

# **TRAFFIC ANALYSIS REPORT**

Monroe Street Neighborhood Greenway

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TO: Project Management Team

FROM: Mat Dolata, PE, PTP | DKS Amanda Deering, EIT | DKS

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# **EXECUTIVE SUMMARY**

The proposed Monroe Street Neighborhood Greenway aims to create a safe travel space for people biking, walking, and driving along Monroe Street. The City of Milwaukie and Clackamas County have each developed plans for Monroe Street, on either side of Linwood Avenue. This report provides an integrated traffic analysis of the bicycle, pedestrian, and traffic control components identified in the two plans.

A mesoscopic travel demand model was developed to assess traffic circulation for all through streets in the study area. The model is used to analyze traffic operations at 28 study intersections, estimate daily vehicle volumes along the Monroe Street corridor, and assess potential neighborhood impacts of volume shifts. The study area includes streets between 21<sup>st</sup> Avenue (to the west) and Fuller Road (to the east) and between King Road (to the north) and Railroad Avenue (to the south).

The analysis was performed with a focus on lowering daily volume of vehicles on Monroe Street to make it more conducive for active transportation. Twenty-one total scenarios that would implement traffic calming, diverters, and other traffic management components in various combinations were analyzed. The analysis was performed in two phases with the analysis outcomes for twelve initial scenarios being used to develop nine refined scenarios that represented more effective combinations of components.

By themselves, none of the traffic calming components would achieve a neighborhood greenway's target daily volume threshold of less than 1,500 vehicles for the entire corridor. Implementation of traffic calming on Monroe Street and the Linwood Avenue diverter would be the most effective individual components for achieving desired daily traffic volume. The 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue diverters would also reduce traffic on Monroe Street but are expected to increase traffic on Jackson Street, Washington Street, and Jefferson Street. The segment of Monroe Street between Oak Street and 42<sup>nd</sup> Avenue is the most difficult to lower to the target volume.

The result of the analysis is two recommended greenway concepts: the Monroe Street alignment and the Washington Street alignment (Figure 1). Each of these would have benefits and tradeoffs for the community to consider. Both concept alignments are effective for Monroe Street to function as a neighborhood greenway and active transportation connection.

The traffic analysis findings generally support the recommendations from the City and County Concept Plans. New findings include the need for a traffic signal at the Harrison Street/42<sup>nd</sup> Avenue intersection in both recommended alignment concepts and the potential need for a new traffic signal at Harrison Street/37<sup>th</sup> Avenue under the Monroe Street alignment concept.





#### Figure 1. Monroe Street Neighborhood Greenway – Recommended Alignment Concept

The Monroe Street alignment concept would include traffic calming on Monroe Street, four diverters (at OR 224, 37<sup>th</sup> Avenue, 42<sup>nd</sup> Avenue, Linwood Avenue), and new traffic signals at Harrison Street/42<sup>nd</sup> Avenue and Oak Street/Monroe Street/Railroad Avenue intersections (Table 1). The concept would also include a pedestrian/bicycle activated signal to cross Linwood Avenue at Monroe Street. This concept is estimated to achieve volumes under 1,500 vehicles per day on the entirety of the corridor east of 37<sup>th</sup> Avenue. Up to 3,000 vehicles per day would be expected to travel the short segment of Monroe Street between Oak Street and 37<sup>th</sup> Avenue. However, there may be significant cut-through traffic on Washington Street, Jackson Street, and 40<sup>th</sup> Avenue, resulting in volumes potentially exceeding 1,000 vehicles per day. This concept would also impact the Harrison Street/37<sup>th</sup> Avenue intersection, such that a new traffic signal may need to be constructed.

The Washington Street alignment concept is identical to the Monroe Street alignment concept except between Oak Street and Home Avenue. It would include an off-street path from Oak Street/Campbell Street joining up with Washington Street at 37<sup>th</sup> Avenue before continuing on-street and reconnecting with Monroe Street via either Home Avenue or Garrett Drive. This concept would be comprised of traffic calming on Washington Street west of 42<sup>nd</sup> Avenue and on Monroe Street east of 42<sup>nd</sup> Avenue, two diverters (at OR 224 and Linwood Avenue), and new traffic signals at Harrison Street/42<sup>nd</sup> Avenue and Oak Street/Monroe Street/Railroad Avenue intersections. Volumes on Monroe Street, east of 42nd Avenue, are estimated to remain below 1,500 vehicles per day. The volume on Washington Street, east of 37<sup>th</sup> Avenue is also expected to remain well below the neighborhood greenway threshold with significantly less motor vehicle volume than was identified for the Monroe Street alignment concept described above. No significant cut-through traffic would be expected to result with this concept. However, volume on Monroe Street between Oak Street and 42<sup>nd</sup> Avenue would likely exceed 4,000 vehicles per day.

Although it would have less impact on vehicle traffic patterns, a disadvantage of the Washington Street alignment concept is that it provides a less direct route for people riding bicycles. This alignment would route greenway travelers off Monroe Street for about three-quarters of a mile. The project team recommends the community consider one of these two recommended concepts for implementing the proposed neighborhood greenway. The different components included in each concept are identified in Table 1.



#### Table 1. Comparison of Recommended Alignment Concept Components

	Monroe St Alignment	Washington St Alignment			
Traffic Calming Location					
Monroe St - west of Campbell St	Х	x			
Monroe St - between Oak St and 42 <sup>nd</sup> Ave	x				
Washington St - between 37 <sup>th</sup> Ave and 42 <sup>nd</sup> Ave*		x			
Monroe St - between 42 <sup>nd</sup> Ave and Linwood Ave	x	x			
Monroe St/Thompson Rd - east of Linwood Ave**	Х	x			
Monroe St Diverter Location					
OR 224	X	x			
37 <sup>th</sup> Ave	X				
42 <sup>nd</sup> Ave	x				
Linwood Ave	Х	x			
New Traffic Signal Location					
Harrison St/42 <sup>nd</sup> Ave	x	x			
Oak St/Monroe St/Railroad Ave	x	x			
37 <sup>th</sup> Ave/Harrison St	X ***				
New Pedestrian Signal Location					
Monroe St/Linwood Ave	X	x			
Monroe St Gap					
Open to pedestrians and cyclists (shared use path)	X	x			
Open to vehicle traffic					

\*Includes utilizing the off-street shared-use trail planned from Oak Street/Campbell Street to 37<sup>th</sup> Avenue at Washington Street.

