CHAPTER 5

5. SPREADSHEET TOOL

This chapter belongs to the activities under task 7 of the project. A spreadsheet tool was developed to help signal operation personnel understand how the relative risk (RR) of left turn crashes varies during the day as turning movement counts vary. This spreadsheet tool embeds the statistical models described in Chapter 4 for different types of intersection approaches. It takes the geometric measurements and turning movement counts as input from the user and produces 24-hour RR diagrams.

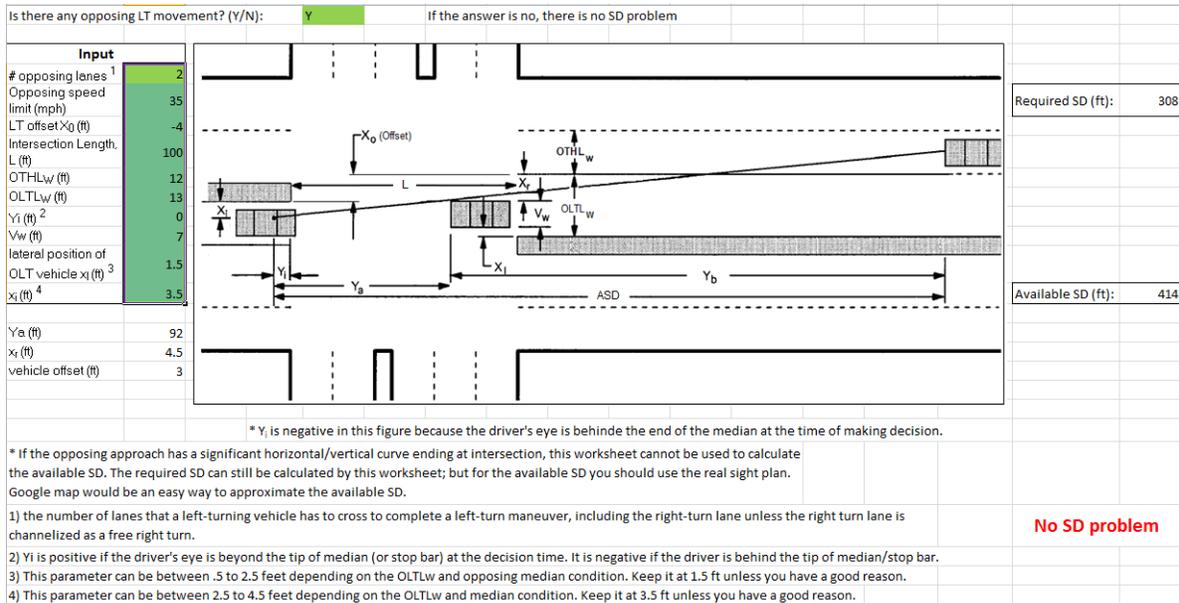## 5.1 Spreadsheet Tool
The spreadsheet tool has 3 main parts:
- SD condition: the first sheet
- RR diagrams: the second sheet
- Supporting data: the last three sheets

All input cells are highlighted green. Users, normally, do not need to change any other cells.

5.1.1 SD Condition
The first step of using the spreadsheet tool is to determine whether or not the intersection approach of interest has a sight distance issue. Figure 5.1 shows the contents of sheet "SD issue" which is used for this purpose. The procedure starts with a question regarding the existence of opposing LT movement. If the answer to this question is no, the approach does not have a SD problem. No further calculations are needed and user can move forward to the RR sheet. Otherwise, a set of input variables (the green list) is needed in order to calculate required SD (RSD) and available SD (ASD). The first two variables are used to calculate the RSD and the rest of them are needed for ASD. All these variables are shown in the diagram. However, there are considerations regarding some of these variables.

The number of opposing lanes is the number of lanes that a left-turning vehicle has to cross to complete a left-turn maneuver, including the right-turn lane unless the right turn lane is channelized as a free right turn. In other word, those lanes to which the LT vehicle must yield.

