

Exercise I - Excel

Part 2 – Power View with Loop Detector Data

CEE412/CET 522 Transportation Data Management and Visualization

Winter 2020

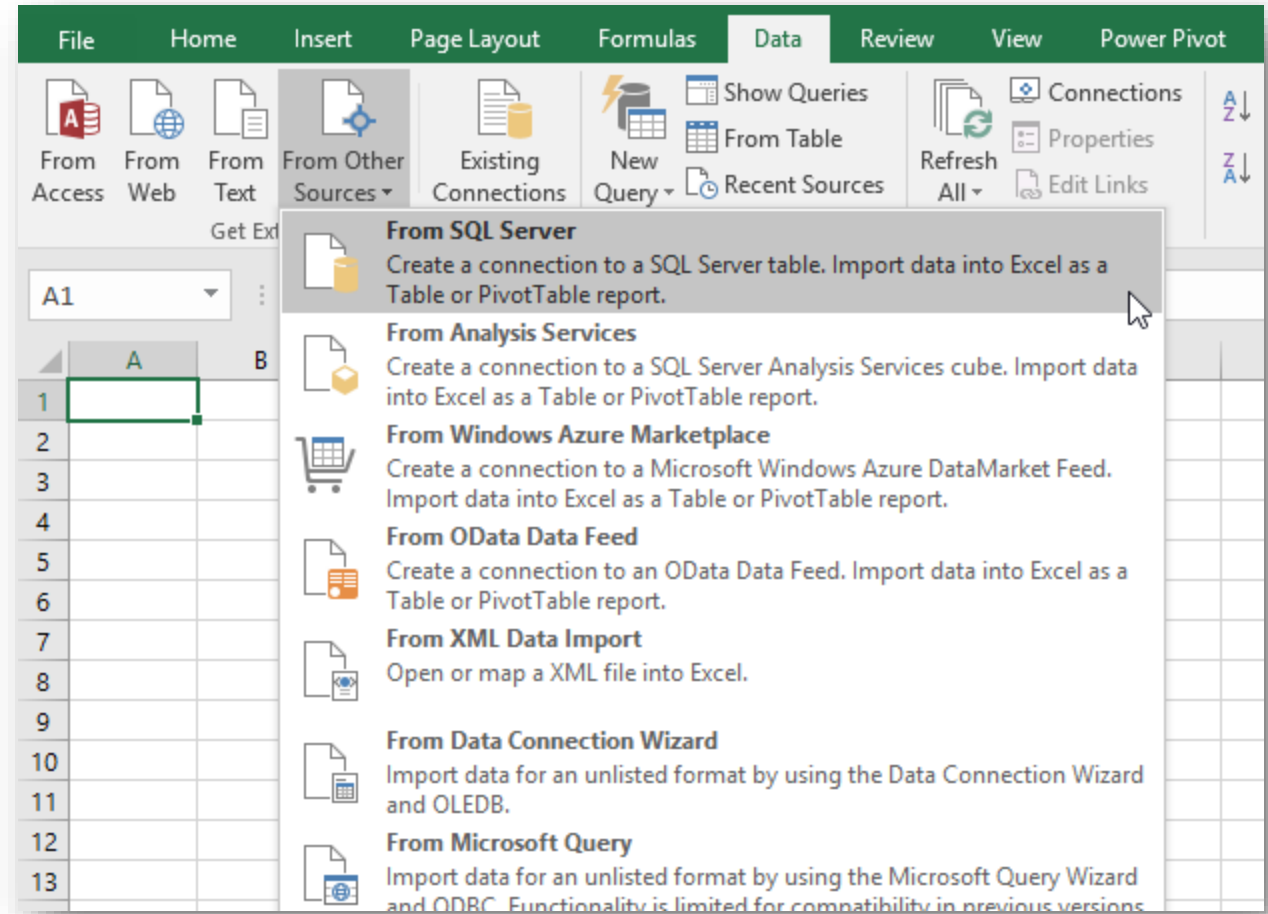


Overview

- In this exercise we will look at freeway loop detector data along Interstate 5 in North Seattle.
- In this case, even though we have data describing a single corridor and travel direction over 1 month, the dataset is far too large to be opened in Excel without PowerPivot.
- Instead of accessing the data as a downloadable file, you will connect directly to SQL server and extract the data yourself.
- We will use maps in Power View to visualize the loop detector locations, and other visualization tools to summarize various aspects of the data we are interested in.