\*\*Includes off-street path on Monroe Street east of 78<sup>th</sup> Avenue, and a shared-use path on north side of Monroe Street between Linwood Avenue and 78<sup>th</sup> Avenue, and a shared-use path on 72<sup>nd</sup> Avenue/Thompson Street between Monroe Street and 74<sup>th</sup> Avenue.

\*\*\*\* The traffic signal was identified as a potential solution based on traffic performance results from the scenario modeling.

Both concepts were analyzed with and without the Monroe Street gap open for motor vehicle traffic, including associated improvements for improving motor vehicle traffic flow along Monroe Street between 72<sup>nd</sup> Avenue and Fuller Road. The analysis indicates that opening the Monroe Street gap to motor vehicle traffic would increase local daily vehicle volumes on Monroe Street, which is not consistent with the objectives of the proposed active transportation route and the neighborhood greenway west of Linwood Avenue.



# PURPOSE

As described in the *Monroe Street Neighborhood Greenway Concept Plan*<sup>1</sup>, "Monroe Street runs through the City of Milwaukie, connecting downtown at the west end to the eastern city boundary at Linwood Avenue. One of only a few continuous east/west connections through the area, Monroe is a two-lane street with a neighborhood character for most of its length through Milwaukie. Because of its connectivity and central location, the route attracts a substantial number of cut-through auto trips in addition to serving residents and businesses located on the street itself". The *Monroe Street Neighborhood Street Design Plan*<sup>2</sup> states that "Monroe Street has long been envisioned as a primary active transportation route linking the Trolley Trail in Milwaukie to the Interstate 205 Multi-Use Path located in the unincorporated portion of the County."

Together, the City of Milwaukie and Clackamas County Concept Plans are coordinated in aiming to create a safe travel space for people biking, walking, and driving along Monroe Street. While Monroe Street would only be designated as a neighborhood greenway within the city limits, the County objectives for Monroe Street are well aligned with the City's. The County's objectives include increasing active transportation options to improve public health, increasing safety and comfort for all users, and creating safe routes to school.

The City's plan states that a combination of traffic calming and diverters can be used to create conditions that meet standards for neighborhood greenways west of Linwood Avenue. Due to high vehicle volumes between Oak Street and 42<sup>nd</sup> Avenue, the plan's recommended greenway route included an off-street path by the railroad tracks along the undeveloped McFarland site, to connect with Washington Street at 37<sup>th</sup> Avenue. This route would shift people walking and biking to Washington Street for a short segment and rejoin with Monroe Street via either Garrett Drive or Home Avenue.

The County's plan includes a roundabout at 72<sup>nd</sup> Avenue and traffic calming measures along Monroe Street and Thompson Road. Active transportation facilities identified in the plan include a combination of shared-use paths, bike lanes and sidewalks. The plan also includes construction of a shared-use path that would open the Monroe Street gap (east of 78<sup>th</sup> Avenue) to people who walk or bike.

The scenarios and recommended concept alignments identified in this analysis include components from both the City and County Concept Plans. This traffic analysis is intended to provide more detailed information related to motor vehicle performance and neighborhood circulation. It identifies potential tradeoffs and unintended consequences that may result from traffic management components.

<sup>1</sup> Monroe Street Neighborhood Greenway Concept Plan. City of Milwaukie, prepared by CH2M. June 2015. <sup>2</sup> Monroe Neighborhood Street Design Plan. Clackamas County, prepared by CH2M. June 2016.



# OBJECTIVES

This traffic analysis is intended to review the concept plans to verify which elements provide for Monroe Street to function most effectively as a neighborhood greenway and active transportation connection. The four primary objectives are to:

- Lower vehicle volumes on the Monroe Street corridor. Neighborhood greenways should have less than 1,500 vehicles per day, though some short segments with as much as 3,000 vehicles per day may be acceptable.<sup>3</sup> Ideally, traffic volumes would be less than 1,000 vehicles per day.<sup>4</sup> The existing vehicle volumes on Monroe Street indicate that significant diversion of traffic is necessary to achieve target volumes appropriate for a neighborhood greenway.
- Lower the vehicle travel speed on the Monroe Street corridor. The majority of vehicle speeds (85<sup>th</sup> percentile) should not exceed 25 miles per hour (mph), with a preferred speed of no more than 20 mph along the corridor.
- Avoid impacts on intersection operations. Intersections should operate at an acceptable level of service, similar to prior operating conditions. Intersections that exceed adopted mobility standards would require improvements to be applied.
- Avoid neighborhood diversion. Nearby local streets should not be unduly impacted by the diversion of traffic off Monroe Street. Ideally trips should be diverted onto collector or arterial facilities that are designed to carry more vehicles.