Is there any opposing LT movement? (Y/N):   Y   If the answer is no, there is no SD problem

Input	
# opposing lanes [1]	2
Opposing speed limit (mph)	35
LT offset X_0 (ft)	-4
Intersection Length, L (ft)	100
$OTHL_W$ (ft)	12
$OLTL_W$ (ft)	13
Y_i (ft) [2]	0
V_w (ft)	7
lateral position of OLT vehicle x_l (ft) [3]	1.5
x_i (ft) [4]	3.5

Y_a (ft)	92
x_r (ft)	4.5
vehicle offset (ft)	3

Required SD (ft):   308

Available SD (ft):   414

No SD problem

* Y_i is negative in this figure because the driver's eye is behinde the end of the median at the time of making decision.

* If the opposing approach has a significant horizontal/vertical curve ending at intersection, this worksheet cannot be used to calculate the available SD. The required SD can still be calculated by this worksheet; but for the available SD you should use the real sight plan. Google map would be an easy way to approximate the available SD.

1) the number of lanes that a left-turning vehicle has to cross to complete a left-turn maneuver, including the right-turn lane unless the right turn lane is channelized as a free right turn.

2) Y_i is positive if the driver's eye is beyond the tip of median (or stop bar) at the decision time. It is negative if the driver is behind the tip of median/stop bar.

3) This parameter can be between .5 to 2.5 feet depending on the $OLTL_W$ and opposing median condition. Keep it at 1.5 ft unless you have a good reason.

4) This parameter can be between 2.5 to 4.5 feet depending on the $OLTL_W$ and median condition. Keep it at 3.5 ft unless you have a good reason.

Figure 5.1 Contents of the "SD issue" sheet

Y_i is the longitudinal distance from the tip of the median (or stop bar) to the driver's eye; positive if inside the intersection and negative if behind the intersection. <u>For majority of intersections Y_i can be considered zero</u>, meaning that the driver's eye is just at the start of the intersection (either end of median or stop bar). At some intersections, though, drivers may advance into the intersection while waiting for an adequate gap. At these situations a reasonable positive value for this variable should be considered. Eastbound and westbound approaches of the intersection shown in Figure 5.2 are examples of such situations ($Y_i \approx 20$ feet would be reasonable for these two approaches).

V_w is the width of the design vehicle that can always be fixed at 7 feet, unless the user has a good reason for taking a different value.

X_l is the lateral distance of the left edge of the opposing left-turn vehicle from the left lane strip. This variable is usually between .5 to 2.5 feet depending on the opposing left-turn lane width ($OLTLw$) and the opposing median condition. User should keep it at 1.5 feet unless s/he has a good reason.

X_i is the lateral position of driver's eye from the left lane strip. This variable is usually between 2.5 to 4.5 feet depending on the left-turn lane width and median condition. User should keep it at 3.5 feet unless s/he has a good reason.

Important note: the reference point for measuring $OLTL_w$, X_l, and X_i is the lane strip and not the edge of median.

If RSD > ASD, there is a potential SD problem.

Figure 5.2 Eastbound and westbound approaches: typical locations at which Yi>0

5.1.2 RR Diagrams

The spreadsheet tool, currently, serves to three types of intersection approaches, all with protected/permitted LT signals:
1. Low speed (<45 mph), no sight distance problem
2. Low speed (<45 mph), with sight distance problem
3. High speed (≥45 mph), with sight distance problem

Based on the user input information in the "SD issue" sheet, the tool identifies the intersection type and applies the respective coefficients. If a high speed approach with no sight distance problem was identified, the user will be notified that the research was not conclusive for this approach type and this tool cannot at present be used. Figure 5.3 shows the contents of the RR sheet. Following sections are recognizable:
1. Model parameters: RR beta coefficients which were estimated in Chapter 4 for each approach type. This should not be edited by the user; so they are locked to prevent inadvertent changes.
2. Base condition: The reference turning movement volumes for RR calculations. Higher base volumes result in lower RR and vice versa.
3. Available turning movement counts: Enter the available turning movement counts for the desired approach (in Figure 5.3, for example, these were available for the hours ending at 7, 8, and 9 AM, 12, 1, 4, 5, and 6 PM). If a count is not available for an hour leave that cell blank.

Important note: The opposing volume means the conflicting volumes including those movements to which a left-turn vehicle must yield. So, it usually means through + right turns and occasionally means only through movement. The latter case happens where right turn is channelized by a traffic island and is no longer a conflicting turning movement.

