

## Technical Memorandum

**DATE:** January 30, 2007

**TO:** D.J. Heffernan - APG

**FROM:** John Bosket, PE; Garth Appanaitis

**SUBJECT: Task 4.1f: Concept Plan Traffic Analysis  
Area Plans for NW Redmond and US 97  
City of Redmond, Oregon**

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This memorandum provides a summary of the traffic analysis performed for the various land use scenarios associated with the Redmond Northwest Area Plan (NAP) and Highway 97 Area Plan (HAP) and is intended to supplement Technical Memorandum #3 – Land Use Alternatives. In addition, street cross-sections for the roadways serving the NAP and HAP have been provided.

### Executive Summary

Comparing the trips generated by each of the three land use scenarios considered for the NAP and HAP indicated that the difference in trips between each scenario was less than 3%. For this reason only one HAP land use alternative was analyzed with each of the three NAP land use alternatives. Future 2027 design hour traffic volumes were developed by applying future growth to existing (2005) 30<sup>th</sup> highest hour volumes. A transportation demand model for the Redmond Area was provided by the Oregon Department of Transportation's Transportation Planning Analysis Unit (TPAU) to determine project-related trips for each scenario; as well as area traffic growth. Because the generated trips by each land use alternative were very similar, the three "build" scenarios analyzed had similar traffic impacts. Five intersections would fail to meet performance standards in 2027 both with and without the project. The majority of these intersections are located along Highway 126 and could be improved by extending the 5-lane section of the highway west of 27<sup>th</sup> Street and the three lane section west of 35<sup>th</sup> Street. The improvements that would be needed include:

- Extend 5-lane section of Highway 126 from 19th Street to west of 27th Street
- Extend 3-lane section of Highway 126 from west of 27th Street to west of 35th Street
- Restrict turn movements to allow to right-in-right-out only to and from 23<sup>rd</sup> Street on Highway 126
- Add a northbound left turn lane at 35<sup>th</sup> Street/Highway 126
- When warranted, consider a traffic signal for Highway 126/35<sup>th</sup> Street
- Add a traffic signal to 27<sup>th</sup> Street/Antler Avenue
- Add a westbound right turn lane to 27<sup>th</sup> Street/Antler Avenue
- Add a northbound right turn lane to 27<sup>th</sup> Street/Antler Avenue
- Add an eastbound left turn to 27<sup>th</sup> Street/Antler Avenue
- Add a traffic signal to 27<sup>th</sup> Street/Spruce Avenue
- Add a traffic signal to 27<sup>th</sup> Street/Maple Avenue

Even with these improvements, design exceptions would need to be requested for Highway 126/19<sup>th</sup> Street and Highway 126/27<sup>th</sup> Street.

Intersections along the Highway 97 Business Route would meet performance standards in 2010 following the opening of the Highway 97 Reroute.

Many of the study intersections would have similar queuing conditions under both the No Build and Build scenarios. However, intersections along Maple Avenue and in the vicinity of the NAP area would experience lengthy queues that could have the potential to hinder traffic operations at adjacent intersections under the Build scenario. Potential improvements to reduce queuing include:

- Add a westbound right turn lane at 19<sup>th</sup> Street/Maple Avenue
- Increase the turn lane storage and give a protected left turn signal phase to the eastbound left turn at US 97 Business/Maple Avenue

## Plan Descriptions

Three alternative land use schemes are currently being considered for both the NAP and the HAP areas. The NAP area is generally bounded in northwest Redmond by 23<sup>rd</sup> Street, 35<sup>th</sup> Street, Upas Avenue and Hemlock Avenue. The three NAP alternatives are:

- 27th Main Street
- String of Pearls
- 29th Town Center

Each of the NAP alternatives are comprised of residential, mixed use, commercial, school, other employment, and park uses in varying configurations. In addition, the “29<sup>th</sup> Town Center” alternative includes a plaza.

The HAP area is located in north Redmond along Highway 97 and is generally bounded by Pershall Way/O’Neil Highway, 10<sup>th</sup> Street, Canal Boulevard, and Spruce Avenue. The three HAP alternatives are:

- Upas Avenue Main Street
- Civic Street
- Village Center

The development of this area would be accompanied by an overcrossing at Upas Avenue to facilitate site access to the two sides of US 97. The three alternatives include residential, mixed, commercial, public, other employment, and park uses. Additional information regarding each land use scenario is located in Technical Memorandum #3.