# TERMINOLOGY

This analysis report summarizes a large amount of technical analysis. The following terms are defined to provide clarity for the rest of the report:

- **Components**. The neighborhood greenway would function through implementation of design treatments and intersection controls intended to better manage traffic on the corridor. These components could include traffic calming, diverters, and other traffic control elements such as traffic signals and mini-roundabouts. Traffic calming itself can reflect a variety of design elements such as raised intersections, chicanes, speed bumps, and curb extensions.
- Scenarios. This analysis evaluated traffic conditions in two phases. The first phase of initial scenarios assessed individual traffic management components (e.g., a single traffic diverter). The second phase combined multiple components based on results from the analysis of initial scenarios (e.g., traffic calming combined with multiple diverter locations). The analysis includes twelve initial scenarios and nine refined scenarios. Each scenario was analyzed as a distinct alternative for consideration.
- **Recommended Alignment Concepts** This analysis recommends two of the nine refined scenarios for community consideration and identifies benefits and tradeoffs between them. As shown in Table 1, the recommended concepts have many components in common but differ in the alignment of the neighborhood greenway between Oak Street and 42<sup>nd</sup> Avenue.

<sup>3</sup> Urban Bikeway Design Guide. National Association of City Transportation Officials (NACTO). 2013.
<sup>4</sup> Portland's Neighborhood Greenways Assessment Report. Portland Bureau of Transportation. 2015.



# APPROACH

To lower the daily volume of vehicles on Monroe Street and make it safer for active transportation, a variety of possible scenarios were modeled to determine travel patterns and traffic volume shifts. Analysis of these scenarios included evaluation of traffic operations at 28 study intersections, neighborhood impacts of traffic volume shifts, and estimated daily vehicle volumes along the Monroe Street corridor and within the study area. An overview of these methods is described below.

# **Traffic Modeling**

A PM peak hour travel demand model was developed for this analysis. This mesoscopic model was developed from a subarea of the most recent 2015 Metro travel demand model using Visum modeling software. A mesoscopic model combines larger scale travel demand modelling capabilities with more detailed roadway and intersection characteristics. The model was calibrated to recent traffic count data.

This approach represents local traffic circulation patterns more realistically and allows for detailed evaluation of intersection operations across many alternative scenarios. The model includes operations analysis that uses the 2000 Highway Capacity Manual (HCM)<sup>5</sup> methodology. Intersection operations results for 2017 were produced with the model and compared to Synchro operations results from a previous 2015 traffic study<sup>6</sup> for calibration purposes. Details on model development are provided in the appendix.

## **Intersection Operations**

Twenty-eight intersections within the Monroe Street study area and in the surrounding area were selected as study intersections for operations analysis (Figure 2).



#### Figure 2. Monroe Street Neighborhood Greenway Subarea and Study Intersections

<sup>5</sup> 2000 Highway Capacity Manual. Transportation Research Board. Washington, D.C. 2000.

<sup>6</sup> Monroe Street Neighborhood Greenway Concept Plan: Traffic Impact Analysis Summary. CH2M. April 10, 2015.



The two primary measures used to evaluate intersection traffic operations are average vehicle delay and volume-to-capacity ratio. Delay is the average waiting time experienced by people driving at an intersection, typically measured in seconds. The delay can also be reported as Level of Service (LOS), which is a rating (A through F) based on average delay thresholds. Volume-to-capacity (v/c) ratios are a decimal representation (between 0.00 and 1.00) of the proportion of capacity that is being utilized at the study intersection. As the ratio approaches 1.00, congestion increases and performance is degraded. These intersection operations results were used to assess the impact of different scenarios on the study intersections' performance during peak demand conditions.

## **Daily Volume Estimates**

The PM peak hour volumes from the traffic model were used to estimate daily vehicle volumes along the Monroe Street corridor and nearby neighborhoods. Twenty-four-hour count data collected along Monroe Street and on other area streets were used to develop factors to convert PM peak hour volumes to estimated daily volumes. These daily volumes were used to describe how travel patterns may shift and the degree to which neighborhood greenway vehicle volume targets are met as a result of different scenarios. It should be noted that these factors were used to approximate a daily volume and are not an exact representation of the Average Daily Traffic (ADT).

## **Neighborhood Diversion**

Some components of the neighborhood greenway scenarios are anticipated to cause diversion onto local streets near Monroe Street, particularly during peak travel demand periods. This is an unintended consequence, the severity of which can be considered in determining the desirability of a given scenario. Neighborhood diversion is identified where vehicle trips are expected to shift from Monroe Street to an alternate route that is not one of the preferred collector and arterial roadways such as Harrison Street, King Road, or Railroad Avenue.



# **BASELINE CONDITIONS**

The year estimated for implementation of the City Concept Plan is 2020. This year was used for the baseline condition of this analysis, with which all scenarios were compared. The County Plan does not have a date of implementation but it was assumed to be constructed in 2020 for this analysis.

# 2020 Traffic Forecasting

The existing conditions (2017) model scenario was developed to calibrate the traffic model and ensure it adequately reflects real-world conditions. The 2017 vehicle trips were scaled up by a two percent growth rate to reflect expected demand in 2020. The Boyer Drive Extension and expected improvements at Boyer Road/Monroe Street and Fuller Road/King Road were implemented in the 2020 baseline model and trips were adjusted accordingly, consistent with the traffic analysis findings from the Boyer Drive Extension study.<sup>7</sup>

## **Intersection Operations**

PM peak hour traffic operations in the 2020 baseline model indicate that most intersections will operate within mobility standards. The two exceptions are Oak Street/Railroad Avenue-Monroe Street and Linwood Avenue/Monroe Street. Without any further changes, these intersections would be expected to operate with level of service (LOS) F and E, respectively during the 2020 PM peak hour. The mobility standard for intersections under City jurisdiction is LOS D. Other study intersections are under either Clackamas County or ODOT jurisdiction and have a v/c ratio mobility standard<sup>8</sup>. The appendix details applicable mobility standards at each study intersection alongside traffic performance results for baseline conditions and each evaluation scenario.

Other significantly congested intersections in the 2020 baseline conditions include OR 224/Harrison Street, Railroad Avenue-Harmony Road/Linwood Avenue, King Road/Linwood Avenue, and Harrison Street/42<sup>nd</sup> Avenue. The appendix provides detailed traffic operations for all 28 study intersections.