4. 'Run' button: Press this button to run the VBA macro to first compute estimated hourly volumes for the times when turning movement counts are not available. The Macro will also compute the standard deviations associated with these volume estimates.
5. Estimated 24-hour turning movement volumes: the Macro will print 24-hour volumes (including counts and estimates) and their standard deviations to this range of the sheet. Although this part is not a user-input part of the sheet, it cannot be locked (protected). Protecting these sheets will cause a run error because it prevents the Macro from writing into these cells.
6. 24-hour relative risks: Using model parameters from part 1 and volume estimates from part 5, this part automatically computes the relative risk for a left-turn crash occurring in each of the 24 hours of the sample day. It also computes the standard deviation for each RR.
7. RR Contour map: it displays how relative risk of a left-turn crash at this type of intersection approach varies as a function of LT and opposing hourly volumes.
8. 24-hour RR diagram: This is the final product of the tool. It plots the risk for each hour along with a ±1 standard deviation range for the relative risk estimates.

Caution: User must not insert any row or column into the RR sheet. Doing so, will crash the tool because it will make the Macro to read available counts from wrong cells and predict completely wrong volume estimates and finally print them to wrong cell.
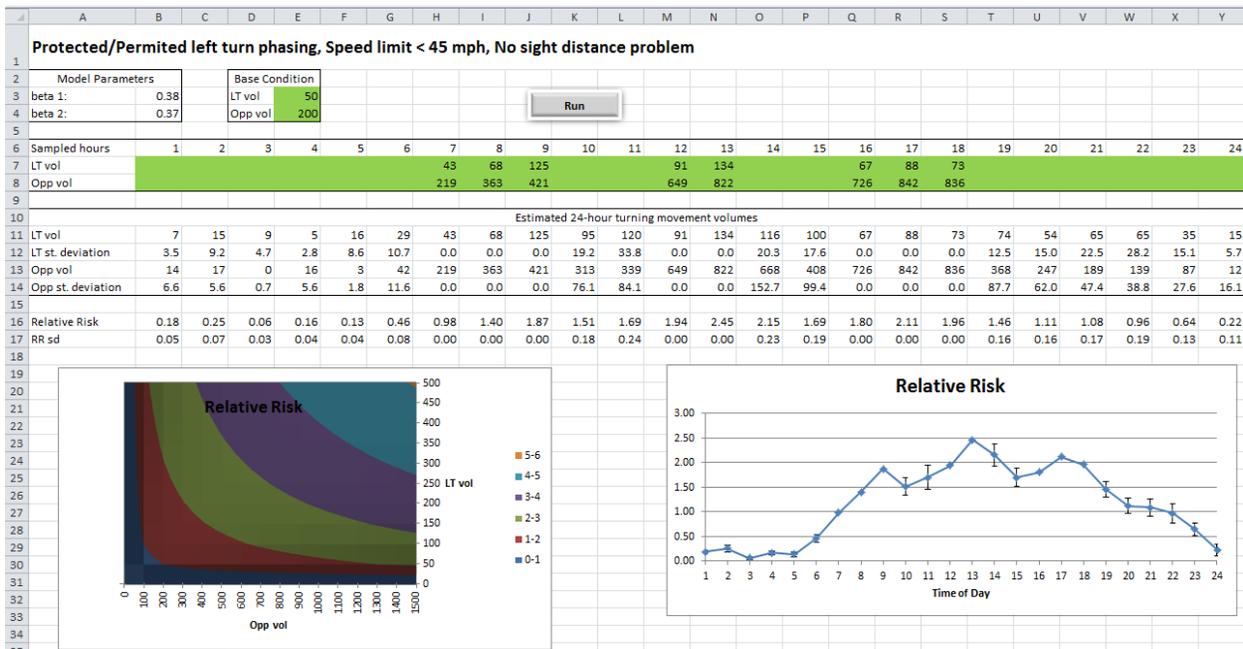

Figure 5.3 Relative risk sheet of the tool.

5.1.3 Supporting Data
The last three sheets of the tool contain information to support Macro program and contour diagrams. Users normally do not need to edit or even look at the information in these sheets; therefore, they are protected with the password "DavisMoshtagh".