## Plan Trip Comparison

Trip generation associated with the land use composition of each scenario was compared to determine the net difference in trips among the various scenarios. Trip generation rates for each land use were obtained through a regression analysis performed on the transportation demand model trip table and applied to land use information provided by Angelo Planning Group. Total trips for the NAP range from approximately 2,260 to 2,320 during the PM peak hour. The “27th Main Street” scenario generates the greatest amount of

trips, though it should be noted that it only generates 3% more than the scenario with the least amount of trips. Total scenario trips for the Highway 97 Area Plan range from approximately 615 to 630 trips during the PM peak hour with the “Village Center” scenario generating the greatest amount of trips. Tables 3-1 and 3-2 list the individual land use components of each scenario, the trips generated by each use, and the total trips for the scenario.

**Table 3-1: Northwest Area Plan - Scenario Trip Generation Comparison**

| Scenario/Use                                | Employees/<br>Households | PM Peak Hour Trips |            |              |
|---|--------------------------|--------------------|------------|--------------|
|   |                          | In                 | Out        | Total        |
| <b>27<sup>th</sup> Main Street Scenario</b> |                          |                    |            |              |
| Retail                                      | 18                       | 19                 | 35         | 54           |
| Service                                     | 9                        | 2                  | 3          | 5            |
| Education                                   | 50                       | 8                  | 19         | 27           |
| Government                                  | 36                       | 13                 | 30         | 43           |
| <i>Employment Total</i>                     | 113                      | 42                 | 87         | 129          |
| Household                                   | 4200                     | 1,525              | 665        | 2,190        |
| <b>Scenario Total</b>                       |                          | <b>1,567</b>       | <b>752</b> | <b>2,319</b> |
| <b>String of Pearls Scenario</b>            |                          |                    |            |              |
| Retail                                      | 7                        | 8                  | 14         | 22           |
| Service                                     | 3                        | 1                  | 1          | 2            |
| Education                                   | 50                       | 7                  | 17         | 24           |
| Government                                  | 24                       | 11                 | 23         | 34           |
| <i>Employment Total</i>                     | 84                       | 27                 | 55         | 82           |
| Household                                   | 4,229                    | 1,533              | 668        | 2,201        |
| <b>Scenario Total</b>                       |                          | <b>1,560</b>       | <b>723</b> | <b>2,283</b> |
| <b>29<sup>th</sup> Town Center Scenario</b> |                          |                    |            |              |
| Retail                                      | 13                       | 15                 | 27         | 42           |
| Service                                     | 6                        | 2                  | 3          | 5            |
| Education                                   | 50                       | 8                  | 19         | 27           |
| Government                                  | 32                       | 13                 | 30         | 43           |
| <i>Employment Total</i>                     | 101                      | 38                 | 79         | 117          |
| Household                                   | 4,125                    | 1,493              | 651        | 2,144        |
| <b>Scenario Total</b>                       |                          | <b>1,531</b>       | <b>730</b> | <b>2,261</b> |