## **Daily Volume**

Daily traffic volume estimates for 2020 are illustrated in Figure 3. Volume along Monroe Street between Oak Street and Linwood Avenue is expected to range from approximately 2,000-5,000 vehicles per day. It should be noted the daily volume on Oak Street crossing the railroad approaches 8,000 vehicles per day. It is not feasible to acheive neighborhood greenway volume targets for this segment, which is why the City's Concept Plan suggests providing an off-street path at this location.

The volumes along Monroe Street, between Linwood Avenue and 72<sup>nd</sup> Avenue, and Thompson Street, between 72<sup>nd</sup> Avenue and Fuller Road, range from approximately 1,000-2,500 vehicles per day. Only short segments of Monroe Street near where traffic flow is restricted (such as the gap east of 78<sup>th</sup> Avenue) are expected to have volumes under 1,000 vehicles per day.

Overall, estimated volumes on Monroe Street indicate that significant diversion of traffic is necessary to achieve targets for a neighborhood greenway.

<sup>7</sup> Boyer Drive Extension: Final Traffic Analysis Report. Clackamas County, prepared by HDR. April 6, 2015. <sup>8</sup> Comprehensive Plan. Clackamas County. Table 5-2a, page 5-20. Updated January 18, 2017.



#### Figure 3. Estimated Daily Vehicle Volume - 2020 Baseline





# **COMPONENTS CONSIDERED**

The following section explains each of the greenway components that were analyzed and their respective impacts based on 2020 traffic model analysis for initial scenarios. These components (locations shown in Figure 4) were sourced from the City and County Concept Plans. The key impacts, both pros and cons, are summarized for each component. These are additional findings to those previously identified in the 2020 baseline conditions. Therefore, only new or significantly different findings are summarized below.



#### Figure 4. Monroe Street Greenway Components

Note: A pedestrian-bicycle activated signal on Monroe Street at the Linwood Avenue crossing is included..

## **Traffic Calming**

The traffic calming considered in this analysis varies by roadway segments: (a) Monroe Street west of Campbell Street, (b) Monroe Street between Oak Street and 42<sup>nd</sup> Avenue\*, (c) Monroe Street east of 42<sup>nd</sup> Avenue to Linwood Avenue and (d) Monroe Street (and Thompson Street) east of Linwood Avenue.

Traffic calming west of Linwood Avenue would be based on the City's Concept Plan. This would include traffic calming devices such as chicanes, speed bumps, and curb extensions. The City plan also would include converting the existing two-way stop at Oak Street/Railroad Avenue-Monroe Street to a traffic signal, to improve safety for all travelers near the railroad crossing. Between 42<sup>nd</sup> Avenue and Linwood Avenue, speed bumps, chicanes, and mini traffic circles would be used to further calm traffic on Monroe Street.

The County plan for Monroe Street includes a mini-roundabout at 72<sup>nd</sup> Avenue and traffic calming measures along both Monroe Street and Thompson Road, including chicanes and speed cushions. The plan recommends that the Monroe Street gap (east of 78<sup>th</sup> Avenue) be improved for use as a connecting path for people biking and walking on Monroe Street.

\*Traffic calming on Washington Street is considered later in this analysis as part of the Washington Street alignment concept. This is an alternative greenway alignment recommended in the City Concept Plan. Traffic



calming in this scenario would include reducing travel speeds on Washington Street west of 42<sup>nd</sup> Avenue using the previously mentioned treatments and reorienting the stop sign direction at 40<sup>th</sup> Avenue to give people riding bikes on Washington Street priority. In addition, traffic control at the Washington Street/42<sup>nd</sup> Avenue intersection would be changed from a two-way to an all-way stop. This traffic calming treatment could be implemented as an alternative to traffic calming on Monroe Street between Oak Street and 42<sup>nd</sup> Avenue.

#### Pros

- Volumes on Monroe Street would decrease wherever traffic calming is applied. Between 42<sup>nd</sup> Avenue and Linwood Avenue, volumes are expected to decrease to below 1,500 vehicles per day.
- Traffic would be diverted primarily to King Road and Railroad Avenue.
- Oak Street/Railroad Avenue-Monroe Street intersection would meet mobility standards with a traffic signal installed.

#### Cons

- Volumes on Monroe Street west of 42<sup>nd</sup> Avenue and east of Linwood Avenue would generally remain above 1,500 vehicles per day.
- Some neighborhood cut-through traffic ranging from 25-75 vehicles in the PM peak hour may occur on 40<sup>th</sup> Avenue, Llewellyn Street, Stanley Avenue, 60<sup>th</sup> Avenue, and 74<sup>th</sup> Avenue.
- Harrison Street/42<sup>nd</sup> Avenue intersection would operate at LOS E during the PM peak hour, exceeding the mobility standard and thus requiring mitigation or improvement.

#### **OR 224 Diverter**

A diverter is a physical barrier in the center of the road that limits conflicts by preventing vehicle turn movements. Generally, diverters prevent left and through vehicle movements from the minor street and left turns from the major street. Cut-outs in the diverter allow people who are walking or riding bikes to make through movements on the minor street. Diverters in these scenarios treat Monroe Street as the minor street that vehicle traffic is diverted away from (i.e., through movements and left turns on Monroe Street are prohibited - only right turns can be made to or from Monroe Street approaches). For the potential OR 224 diverter only, southbound right turns from OR 224 to Monroe Street would also be prohibited.

#### Pros

- Comfort of crossing OR 224 for people biking and walking would be significantly improved.
- Volumes on Monroe Street west of OR 224 would decrease to approximately 1,100 to 2,200 vehicles per day.
- Traffic would be diverted primarily to Washington Street and Harrison Street west of OR 224.

