Intersection Volume Balancing Tool
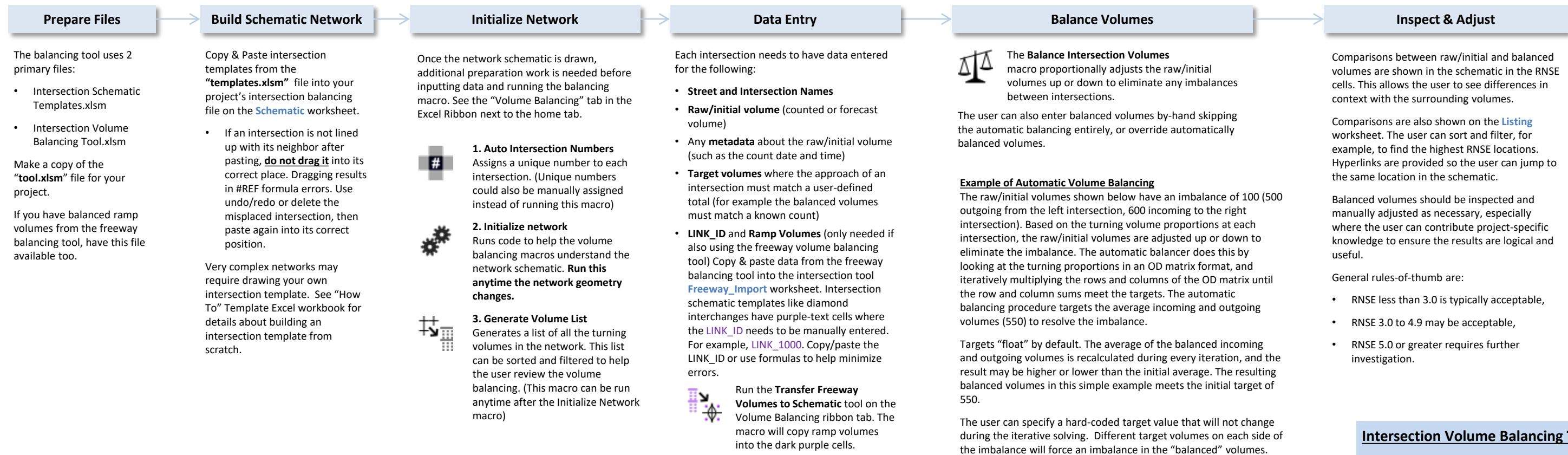
Using the intersection volume balancing tool generally follows this workflow:

| Prepare Files | → | Build Schematic Network | → | Initialize Network | → | Data Entry | → | Balance Volumes | → | Inspect & Adjust |

Prepare Files

The balancing tool uses 2 primary files:

- Intersection Schematic Templates.xlsm
- Intersection Volume Balancing Tool.xlsm

Make a copy of the "**tool.xlsm**" file for your project.

If you have balanced ramp volumes from the freeway balancing tool, have this file available too.

Build Schematic Network

Copy & Paste intersection templates from the "**templates.xlsm**" file into your project's intersection balancing file on the **Schematic** worksheet.

- If an intersection is not lined up with its neighbor after pasting, **do not drag it** into its correct place. Dragging results in #REF formula errors. Use undo/redo or delete the misplaced intersection, then paste again into its correct position.

Very complex networks may require drawing your own intersection template. See "How To" Template Excel workbook for details about building an intersection template from scratch.

Initialize Network

Once the network schematic is drawn, additional preparation work is needed before inputting data and running the balancing macro. See the "Volume Balancing" tab in the Excel Ribbon next to the home tab.

1. Auto Intersection Numbers
Assigns a unique number to each intersection. (Unique numbers could also be manually assigned instead of running this macro)

2. Initialize network
Runs code to help the volume balancing macros understand the network schematic. **Run this anytime the network geometry changes.**

3. Generate Volume List
Generates a list of all the turning volumes in the network. This list can be sorted and filtered to help the user review the volume balancing. (This macro can be run anytime after the Initialize Network macro)

Data Entry

Each intersection needs to have data entered for the following:

- **Street and Intersection Names**
- **Raw/initial volume** (counted or forecast volume)
- Any **metadata** about the raw/initial volume (such as the count date and time)
- **Target volumes** where the approach of an intersection must match a user-defined total (for example the balanced volumes must match a known count)
- **LINK_ID** and **Ramp Volumes** (only needed if also using the freeway volume balancing tool) Copy & paste data from the freeway balancing tool into the intersection tool **Freeway_Import** worksheet. Intersection schematic templates like diamond interchanges have purple-text cells where the LINK_ID needs to be manually entered. For example, LINK_1000. Copy/paste the LINK_ID or use formulas to help minimize errors.

Run the **Transfer Freeway Volumes to Schematic** tool on the Volume Balancing ribbon tab. The macro will copy ramp volumes into the dark purple cells.

Balance Volumes

The **Balance Intersection Volumes** macro proportionally adjusts the raw/initial volumes up or down to eliminate any imbalances between intersections.

The user can also enter balanced volumes by-hand skipping the automatic balancing entirely, or override automatically balanced volumes.