**Table 3-2: Highway 97 Area Plan - Scenario Trip Generation Comparison**

| Scenario/Use                   | Employees/<br>Households | PM Peak Hour Trips |            |            |
|--------------------------------|--------------------------|--------------------|------------|------------|
|                                |                          | In                 | Out        | Total      |
| <b>Civic Street Scenario</b>   |                          |                    |            |            |
| Retail                         | 59                       | 48                 | 88         | 136        |
| Service                        | 226                      | 52                 | 58         | 110        |
| Other                          | 280                      | 29                 | 169        | 198        |
| Government                     | 0                        | 0                  | 0          | 0          |
| <i>Employment Total</i>        | <b>565</b>               | <b>129</b>         | <b>315</b> | <b>444</b> |
| Household                      | 456                      | 119                | 52         | 171        |
| <b>Scenario Total</b>          |                          | <b>248</b>         | <b>367</b> | <b>615</b> |
| <b>Upas Avenue Main Street</b> |                          |                    |            |            |
| Retail                         | 59                       | 48                 | 88         | 136        |
| Service                        | 225                      | 52                 | 57         | 109        |
| Other                          | 280                      | 29                 | 169        | 198        |
| Government                     | 8                        | 2                  | 5          | 7          |
| <i>Employment Total</i>        | <b>572</b>               | <b>131</b>         | <b>319</b> | <b>450</b> |
| Household                      | 442                      | 115                | 50         | 165        |
| <b>Scenario Total</b>          |                          | <b>246</b>         | <b>369</b> | <b>615</b> |
| <b>Village Center Scenario</b> |                          |                    |            |            |
| Retail                         | 59                       | 48                 | 88         | 136        |
| Service                        | 226                      | 51                 | 58         | 109        |
| Other                          | 280                      | 29                 | 169        | 198        |
| Government                     | 16                       | 5                  | 11         | 16         |
| <i>Employment Total</i>        | <b>581</b>               | <b>133</b>         | <b>326</b> | <b>459</b> |
| Household                      | 455                      | 119                | 52         | 171        |
| <b>Scenario Total</b>          |                          | <b>252</b>         | <b>378</b> | <b>630</b> |

Due to the small scale of difference in trip generation among the HAP scenarios, only a single scenario was chosen for analysis. The difference in trip generation between the NAP scenario that would generate the most trips and that which would generate the least is less than 3%. However, this difference equates to 60 peak trips, while the difference is only 15 trips with the HAP scenarios. In addition, land uses within the NAP shift more among the scenarios (for example the schools are located east or west of 27<sup>th</sup> Street) which could lead to impacts on local intersections. For this reason, analysis was performed for the three combinations of NAP land uses with the single HAP land use scenario for a total of three scenarios, including:

- 2027 HAP Civic Street & NAP 27th Main Street
- 2027 HAP Civic Street & NAP String of Pearls
- 2027 HAP Civic Street & NAP 29th Town Center

## Future Volumes

Future 2027 design hour volumes were developed for the No Build and the three Build scenarios. Previous traffic counts and work associated with the US 97 Redmond Refinement Plan, North Redmond US 97 IAMP, and City of Redmond Transportation System Plan Update were utilized along with the demand model provided by TPAU that incorporated the various NAP and HAP land use scenarios considered. Future volumes were projected by applying an increment of the growth found to occur between the base and future year scenarios in the model to existing (2005) 30<sup>th</sup> highest hour volumes which were developed through the earlier studies referenced. Future volumes were forecast for each NAP/HAP land use combination considered for analysis. Figure 3-1 shows the projected 2027 background (No Build) and 2027 Main Street (Build) design hour traffic volumes at each study intersection. Because the differences in generated trips between the various NAP scenarios was relatively small, only volumes generated by the “27<sup>th</sup> Main Street” scenario, which generated the most trips, are provided in this figure.

**FIGURE 3-1: 2027 Traffic Volumes**

## Intersection Operations

Level of Service (LOS) and volume to capacity (v/c) ratios are both used as measures of effectiveness for intersection operation. LOS is similar to a “report card” rating based upon average vehicle delay. Level of Service A, B, and C indicate conditions where traffic moves without significant delays over periods of peak hour travel demand. Level of Service D and E are progressively worse peak hour operating conditions. Level of Service F represents conditions where average vehicle delay exceeds 80 seconds per vehicle entering a signalized intersection and demand has exceeded capacity. This condition is typically evident in long queues and delays. Unsignalized intersections provide levels of service for major and minor street turning movements. For this reason, LOS E and even LOS F can occur for a specific turning movement; however, the majority of traffic may not be delayed (in cases where major street traffic is not required to stop). LOS E or F conditions at unsignalized intersections generally provide a basis to study intersections further to determine availability of acceptable gaps, safety and traffic signal warrants.

A volume to capacity ratio (v/c) is the peak hour traffic volume at an intersection divided by the maximum volume that intersection can accommodate. For example, when a v/c is 0.80, peak hour traffic is using 80 percent of the intersection capacity. If traffic volumes exceed capacity, queues will form and will lengthen until demand subsides below the available capacity. When the v/c approaches 1.0, intersection operation becomes unstable and small disruptions can cause traffic flow to deteriorate.