- Daily vehicle volumes would not be significantly reduced east of OR 224.
- 25<sup>th</sup> Avenue, 28<sup>th</sup> Avenue, and 29<sup>th</sup> Avenue may see a net increase of approximately 10 to 20 PM peak hour trips each.
- Harrison Street/42<sup>nd</sup> Avenue intersection would operate at LOS E during the PM peak hour, exceeding the mobility standard and thus requiring mitigation or improvement.



## **37<sup>th</sup> Avenue Diverter**

This potential diverter at Monroe Street/37<sup>th</sup> Avenue would only allow right turns on Monroe Street and through and right movements on 37<sup>th</sup> Avenue.

#### Pros

- Daily vehicle volumes on Monroe Street would decrease between Oak Street and 42<sup>nd</sup> Avenue.
- Approximately 150 to 250 vehicles would be diverted off Monroe Street in the PM peak hour, most of which would likely re-route to Harrison Street.

#### Cons

- Volumes on Monroe Street would still exceed 3,000 vehicles per day between Oak Street and 42<sup>nd</sup> Avenue.
- Llewellyn Street, Jefferson Street, Washington Street, and Jackson Street are all local streets that could see 20 to 70 additional vehicles in the PM peak hour.
- Harrison Street/42<sup>nd</sup> Avenue and Harrison Street/37<sup>th</sup> Avenue intersections would operate at LOS E during the PM peak hour, exceeding the mobility standard and thus requiring mitigation or improvement.

## 42<sup>nd</sup> Avenue Diverter

The potential diverter at Monroe Street/42<sup>nd</sup> Avenue would only allow right turns on Monroe Street and through and right movements on 42<sup>nd</sup> Avenue.

#### Pros

- Volume on Monroe Street would lower to approximately 600 vehicles per day just east of the 42<sup>nd</sup> Avenue.
- Approximately 200 to 350 vehicles are expected to be diverted off Monroe Street between 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue in the PM peak hour.

- Volume on Monroe Street between 44<sup>th</sup> Avenue and Linwood Avenue would still exceed the target greenway volume, with approximately 2,100 to 2,700 vehicles per day.
- Compared to the 37<sup>th</sup> Avenue diverter, less traffic would divert to Harrison Street and more may cut through local neighborhoods.
- Neighborhood streets such as Washington Street, Jefferson Street, Jackson Street, and 40<sup>th</sup> Avenue could see 50 to 200 additional vehicles in the PM peak hour. These roadways may experience volumes that exceed 1,000 vehicles per day.
- Harrison Street/42<sup>nd</sup> Avenue intersection would operate at LOS E during the PM peak hour, exceeding the mobility standard and thus requiring mitigation or improvement.



## Linwood Avenue Diverter

The potential diverter at Monroe Street/Linwood Avenue would only allow right turns on Monroe Street and through and right movements on Linwood Avenue.

#### Pros

- Compared to other diverters analyzed, this would have the widest geographical impact for lowering vehicle volumes on Monroe Street.
- Volumes on Monroe Street east of Linwood Avenue are estimated to decrease to below 1,500 vehicles per day except for a short segment west of Maplehurst Road.
- About 50 to 150 vehicles would be diverted off Monroe Street between 42<sup>nd</sup> Avenue and 70<sup>th</sup> Avenue in the PM peak hour. Most of these trips would be diverted to King Road, with an increase expected on Linwood Avenue and Railroad Avenue as well.
- Monroe Street/Linwood Avenue intersection operations would significantly improve to LOS B, no longer failing to meet the mobility standard (as identified in the 2020 baseline conditions).

#### Cons

- Some PM peak hour traffic may be diverted to local streets to circumvent the diverter, including approximately 20 to 40 vehicles each on Jack Road and Montgomery Drive.
- Harrison Street/42<sup>nd</sup> Avenue intersection would operate at LOS E during the PM peak hour, which exceeds the mobility standard and thus would require some mitigation or improvement.
- Traffic congestion would be increased at King Road/Linwood Avenue although the intersection would continue to operate within the applicable mobility standard. Intersection operations (v/c ratio) would increase from v/c 0.92 in the baseline conditions to v/c of 0.97 with the diverter in place.

## Signal at Harrison Street and 42<sup>nd</sup> Avenue

Since the diversion of trips away from Monroe Street would tend to re-route traffic to Harrison Street, operations at Harrison Street/42<sup>nd</sup> Avenue would be impacted. This potential component would implement a traffic signal at this intersection. This intersection is currently an all-way stop controlled intersection but is identified as a needed improvement to a traffic signal in the City of Milwaukie Transportation System Plan (TSP)<sup>9</sup>.

#### Pros

- The potential new signal at Harrison Street/42<sup>nd</sup> Avenue intersection would operate at LOS B.
- This traffic signal would encourage vehicle traffic to travel on Harrison Street, minimizing potential cut-through traffic on Llewellyn Street.

#### Cons

• Daily volumes along Monroe Street would not be significantly affected by the traffic signal alone.

<sup>9</sup> *Transportation System Plan.* City of Milwaukie. Figure 1-5, page 23. Updated February 13, 2016.



## Monroe Street Gap Open

This component involves opening the gap in Monroe Street east of 78<sup>th</sup> Avenue to not only bicycle and pedestrian traffic (as outlined in the County Concept Plan) but also motor vehicle traffic. Unlike the components previously analyzed, opening the gap to motor vehicle traffic is not designed to support Monroe Street operating as a neighborhood greenway or as a safe active transportation corridor suitable for users of all ages and abilities. This potential component is intended to balance traffic volumes between Thompson Street and Monroe Street and provide more direct motor vehicle connections.

It is assumed that if the gap is connected for motor vehicles, the adjacent roadway segments between 72<sup>nd</sup> Avenue and Fuller Road would be improved (including widening and constructing to county standards) and that the county would take over maintenance responsibility. The 72<sup>nd</sup> Avenue intersection would be reconfigured to allow for direct through travel on Monroe Street without a stop. The stop sign at 74<sup>th</sup> Avenue would also be redirected to give through travelers on Monroe Street priority. As a result of the package of improvements, consistent travel at 25 mph on Monroe Street would be possible between 72<sup>nd</sup> Avenue and Fuller Road (and the Boyer Street Extension).

