved crashes, as shown in Exhibit 43, despite a lower number of pedestrians crossing during the peak hours of the day. The intersection had a trend of rear-end crashes. Due to surrounding land uses, the crossing volume may be higher during off-peak hours and during school athletic events compared to the peak hours. Students were observed using the crossing to access a food cart during the lunch hour.

The southbound intersection approach has restricted sight distance to the east due to a lack of maintenance of vegetation on the school property corner and the approach grade, as shown in Exhibit 44. The northbound approach (Motel 6 driveway) has restricted sight distance caused by a fence in the southwest corner of the intersection, as shown in Exhibit 45.

The crosswalk was observed to be difficult to see when approaching in the westbound direction because trees blocked the crosswalk signs. The team noted the crosswalk was particularly difficult to see during nighttime conditions. The transit stops are also located prior to the crosswalks. The recorded boardings at these transit stops were relatively low compared to others in the corridor. In addition, there is a food cart next to the motel that may have led to some pedestrian demand at this crossing.

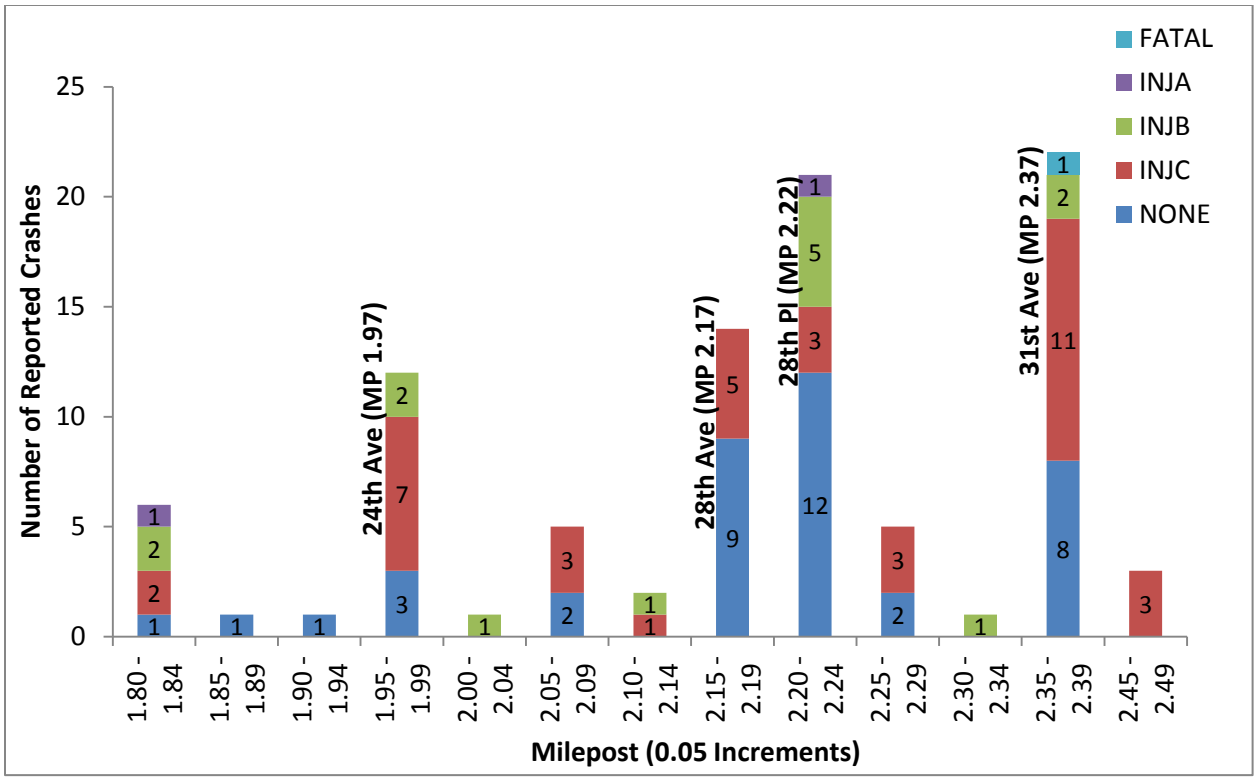

Exhibit 43 Locations of Crashes Involving Pedestrians (Involved or Injured)

Exhibit 44 Restricted Sight Distance to the East from Southbound Approach

Exhibit 45 Motel 6 Driveway Conflicts with Bicyclists

The qualitative risk rating associated with the safety issues at the Powell Boulevard/31st Avenue intersection, is presented in Table 12.

Table 12 Qualitative Risk Rating of Safety Issues at Powell Boulevard/31st Avenue Intersection

Function	Classification	Reasoning
Exposure	Category III	Crosswalk was observed to be used frequently and by school students during lunch hours
Probability	Category III	High number of rear-end crashes involving pedestrians
Consequence	Category III	Potential to involve injured pedestrians. One fatality occurred near this location
Overall	*III*	-

Suggestions for Powell Boulevard/31st Avenue:

- Consider improving pedestrian crossing, as shown in the concept in Exhibit 46, to include:
  - Pedestrian refuge island;
  - RRFB;
  - No-lane change striping and advanced warning signs; and,
  - Pedestrian-scale lighting, placed in advance of the crossing.
- Consider improving signage and pavement markings at Motel 6 exit-only driveway.
- Consider removing the fence on northwest corner of Motel 6 property to improve sight distance.

- Consider removing vegetation in northeast corner of the intersection to improve sight distance.
- Consider making the southbound approach right-only (due to new pedestrian refuge median as well as restricted sight distance).

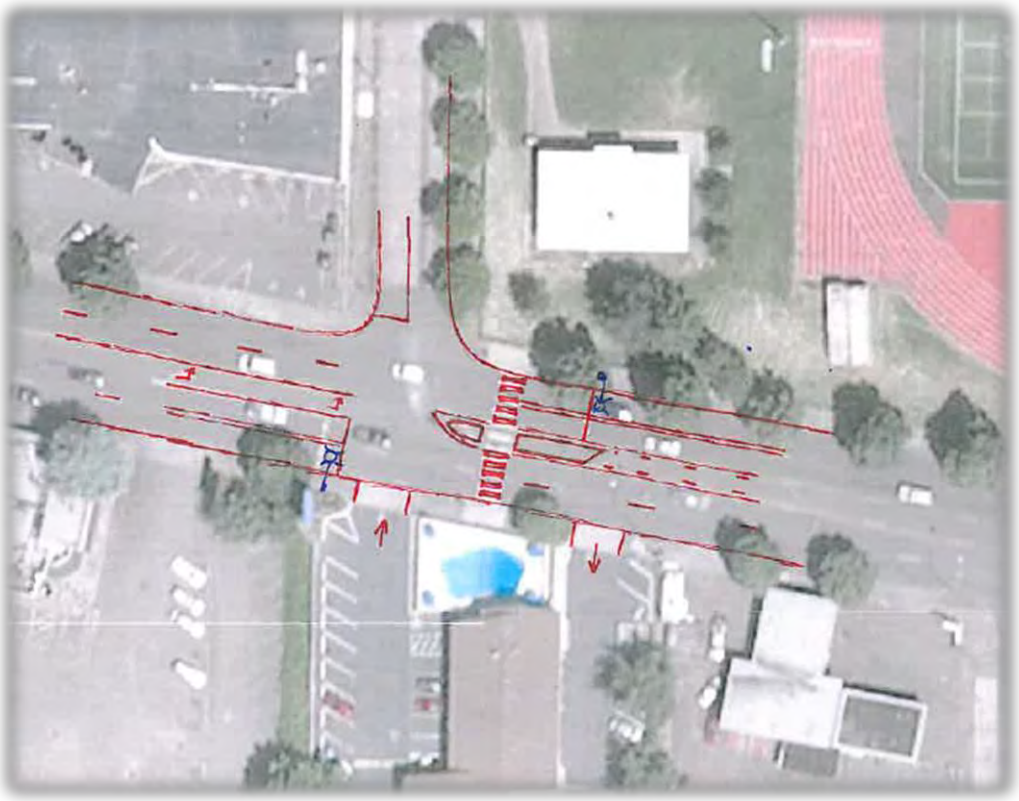

Exhibit 46 Conceptual Intersection Improvements at Powell Boulevard/31st Avenue

Location: Powell Boulevard & 33rd Avenue

The Powell Boulevard/33rd Avenue intersection is a signalized intersection with single-lane side street approaches. As shown in Exhibit 47, there are two ZipCar parking spaces on the east side of the south leg, at the intersection in the location where the sidewalk on the east side of the street ends before reaching the intersection, causing pedestrians to walk in the roadway for the short distance between the sidewalk and the intersection.

The signal has permitted left-turn phases for all approaches. The RSA team observed it was difficult to make left-turns from Powell Boulevard with the permitted phases. In addition, the cycle length was observed to be relatively long. Pedestrians were observed to cross during the Don't Walk time. Bicyclists were observed using the pedestrian push button after waiting for the signal to change, as illustrated in Exhibit 48. Although there was a bicycle detection symbol in the pavement on the side street approaches, it was unclear if the detector is functioning.

Similar issues to those seen at other intersections were also observed here:

- Shrubs on the northeast corner block sight distance for drivers;
- Dented poles on the corners indicate difficulty making turns; and,
- Pedestrian signal heads are mounted low.

Exhibit 47 ZipCar Parking Spaces at the Intersection

Exhibit 48 Bicyclists Using Pedestrian Push Buttons

The qualitative risk rating associated with the safety issues at the Powell Boulevard/33rd Avenue intersection, is presented in Table 13.

Table 13 Qualitative Risk Rating of Safety Issues at Powell Boulevard/33rd Avenue Intersection

Function	Classification	Reasoning
Exposure	Category II	Lower volumes
Probability	Category II	Relatively low number of crashes
Consequence	Category II	Crash history shows primarily PDOs and moderate/minor injuries
Overall	*II*	-

Suggestions for Powell Boulevard/33rd Avenue:

- Consider tree trimming to increase visibility of signs and sight distance to the intersection.
- Consider relocating the ZipCars parking south, completing the sidewalk on the east side of 33rd Avenue, and installing a bulb-out at the southeast corner, as illustrated by the concept in Exhibit 49. The bulb-out would provide a buffer for parked cars on 33rd Avenue and shorten

the distance pedestrians are required to cross on 33rd Avenue. The bulb-out is preferred over the left-turn lane because traffic volumes on 33rd Avenue are low and pavement width on 33rd Avenue (north of Powell Boulevard) is limited.

- Review signal timing and cycle lengths:
    - Consider pedestrian and bicyclist wait times;
    - Consider protected/permissive left-turn phasing from the mainline;
    - Consider providing an indication of bicycle detection to discourage impatience;
    - Consider running the signal at 33rd Avenue with half cycle compared to other signals within the corridor due to pedestrian/bicyclists frustration; and,
    - Consider installing a new signal with mast arms. Pole placement will be a focus to improve awareness of the approaching intersection as well as ensure adequate turning radii.

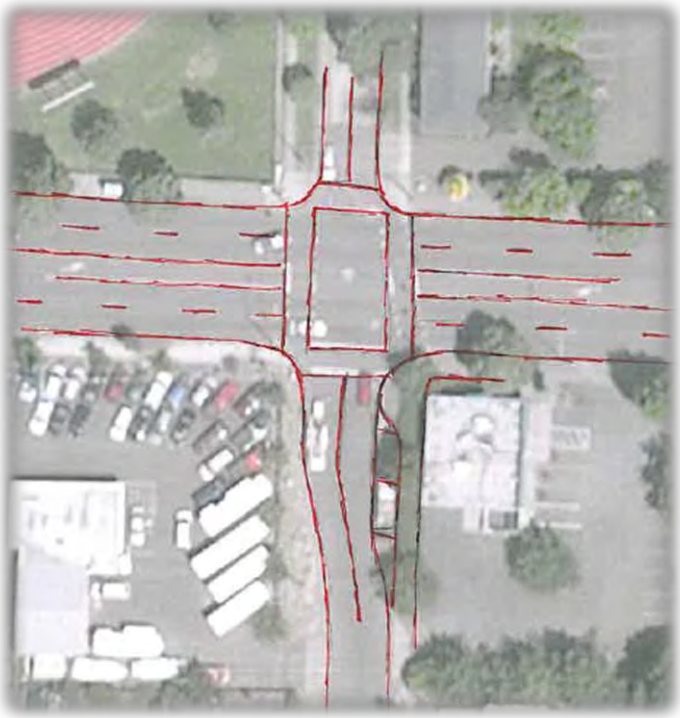

Exhibit 49 Conceptual Intersection Configuration at Powell Boulevard/33rd Avenue

Road Segment: Powell Boulevard from 28th Avenue to 29th Avenue

The following section discusses the issues observed at 28th Avenue, 28th Place, and 29th Avenue. The suggestions for these locations impact those of the other intersections due to their proximity and the relationship between pedestrian crossings, bike crossings, and transit stops. Issues for each individual intersection will be presented, but suggestions will be provided after introducing issues at each of the intersections.

Issues at Powell Boulevard & 28th Avenue

The Powell Boulevard/28th Avenue intersection is a four-leg unsignalized intersection with a median restricting north-south through movements and left-outs but allows left-ins. Cleveland High School is located on the northwest corner. The southwest corner houses the Catholic Charities building that includes a daycare center. Westbound drivers were observed using the eastbound left-turn lane to access the daycare parking lot during the AM peak hours. Other daycare drop-offs used the westbound left-turn lane at 28th Avenue and parked on 28th Avenue. There is relatively high density residential housing located south of Powell Boulevard. A westbound TriMet stop, with a relatively large pedestrian plaza area, is located just east of 28th Avenue, in front of the location where pedestrians were observed crossing Powell Boulevard.

Students were observed walking from the south up 28th Avenue to reach the high school and crossing at the 28th Avenue/Powell Boulevard intersection, despite the lack of a marked crossing (this is a legal crossing), as shown in Exhibit 50 and Exhibit 51. Although the lack of a marked crossing does not make the crossing illegal, crossings at 28th Avenue are more challenging than crossing at the marked crossings at 28th Place or 26th Avenue. Parents were also observed dropping their students off on 28th Avenue, south of Powell Boulevard. The majority of these students then crossed Powell Boulevard at 28th Avenue. Other people were observed crossing at the intersection to catch westbound TriMet buses. These pedestrians exhibited risky behaviors because they were often trying to cross Powell Boulevard quickly by stepping into the roadway to get vehicles to yield to reach the transit stop before the bus arrived.

The crash history showed a trend of rear-end crashes at this location. Exhibit 43 shows that at least 14 reported crashes were pedestrian crashes or involved pedestrians. In addition to the pedestrian crossings the intersection, queues from the signal at 26th Avenue were observed extending past the intersection. Queues in the left-turn pockets at the intersection were also noted to restrict sight distance, due to the vertical curvature of the roadway.