Example of Automatic Volume Balancing

The raw/initial volumes shown below have an imbalance of 100 (500 outgoing from the left intersection, 600 incoming to the right intersection). Based on the turning volume proportions at each intersection, the raw/initial volumes are adjusted up or down to eliminate the imbalance. The automatic balancer does this by looking at the turning proportions in an OD matrix format, and iteratively multiplying the rows and columns of the OD matrix until the row and column sums meet the targets. The automatic balancing procedure targets the average incoming and outgoing volumes (550) to resolve the imbalance.

Targets "float" by default. The average of the balanced incoming and outgoing volumes is recalculated during every iteration, and the result may be higher or lower than the initial average. The resulting balanced volumes in this simple example meets the initial target of 550.

The user can specify a hard-coded target value that will not change during the iterative solving. Different target volumes on each side of the imbalance will force an imbalance in the "balanced" volumes.

Inspect & Adjust

Comparisons between raw/initial and balanced volumes are shown in the schematic in the RNSE cells. This allows the user to see differences in context with the surrounding volumes.

Comparisons are also shown on the **Listing** worksheet. The user can sort and filter, for example, to find the highest RNSE locations. Hyperlinks are provided so the user can jump to the same location in the schematic.

Balanced volumes should be inspected and manually adjusted as necessary, especially where the user can contribute project-specific knowledge to ensure the results are logical and useful.

General rules-of-thumb are:

- RNSE less than 3.0 is typically acceptable,
- RNSE 3.0 to 4.9 may be acceptable,
- RNSE 5.0 or greater requires further investigation.

Example Intersection Template: 4-leg intersection

Volume Cell Colors

Raw/initial (grey)	LINK_ID (purple text, no cell shading)
Balanced (blue)	Ramp Volume for LINK_ID
Target	Imbalance to next intersection

Name and information about the intersection

Each approach shows the raw/initial, balanced, RNSE difference, and turning % proportion for each turning movement.

"Local OD Raw" – lists the raw/initial turning movements in OD format. (This data is needed for the automatic volume balancing macro)

"Local OD Estimated" – lists the balanced turning movements in OD format that were generated by the automatic volume balancing macro.

Raw/Initial Volumes
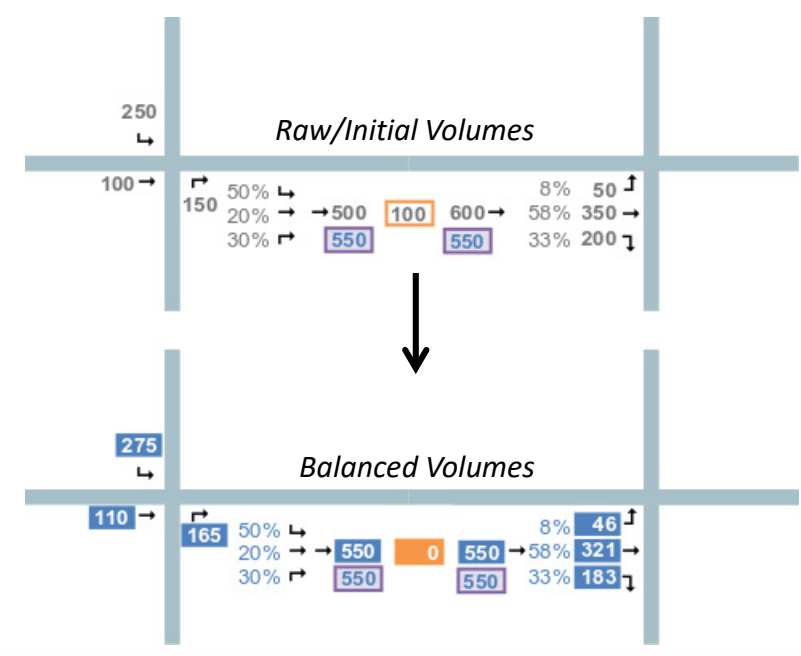
Balanced Volumes

Intersection Volume Balancing Tips

- The automatic balancer targets the average imbalance as an initial guess to avoid over or under estimating traffic volumes, and to avoid propagating imbalances throughout the network. The user should carefully inspect and adjust locations of trusted count locations, by directly specifying targets and/or balanced volumes.
- Multiple successive runs of the automatic balancing procedure generally does not improve upon the balanced solution, and in some cases can make the final solution worse. Manual balancing may be required.
- The output of the automatic balancing may leave small imbalances due to rounding. Output volumes would need to be manually adjusted to create zero imbalance throughout the network.

Dealing with Driveways

- The Intersection Schematic Template file contains a **Driveways** worksheet with cells that can be copied/pasted in your network. Local OD matrices may need to be moved first to make room for the driveway cells. The driveway cells include a comment that explains how to link the cells together in the network.
- If the raw/initial imbalance appears reasonable for the driveway, the targets can be fixed by directly overriding the target volume with the raw/initial volume on either side of the driveway.

- If the raw/initial imbalance does not appear reasonable, the user can override the targets on either side of the driveway to create a user-specified imbalance. The automatic balancing could also be run as if there was no driveway, then the user could adjust targets to define an imbalance, and re-run the automatic balancing macro.
- If the driveway will be included as an intersection in a traffic simulation, consider including an intersection for the driveway in the balancing schematic.