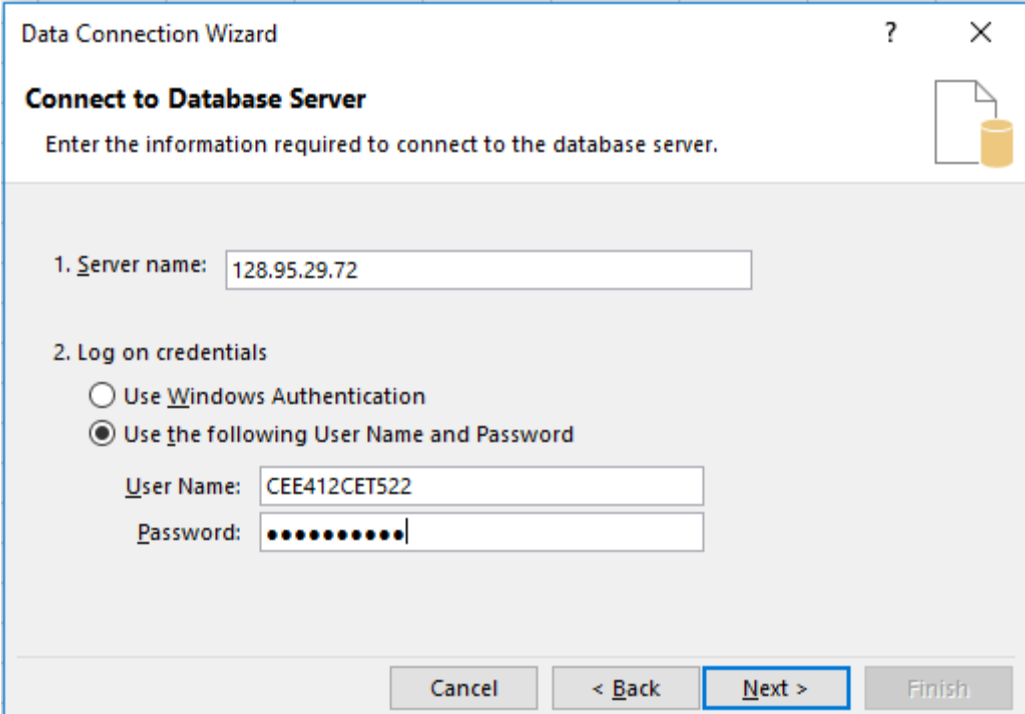
Step 1: Connect to a Data Source

- SQL Server is a database management software from Microsoft, and Excel has built-in tools to obtain data directly from this and other sources. We will learn a lot about SQL server later, for now we will just use to as a data source without further discussion.
- Under the **Data** tab, click **Get External Data** → **From Other Sources** → **From SQL Server** as shown.



Step 1: Connect to a Data Source

- In the resulting window, use the Server Name 128.95.29.72. This is the IP address of the server you are connecting to.
- Fill out the fields as shown, after selecting “Use the following name and password”.
- The user name is “CEE412CET522”, and the password is “2020Winter” (case sensitive).
- Click **Next**.



The screenshot shows a 'Data Connection Wizard' window with the title 'Connect to Database Server'. The instruction says 'Enter the information required to connect to the database server.' The window contains two main sections: '1. Server name:' with a text box containing '128.95.29.72', and '2. Log on credentials' with two radio button options. The first option is 'Use Windows Authentication' (unselected), and the second is 'Use the following User Name and Password' (selected). Below the second option are two text boxes: 'User Name:' containing 'CEE412CET522' and 'Password:' containing a masked password of 12 dots. At the bottom right, there are four buttons: 'Cancel', '< Back', 'Next >' (which is highlighted with a blue border), and 'Finish'.

Step 1: Connect to a Data Source

- You will see a number of tables that are available to this user account, only two of which are needed for this assignment. Make sure that **CEE412_CET522_W20** is the selected data base here.
- Click **Enable Selection of multiple tables** here.
- Now, in the table selection window, make sure that only the tables named “E1_STcabinets” and “E1_STloopdat” are selected as shown here.
- Uncheck the **Import relationships between selected tables** check box here.
- Click **Next**.

Data Connection Wizard

Select Database and Table

Select the Database and Table/Cube which contains the data you want.

Select the database that contains the data you want:

CEE412_CET522_W20

☒ Connect to a specific table:

☒ Enable selection of multiple tables

| Name | Owner | Description | Modified | Created | Type |
|---|-------|-------------|----------|---------------------|-------|
| <input checked="" type="checkbox"/> E1_STcabinets | dbo | | | 1/9/2020 2:24:04 PM | TABLE |
| <input checked="" type="checkbox"/> E1_STloopdat | dbo | | | 1/9/2020 2:24:04 PM | TABLE |

☒ Import relationships between selected tables

Select Related Tables

Cancel < Back **Next >** Finish

Step 1: Connect to a Data Source

- In the resulting dialog box, change the field **Friendly Name** to something that makes sense to you, here I use “Cabinets and loops”. You can add some descriptive information in the Description box, but this is not critical.
- Check the box **Save password in file** here.
- You will probably get a warning about unencrypted password storage, but it should not be a problem if you do not share your file with anyone. In any case, this account has very limited privileges, and so it is not a serious concern. Click **Yes**.
- Click **Finish** to complete the connection.

Data Connection Wizard

Save Data Connection File and Finish

Enter a name and description for your new Data Connection file, and press Finish to save.

File Name: 128.95.204.131 CEE412_W17 Multiple Tables.odc Browse...

☒ Save password in file

Description: Connecting to tables containing information about cabinets and loop data in a month of 2011.

Friendly Name: Cabinets and loops

Search Keywords:

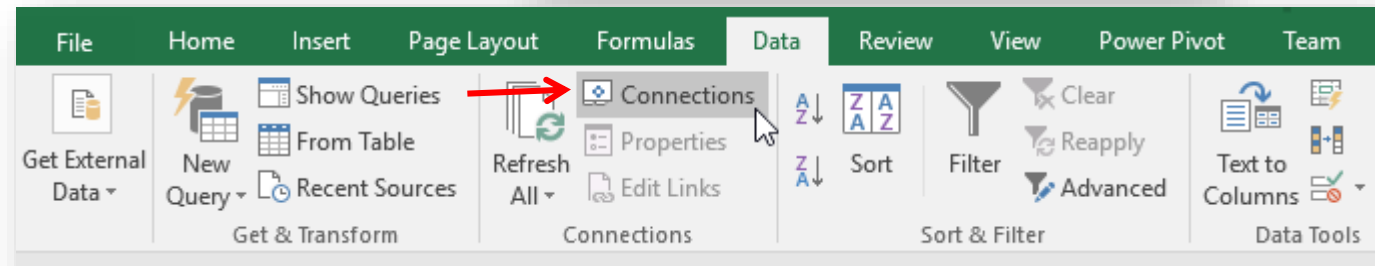
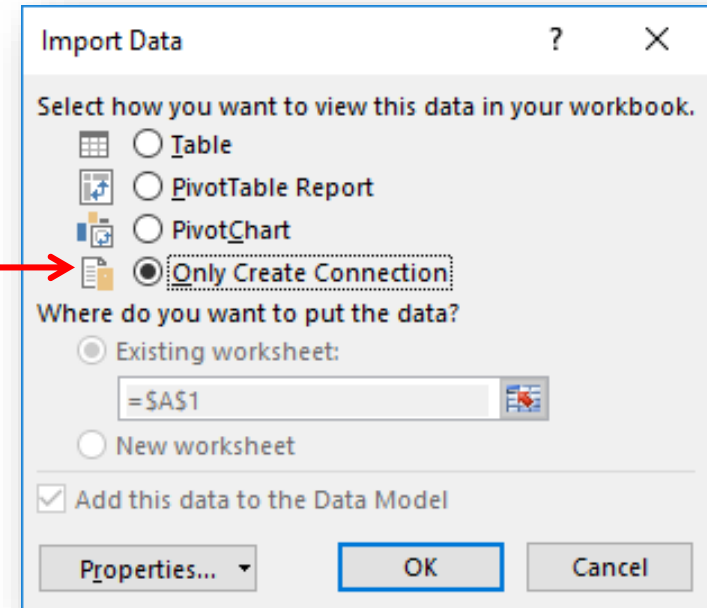
☐ Always attempt to use this file to refresh data

Excel Services: Authentication Settings...

Cancel < Back Next > Finish

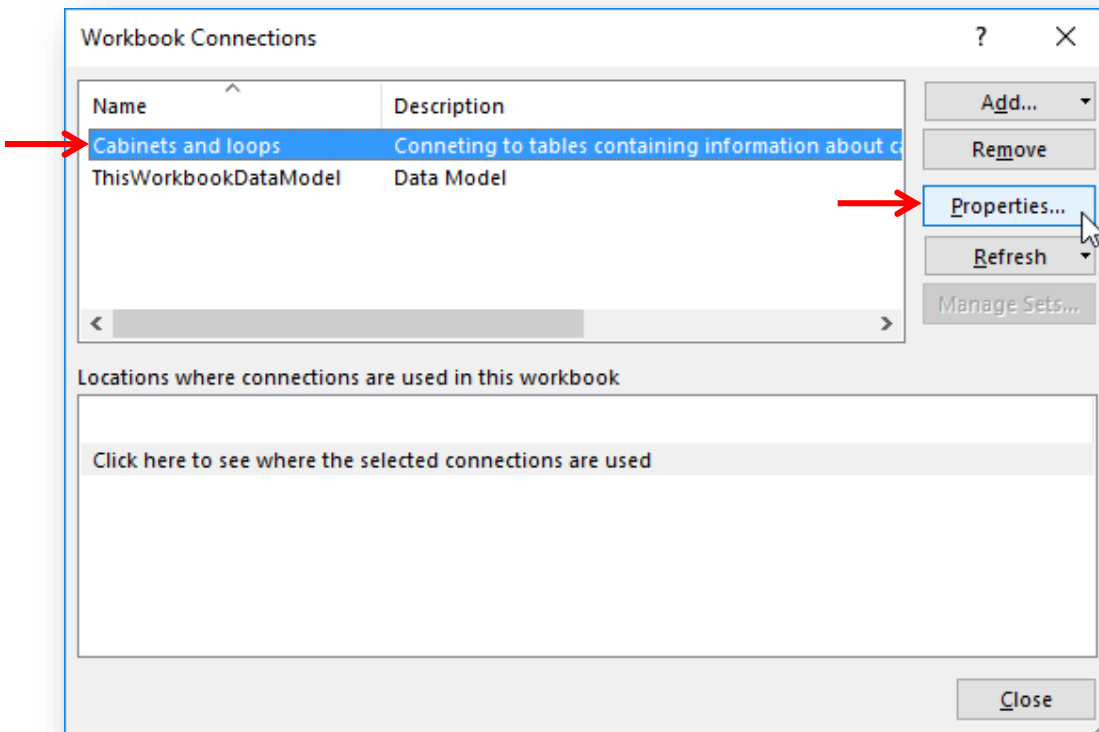
Step 1: Connect to a Data Source

- In the resulting dialog box, select **Only Create Connection** as shown on the right. Click **OK**.
- Your sheet may take a few minutes to retrieve the data, when it is finished we can proceed.
- Next we want to set the refresh interval for your connection. Basically, you need to tell Excel how often it should refresh the data from the source. If it is too frequent, Excel will run slow because it will constantly be trying to re-query the data from SQL Server.
- In Excel main window, Click **Data** → **Connections** as shown.