### Operating Standards

ODOT has adopted mobility standards for state facilities through the 1999 Oregon Highway Plan (OHP)<sup>1</sup> to be used for identifying needs of existing facilities. Table 6 in Policy 1F of the OHP displays the maximum allowable volume to capacity ratios for the 30th highest annual hour of traffic in areas outside of the Portland Metropolitan Area.

At signalized intersections, these standards are to be applied to the intersection as a whole. At unsignalized intersections, these standards are applicable only to movements that are not required to stop. For other movements at unsignalized intersections that are required to stop or otherwise yield the right of way, the standards for District/Local Interest Roads shall be applied for areas within urban growth boundaries and a maximum volume to capacity ratio of 0.80 shall be applied for areas outside of urban growth boundaries. However, when an intersection acts as an interchange ramp terminal, the applicable volume to capacity ratio will be the smaller of the values of the volume to capacity ratio for the crossroad or 0.85.

The majority of study intersections that are under ODOT jurisdiction are located along Highway 126, which is classified as a statewide highway and is a freight route. The signalized intersection at 19<sup>th</sup> Street has a v/c standard of 0.80, while the proposed signal at 27<sup>th</sup> Street is required to meet a v/c ratio of 0.70. Both unsignalized intersections at 23<sup>rd</sup> Street and 35<sup>th</sup> Street must meet the district/local interest road standard of 0.80. The interchange ramps of the US 97 Reroute are subject to a v/c ratio of 0.85 for the performance standard

All non-state roadways within the Redmond UGB are under the jurisdiction of the City of Redmond. The City has adopted standards for performance of City streets requiring operation of level of service E or better during the peak 15 minutes of the peak hour of the average weekday. A lesser standard is allowed at unsignalized intersections with low volume minor street approaches, requiring operation at a volume to capacity ratio less than 0.90 and a 95th percentile vehicle queue less than four vehicles during the peak hour.

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<sup>1</sup> 1999 Oregon Highway Plan, Oregon Department of Transportation, August 2005 update.

### **2027 HAP/NAP Concept Plan Buildout**

The 30 study intersections were analyzed for the No Build and three Build scenarios. Development scenarios assume full buildout of the concept plans. Only a single HAP scenario was analyzed due to the findings of the trip generation analysis that indicated each scenario would generate nearly identical traffic volumes. Build scenarios in this document are referred to by the NAP alternative land use since each scenario contains the same HAP land use.

A saturation flow rate of 1,800 vehicles per lane per hour was assumed for all streets. Parking use was included along intersection approaches of streets in the study area, and non arterial streets outside the study area. A four second lost time was used at signalized intersections. Maple Avenue and 27<sup>th</sup> Street were assumed to be three lane sections with center turn lanes unless the intersection is already constructed and contains additional turn lanes.

Table 3-3 lists the intersection operations of all study intersections under the four scenarios. Note that shaded cells indicate the performance standard is exceeded at the intersection. Two intersections, 27<sup>th</sup> Street/Spruce Avenue and 27<sup>th</sup> Street/Maple Avenue were analyzed as signalized intersections in the Build scenarios to allow for better comparison between alternatives since both were found to not otherwise meet performance standards.