The qualitative risk rating associated with the safety issues at the intersection of Powell Boulevard/28th Avenue, is presented in Table 14.

Table 14 Qualitative Risk Rating of Safety Issues at Powell Boulevard/28th Avenue Intersection

Function	Classification	Reasoning
Exposure	Category III	High volume of pedestrians cross at this location to access school and transit stop
Probability	Category III	Crash history shows a high number of pedestrian-involved and rear-end crashes at this location
Consequence	Category III	Bicyclists and pedestrians are vulnerable users
Overall	*III*	-

Exhibit 50 Students Crossing Powell Boulevard

Exhibit 51 Students Crossing Powell Boulevard while Vehicle Turns Left

Issues at Powell Boulevard & 28th Place

The Powell Boulevard/ 28th Place intersection is a three-leg unsignalized intersection with a marked pedestrian crossing located on the east side of the intersection. The pedestrian crossing has a pedestrian refuge island. A McDonald's restaurant is located northeast of the intersection, and a Wendy's restaurant is located in the southeast corner of the intersection. The McDonald's restaurant is in the process of developing an updated site plan that includes changes to existing driveways. Queues from the nearby eastbound and westbound bus stops were observed to block the crosswalk at times. In addition, westbound queues from the 26th Avenue signal were observed to back up to the intersection during some peak times of the day.

Traffic counts and field observations showed the pedestrian crossing is heavily used at this location. Crash data showed a trend of rear-end crashes, including several pedestrian crashes at this location. Some reported rear-end crashes involved pedestrians, although they were not pedestrian crashes.

The qualitative risk rating associated with the safety issues at the Powell Boulevard/28th Place intersection, is presented in Table 15.

Table 15 Qualitative Risk Rating of Safety Issues at Powell Boulevard/28th Place Intersection

Function	Classification	Reasoning
Exposure	Category III	High number of pedestrians crossing here
Probability	Category III	High number of crashes occurred at this location
Consequence	Category III	Crash history shows injury crashes
Overall	*III*	-

Issues at Powell Boulevard & 29th Avenue

The Powell Boulevard/29th Avenue intersection is an unsignalized intersection serving Hopworks Urban Brewery on the south side of Powell Boulevard and connects with residential areas north of Powell Boulevard. Therefore, retaining left-turning movements from Powell Boulevard onto 29th Avenue is important at this location. There are no special pedestrian crossing treatments. The northeast corner contains a mixture of commercial uses, including a bowling alley. With the exception of the frontage of Hopworks Urban Brewery, both sides of Powell Boulevard have driveways. Crash data did not show a high number of reported crashes at driveways. The different land uses within the area (commercial, restaurants, bowling alley, bars) create an interaction among one another, encouraging pedestrian crossings in the area.

The qualitative risk rating associated with the safety issues at the Powell Boulevard/29th Avenue intersection, is presented in Table 16.

Table 16 Qualitative Risk Rating of Safety Issues at Powell Boulevard/29th Avenue Intersection

Function	Classification	Reasoning
Exposure	Category I	Vehicle turning movements at the intersection are low, and pedestrian crossing volumes are lower than marked crossings
Probability	Category I	Relatively low crash history
Consequence	Category III	Potential for severe crashes with pedestrians
Overall	*II*	-

Suggestions for 28th Avenue, 28th Place, and 29th Avenue

The issues summarized at 28th Avenue, 28th Place, and 29th Avenue are related. This section presents suggestions for these three intersections. As the previous sections summarized, there is currently a marked pedestrian crossing at 28th Place, but pedestrians also use the median at 28th Avenue to cross

to reach the school or transit stop. Because pedestrians cross at this location, adding a marked crossing at 28th Avenue should be considered. The location of transit stops needs to be included in the crossing evaluation, because crossing locations need to be considered relative to transit stops. In addition, if bike lanes are removed from 26th Avenue as presented as an option with the 26th Avenue suggestions, a bicycle crossing will need to be considered further east of 26th Avenue.

The RSA Team considered a variety of options before arriving at two suggestions for this section of the corridor. The two options presented reflect those that the RSA team felt would best address the issues of various users in this section. Some of the options considered were not suggested due to concerns about bicyclist expectations, confusion, and conflicts with roadway movements.

The 20's Bikeway project suggested an option of creating a southbound bicycle lane on 26th Avenue in conjunction with a bicycle boulevard on 28th Avenue (functioning as a bicycle couplet with 26th Avenue southbound and 28th Avenue northbound). This was not included in the recommendations for several reasons:

The team discussed that bicyclists are unlikely to take a different route northbound and southbound when vehicles travel both directions on both roadways and 28th Avenue provides an option for bicyclists to travel both directions on the same route. The following two options are presented as the two suggestions for this section of the corridor. Specific elements of each option are discussed in more detail below.

Option #1: New Traffic Signal at 28th Place

Option #1 is summarized in Exhibit 52, which includes a new traffic signal at 28th Place. This option allows for more consistent signal spacing along Powel Boulevard within the study area.

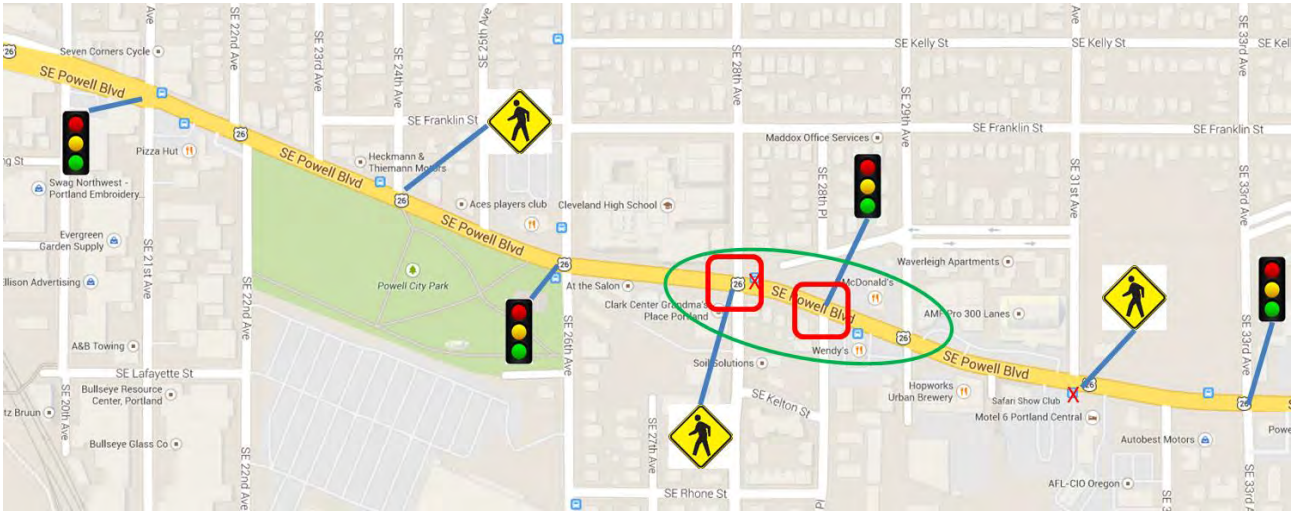

Exhibit 52 Corridor Option #1

Option #1 includes the following key elements at each intersection:

- 28th Avenue:
    - Consider providing a "Z" crossing to allow pedestrians to cross in two stages facing oncoming traffic, as illustrated in Exhibit 53.
        - No RRFB is suggested for the pedestrian crossing at 28th Avenue due to its proximity to the two upstream signals.
    - Consider removing the westbound left-turn pocket to enhance the median for pedestrians and signage. This alternative will need to consider traffic patterns and access to the Catholic Charities building and residential areas.
    - Reevaluate the westbound transit stop at 28th Avenue with the new pedestrian crossing locations to determine if it should be relocated or removed.
    - Consider partnering with the school or local businesses for education on pedestrian safety campaigns.

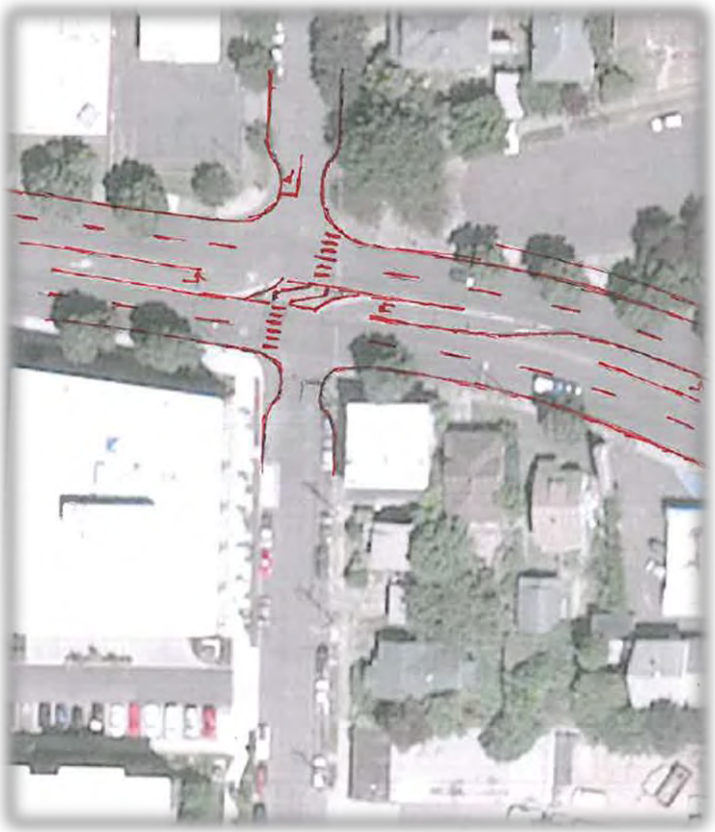

Exhibit 53 Conceptual Configuration of 28th Ave Crossing under Option #1

- 28th Place:
    - Consider installing a traffic signal at 28th Place. This signal would be designed to enhance the existing marked pedestrian crossing and to accommodate bicycle crossings and connect with a larger north-south bicycle corridor. The signal design would need to consider how to connect bicyclists with the north-south bicycle route currently planned for 28th Avenue before and after the crossing at Powell Boulevard. This signal would need to be coordinated with the existing signal at 26th Avenue due to the close proximity.
    - Review McDonald's site plan and coordinate with them with the intent to orient entries towards the new crossing, or use signage to direct people to the crossing. Review transit stop locations and spacing with respect to the pedestrian crossing locations to determine if any stops could be closed or relocated. Exhibit 54 illustrates two potential options with modifications to McDonald's site plan:
        - The sketch on the left shows incorporating the driveway into the signal and provides clearly marked bicycle crossings within the signalized intersection. The bike route can be diverted back to 28th Avenue and/or access to the neighborhood to the north.
        - The sketch on the rights eliminates McDonald's access on Powell Boulevard and reroutes exiting motorists via Waverleigh Boulevard and 29th Avenue. The fourth and northern leg of this intersection will provide access to the bike route.

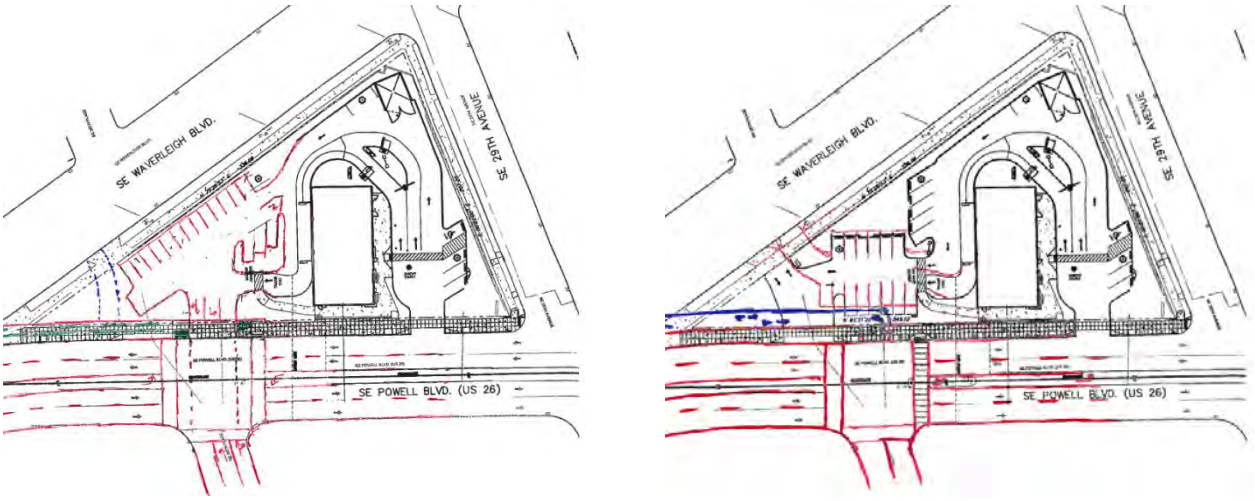

Exhibit 54 Conceptual McDonalds Site Plan Modifications Within Option #1

- 29th Avenue:
    - Consider combining access points on the north side of Powell Boulevard or developing an access management plan with instructions for consolidation upon redevelopment.
    - Consider adding a buffered landscape strip or bike racks on the north and south sides of Powell Boulevard (as Hopworks Urban Brewery has done on the south side) to discourage pedestrians from crossing midblock.

Corridor Option #2: Traffic Signal at 28th Avenue

Option #2 includes a new traffic signal at 28th Avenue, as illustrated in Exhibit 55. This option will have two closely spaced signalized intersections.