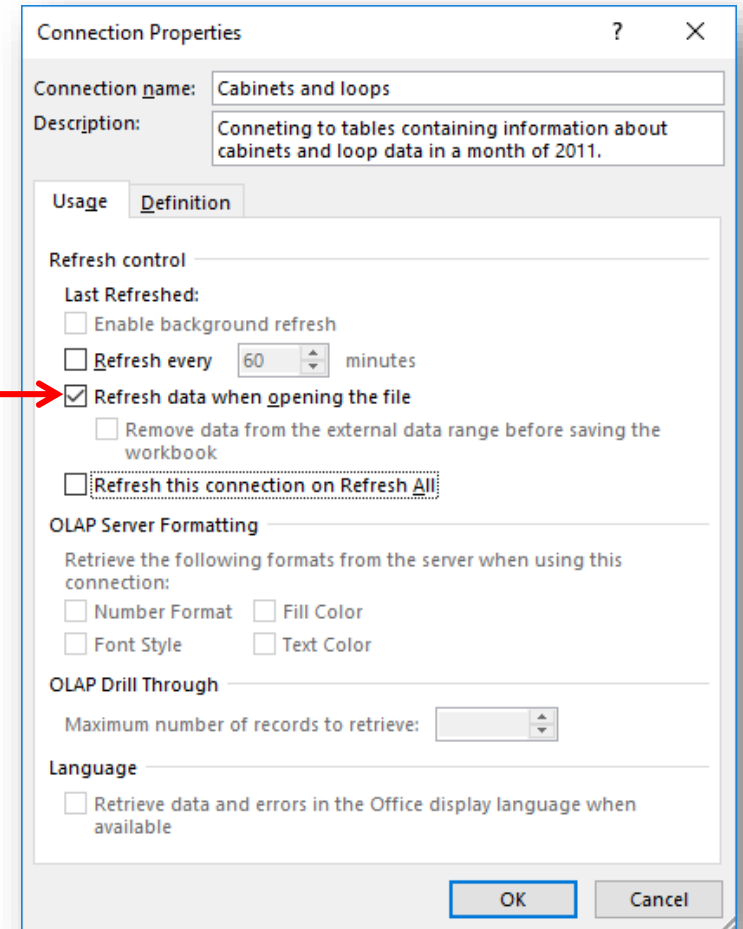


Step 1: Connect to a Data Source

- In the Workbook Connections window, select the data source you just created, and then click **Properties**.



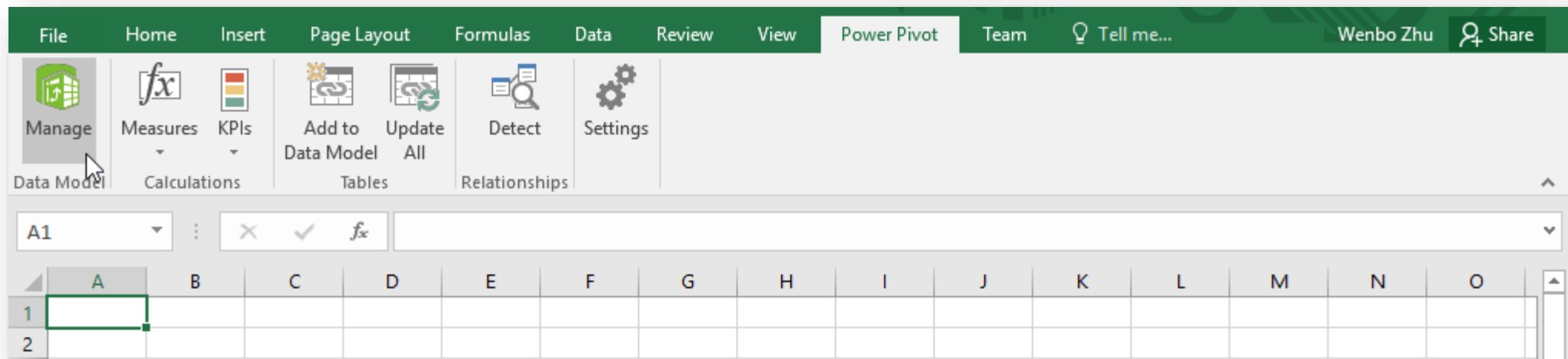
- In the Connection Properties window, select **Refresh data when opening the file** as shown on the right. Make sure no other refresh control boxes are selected, then click **OK**.



- Close the Workbook Connections window.

Step 2: Look at the Data

- Due to the data size, you will not be able to view the data tables in Excel spreadsheets.
- However, it is possible to view the data tables in the Power Pivot window because of its ability to handle large data sets.
- Under **Power Pivot** tab, click **Manage** to open the Power Pivot window. You will see the two tables you just extracted from the SQL server.
- The data will be illustrated on the next two slides for you information.



Step 2: Look at the Data

- E1_STcabinets table: a table of loop detector descriptions (including location).
- We are only concerned with several key fields, including ID (a unique id number for the sensor that recorded this data), Latitude, Longitude, and Milepost.

| | CabName | UnitType | ID | Latitude | Longitude | Route | Milepost | direction | UnitName | isHOV | isM... | isDu... | isRe... | isAu... | isCo... |
|----|------------|----------|------|----------|-----------|-------|----------|-----------|----------------|-------|--------|---------|---------|---------|---------|
| 1 | 005es16512 | station | 7527 | 47.6019 | -122.3247 | 005 | 165.12 | N | 005es16512:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 2 | 005es16551 | station | 8111 | 47.6067 | -122.3294 | 005 | 165.51 | N | 005es16551:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 3 | 005es16704 | station | 8007 | 47.6283 | -122.3276 | 005 | 167.04 | N | 005es16704:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 4 | 005es16732 | station | 7896 | 47.6317 | -122.3245 | 005 | 167.32 | N | 005es16732:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 5 | 005es16756 | station | 7545 | 47.6349 | -122.3236 | 005 | 167.56 | N | 005es16756:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 6 | 005es16802 | station | 7892 | 47.6417 | -122.3233 | 005 | 168.02 | N | 005es16802:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 7 | 005es16831 | station | 7294 | 47.646 | -122.3224 | 005 | 168.31 | N | 005es16831:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 8 | 005es16885 | station | 8021 | 47.6538 | -122.3226 | 005 | 168.85 | N | 005es16885:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 9 | 005es16920 | station | 7964 | 47.6587 | -122.3221 | 005 | 169.2 | N | 005es16920:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 10 | 005es17025 | station | 7478 | 47.6743 | -122.3208 | 005 | 170.25 | N | 005es17025:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 11 | 005es17130 | station | 7777 | 47.6877 | -122.3277 | 005 | 171.3 | N | 005es17130:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 12 | 005es17215 | station | 7997 | 47.6998 | -122.3292 | 005 | 172.15 | N | 005es17215:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |
| 13 | 005es17254 | station | 7222 | 47.7057 | -122.32 | 005 | 172.54 | N | 005es17254:... | FALSE | FALSE | FALSE | FALSE | FALSE | FALSE |