**Table 3-3: 2027 PM Peak Hour Study Intersection Operations**

| Intersection  | No Build Scenario |     |      | 27 <sup>th</sup> Main Street Build Scenario |     |      | String of Pearls Build Scenario |     |      | 29 <sup>th</sup> Town Center Build Scenario |     |      |
|---|-------------------|-----|------|---|-----|------|---------------------------------|-----|------|---|-----|------|
|   | Delay (s)         | LOS | V/C  | Delay (s)                                   | LOS | V/C  | Delay (s)                       | LOS | V/C  | Delay (s)                                   | LOS | V/C  |
| <b>ODOT Unsignalized Intersections</b>                            |                   |     |      |   |     |      |                                 |     |      |   |     |      |
| US 97/ O'Neil Highway <sup>2</sup>                                |                   | NA  | NA   |   | NA  | NA   |                                 | NA  | NA   |   | NA  | NA   |
| Highway 126/ 23 <sup>rd</sup> Street                              |                   | D/F | >1.0 |   | D/F | >1.0 |                                 | D/F | >1.0 |   | D/F | >1.0 |
| Highway 126/ 35 <sup>th</sup> Street                              |                   | A/F | >1.0 |   | A/F | >1.0 |                                 | A/F | >1.0 |   | A/F | >1.0 |
| O'Neil Highway/ Canal Boulevard                                   |                   | A/B | 0.33 |   | A/C | 0.64 |                                 | A/C | 0.64 |   | A/C | 0.64 |
| US 97 Reroute NB Ramps/ US 97 Business                            |                   | A/B | 0.30 |   | A/B | 0.45 |                                 | A/B | 0.44 |   | A/B | 0.44 |
| US 97 Reroute SB Ramps/ US 97 Business                            |                   | A/C | 0.62 |   | A/C | 0.74 |                                 | A/C | 0.73 |   | A/C | 0.73 |
| <b>ODOT Signalized Intersections</b>                              |                   |     |      |   |     |      |                                 |     |      |   |     |      |
| Highway 126/ 19 <sup>th</sup> Street                              | >80.0             | F   | >1.0 | >80.0                                       | F   | >1.0 | >80.0                           | F   | >1.0 | >80.0                                       | F   | >1.0 |
| Highway 126/ 27 <sup>th</sup> Street                              | 47.8              | D   | >1.0 | 67.7  | E   | 0.98 | 72.8                            | E   | >1.0 | 67.2  | E   | >1.0 |
| <b>City of Redmond Unsignalized Intersections</b>                 |                   |     |      |   |     |      |                                 |     |      |   |     |      |
| 9 <sup>th</sup> Street/ Black Butte Boulevard <sup>3</sup>        | 16.1              | C   | 0.70 | 19.4  | C   | 0.80 |                                 | C   | 0.80 | 19.5  | C   | 0.80 |
| Canyon Drive/ Black Butte Boulevard                               |                   | A/C | 0.47 |   | A/C | 0.48 |                                 | A/C | 0.47 |   | A/C | 0.49 |
| 19 <sup>th</sup> Street/ Spruce Avenue                            |                   | A/A | 0.12 |   | A/B | 0.29 |                                 | A/B | 0.28 |   | A/B | 0.28 |
| 19 <sup>th</sup> Street/ Hemlock Avenue                           |                   | A/E | 0.18 |   | A/E | 0.20 |                                 | A/E | 0.20 |   | A/E | 0.20 |
| 27 <sup>th</sup> Street/ Spruce Avenue                            |                   | A/B | 0.22 |   | A/F | >1.0 |                                 | A/F | >1.0 |   | A/F | >1.0 |
| 27 <sup>th</sup> Street/ Maple Avenue                             |                   | A/C | 0.54 |   | A/F | >1.0 |                                 | A/F | >1.0 |   | A/F | >1.0 |
| 27 <sup>th</sup> Street/ Hemlock Avenue                           |                   | A/B | 0.38 |   | A/C | 0.74 |                                 | A/C | 0.72 |   | A/C | 0.73 |
| 27 <sup>th</sup> Street/ Antler Avenue                            |                   | B/F | >1.0 |   | B/F | >1.0 |                                 | B/F | >1.0 |   | B/F | >1.0 |
| 35 <sup>th</sup> Street/ Maple Avenue                             |                   | A/B | 0.21 |   | A/B | 0.14 |                                 | A/B | 0.14 |   | A/B | 0.14 |
| 35 <sup>th</sup> Street/ Hemlock Avenue                           |                   | A/A | 0.06 |   | A/B | 0.16 |                                 | A/B | 0.16 |   | A/A | 0.14 |
| 35 <sup>th</sup> Street/ Antler Avenue                            |                   | A/B | 0.09 |   | A/B | 0.22 |                                 | A/B | 0.19 |   | A/B | 0.20 |
| King Way/Canal Boulevard  |                   | A/B | 0.25 |   | A/B | 0.33 |                                 | A/B | 0.33 |   | A/B | 0.33 |
| 10 <sup>th</sup> Street/ Pershall Way                             |                   | A/A | 0.14 |   | A/C | 0.51 |                                 | A/C | 0.48 |   | A/C | 0.48 |
| 10 <sup>th</sup> Street/ Quince Avenue                            |                   | A/B | 0.42 |   | A/C | 0.62 |                                 | A/C | 0.60 |   | A/C | 0.58 |
| <b>City of Redmond Signalized Intersections</b>                   |                   |     |      |   |     |      |                                 |     |      |   |     |      |
| US 97 Business NB (5 <sup>th</sup> Avenue)/ Black Butte Boulevard | 15.3              | B   | 0.90 | 19.0  | B   | 0.92 | 18.8                            | B   | 0.92 | 18.5  | B   | 0.92 |
| US 97 Business SB (6 <sup>th</sup> Avenue)/ Black Butte Boulevard | 29.4              | C   | 0.92 | 45.4  | D   | >1.0 | 45.1                            | D   | >1.0 | 43.4  | D   | >1.0 |
| 10 <sup>th</sup> Street/ Maple Avenue                             | 35.8              | D   | 0.86 | 33.2  | C   | 0.84 | 33.2                            | C   | 0.84 | 33.1  | C   | 0.84 |
| 19 <sup>th</sup> Street/ Antler Avenue                            | 14.3              | B   | 0.76 | 18.1  | B   | 0.84 | 16.2                            | B   | 0.82 | 15.6  | B   | 0.81 |
| 19 <sup>th</sup> Street/ Maple Avenue                             | 21.2              | C   | 0.78 | 42.9  | D   | 0.99 | 46.5                            | D   | >1.0 | 45.6  | D   | >1.0 |
| 27 <sup>th</sup> Street/ Spruce Avenue                            | --                | --  | --   | 15.2  | B   | 0.71 | 15.2                            | B   | 0.71 | 14.8  | B   | 0.71 |
| 27 <sup>th</sup> Street/ Maple Avenue                             | --                | --  | --   | 25.7  | C   | 0.85 | 24.9                            | C   | 0.80 | 24.5  | C   | 0.79 |
| US 97 Business/ Quince Avenue                                     | 11.2              | B   | 0.34 | 12.7  | B   | 0.51 | 12.5                            | B   | 0.49 | 12.3  | B   | 0.48 |
| US 97 Business/ Oak Avenue  | 38.2              | D   | 0.61 | 38.9  | D   | 0.72 | 39.5                            | D   | 0.72 | 39.8  | D   | 0.72 |
| US 97 Business/ Maple Avenue                                      | 29.0              | C   | 0.72 | 36.4  | D   | 0.94 | 35.9                            | D   | 0.94 | 35.3  | D   | 0.93 |