#### Pros

- Volumes on the newly opened segment of Monroe Street would be expected to remain slightly below 1,500 vehicles per day.
- Vehicle volumes on Thompson Road would decrease by about 100 to 150 vehicles in the PM peak hour.
- No significant change to travel patterns beyond the immediate vicinity (between 72<sup>nd</sup> Avenue and Fuller Road) would be expected.

- Shifting traffic to Monroe Street is counter to the objectives of the other components that support the neighborhood greenway.
- East of 72<sup>nd</sup> Avenue, 150 to 250 vehicles may shift to Monroe Street from Thompson Road and King Road in the PM peak hour.
- Daily vehicle volumes on Monroe Street from 72<sup>nd</sup> Avenue to Fuller Road would increase by 1,100 to 1,600 vehicles per day, for a total of 1,400 to 1,700 vehicles per day on that segment.



# MONROE STREET ALIGNMENT CONCEPT

This concept (combination of traffic management components) is recommended because it would be expected to achieve the greenway volume target, of less than 1,500 vehicles per day, on most of Monroe Street. Monroe Street west of 42<sup>nd</sup> is the most challenging segment to lower to the target vehicle volume. Thus, the Monroe Street alignment concept was formed through several iterations of scenario refinement and testing. Four different refinement scenarios are presented below, including the recommended Monroe Street alignment concept. Table 2 summarizes the different components included in each scenario. Traffic volume graphics for each scenario can be found in the appendix. These scenarios do not include opening the Monroe Street gap to motor vehicles.

	Refinement	Refinement	Refinement	Monroe St	
	1	2	3	Alignment	
Traffic Calming Location					
Monroe St - west of Campbell St	х	Х	х	x	
Monroe St - between Oak St and 42 <sup>nd</sup> Ave	х	Х	х	x	
Washington St - between 37 <sup>th</sup> Ave and 42 <sup>nd</sup> Ave					
Monroe St - between 42 <sup>nd</sup> Ave and Linwood Ave	х	х	х	x	
Monroe St/Thompson Rd - east of Linwood Ave	х	х	х	x	
Monroe St Diverter Location					
OR 224	х	Х	х	x	
37 <sup>th</sup> Ave		х		x	
42 <sup>nd</sup> Ave			х	x	
Linwood Ave	х	Х	х	x	
New Traffic Signal Location					
Harrison St/42 <sup>nd</sup> Ave	х	х	х	x	
Oak St/Monroe St/Railroad Ave	х	х	х	x	
37 <sup>th</sup> Ave/Harrison St		x <sup>*</sup>		<b>x</b> *	
New Pedestrian Signal Location					
Monroe St/Linwood Ave	х	х	х	х	
Monroe St Gap					
Open to pedestrians and cyclists (shared use path)	Х	Х	х	x	
Open to vehicle traffic					

#### Table 2. Matrix of Refinement Scenario Components – Monroe Street Alignment

\* The traffic signal was identified as a potential solution based on traffic performance results from the scenario modeling.

# Refinement 1: Traffic calming on Monroe Street, signal at Harrison Street/42<sup>nd</sup> Avenue, diverters at Linwood Avenue and OR 224

This refinement scenario combines the aforementioned traffic calming on Monroe Street with a new traffic signal at Harrison Street/42<sup>nd</sup> Avenue and diverters at OR 224 and Linwood Avenue.

#### Pros

• Volume on Monroe Street east of 42<sup>nd</sup> Avenue would be under 1,5000 vehicles per day.



- The two diverters would be effective in shifting volume off Monroe Street with relatively little neighborhood impact.
- The new traffic signal at Harrison Street/42<sup>nd</sup> Avenue would support traffic re-routing onto Harrison Street.
- No intersections are expected to exceed mobility standards, including two intersections that were identified as exceeding standards in the baseline conditions: Oak Street/Railroad Avenue-Monroe Street and Monroe Street/Linwood Avenue. These intersections would operate at LOS C and B, respectively.

#### Cons

- Although mobility standards would be met, conditions are expected to worsen at already congested intersections such as OR 224/Harrison Street and Railroad Avenue-Harmony Road/Linwood Avenue (both have v/c ratios of 0.99), and King Road/Linwood Avenue (v/c ratio of 1.00)<sup>10</sup>.
- Volume on Monroe Street west of 42<sup>nd</sup> Avenue would be greater than 3,500 vehicles per day.
- Neighborhood cut-through traffic may occur on sections of 25<sup>th</sup> Avenue, Stanley Avenue, Montgomery Drive, Jack Road, Queen Road, and 74<sup>th</sup> Avenue.

## **Refinement 2: Refinement 1 with diverter at 37<sup>th</sup> Avenue**

To lower vehicle volume on Monroe Street west of 42<sup>nd</sup> Avenue, the diverter at 37<sup>th</sup> Avenue was added to the previous refinement scenario.

#### Pros

• The additional diverter at 37<sup>th</sup> Avenue would lower daily volume west of 42<sup>nd</sup> Avenue by 1,300 to 1,800 vehicles per day compared to Refinement 1.

#### Cons

- Harrison Street/37<sup>th</sup> Avenue intersection would operate at LOS F during the PM peak hour, exceeding the mobility standard and thus requiring mitigation or improvement.
- Volume on Monroe Street between 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue would still exceed 1,900 to 2,600 vehicles per day.
- Volume on Monroe Street west of 37<sup>th</sup> Avenue would still exceed 3,000 vehicles per day.
- This scenario could increase neighborhood cut-through trips on Jackson Street and 40<sup>th</sup> Avenue by 30 to 70 PM peak hour trips and on a small segment of 37<sup>th</sup> Avenue by approximately 200 PM peak hour trips.
- Although mobility standards would be met, conditions would likely worsen at already congested intersections such as OR 224/Harrison Street and Railroad Avenue-Harmony Road/Linwood Avenue (both have v/c ratios of 0.99) and King Road/Linwood Avenue (v/c ratio of 1.00).