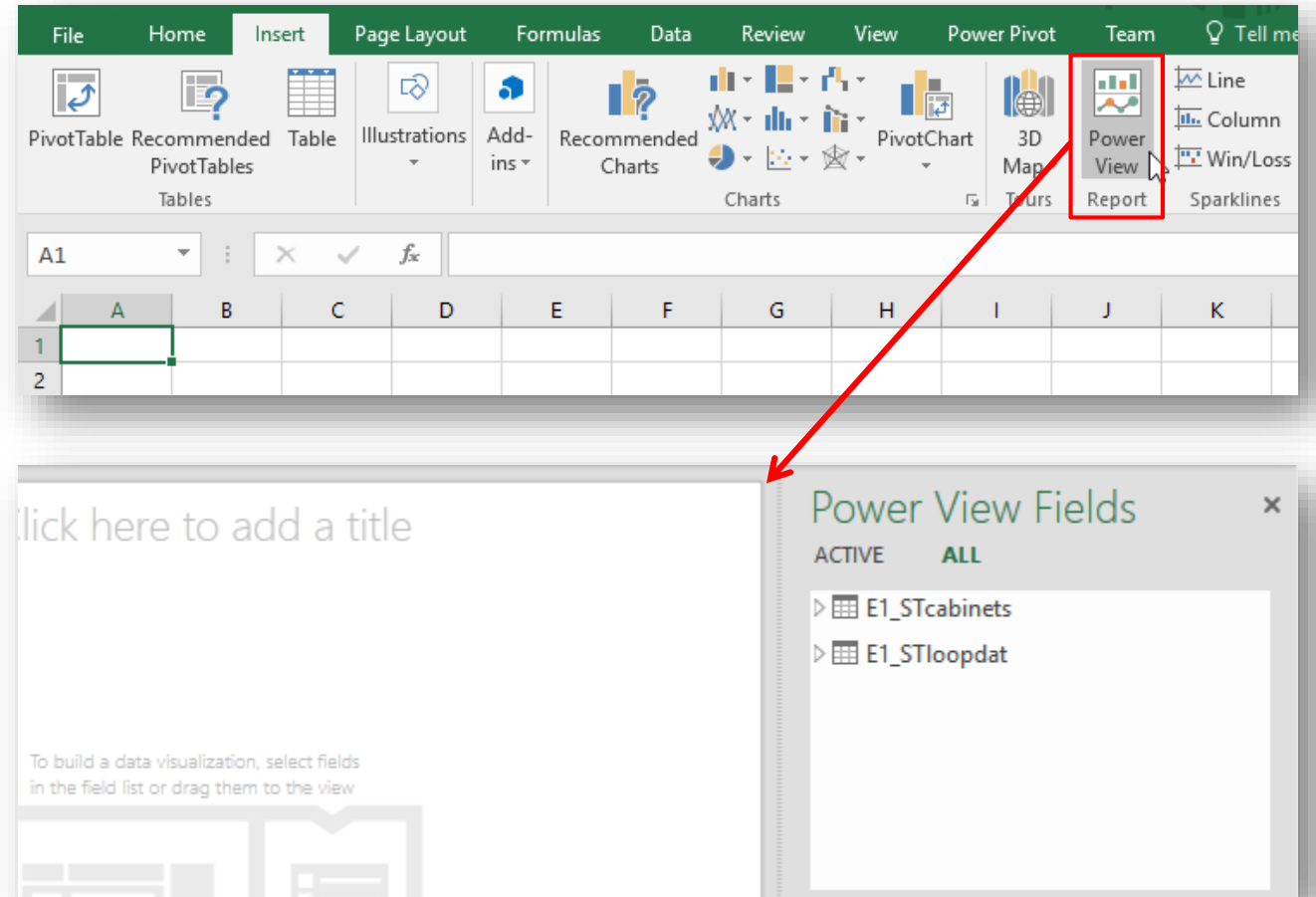
Step 2: Look at the Data

- E1_STloopdat table: a table of traffic data reported by loop detectors
- We are only concerned with LoopID (a unique id number for the sensor that recorded this data), HOUR, DATE, VOLUME (20-second vehicle count), and SPEED (speed in miles per hour)

| | LOOPID | STAMP | HOUR | DATE | INCIDENT | DATA | FLAG | VOLUME | SCAN | SPEED |
|--------|--------|-----------------------|------|-----------|----------|------|------|--------|------|-------------|
| 776104 | 7478 | 5/28/2011 10:47:00 AM | 10 | 2011-0... | 0 | 4 | 0 | 43 | 164 | 72.83197... |
| 776105 | 7478 | 5/28/2011 10:47:40 AM | 10 | 2011-0... | 0 | 4 | 0 | 13 | 43 | 83.97932... |
| 776106 | 7478 | 5/28/2011 10:49:00 AM | 10 | 2011-0... | 0 | 4 | 0 | 44 | 169 | 72.32084... |
| 776107 | 7478 | 5/28/2011 10:53:00 AM | 10 | 2011-0... | 0 | 4 | 0 | 48 | 198 | 67.34006... |
| 776108 | 7478 | 5/7/2011 10:02:00 AM | 10 | 2011-0... | 0 | 4 | 0 | 44 | 162 | 75.44581... |
| 776109 | 7478 | 5/7/2011 10:04:20 AM | 10 | 2011-0... | 0 | 4 | 0 | 13 | 48 | 75.23148... |
| 776110 | 7478 | 5/7/2011 10:09:40 AM | 10 | 2011-0... | 0 | 4 | 0 | 13 | 47 | 76.83215... |
| 776111 | 7478 | 5/7/2011 10:12:00 AM | 10 | 2011-0... | 0 | 4 | 0 | 46 | 177 | 72.19083... |
| 776112 | 7478 | 5/7/2011 10:17:00 AM | 10 | 2011-0... | 0 | 4 | 0 | 45 | 170 | 73.52941... |
| 776113 | 7478 | 5/7/2011 10:25:00 AM | 10 | 2011-0... | 0 | 4 | 0 | 49 | 176 | 77.33585... |
| 776114 | 7478 | 5/4/2011 10:06:20 AM | 10 | 2011-0... | 0 | 4 | 0 | 15 | 80 | 52.08333... |
| 776115 | 7478 | 5/4/2011 10:09:40 AM | 10 | 2011-0... | 0 | 4 | 0 | 18 | 98 | 51.02040... |
| 776116 | 7478 | 5/4/2011 10:13:40 AM | 10 | 2011-0... | 0 | 4 | 0 | 43 | 199 | 60.02233... |