<sup>2</sup> This intersection was assumed to become an overpass, per the recommendations in the North Redmond US 97 IAMP

<sup>3</sup> All-way stop controlled intersection

Note: *Shaded* values indicate that performance standards are exceeded

When comparing the operational characteristics at study intersections under various scenarios in Table 3-3, it can be seen that there are some occurrences where operations improve from No Build to Build conditions even though no mitigations has occurred. These changes result because of modified trip assignments on the area street network by the travel demand model in response to congestion experienced.

Five study intersections would not meet applicable performance standards under the No Build scenarios in 2027. These same intersections, in addition to two others, would not meet performance standards under the Build scenario. The majority of intersections that would not meet standards are located along Highway 126. A discussion of each intersection and potential improvements follow.

*Highway 126/ 19th Street* – The east-west volume on Highway 126 requires a large portion of green time at the signal since the 5-lane section of the highway does not continue west of the intersection. Extending the 5-lane section of Highway 126 from 19th Street to 27th Street and retaining the westbound right turn lane would improve the intersection v/c ratio to 0.80, but would not meet the ODOT standard of 0.70 (HDM). Additional improvements to this intersection could be a dual westbound left turn lane and widening 19<sup>th</sup> Street to have two receiving lanes. It is recommended that a design exception be requested rather than pursuing the additional mitigation due to the costs associated with the improvements.

*Highway 126/ 23rd Street* – The volume on Highway 126 does not allow sufficient gaps for vehicles turning left onto the highway from 23rd Street, which is stop-controlled. Extending the 5-lane section of Highway 126 from 19th Street to 27th Street and building a northbound left turn lane would allow the intersection to meet ODOT performance standards. The intersection would meet ODOT performance standards with full access, however restricting access to right-in-right-out movements is recommended.