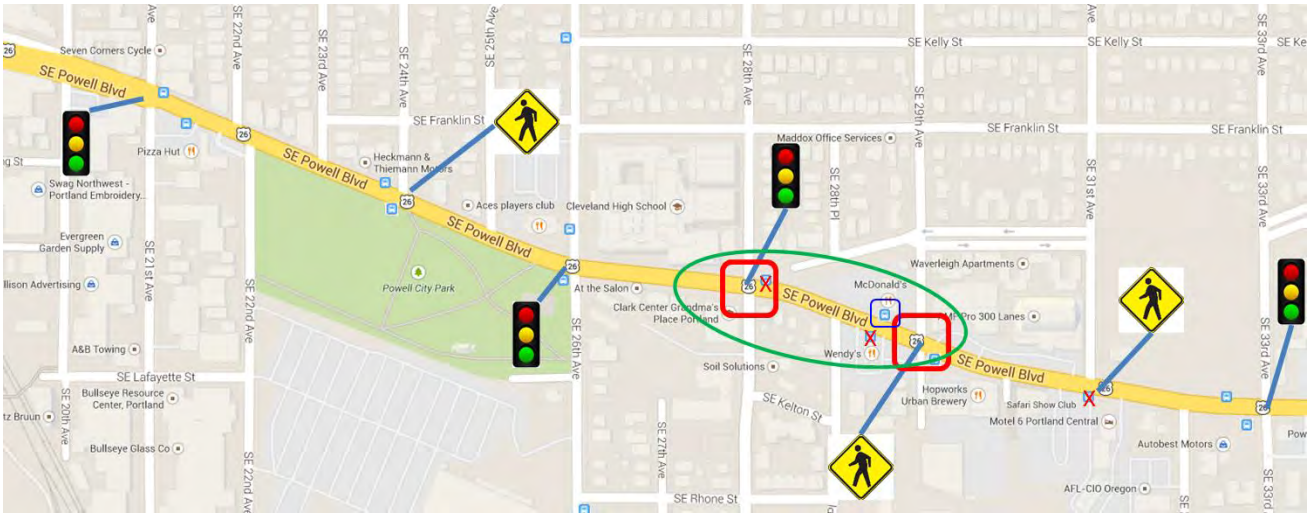

Exhibit 55 Corridor Option #2

Option #2 includes the following key elements at each intersection:

- 28th Avenue:
    - Consider adding a traffic signal that allows through movements for bicyclists while restricting vehicle traffic to right-in/right-out on the side streets, as shown in the concept in Exhibit 56. This option may consider bicycle detection (with indication of detection to bicyclists) at the signal. The signal would need to be coordinated with the signal at 26th Avenue due to close proximity, as well as progression along the corridor. Impacts to traffic patterns associated with destinations along 28th Avenue, including the Catholic Charities building, would need to be evaluated under this option.

Exhibit 56 28th Ave Traffic Signal Allowing Pedestrian and Bike Crossings and Right-turns Only

- 28th Place:
    - Consider closing the pedestrian crossing at 28th Place and relocating it to 29th Avenue to provide better spacing between pedestrian crossings throughout the corridor. The existing crossing location is too close to the new signal at 28th Avenue to be kept and enhanced with a RRFB due to vehicle queues extending through the crosswalk, confusion to drivers, and a potential increase in westbound left-turning vehicles at 28th Place due to the restriction at 28th Avenue.
    - Review McDonald's site plan and coordinate with them the intent to orient entries towards new crossing, or use signage to direct people to the crossing.
    - Review transit stop locations and spacing with respect to the pedestrian crossing locations to determine if any stops could be closed or relocated.
- 29th Avenue:
    - Consider installing an enhanced crossing, as shown in the concept in Exhibit 57. This crossing is needed to replace the existing one at 28th Place to provide adequate spacing between pedestrian crossings to encourage pedestrians to use the marked crossings. Because a center median would restrict eastbound left-turn movements, an overhead RRFB may be needed in place of one in the center median. The other elements of an enhanced crossing specified in the corridor-wide suggestions should also be considered at this location.
    - A review of transit stop locations should also accompany a new pedestrian crossing at 29th Avenue.
    - Consider combining access points on the north side of Powell Boulevard or developing an access management plan with instructions for consolidation upon redevelopment.

- Consider adding a buffered landscape strip or bike racks on the north and south sides of Powell Boulevard (as Hopworks Urban Brewery has done on the south side) to discourage pedestrians from crossing midblock.

Exhibit 57 Potential Intersection Improvements at 29th Avenue under Option #2

SUMMARY OF FINDINGS AND SUGGESTIONS

The table below indexes all issues identified during the RSA. This table is formatted to allow ODOT to provide a response to each safety issue. The first three columns of this table are consistent with the RSA report.

Location	Issue	Suggestion	Agency Response/Comment
Study Corridor	Unpredictable Yielding at Pedestrian Crossings	Review bus stop locations relative to pedestrian crossings	
		Upgrade unsignalized crossings to enhanced crossings with pedestrian refuge islands, visible advanced warning signage, “No Lane Change” striping, and rapid rectangular flashing beacons (RRFB). Use a consistent crossing design throughout the corridor.	
		Provide pedestrian-scale lighting in advance of each unsignalized pedestrian crossing to illuminate the pedestrian in the crosswalk	
		Trim trees to provide clear height to make visible signs to drivers	
		Provide signing and striping improvements to increase awareness of pedestrian crossings	
		Provide a leading pedestrian phase at signalized intersections	
		Expand pedestrian landing areas on the corners of Powell Boulevard/26th Avenue	
	Congestion and Associated Traffic Signal Queuing	Consider signal timing modifications	
		Consider reevaluating signal progression on Powell Boulevard	
		Review the signal cycle lengths	
		Complete tree trimming to increase visibility of signs and approaching signals	
		Consider supplemental signal heads at near left side corner	
		Review sign placement and visibility	
	Permissive Phasing and Traffic Signal Conflicts	Consider providing protected or protected/permitted left-turn phasing	
		Consider providing a leading pedestrian phase at signals when using protected/permitted left-turn phasing	
		Consider using the pedestrian function with the flashing yellow arrow (FYA) signals that will not allow a FYA to come up when a pedestrian call is placed	
		Consider prohibiting right turns on red at locations with	
		A crash history involving right turning vehicles (21st Avenue) and/or involving pedestrians/bicyclists with right turning vehicles (26th Avenue), and/or	
		Limited sight distance (21st Avenue)	
	Number of Access Points and Types of Land Uses	Consider developing an access management plan for Powell Boulevard (with emphasis between 29th Avenue and 31st Avenue) that may	
		Prioritize for access review those locations with access points overlapping with pedestrian refuge islands as candidates	
		Consider developing and implementing a policy to consolidate access points upon redevelopment	
		Consider providing zoning guidance on access and building orientation for the properties along the corridor	
	Lack of Protection for Bicycle Crossings	Install bike boxes at signalized intersections	
		Use bike detection at signalized intersections; this could be designed to have an indicator informing bicyclists when they are detected	
		Consider installing bike lanes on cross-streets heavily traveled by bicyclists (21st Avenue, 26th Avenue (wider), 33rd Avenue)	
		Consider installing sharrows on lower volume, lower speed streets to inform drivers to share the lane with bicyclists and/or inform cyclists of a potential bike route	

Location	Intersection	Suggestion	Agency Response/Comment
Intersection Specific	Powell Boulevard & 20th Avenue	Add right-turn arrow pavement markings on the northbound and southbound approaches.	
		Add One Way signage for the northbound and southbound approaches.	
	Powell Boulevard & 21st Avenue	Restripe the north- and southbound approaches to include left-turn lanes:	
		Remove some parking on 21st Avenue to accommodate the turn lanes; and,	
		Investigate the feasibility of allowing right-turns on red with shared through/right lane closer to curb.	
		Provide protected/ permissive left-turn phasing for all approaches.	
		Consider restricting right-turn on-red for the northbound approach using signage.	
		Install supplemental signal heads to increase awareness of approaching intersection.	
		Rebuild signal with mast arm street name signs to increase visibility; consider placing signal poles to accommodate truck movements in the new design.	
		Consider a queue detection and warning system to detect queues associated with 21st Avenue signal.	
	Powell Boulevard & 22nd Avenue	Install a curb extension on the Southeast corner.	
		Move the stop bar on northbound approach closer to intersection to increase sight distance.	
	Powell Boulevard & 24th Avenue	Consider adding an RRFB and pedestrian scale lighting in advance of the crosswalk.	
		Consider removing select tree(s) to increase visibility of crossing, signage, and pedestrians; Consider eliminating or relocating eastbound TriMet stop downstream of the crosswalk.	
	Powell Boulevard & 26th Avenue	Review and consider modifying signal timing	
		Review and consider lengthening cycle lengths;	
		Consider providing protected/permissive phasing for northbound and southbound left-turn phases; and,	
		Consider using leading pedestrian intervals.	
		Consider a queue jump for eastbound buses.	
		Consider installing a new signal, with the following considerations	
		Modify the pole locations and curb radii to accommodate turns; and,	
		Expand pedestrian refuge area on corners.	
		Consider working with Cleveland High School and Portland Public Schools to create a pedestrian plaza in front of the high school.	
		Consider closing residential driveway on the southeast corner.	
		Consider the following two options to accommodate bikes crossing Powell Boulevard	
		Widen both sides by removing the landscape strip and moving the bus stop to accommodate wider bike lanes on both sides and,	
		Remove the bike lanes and replace with a bike crossing further east on Powell Boulevard.	
	Powell Boulevard & 31st Avenue	Consider improving pedestrian crossing to include:	
		Pedestrian refuge island;	
		RRFB;	
		No lane change striping and advanced warning signs and,	
		Pedestrian-scale lighting, placed in advance of the crossing.	
		Consider improving signage and pavement markings at Motel 6 exit-only driveway.	
		Consider removing the fence on northwest corner of Motel 6 property to improve sight distance.	
		Consider removing vegetation in northeast corner of the intersection to improve sight distance.	
		Consider making the southbound approach right-only (due to new pedestrian refuge median as well as restricted sight distance).	
	Powell Boulevard & 33rd Avenue	Consider tree trimming to increase visibility of signs and sight distance to the intersection.	
		Consider relocating the ZipCars parking south, completing the sidewalk on the east side of 33rd Avenue, and installing a bulb-out at the southeast corner.	
		Review signal timing and cycle lengths:	
		Consider pedestrian and bicyclist wait times;	
		Consider protected/permissive left-turn phasing from the mainline;	
		Consider providing an indication of bicycle detection to discourage impatience;	
		Consider running the signal at 33rd Avenue with half cycle compared to other signals within the corridor due to pedestrian/bicyclists frustration; and,	
		Consider installing a new signal with mast arms, with a focus on pole placement.	

Location	Intersection	Suggestion	Agency Response/Comment
Powell Boulevard, Between 28th Avenue and 29th Avenue (Option 1)	Powell Boulevard & 28th Avenue	Consider providing a "Z" crossing to allow pedestrians to cross in two stages facing oncoming traffic:	
		No RRFB is suggested for the pedestrian crossing at 28th Avenue due to its proximity to the two upstream signals.	
		Consider removing the westbound left-turn pocket to enhance the median for pedestrians and signage.	
		Reevaluate the westbound transit stop at 28th Avenue with the new pedestrian crossing locations.	
		Consider partnering with the school or local businesses for education on pedestrian safety campaigns.	
	Powell Boulevard & 28th Place	Consider installing a traffic signal at 28th Place. This signal would be designed to enhance the existing marked pedestrian crossing and to accommodate bicycle crossings and connect with a larger north-south bicycle corridor.	
		Review McDonald's site plan and coordinate with them with the intent to orient entries towards the new crossing, or use signage to direct people to the crossing. Review transit stop locations and spacing with respect to the pedestrian crossing locations to determine if any stops could be closed or relocated.	
		Option #1: Incorporate the driveway into the signal and provides clearly marked bicycle crossings within the signalized intersection. The bike route can be diverted back to 28th Avenue and/or access to the neighborhood to the north.	
		Option #2: Eliminate McDonald's access on Powell Boulevard and reroutes exiting motorists via Waverleigh Boulevard and 29th Avenue. The fourth and northern leg of this intersection will provide access to the bike route.	
	Powell Boulevard & 29th Avenue	Consider combining access points on the north side of Powell Boulevard or developing an access management plan with instructions for consolidation upon redevelopment.	
		Consider adding a buffered landscape strip or bike racks on the north and south sides of Powell Boulevard (as Hopworks Urban Brewery has done on the south side) to discourage pedestrians from crossing midblock.	
Powell Boulevard, Between 28th Avenue and 29th Avenue (Option 2)	Powell Boulevard & 28th Avenue	Consider adding a traffic signal that allows through movements for bicyclists while restricting vehicle traffic to right-in/right-out on the side streets. This option may consider bicycle detection.	
	Powell Boulevard & 28th Place	Consider closing the pedestrian crossing at 28th Place and relocating it to 29th Avenue to provide better spacing between pedestrian crossings throughout the corridor.	
		Review McDonald's site plan and coordinate with them with the intent to orient entries towards new crossing, or use signage to direct people to the crossing.	
		Review transit stop locations and spacing with respect to the pedestrian crossing locations to determine if any stops could be closed or relocated.	
	Powell Boulevard & 29th Avenue	Consider installing an enhanced crossing. Because a center median would restrict eastbound left-turn movements, an overhead RRFB may be needed in place of one in the center median. The other elements of an enhanced crossing specified in the corridor-wide suggestions should also be considered at this location.	
		A review of transit stop locations should also accompany a new pedestrian crossing at 29th Avenue.	
		Consider combining access points on the north side of Powell Boulevard or developing an access management plan with instructions for consolidation upon redevelopment.	
		Consider adding a buffered landscape strip or bike racks on the north and south sides of Powell Boulevard (as Hopworks Urban Brewery has done on the south side) to discourage pedestrians from crossing midblock.	