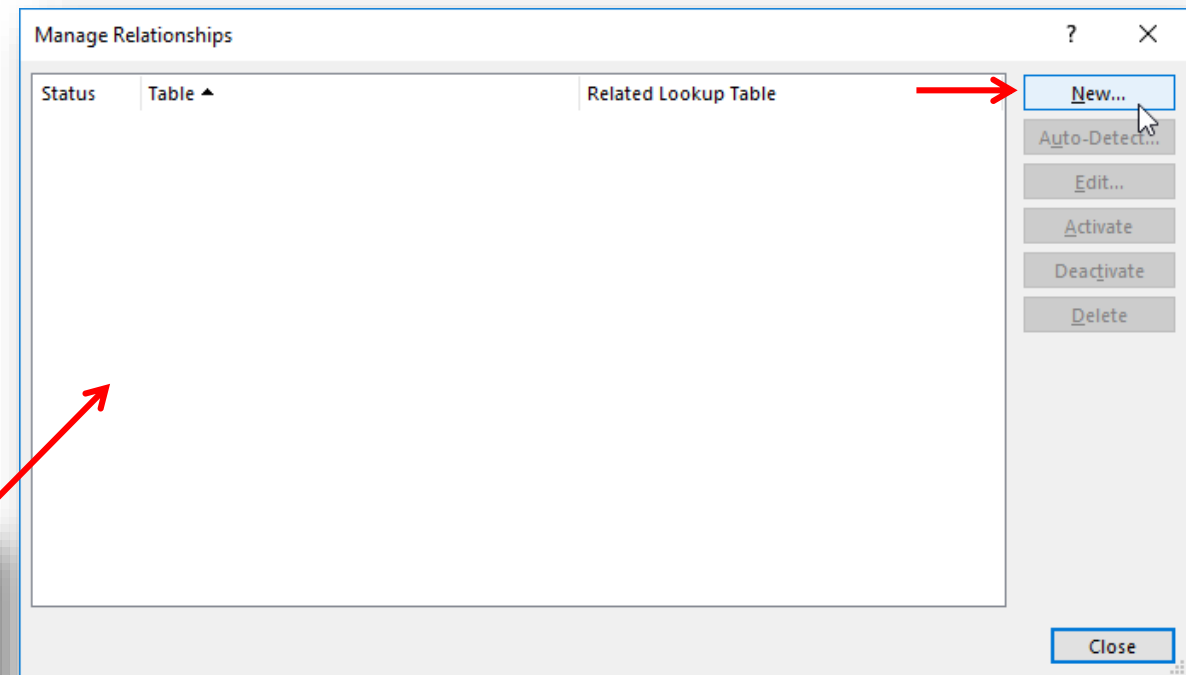
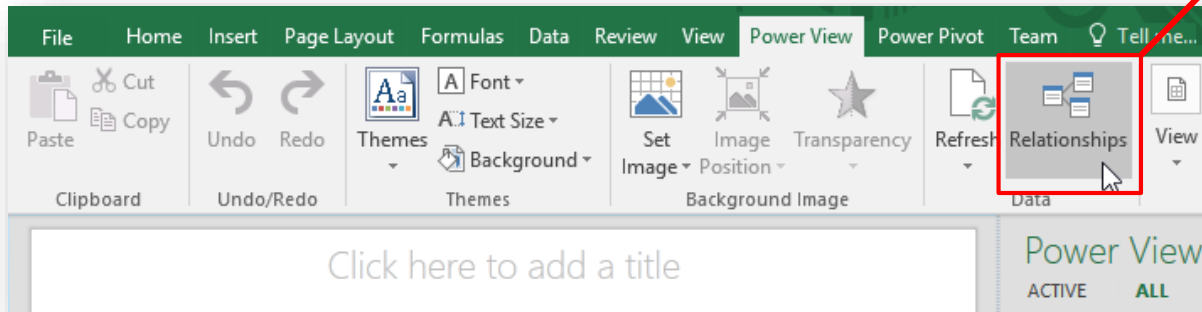
Step 3: Create Relationship

- Close the Power Pivot window, and create a Power View Report just as we did in the accidents example. Click **Insert** → **Power View** as shown.
- You should have following two tables in your datamodel: E1_STcabinets and E1_STloopdat.
- Now, we need to create a relationship between the two tables so that each observation in STloopdat can be associated with a location in the STcabinets table.