*Highway 126/ 27th Street* – The volume on Highway 126 requires a large portion of green time at the signal since the highway is a 3-lane section. Extending the 5-lane section of Highway 126 from 19th Street to 27th Street would improve the intersection v/c ratio to 0.71. The ODOT performance standard of 0.70 (HDM) would not be met, but it is recommended that a design exception be sought at this location.

*Highway 126/ 35th Street* – The configuration of the intersection does not allow vehicles turning left from 35th to use a center lane on Highway 126 to facilitate the maneuver. Extending the 3-lane section of Highway 126 west through 35th Avenue and building a northbound left turn lane would allow the intersection to meet ODOT performance standards. While ODOT performance standards would be met, there would be severe delay to vehicles on 35<sup>th</sup> Street. When warranted, a traffic signal should be considered at this location to alleviate the delay to vehicles on 35<sup>th</sup> Street.

*27th Street/ Antler Avenue* – The intersection has high traffic volume on both streets and meets the peak hour signal warrant. A traffic signal, westbound right turn lane, northbound right turn lane, and eastbound left turn lane would allow the intersection to meet City of Redmond performance standards.

*27th Street/ Maple Avenue* – The intersection has high traffic volume on 27th Street and requires a traffic signal. It is further recommended that a westbound right turn lane be constructed as well.

*27th Street/ Spruce Avenue* – The intersection has high traffic volume on Spruce Avenue and requires a traffic signal.

The mitigated intersection operations for intersections that would not meet standards without further improvements are listed in Table 3-4. Performance standards for the Highway Design Manual apply for mitigated scenarios. Applicable operating standards are a v/c ratio of 0.75 for Highway 126/23<sup>rd</sup> Street and Highway 126/35<sup>th</sup> Street, and a v/c ratio of 0.70 for Highway 126/19<sup>th</sup> Street and Highway 136/27<sup>th</sup> Street.

Traffic operations are similar among the three Build scenarios (as indicated in Table 3-3) so operations were only analyzed for the 27th Main Street Build Scenario. Operations for 27th Street/Maple Avenue and 27th Street/Spruce Avenue with a traffic signal are listed in Table 3-3 to show the difference between Build scenarios since these intersections are in the vicinity of the project area and would be more sensitive to localized change in trip assignments.

While the intersection of Maple Avenue/19<sup>th</sup> Street meets City of Redmond performance standards, it was noted that the intersection could be significantly improved by adding a westbound right turn lane.

**Table 3-4: 2027 PM Peak Hour Study Intersection Operations - Mitigated**

| Intersection                                      | No Build Scenario (Unmitigated) |     |      | 27 <sup>th</sup> Main Street Build Scenario (Unmitigated) |     |      | 27 <sup>th</sup> Main Street Build Scenario (Mitigated) |     |      |
|---|---------------------------------|-----|------|---|-----|------|---|-----|------|
|   | Delay (s)                       | LOS | V/C  | Delay (s)   | LOS | V/C  | Delay (s)   | LOS | V/C  |
| <b>ODOT Unsignalized Intersections</b>            |                                 |     |      |   |     |      |   |     |      |
| Highway 126/ 23 <sup>rd</sup> Street              |                                 | D/F | >1.0 |   | D/F | >1.0 |   | B/F | 0.73 |
| Highway 126/ 35 <sup>th</sup> Street              |                                 | A/F | >1.0 |   | A/F | >1.0 |   | A/F | 0.66 |
| <b>ODOT Signalized Intersections</b>              |                                 |     |      |   |     |      |   |     |      |
| Highway 126/ 19 <sup>th</sup> Street              | >80.0                           | F   | >1.0 | >80.0   | F   | >1.0 | 37.1  | D   | 0.80 |
| Highway 126/ 27 <sup>th</sup> Street              | 47.8                            | D   | >1.0 | 67.7  | E   | 0.98 | 22.4  | C   | 0.71 |
| <b>City of Redmond Unsignalized Intersections</b> |                                 |     |      |   |     |      |   |     |      |
| 27 <sup>th</sup> Street/ Antler Avenue            |                                 | B/F | >1.0 |   | B/F | >1.0 | 44.6  | D   | 0.99 |

Note: *Shaded* values indicate that performance standards are exceeded

Study intersections were also analyzed to determine the extent of future queuing. Queuing analysis was performed using multiple simulation runs of SimTraffic. Figure 3-2 lists the 95th-percentile queues at each intersection for the No Build and 27th Main Street Build scenarios. Queuing analysis was not performed for the other individual Build scenarios due to the similarity in intersection performance presented in Table 3-3. Capacity improvements needed to meet agency performance standards (as previously listed) were assumed to be in place.