Appendix A

Powell Boulevard Road Safety Audit Findings Presentation

ROAD SAFETY AUDIT
Powell Blvd: 20th Ave to 33rd Ave
(M.P. 1.76 to M.P. 2.49)

Preliminary Findings Meeting

June 6, 2014
Portland, Oregon

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RSA Team

- Hermanus Steyn
  - KAI, Principal Engineer
- Joel McCarroll
  - ODOT Region 4 Traffic
- Mike Coleman
  - Port of Portland
- Jabra Khasho
  - City of Beaverton
- Nate Young
  - Hopworks, Citizen panelist
- Ashleigh Griffin
  - KAI, Transportation Analyst

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Presentation Outline

- Overview of Road Safety Audit (RSA) Process
- Scope of RSA and Study Area
- Review of Traffic Volumes and Crash Data
  - Corridor Wide
  - Intersection Specific
- Preliminary Findings
- Next Steps

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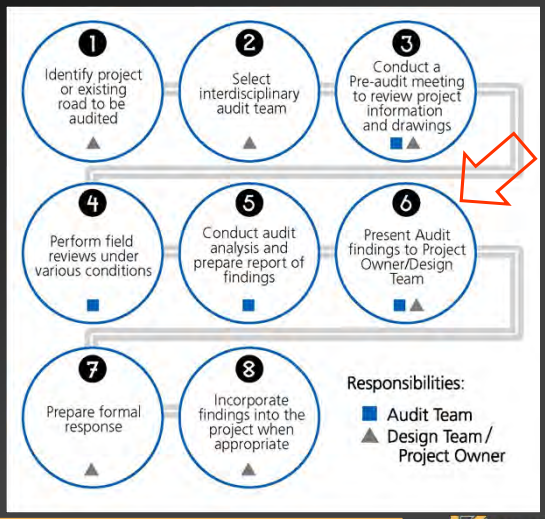
FHWA RSA Process



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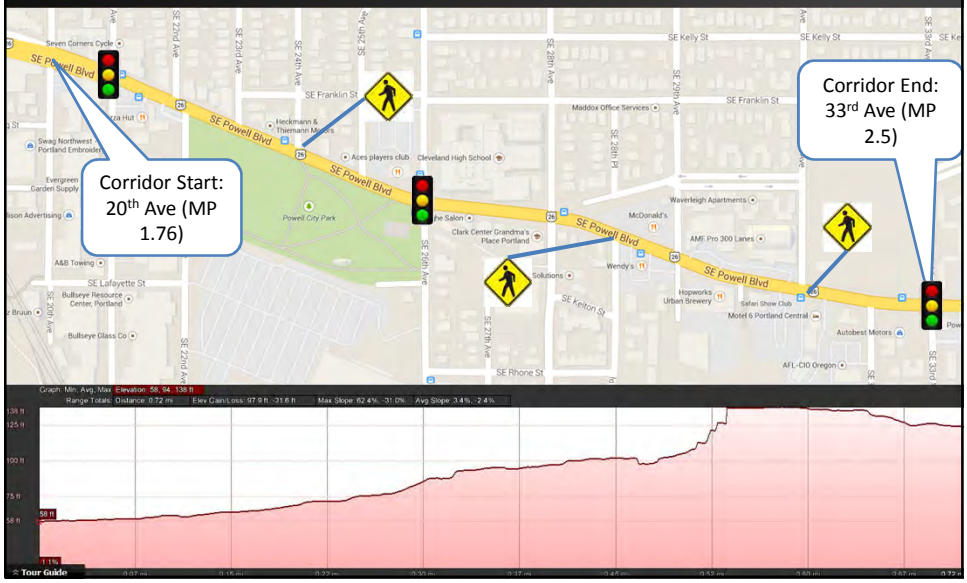
Study Segment



Background Information

- 5-lane Urban Principal Arterial
  - Two-way left-turn lane
- 2012 AADT = 34,200 – 38,100 veh/day
- 3% trucks
- Three signalized intersections
  - 21st Ave
  - 26thAve
  - 33rd Ave
- Striped crosswalks
  - 24th Ave
  - 28th Pl
  - 31st Ave
- Land use varies
  - Residential
  - Commercial
  - Schools/parks
- Multiple TriMet stops

- Several multimodal attractors/generators
  - Cleveland High School
  - Powell City Park

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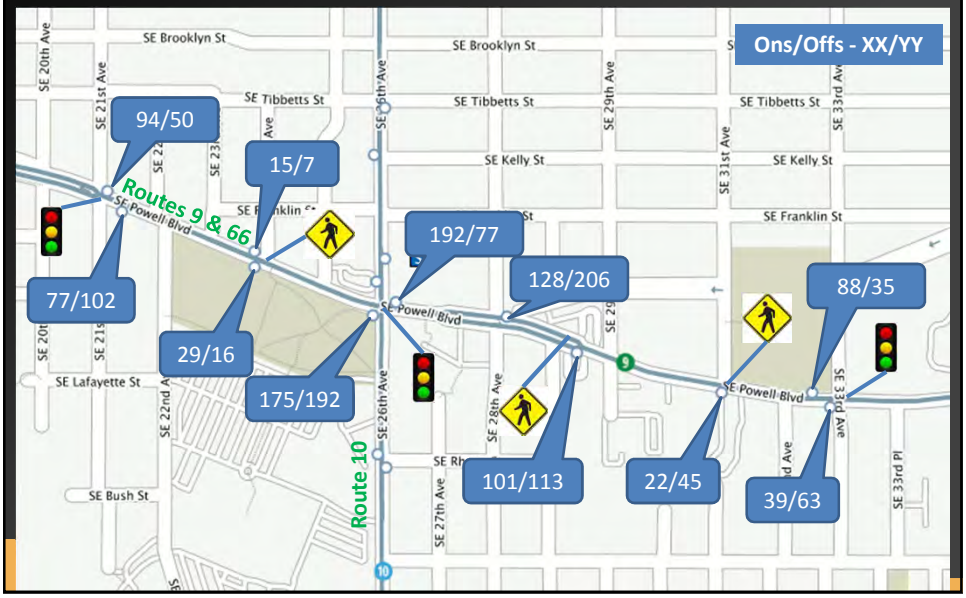
TriMet Bus Stops – Weekday Fall 2013



Statewide Comparison

Segment	5-Year Average Crash Rate
Study Segment Vicinity MP 1.61 to MP 2.91 (SE 39th Ave)	6.54
Similar Segment MP 2.91 (SE 39th Ave) to MP 3.45 (Foster Rd)	5.59
Statewide Urban Non-Freeway Principal Arterials	2.82

Source: ODOT Crash Rate Book 2012

Crash Data Trends: Corridor Wide

- Crash Data
  - January 2008 through September 2013

- Trends Reviewed
  - *Severity*
  - *Year*
  - *Month*
  - *Day of Week*
  - *Time of Day*
  - *Crash Cause*
  - *Collision Type*

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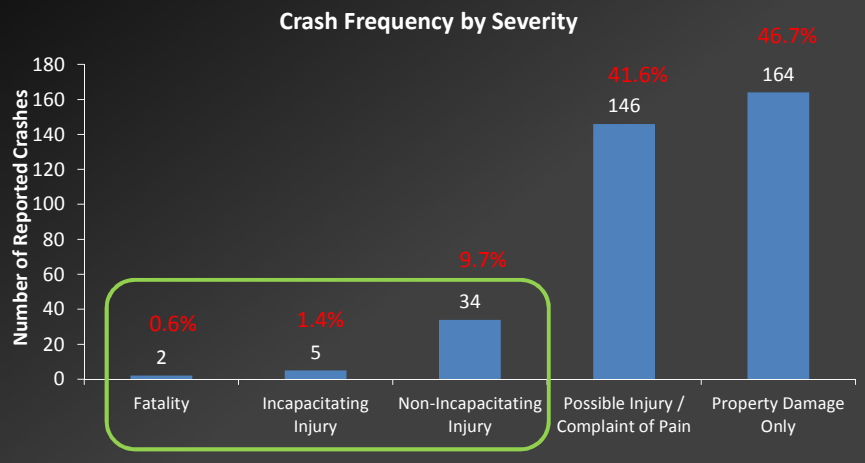
Corridor Crash Trends: Severity



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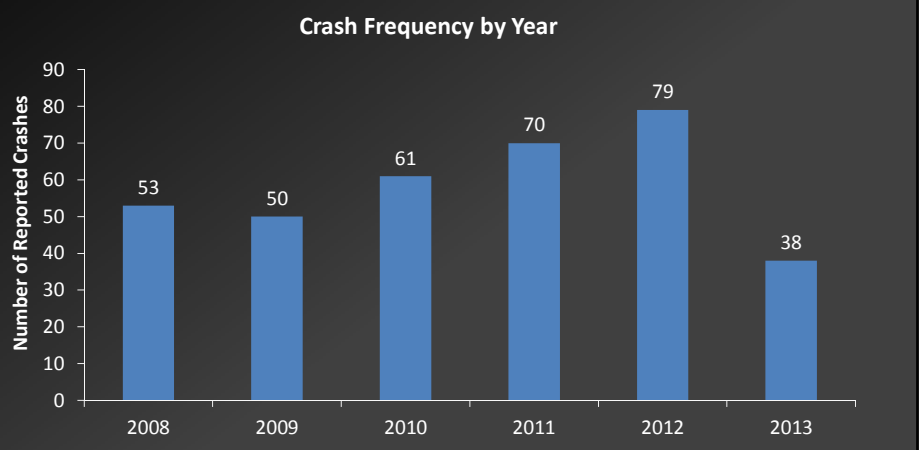
Corridor Crash Trends: Year



Note: 2013 data is only available through September 30, 2013

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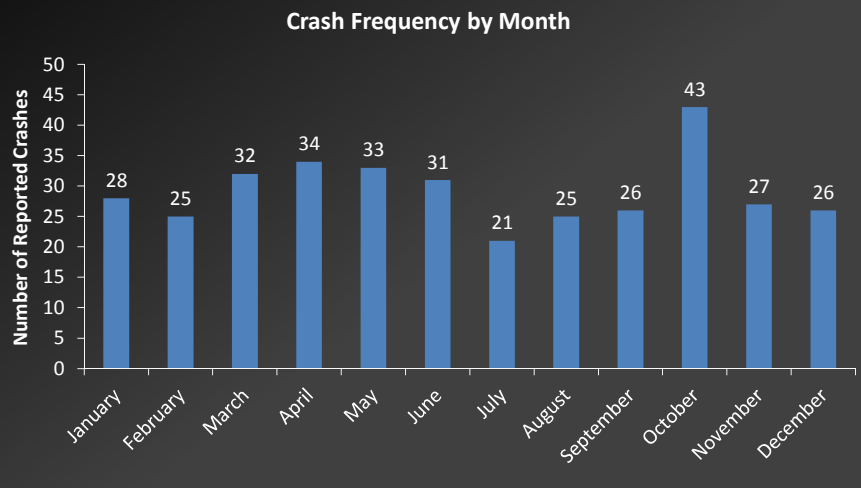
Corridor Crash Trends: Month



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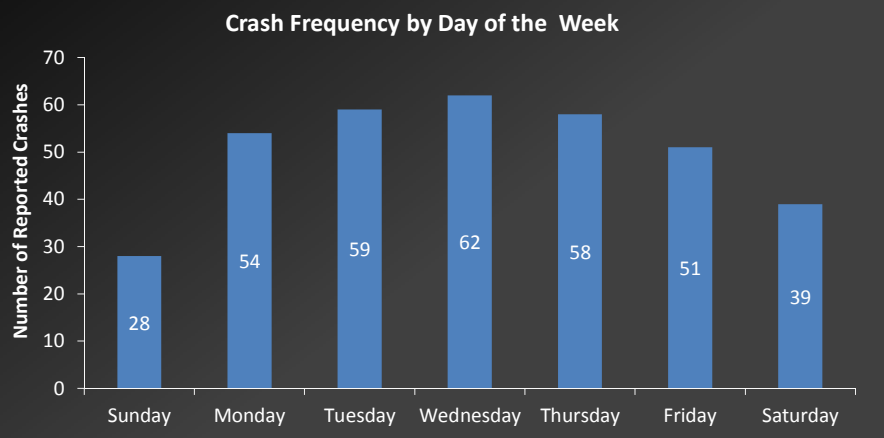
Corridor Crash Trends: Day of the Week



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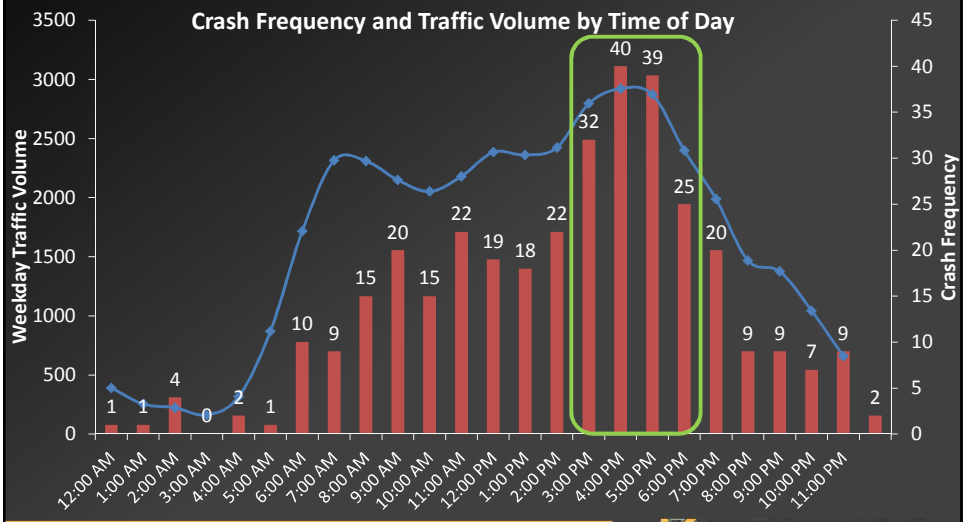
Corridor Crash Trends: Time of Day



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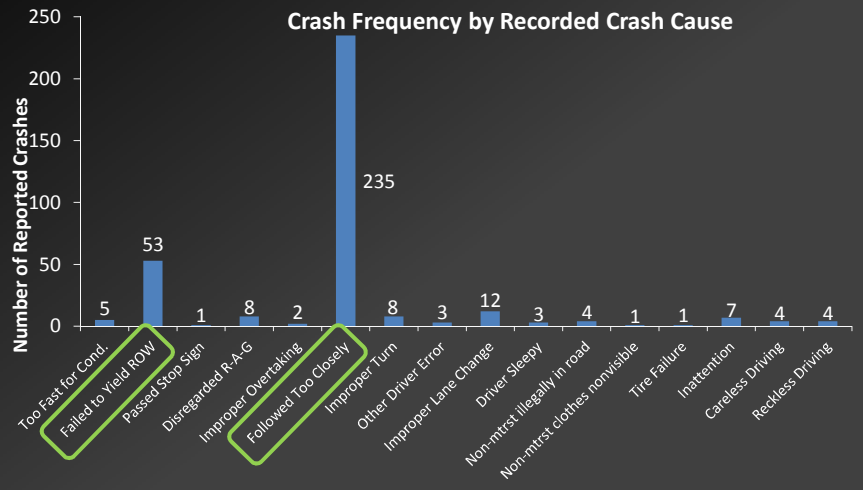
Corridor Crash Trends: Crash Cause



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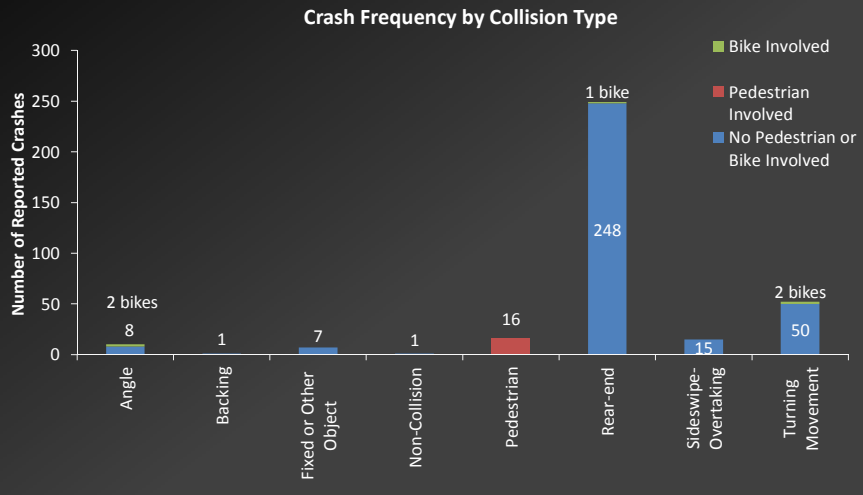
Corridor Crash Trends: Collision Type