<sup>10</sup> The applicable mobility standard for King Road/Linwood Ave is 1.10 per Clackamas County Comprehensive Plan, Table 5-2a.



# **Refinement 3: Refinement 1 with diverter at 42<sup>nd</sup> Avenue**

This scenario refinement combines the first refinement scenario with the diverter at 42<sup>nd</sup> Avenue, to compare with the 37<sup>th</sup> diverter scenario, determining which one more effectively lowers volume on Monroe Street with limited neighborhood impacts.

#### Pros

• Volume on Monroe Street between 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue would decrease to 1,600 to 2,200 vehicles per day (approximately 300 fewer vehicles than in Refinement 2.)

#### Cons

- Neighborhood cut-through would generally be more severe compared to Refinement 2 (37<sup>th</sup> Avenue diverter).
- Volume on Jefferson Street, Washington Street, and 42<sup>nd</sup> Avenue may increase by 100-150 trips in the PM peak hour, and potentially increasing their daily volume above 1,000 vehicles per day.
- West of 37<sup>th</sup> Avenue, Monroe Street would be expected to still exceed 3,500 vehicles per day.
- Although mobility standards would be met, conditions would likely worsen at already congested intersections such as OR 224/Harrison Street, Railroad Avenue-Harmony Road/Linwood Avenue, and King Road/Linwood Avenue (v/c ratios of 0.99).

# Monroe Street Alignment Concept: Refinement 1 with diverters at 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue

This scenario pairs both the 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue diverters with the refinement scenario previously identified. The result is the only feasible scenario identified that meets the daily volume threshold with fewer than 3,000 vehicles per day on Monroe Street west of 37<sup>th</sup> Avenue (as shown in Figure 5).

#### Pros

- Volume on Monroe Street east of 37<sup>th</sup> Avenue would be under 1,500 vehicles per day, with most of the corridor under 1,000 vehicles per day.
- The Oak Street/Railroad Avenue-Monroe Street intersection would operate at LOS C with a new traffic signal constructed.
- The Monroe Street/Linwood Avenue intersection would operate at LOS B with the diverter constructed.

- Significant cut-through traffic would be expected on Washington Street, Jackson Street, and 40<sup>th</sup> Avenue, with daily volumes potentially exceeding 1,000 vehicles per day.
- Harrison Street/37<sup>th</sup> Avenue intersection would operate at LOS F during the PM peak hour, exceeding the mobility standard and thus requiring mitigation or improvement, but would operate at LOS B with the construction of a new traffic signal
- Although mobility standards would be met, conditions would likely worsen at already congested intersections such as OR 224/Harrison Street and Railroad Avenue-Harmony Road/Linwood Avenue (both have v/c ratios of 0.99), and King Road/Linwood Avenue (v/c ratio of 1.00).





#### Figure 5. Estimated Daily Vehicle Volume – Monroe Street Alignment Concept

Estimated neighborhood diversion in the PM peak hour is presented in Figure 6. All streets not highlighted are not expected to see significant diversion under this recommended concept. As discussed above, noticeable diversion of trips would be expected on residential streets such as Washington Street, Jackson Street, 40<sup>th</sup> Avenue, and 42<sup>nd</sup> Avenue.

Figure 6. Potential Neighborhood Diversion (PM Peak Hour) – Monroe Street Alignment Concept





# WASHINGTON STREET ALIGNMENT CONCEPT

This concept modifies the Refinement 1 scenario to reflect a greenway alignment along Washington Street, as identified in the City Concept Plan. This concept avoids the need to reduce daily vehicle volumes on Monroe Street west of 42<sup>nd</sup> Avenue by realigning a portion of the greenway along Washington Street. People biking and walking would use an off-street path that follows the railroad tracks to connect between Oak Street and Washington Street. The greenway route would then continue on-street via Washington Street at 37<sup>th</sup> Street, connecting to Monroe Street via either Home Avenue or Garrett Drive. Table 3 includes the components of the Washington Street alignment concept compared to the Monroe Street alignment concept as well as the Refinement 1 scenario.

#### Table 3. Matrix of Scenario Components – Washington Street Alignment

	Refinement 1	Monroe St Alignment	Washington St Alignment		
Traffic Calming Location					
Monroe St - west of Campbell St	х	Х	x		
Monroe St - between Oak St and 42 <sup>nd</sup> Ave	х	Х			
Washington St - between 37 <sup>th</sup> Ave and 42 <sup>nd</sup> Ave			x		
Monroe St - between 42 <sup>nd</sup> Ave and Linwood Ave	х	Х	x		
Monroe St/Thompson Rd - east of Linwood Ave	х	Х	x		
Monroe St Diverter Location					
OR 224	х	Х	x		
37 <sup>th</sup> Ave		Х			
42 <sup>nd</sup> Ave		Х			
Linwood Ave	х	Х	x		
New Traffic Signal Location					
Harrison St/42 <sup>nd</sup> Ave	х	Х	x		
Oak St/Monroe St/Railroad Ave	х	Х	x		
37 <sup>th</sup> Ave/Harrison St		X <sup>*</sup>			
New Pedestrian Signal Location					
Monroe St/Linwood Ave	х	Х	x		
Monroe St Gap					
Open to pedestrians and cyclists (shared use path)	х	Х	x		
Open to vehicle traffic					

\* The traffic signal was identified as a potential solution based on traffic performance results from the scenario modeling.