Step 3: Create Relationship

- Recall that in the last exercise, we created a relationship in the Power Pivot diagram view.
- You can create the relationship here in the same way. But in this exercise we will go through an alternative step that creates the relationship directly in Power View.
- Under the **Power View** tab, click **Relationships** to open the Relationship Manager window.
- Click **New...** to create a new relationship.



Step 3: Create Relationship

- In the Create Relationship window, fill out the fields as shown.
- The LOOPID field in the E1_STloopdat table is the same value as the ID field in the E1_STcabinets table, and can be used to establish the relationship.
- Note that E1_STcabinets must be the Related table, associated with the Primary related column. This is because ID is unique in all rows of the E1_STcabinets table, which is not the case for LOOPID in the E1_STloopdat table.
- Click **OK** and then close the relationship manager when finished.

Make sure the
order is correct

Create Relationship

Pick the tables and columns you want to use for this relationship

| | | | |
|----------------|---------------|---------------------------|--------|
| Table: | E1_STloopdat | Column (Foreign): | LOOPID |
| Related Table: | E1_STcabinets | Related Column (Primary): | ID |

Creating relationships between tables is necessary to show related data from different tables on the same report.

OK Cancel

Step 4: Create a Map

- Start create Power View plot by adding fields from the tables.
- Add the CabName, Latitude, and Longitude fields from the E1_STcabinets table, and make sure they are set to **Do Not Summarize** as shown.
- You can then add the HOUR and VOLUME fields from the E1_STloopdat table. Make sure that HOUR is set to **Do Not Summarize** and that VOLUME is set to **Sum** as shown.
- If you get an error displaying the table, this is because the relationship has not been activated.
- Click **Power View** → **Refresh** → **Refresh All** to refresh your data model and activate the relationship.

The screenshot shows the 'Power View Fields' pane with the following details:

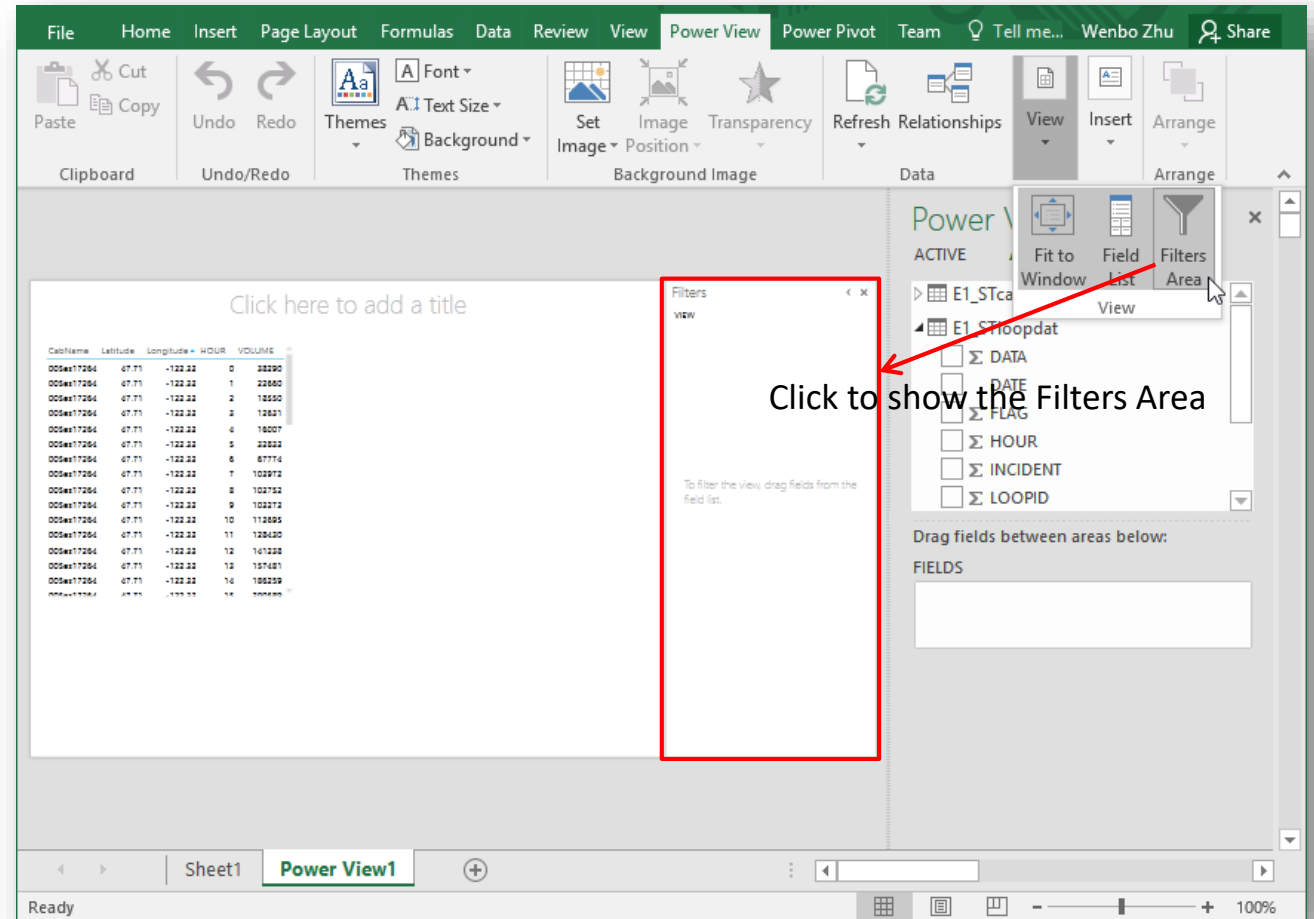
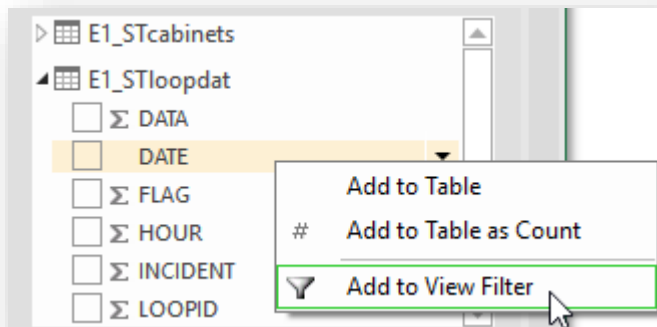
- Relationships:** A yellow box highlights the message 'Relationships between tables may be needed.' with a 'CREATE...' button. A red arrow points from this box to the 'Refresh All' button in the 'Power View' ribbon.
- Fields List:**
 - ☐ Σ LOOPID
 - ☐ Σ SCAN
 - ☐ Σ SPEED
 - ☐ STAMP
 - ☒ Σ VOLUME
- Drag fields between areas below:**
 - TILE BY:** (Empty)
 - FIELDS:**
 - CabName
 - Latitude
 - Longitude
 - HOUR
 - Σ VOLUME