Many of the study intersections would have similar queuing conditions under both the No Build and Build scenarios. However, intersections along Maple Avenue and in the vicinity of the NAP area would experience lengthy queues that could have the potential to hinder traffic operations at adjacent intersections under the Build scenario. Queues at 27th Street/Antler Avenue would be over 500 feet in the No Build scenario and would climb to nearly 1,000 feet in the Build Scenario. Some approaches would have the potential for queues in excess of 1,000 feet. The intersections of 10th Street/Maple Avenue, 19th Street/Maple Avenue, and US 97 Business/Maple Avenue also have potential for queues to exceed 1000 feet for the Build scenario. Queues at 10<sup>th</sup> Street/Maple Avenue are due to queuing at US 97 Business/Maple Avenue caused by the eastbound left turn queues. Queuing at these two locations can be improved by extending the eastbound left turn queue storage at US 97 Business/Maple Avenue and giving the movement protected left turn signal phasing. The addition of the westbound right turn lane at 19<sup>th</sup> Street/Maple Avenue would improve queues at that intersection. Queuing at 27<sup>th</sup> Street/Antler Avenue may require a 5-lane section on 27<sup>th</sup> Avenue, but will be investigated again with the updated demand model.

**2010 US 97 Highway Conditions**

Traffic conditions at the study intersections along the highway corridor were also analyzed to determine impacts during the year of opening of the US 97 Reroute project in 2010. Intersection turn movement volumes were interpolated based on previous work for the US 97 Redmond Refinement Plan. The NAP and HAP were assumed<sup>4</sup> to be at 20% of full buildout by that year. Many of these intersections are currently under ODOT jurisdiction but would transfer to City of Redmond control upon the completion of the US 97 Reroute. All intersections would meet City of Redmond operating standards in 2010. Study intersection performance is listed in Table 3-5.

**Table 3-5: 2010 Highway Study Intersection Operations**

| Intersection  | No Build Scenario (Unmitigated) |     |      | No Build Scenario (Mitigated) |     |      |
|---|---------------------------------|-----|------|-------------------------------|-----|------|
|   | ADT                             | LOS | V/C  | ADT                           | LOS | V/C  |
| <b>ODOT Unsignalized Intersections</b>                            |                                 |     |      |                               |     |      |
| US 97 Reroute NB Ramps/ US 97 Business                            | 3250                            | A/A | 0.17 | 4000                          | A/B | 0.19 |
| US 97 Reroute SB Ramps/ US 97 Business                            | 3250                            | A/B | 0.33 | 4000                          | A/B | 0.35 |
| <b>City of Redmond Signalized Intersections</b>                   |                                 |     |      |                               |     |      |
| US 97 Business/ Quince Avenue                                     | 4500                            | A   | 0.19 | 6250                          | A   | 0.20 |
| US 97 Business/ Oak Avenue  | 7500                            | C   | 0.36 | 8500                          | C   | 0.38 |
| US 97 Business/ Maple Avenue                                      | 9250                            | C   | 0.41 | 10000                         | C   | 0.45 |
| US 97 Business NB (5 <sup>th</sup> Avenue)/ Black Butte Boulevard | 9000                            | A   | 0.49 | 9000                          | A   | 0.49 |
| US 97 Business SB (6 <sup>th</sup> Avenue)/ Black Butte Boulevard | 6500                            | B   | 0.48 | 7000                          | B   | 0.50 |

<sup>4</sup> Estimate provided by DJ Heffernan, Angelo Planning, January 23, 2007.

**Insert Figure 3-2 – 95<sup>th</sup> Percentile Queues**

## Street Cross-sections

Cross-sections for roadways serving the NAP and HAP areas were developed through coordination with the City of Redmond Public Works Director<sup>5</sup> and are largely based on current City design standards with some modifications to reflect desired updates and the special needs of the NAP and HAP. The proposed cross-sections are included in the body of the NAP and HAP documents.

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<sup>5</sup> Telephone conversation with Chris Doty, January 19, 2007.