Traffic calming in this scenario would include reducing travel speeds on Washington Street west of 42<sup>nd</sup> Avenue using the previously mentioned traffic calming treatments (as outlined in the City Concept Plan). The scenario would also include reorienting the stop sign direction at 40<sup>th</sup> Avenue to give people riding bikes on Washington Street the priority. In addition, traffic control at the Washington Street/42<sup>nd</sup> Avenue intersection would be changed from a two-way to an all-way stop. This traffic calming treatment could be implemented as an alternative to traffic calming on Monroe Street between Oak Street and 42<sup>nd</sup> Avenue, as shown in Table 3.

## Washington Street Alignment: Refinement 1 + modified traffic calming

This concept facilitates active travel on Washington Street between 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue as an alternative to travel on Monroe Street along the same segment with fewer diverters applied (compared to the Monroe Street alignment concept).

#### Pros

- Volumes on Monroe Street east of 42<sup>nd</sup> Avenue would be less than 1,500 vehicles per day.
- Volumes on Washington Street between 37<sup>th</sup> Avenue and 42<sup>nd</sup> Avenue would be less than 500 vehicles per day.
- All study intersections would operate within mobility standards.
- There would be no significant additional cut-through traffic expected beyond what was previously identified in Refinement 1 and diversion would generally be less than in the Monroe Street alignment concept.

- The neighborhood greenway route would be less direct and intuitive to new users as it would be shifted off Monroe Street for approximately three-quarters of a mile.
- Volumes on Monroe Street west of 42<sup>nd</sup> Avenue would exceed 4,000 vehicles per day.
- Although mobility standards would be met, conditions would likely worsen at already congested intersections such as OR 224/Harrison Street and Railroad Avenue-Harmony Road/Linwood Avenue (both have v/c ratios of 0.99), and King Road/Linwood Avenue (v/c ratio of 1.00).
- Neighborhood cut-through traffic may occur on sections of 25<sup>th</sup> Avenue, Stanley Avenue, Montgomery Drive, Queen Road, and 74<sup>th</sup> Avenue.





#### Figure 7. Estimated Daily Vehicle Volume – Washington Street Alignment Concept

Estimated neighborhood diversion in the PM peak hour is presented in Figure 8. All streets not highlighted are not expected to see significant diversion under this recommended concept. As discussed above, some minor levels of cut-through travel may occur including on Montgomery Drive, Queen Road, Jack Road, and Stanley Avenue.



Figure 8. Potential Neighborhood Diversion (PM Peak Hour) – Washington Street Alignment Concept



# LINWOOD DIVERTER SENSITIVITY

Results of a sensitivity analysis performed for both of the recommended concepts, with and without the Linwood Avenue diverter, are summarized below. Both the recommended Monroe Street alignment and the Washington Street alignment concepts include a diverter at Linwood Avenue. This component on its own was shown to be an effective diverter at lowering volume over much of the study area. However, the Linwood Avenue diverter, in combination with other components of the recommended concepts, would increase demand on several intersections along Linwood Avenue that are already congested.

#### **Key Findings**

- Volumes on Monroe Street would increase without the Linwood diverter, exceeding 1,500 vehicles per day for a few blocks on either side of Linwood Avenue.
- Cut-through traffic would increase on 60<sup>th</sup> Avenue and Maplehurst Road by about 200 hundred vehicles per day without the Linwood diverter.
- Intersection operations at King Road/Linwood Avenue during the PM peak hour (mobility standard of maximum 1.10 v/c ratio) are expected to improve from v/c of 1.00 to 0.96 without the Linwood diverter.
- Intersection operations at Railroad Avenue-Harmony Road/Linwood Avenue during the PM peak hour would marginally improve from v/c of 0.99 to 0.98 without the Linwood diverter.
- Intersection operations at Monroe Street/Linwood Avenue during the PM peak hour would degrade from LOS B to LOS C without the Linwood diverter, which still meets the City mobility standard of LOS D.

The diverter was identified in both the City and County Concept plans. Because it is a critical component for achieving target daily vehicle volumes on Monroe Street, it is recommended that the Linwood Avenue diverter be implemented as part of the recommended greenway concept.



# MONROE STREET GAP SENSITIVITY

Results of a sensitivity analysis performed for both of the recommended concepts, with and without the improvements identified to support motor vehicle travel through Monroe Street gap, are summarized below. Opening the gap on Monroe Street east of 78<sup>th</sup> Avenue to motor vehicle traffic (along with associated corridor improvements for continuous through traffic<sup>11</sup>) would generally be inconsistent with the overall goals of the City and County Concept Plans.

#### **Key Findings**

- Approximately 700 to 800 vehicles per day are expected to use the newly opened Monroe Street gap.
- Approximately 400 to 600 vehicles per day would shift from Thompson Road to the segment of Monroe Street east of 72<sup>nd</sup> Avenue.
- Increases in vehicular traffic on Monroe Street would lead to more conflicts with people using the new neighborhood greenway to the west.
- Cut-through traffic on 77<sup>th</sup> Avenue could increase by 20 to 50 vehicles in the PM peak hour.
- Study intersection operations would not be significantly affected.

The main finding of this evaluation is that opening the Monroe Street gap to motor vehicle traffic is estimated to increase local daily vehicle volumes on Monroe Street, which is not consistent with the objectives of the proposed active transportation route and the neighborhood greenway west of Linwood Avenue.

<sup>11</sup> The adjacent roadway segments on Monroe Street would be improved (including widening and constructing to county standards) so that it would be possible to travel consistently at 25 mph between 72<sup>nd</sup> Avenue and Fuller Road (and the Boyer Street Extension). The 72<sup>nd</sup> Avenue intersection would be reconfigured to allow for direct through travel on Monroe Street without a stop. The stop sign at 74<sup>th</sup> Avenue would also be redirected to give through travelers on Monroe Street priority.