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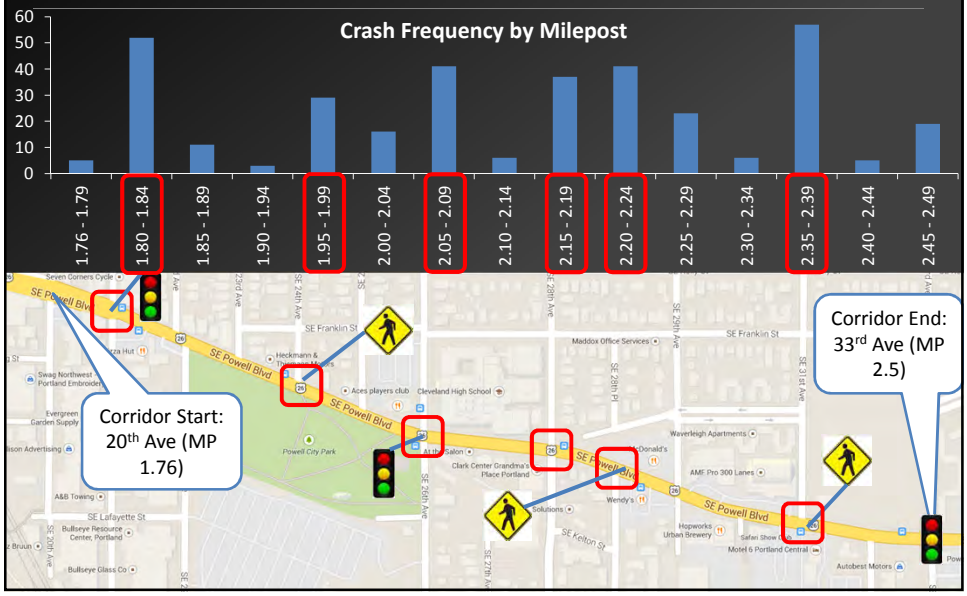
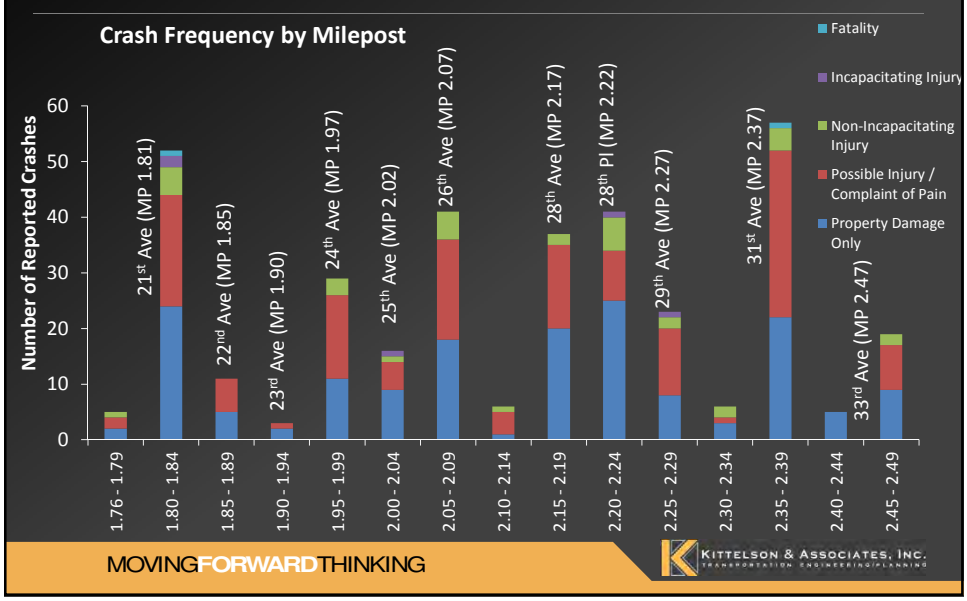
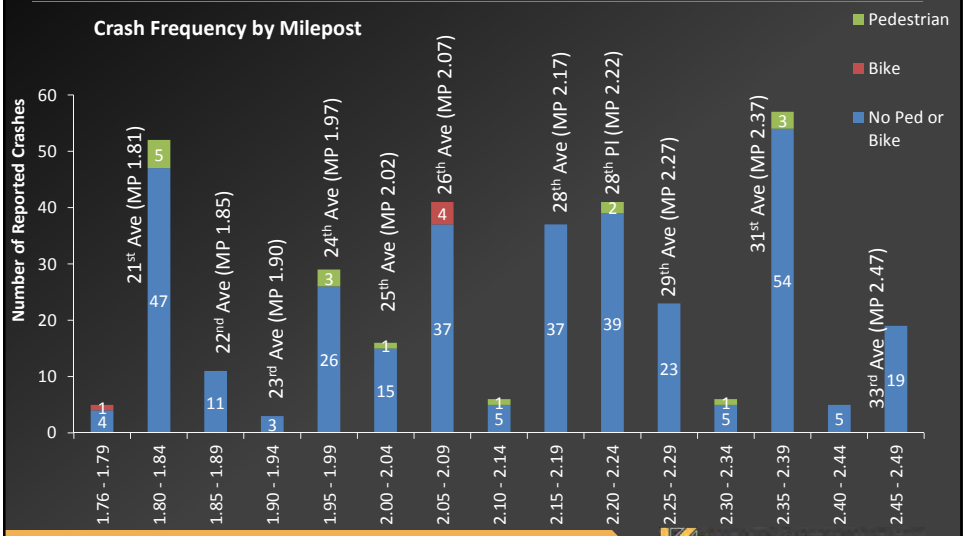
Crash Trends: Milepost



Crash Trends: Milepost



Crash Trends: Milepost



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Preliminary Findings

- System-Wide
  - Issues and suggestions that are similar throughout the corridor
  - Applicability extents beyond study limits
- Intersection Specific
  - Each intersection has unique characteristics and issues that may warrant additional suggestions and specific suggestions for implementing the system-wide suggestions

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System-Wide Issue: Pedestrian Crossings

- Location
  - Coordination with transit stops
- Visibility
  - Visibility/reflectivity of objects
    - Restricted by trees
  - Sight lines from drivers and pedestrians
    - Restricted by buildings, trees, roadway curvature
- Crossings at traffic signals

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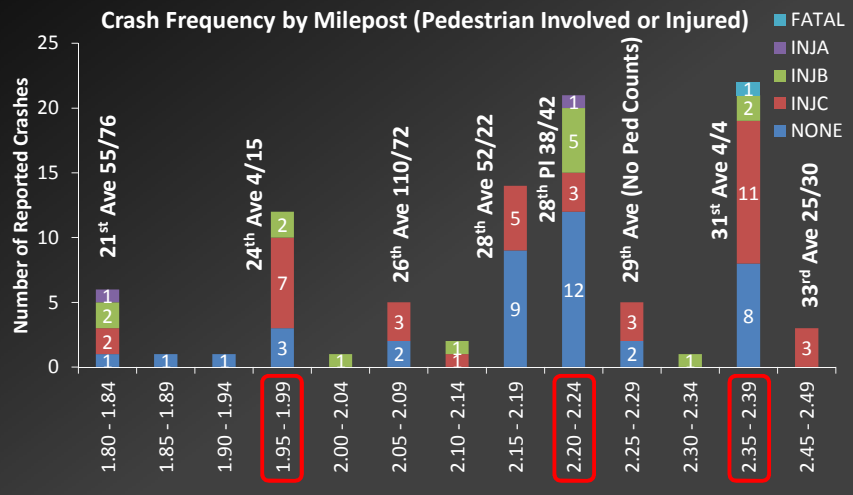
System-Wide Issue: Pedestrian Crossings

#AM/#PM Ped Crossings



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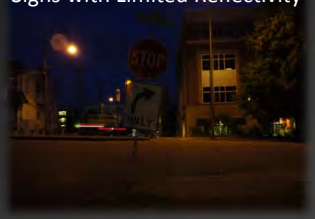
System-Wide Issue: Pedestrian Crossings

Signs with Limited Reflectivity



Signs Blocked by Trees

Signs Blocked by Trees

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System-Wide Issue: Pedestrian Crossings

Limited Sight Distance – Horizontal Curve

Restricted Sight Distance for Pedestrian

Placement of Transit Stops

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System-Wide Suggestion: Pedestrian Crossings

- Enhanced crossings (RRFB)
- Lighting
- Signing/Striping Improvements
- Tree Trimming
- Review Bus Stop Locations Relative to Crossings

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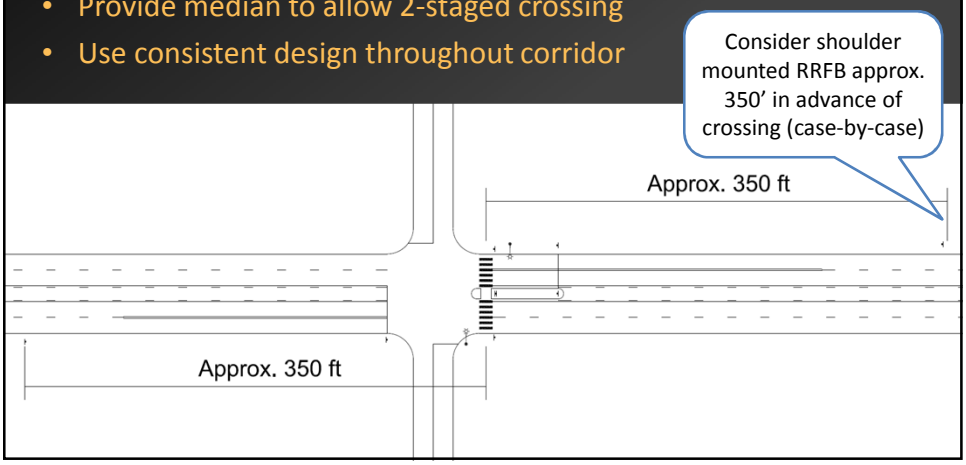
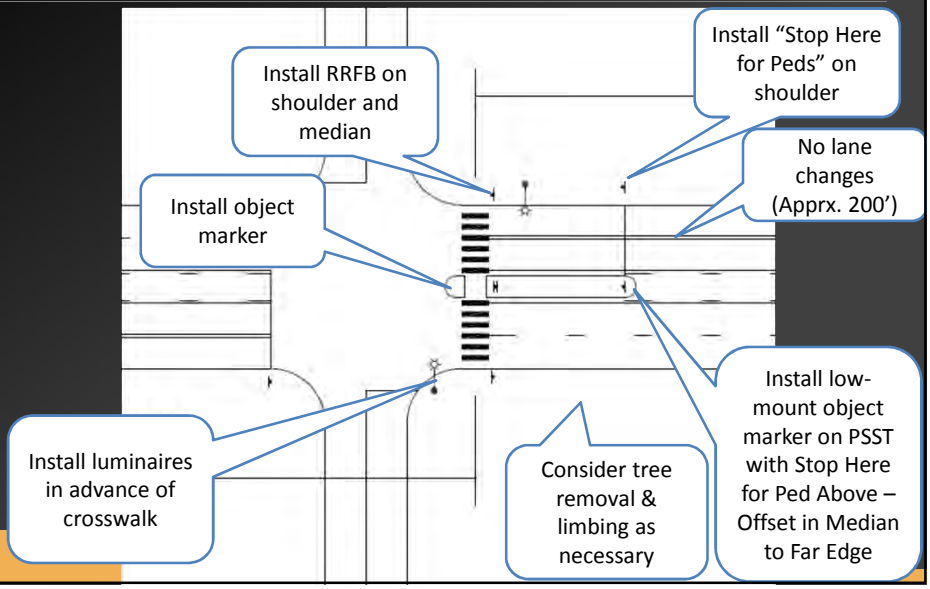
System-Wide Suggestion: Pedestrian Crossings

- Upgrade unsignalized crossings to include Rectangular Rapid Flashing Beacons (RRFBs) and pedestrian-scale lighting
- Provide median to allow 2-staged crossing
- Use consistent design throughout corridor



System-Wide Suggestion: Pedestrian Crossings



System-Wide Suggestion: Pedestrian Crossings

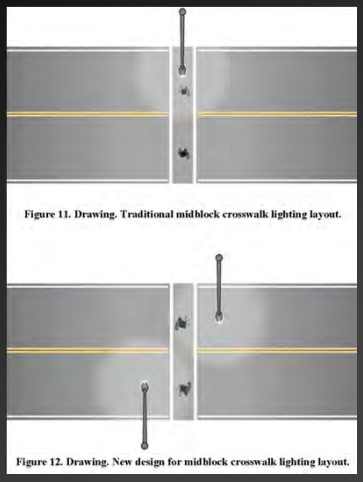


Figure 11. Drawing. Traditional midblock crosswalk lighting layout.

Figure 12. Drawing. New design for midblock crosswalk lighting layout.

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System-Wide Issue: Signal Queuing

- Rear-end crashes associated with queues
  - Queues extend to/through next signal

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System-Wide Issue: Signal Conflicts

- Permissive left-turn phasing

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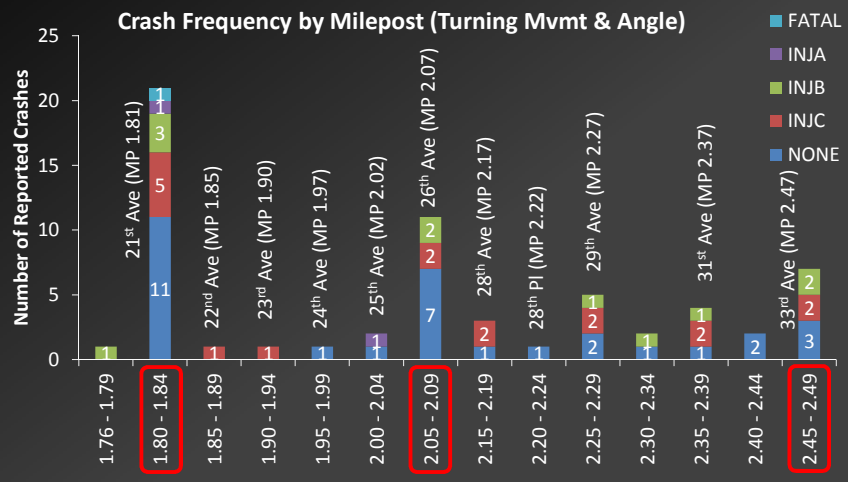
System-Wide Issue: Signal Queuing & Conflicts



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System-Wide Suggestion: Signal Queuing

- Signal timing improvements
  - Cycle length
  - Consider reevaluating signal progression on Powell Blvd
- Tree trimming to increase visibility of signs and approaching signal & queues
- Consider supplemental signal heads at near left side corner

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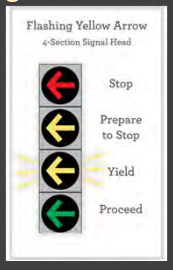
System-Wide Suggestion: Signal Queuing

System-Wide Suggestion: Signal Conflicts

- Consider using pedestrian function with FYA
  - FYA will not come up when a pedestrian call is placed
- Consider prohibiting right turns on red with a crash history
  - Involving pedestrians/bicyclists with right turning vehicles
  - Limited sight distance
- Consider providing protected/permitted left-turn phasing
- Consider leading pedestrian phase



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System-Wide Issue: Access Points and Land Use

System-Wide Issue: Access Points & Land Use

- Mixed land use
  - School, residential, park, restaurants, bowling alley
- Access points overlap with pedestrian crossing medians
- Left-turns from driveways and side streets are difficult due to limited sight distance and approaching grades

System-Wide Suggestion: Access Points and Land Use

- Consider developing an access management plan (particularly between 29th and 31st Avenue)
  - Prioritize locations with access that overlap ped crossing medians
  - Consider policy to consolidate access upon redevelopment
- Consider zoning guidance on access and building orientation

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System-Wide Issue: Bike Crossings

- Bicyclists Cross at
  - Signals
  - Pedestrian Crossings
- Limited Right-of-Way on Powell

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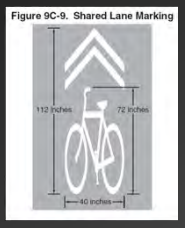
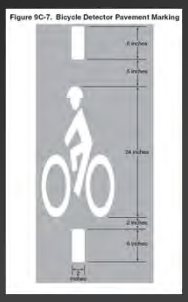
System-Wide Suggestion: Bike Crossings

- Bike boxes
- Bike detection
- Bike lanes
- Sharrows





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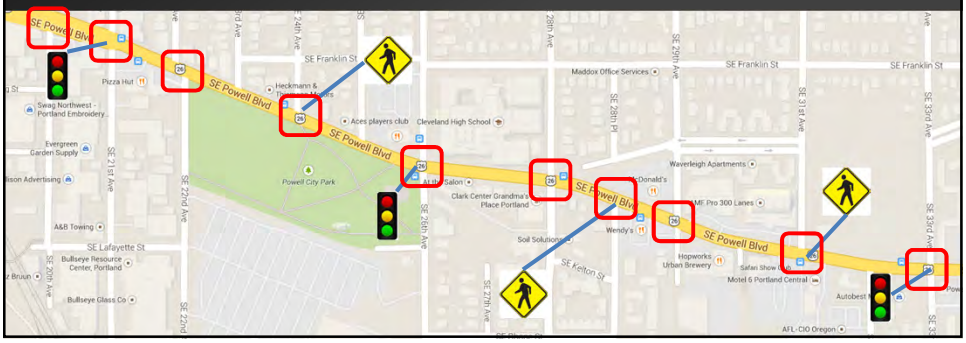
Intersection Specific Trends

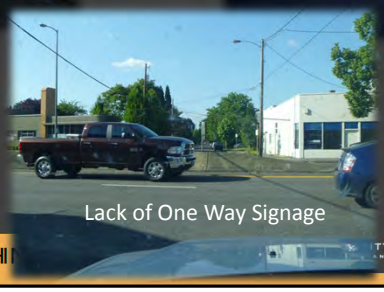
- Powell Blvd & 20th Ave
- Powell Blvd & 21st Ave
- Powell Blvd & 22nd Ave
- Powell Blvd & 24th Ave
- Powell Blvd & 26th Ave
- Powell Blvd & 28th Ave
- Powell Blvd & 28th Pl
- Powell Blvd & 29th Ave
- Powell Blvd & 31st Ave
- Powell Blvd & 33rd Ave



Issues: Powell Blvd & 20th Ave

Lack of Right Turn Only Pavement Marking

Limited Sight Distance (Northbound) & Eastbound Bikes

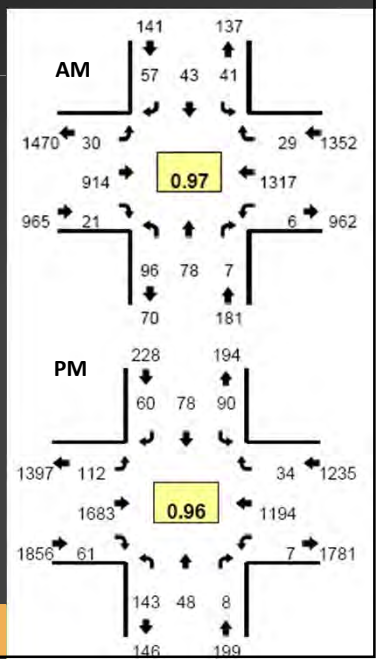


Lack of One Way Signage

Suggestion: Powell Blvd & 20th Ave

- Right turn arrow striping
- One way signage
- Long term:
  - Queue detection and warning system associated with 21st Avenue signal

Powell Blvd & 21st Ave



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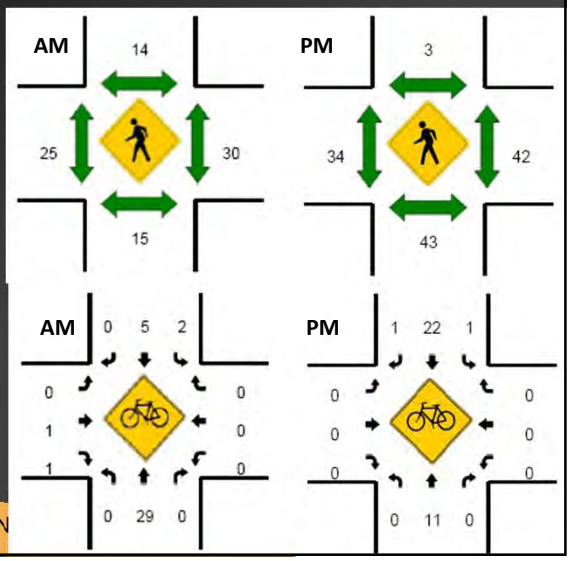
Powell Blvd & 21st Ave



MOVINGFORWARDTHINKIN

Powell Blvd & 21st Ave

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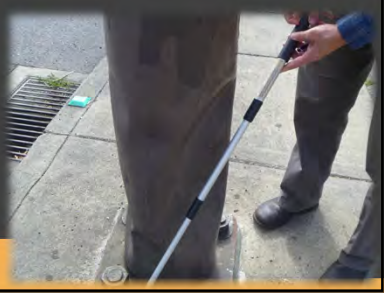
Issues: Powell Blvd & 21st Ave

- Single-lane north- and southbound approaches
- Crash data:
  - Turning movement

Heavy Bicycle Use

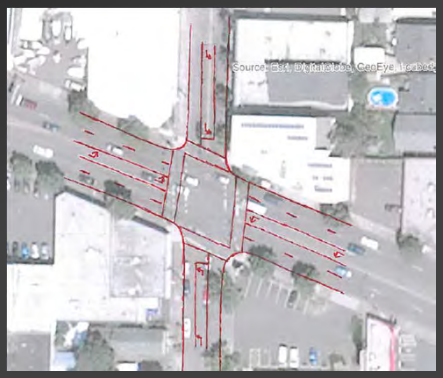
Permissive Phasing

Dented Poles



Suggestion: Powell Blvd & 21st Ave

- Restripe north- and southbound approaches
  - Remove some North/South parking on 21st Ave
- Provide protected/ permissive left-turn along all approaches



Suggestion: Powell Blvd & 21st Ave

- Restrict right-turn on-red (sight distance for northbound right)
- Install supplemental signal heads
- Rebuild signal with mast arm street name signs
- Long-term: queue detection and warning system (eastbound)

Powell Blvd & 22nd Ave

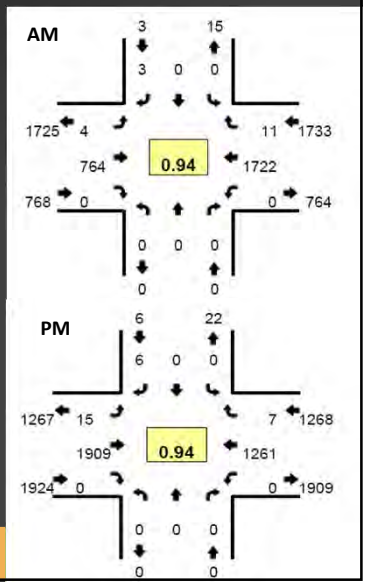
- Angle parking on east side is used incorrectly
- Northbound stop bar is set back too far
- Offset intersections

- Suggestions:
  - Curb extension on SE corner
  - Move stop bar up to improve sight distance

MOVINGFORWARDTHINKING

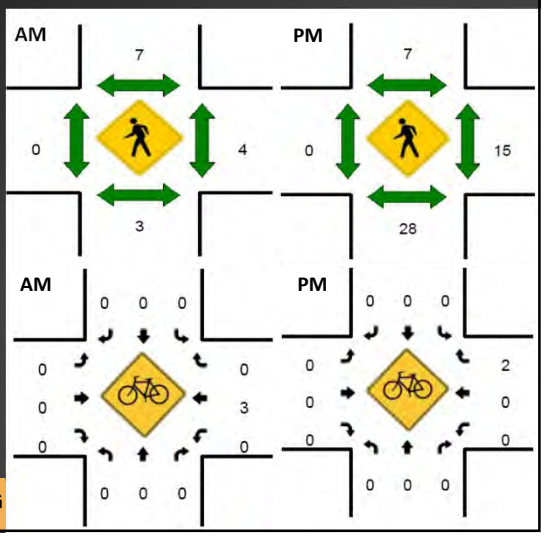
KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Powell Blvd & 24th Ave



MOVINGFORWARDTHINKING

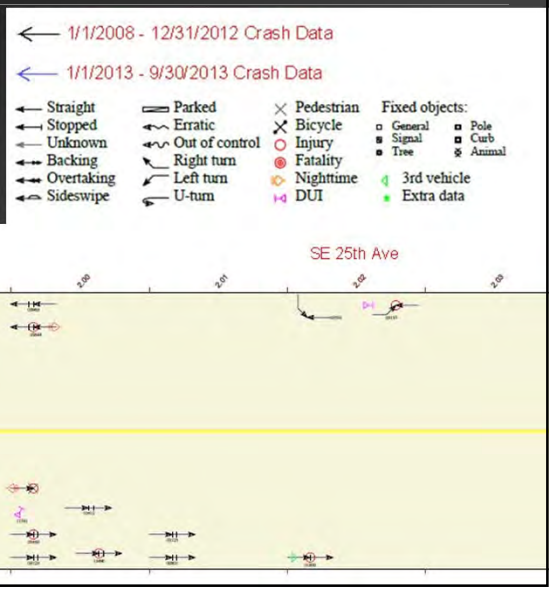
Powell Blvd & 24th Ave



MOVINGFORWARDTHINKING

Powell Blvd & 24th Ave

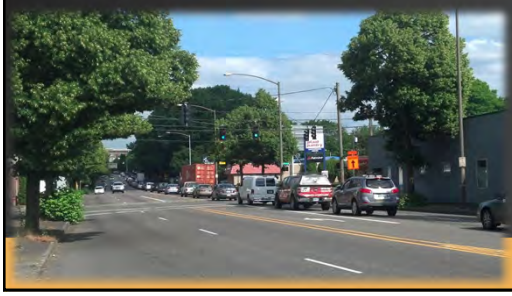
- Rear-end crashes



Issues: Powell Blvd & 24th Ave

- Intersection & crossing blocked by queues during AM & PM peak hours
- Bus stop located before crossing (eastbound)
  - Transit Ons/Offs are relatively low

Queue blocking crosswalk during PM peak



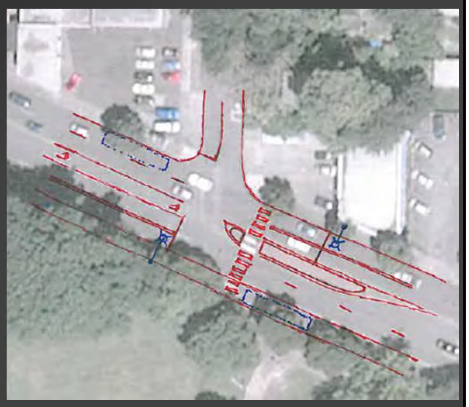
Eastbound transit stop located prior to crosswalk

Issues: Powell Blvd & 24th Ave

- Difficult to see crossing at night
  - Luminaire located behind crosswalk

Suggestion: Powell Blvd & 24th Ave

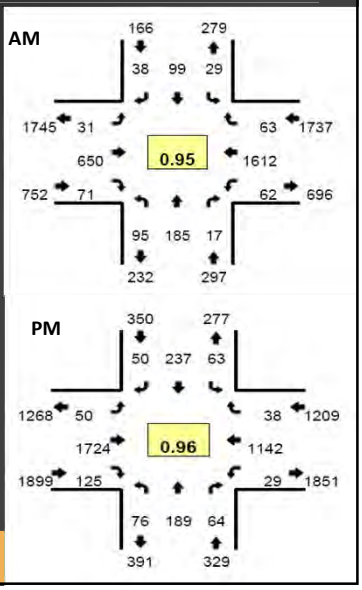
- Enhance crossing with RRFB and lighting
- Remove tree(s) to increase visibility
- Consider eliminating/ relocating eastbound TriMet stop
- Consider moving crosswalk west and adding signing to median



MOVINGFORWARDTHINKING

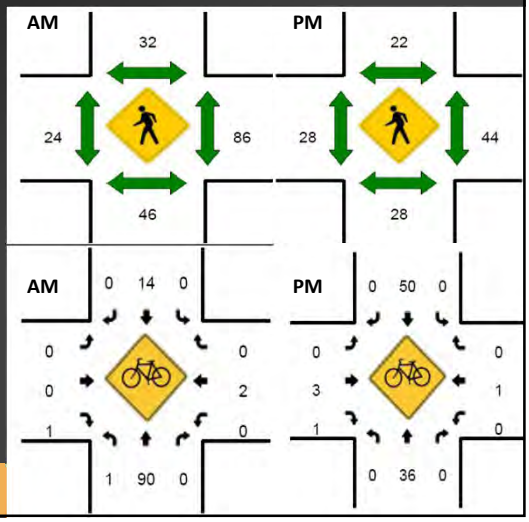
KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Powell Blvd & 26th Ave



MOVINGFORWARDTHINKING

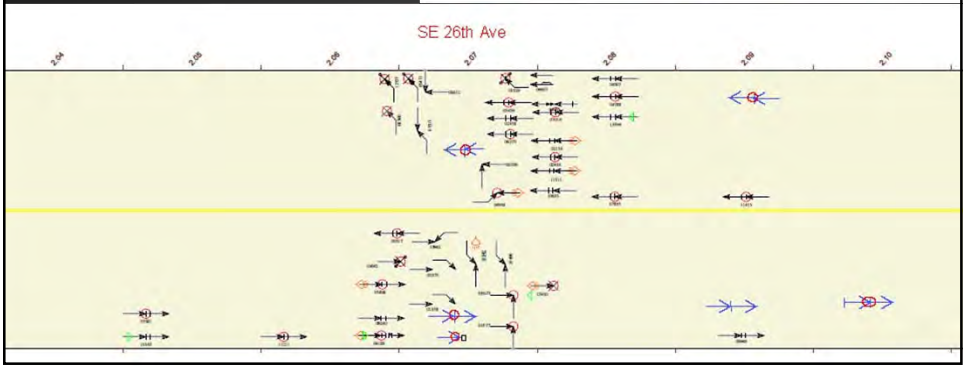
Powell Blvd & 26th Ave



MOVINGFORWARDTHINKING

Powell Blvd & 26th Ave

- Pedestrian/bike crashes
- Rear-end crashes
- Turning movement crashes



Issues: Powell Blvd & 26th Ave

- Difficult to see next signal signs
- Signal timing
  - Very short cycles observed during PM peak hours
  - Red light running at end of cycle lefts
  - Permissive left-turns on north/south approaches; protected on Powell Blvd
- Tree conflicts with westbound bus stop

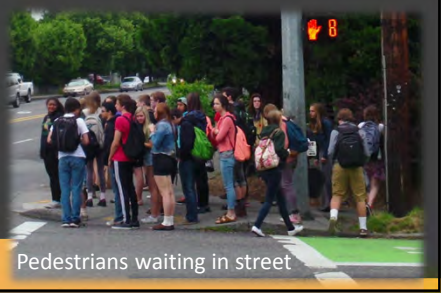
High school drop-off in bus stop & midblock crossings from teachers' lot

Tree blocks bus stop

MOVINGFORWARDTHINKING

Issues: Powell Blvd & 26th Ave

- Large number of pedestrians do not fit on corners
- Right-turns are tight at the NE and SW corners
- Heavy north/south bike traffic
- Limited cross-section width
  - 3' bike lanes at intersection
- Driveway located on SE corner



Pedestrians waiting in street

MOVINGFORWARDTHINKING

Suggestion: Powell Blvd & 26th Ave

- Modify signal timing
  - Cycle lengths
  - Provide protected/permissive phasing for north and south left-turn phases
  - Consider leading pedestrian interval
- Consider queue jump for eastbound buses

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Suggestion: Powell Blvd & 26th Ave

- Consider installing new signal
  - Modify pole location and curb radii to accommodate turns
  - Expand pedestrian refuge area on corners
- Consider closing residential driveway on SE corner

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Suggestion: Powell Blvd & 26th Ave

- Widen both sides by removing landscape strip and moving bus stop to accommodate wider bike lanes on both sides

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

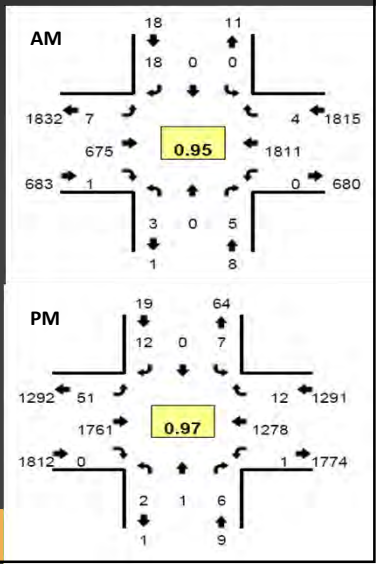
Suggestion: Powell Blvd & 26th Ave

- Remove bike lanes and replace with bike crossing further east

MOVINGFORWARDTHINKING

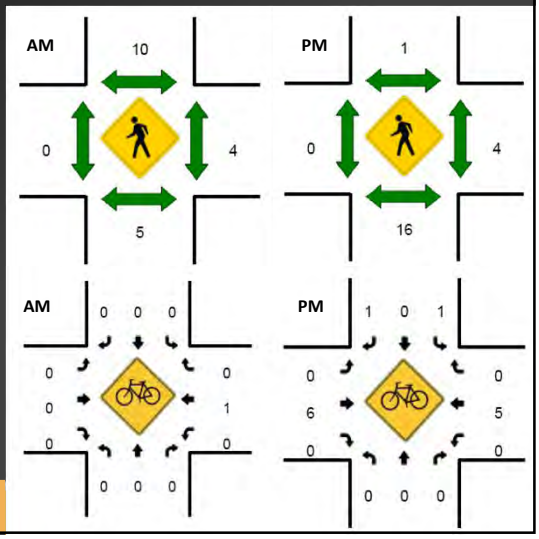
KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Powell Blvd & 31st Ave



MOVINGFORWARDTHINKING

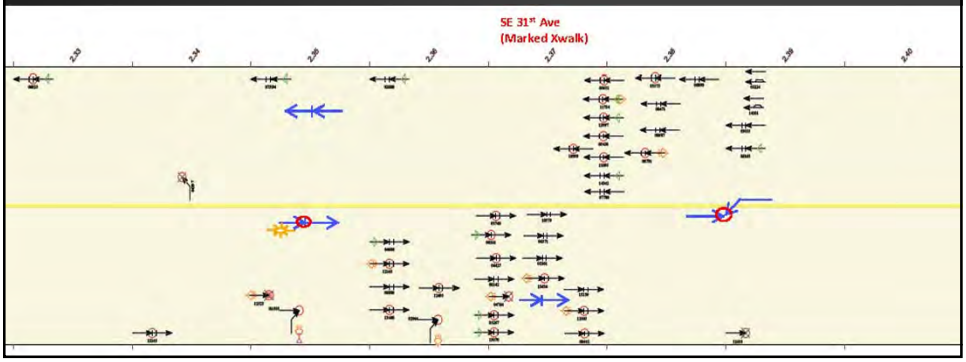
Powell Blvd & 31st Ave



MOVINGFORWARDTHINKING

Powell Blvd & 31st Ave

- Rear-end crashes
- Pedestrian crashes



Issues: Powell Blvd & 31st Ave

- Sight distance for side street turns
  - To the east
- NE corner (school property) lacks maintenance of vegetation, creating sight distance issue
- No two-stage crossing available for pedestrians
- Transit stops located in front of crosswalks
  - Ons/offs are relatively low

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

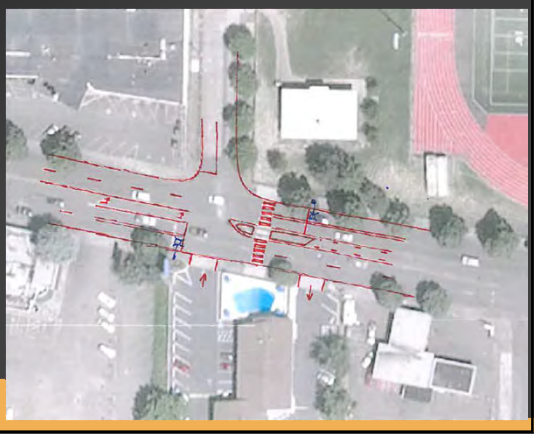
Issues: Powell Blvd & 31st Ave

- Crosswalk difficult to see
  - Trees restrict sight distance westbound
- Crash history shows high number of crashes and pedestrian-involved crashes

Blocked signage in westbound direction

Suggestion: Powell & 31st Ave

- Improve pedestrian crossing to include
  - Pedestrian refuge island
  - RRFB
  - Lighting



MOVINGFORWARDTHINKING

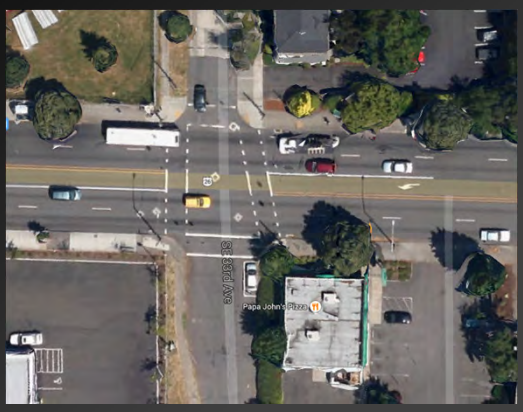
Suggestion: Powell & 31st Ave

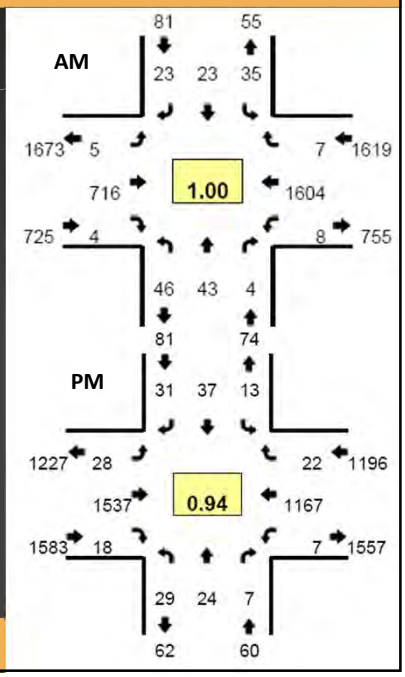
- Improve signage and pavement markings at Motel 6 exit-only driveway
- Remove fence on northwest corner of Motel 6 property to improve sight distance
- Consider making the southbound approach right-only (due to median)

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

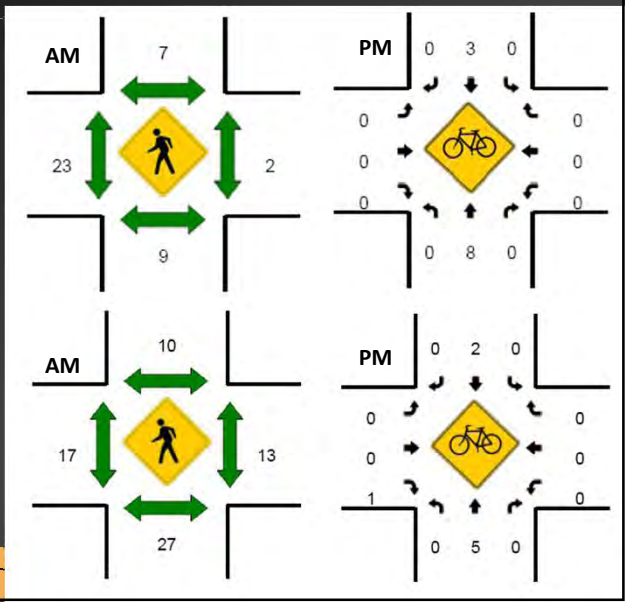
Powell Blvd & 33rd Ave





MOVINGFORWARDTHINKING

Powell Blvd & 33rd Ave



MOVINGFORWARDTH

Issues: Powell Blvd & 33rd Ave

- Low mounting of signal heads
- Difficult to turn left off of Powell
- Long signal cycle
  - Pedestrians and bicyclists became impatient
  - Bicyclists used pedestrian push button, even though striping indicated bicycle detection

Bicyclists using pedestrian push button

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Issues: Powell Blvd & 33rd Ave

- Sidewalk section missing on east side of south leg at intersection
- Shrubs on northeast corner block drivers' vision
- Dented poles
- Zip cars parked on south leg of intersection, at intersection

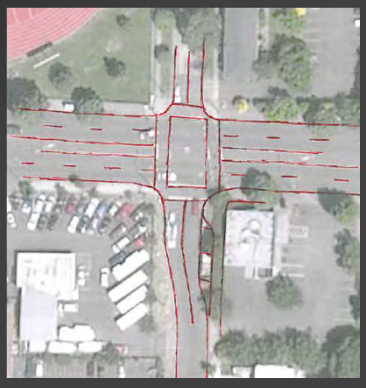
ZipCar located at intersection

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.

Suggestion: Powell Blvd & 33rd Ave

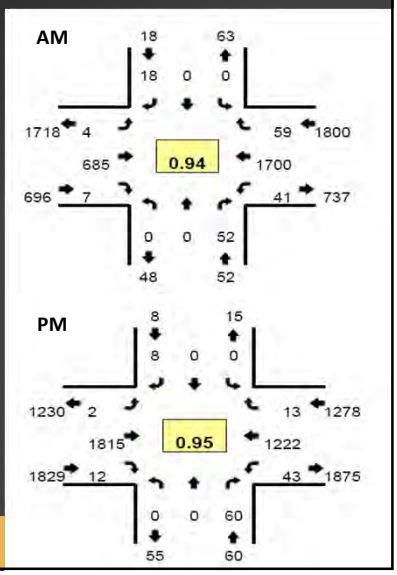
- Tree trimming
- Protected left-turn phasing on mainline
- Review signal timing
  - Consider pedestrians and wait times
- Provide indication of bicycle detection to discourage impatience
- Consider double-cycling the signal at 33rd Ave (pedestrians were frustrated and crossed during Don't Walk time)
- Consider new signal



MOVINGFORWARDTHINKING

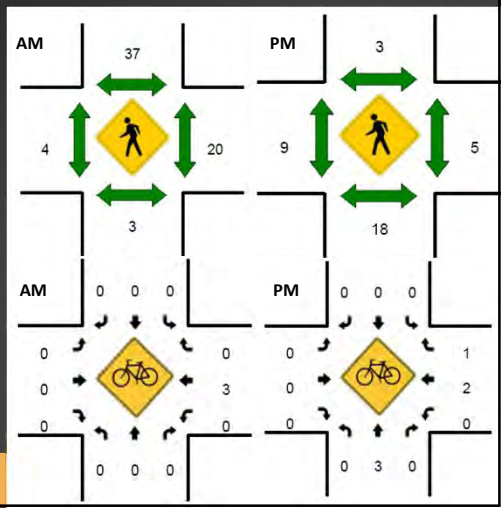
KITTELSON & ASSOCIATES, INC.

Powell Blvd & 28th Ave



MOVINGFORWARDTHINKING

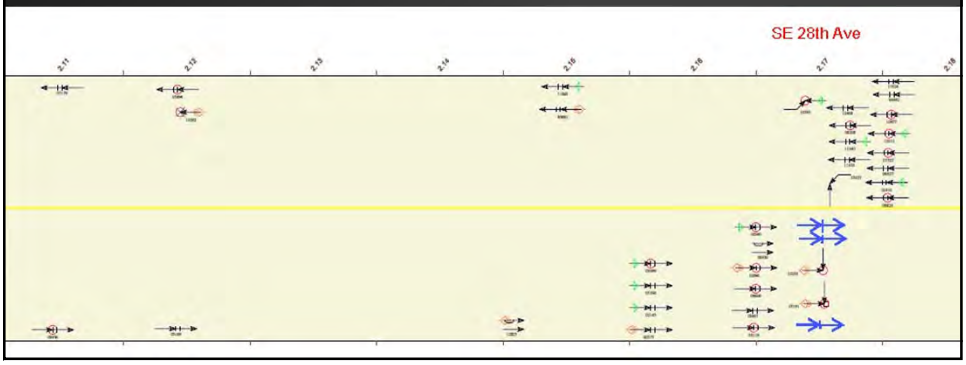
Powell Blvd & 28th Ave



MOVINGFORWARDTHINKING

Powell Blvd & 28th Ave

- Rear-end crashes
- Angle (night)

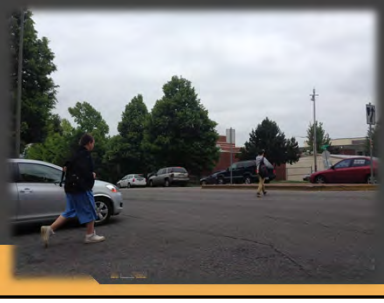


Issues: Powell Blvd & 28th Ave

- Heavily used as pedestrian crossing
  - Students to/from school
  - Parent drop-offs on 28th Ave, south of Powell
  - Pedestrians catching TriMet westbound bus (risky behavior)

3 students crossing (running)

Students crossing after parent drop-off on 28th Ave



Issues: Powell Blvd & 28th Ave

- Queues in left-turn pockets block sight distance because of curve

Students crossing while vehicle turns left

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

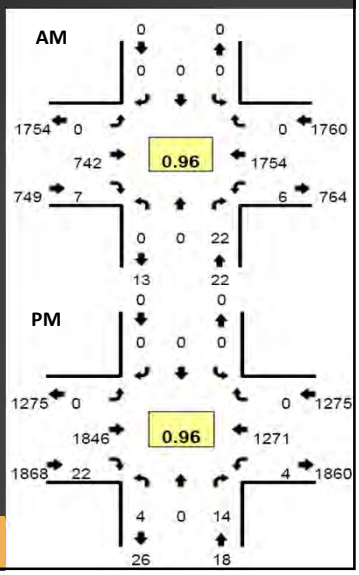
Issues: Powell Blvd & 28th Ave

- Queues from signal often back up past this location
- Westbound bus stop is located in front of median (which is used as a crossing)
- Large residential land use to the south
- Westbound left-turns into parking lot by daycare

MOVINGFORWARDTHINKING

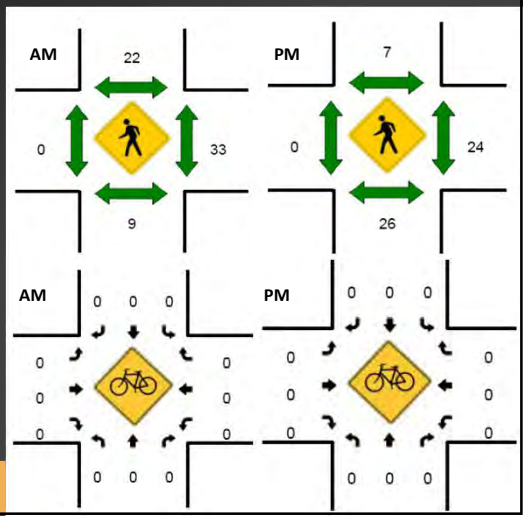
KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Powell Blvd & 28th Pl



MOVINGFORWARDTHINKING

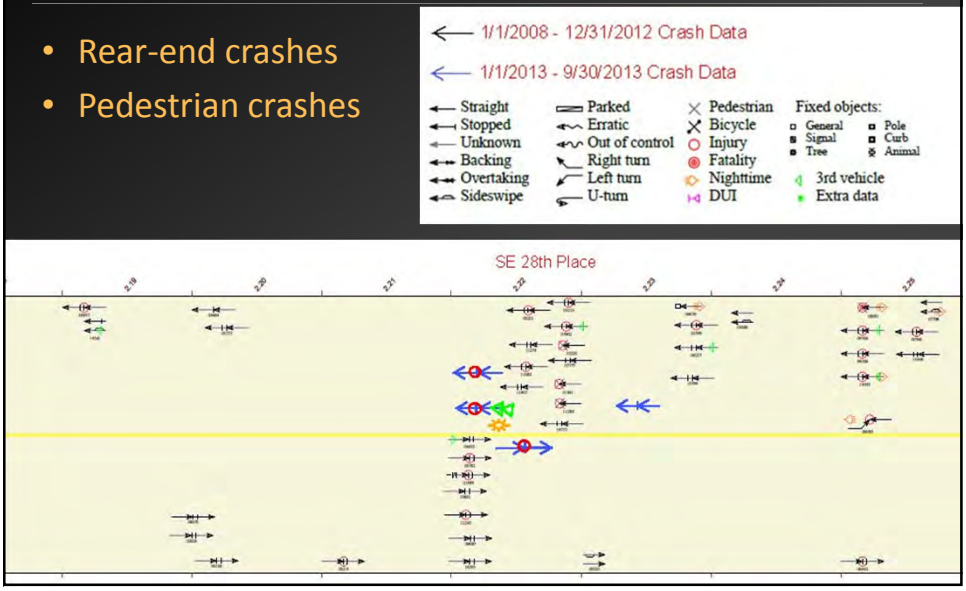
Powell Blvd & 28th Pl



MOVINGFORWARDTHINKING

Powell Blvd & 28th Pl

- Rear-end crashes
- Pedestrian crashes



Issues: Powell Blvd & 28th Pl

- Traffic from bus stops block crosswalk
- Queues from 26th Ave signal sometimes block crosswalk

Issues: Powell Blvd & 28th Pl

- Limited visibility of signs and lighting
- Vehicles making westbound left-turns onto side street just past pedestrian median

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.

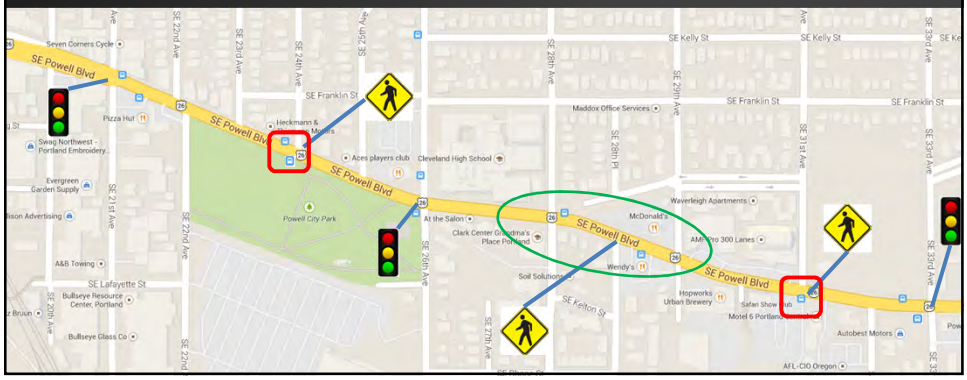
Powell Blvd & 29th Ave

- Issues:
  - Both sides of Powell have many driveways
  - Interaction between commercial land uses
  - Crash data does not show strong trends at driveways
  - If land use changes, reevaluation may be needed

MOVINGFORWARDTHINKING

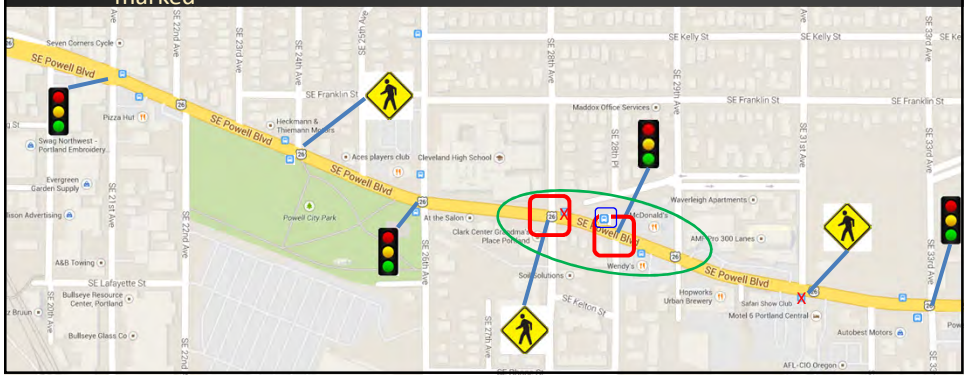
Corridor – how do 28th Ave, 28th Pl, & 29th Ave interact?
Existing Signals/Marked Crossings/Transit Stops

- Three signals
- Three marked crossings
- Transit stop being evaluated
  - Low ons and offs



Suggestion: Option #1
Signals/Marked Crossings/Transit Stops

- Add new signal at 28th Place
- Marked crossings
  - Two with RRFBs
  - One between signals staggered marked
- Transit stop being evaluated
  - Potential elimination x
  - Potential relocate

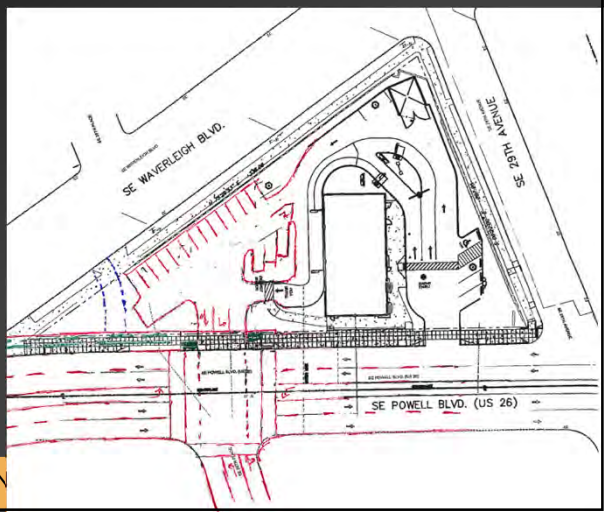


Suggestion: Powell Blvd & 28th Ave

- Provide "Z" crossing to allow pedestrians to cross in two stages facing oncoming traffic
  - Improved crossing with upstream signals
  - Potential to remove westbound left-turn pocket to improve median

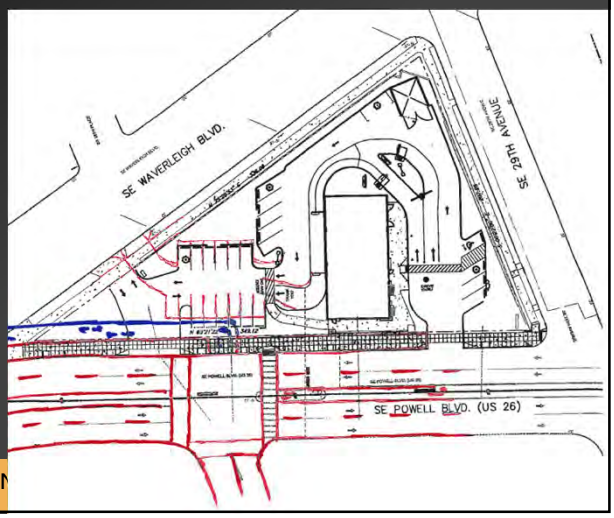
Suggestions: Powell Blvd & 28th Pl

- Review McDonald's new site plan and orient door towards new crossing or use signage to direct people



Suggestions: Powell Blvd & 28th Pl

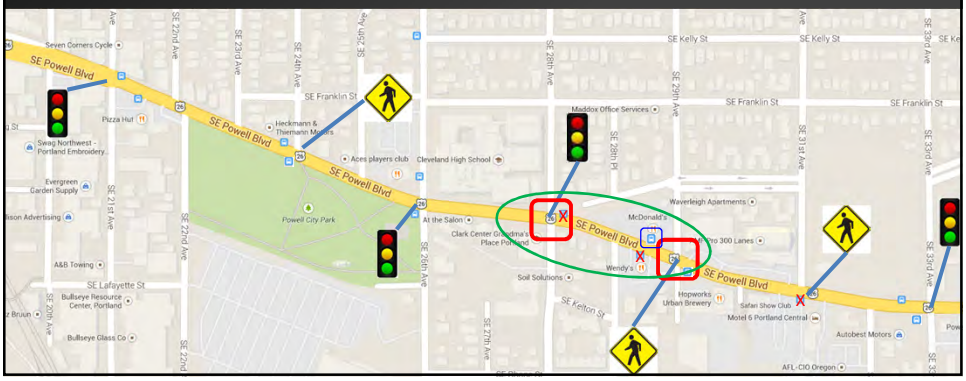
- Review McDonald's new site plan and orient door towards new crossing or use signage to direct people



MOVINGFORWARDTHIN

Suggestion: Option #2 Signals/Marked Crossings/Transit Stops

- Add new signal at 28th Ave
- Marked crossings
  - Two with RRFBs at existing
  - New RRFB at 29th Ave (overhead)
- Transit stop being evaluated
  - Potential elimination x
  - Potential relocate ▢



Suggestion: Powell Blvd & 28th Ave

- Signalize intersection allowing:
  - Pedestrian & bicycle crossings, and right-turns only

Suggestions: Powell Blvd & 28th Pl

- Other explorations

MOVINGFORWARDTHINKING

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

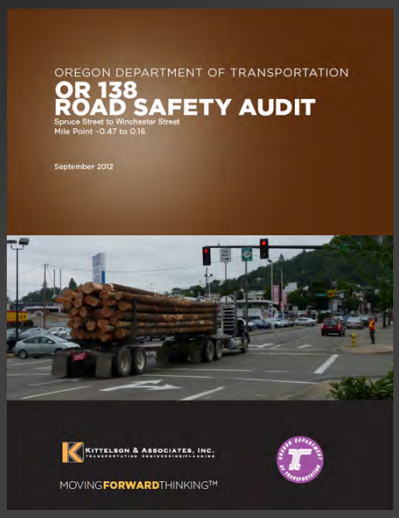
Powell Blvd & 29th Ave

- Suggestions:
  - Combine access points on north side
  - Add buffered landscape strip or bike racks on north/south side
  - If signal at 28th Ave, then potential RRFB at 29th Ave

MOVINGFORWARDTHINKING

Next Steps

- Complete Draft Report and submit by June 20th
- ODOT Review
  - 2-3 weeks
- Submit Final Report
  - Mid July



MOVINGFORWARDTHINKING

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Questions/Comments?

MOVINGFORWARDTHINKING

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