Two context menus are shown with red arrows pointing to them:

- Left Context Menu (for CabName, Latitude, Longitude):**
 - Remove Field
 - Do Not Summarize
 - ☒ Sum
 - Average
 - Minimum
 - Maximum
 - Count (Not Blank)
 - Count (Distinct)
- Right Context Menu (for HOUR, Σ VOLUME):**
 - Remove Field
 - ☒ Do Not Summarize
 - Sum
 - Average
 - Minimum
 - Maximum
 - Count (Not Blank)
 - Count (Distinct)
 - Show items with no data

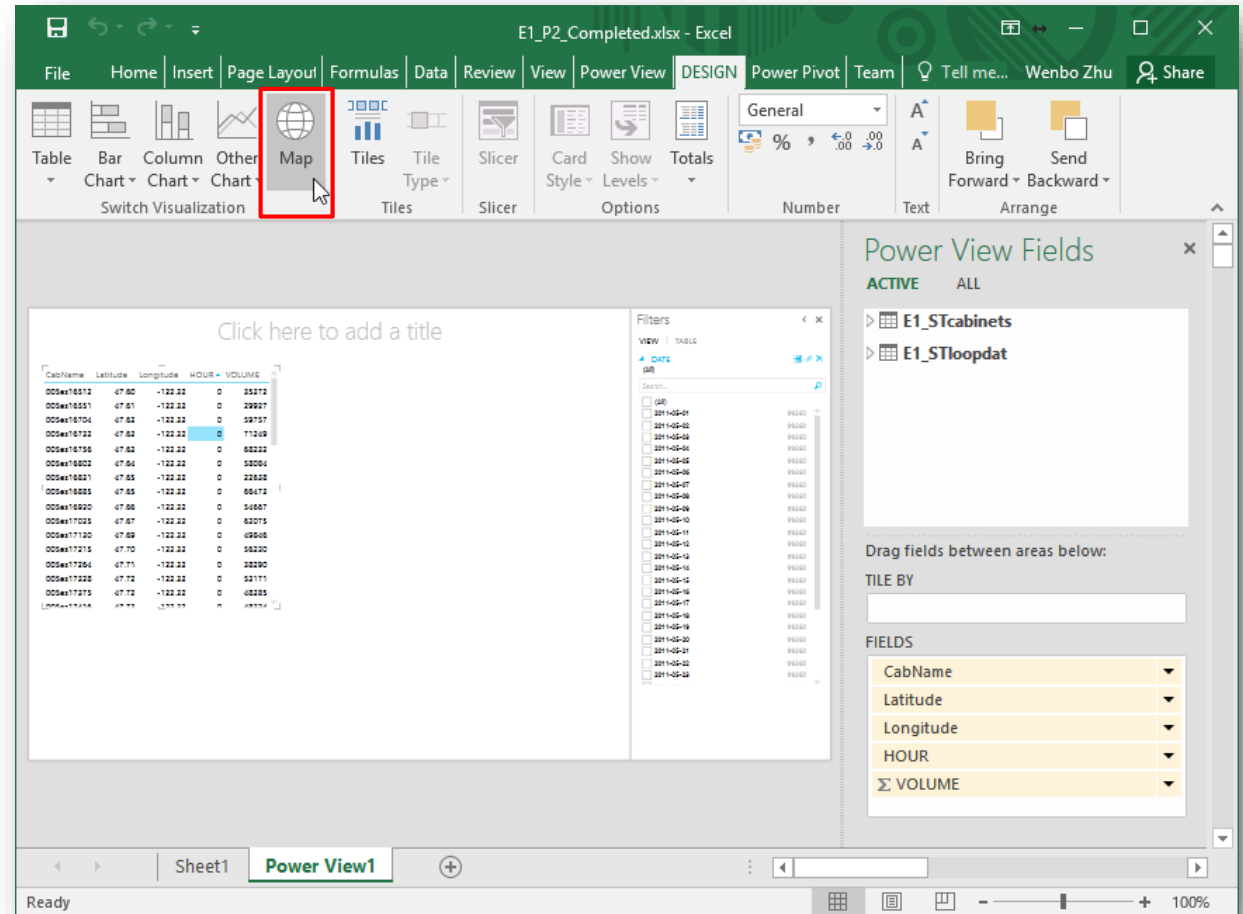
Step 4: Create a Map

- Next we want to add the DATE field as a filter of the report.
- Make sure your filters area is shown. If not, click **Power** → **View** → **Filters Area** to show it.
- In the Field List, right click on the DATE field in the E1_STloopdat table and click **Add to View Filter** as shown below.



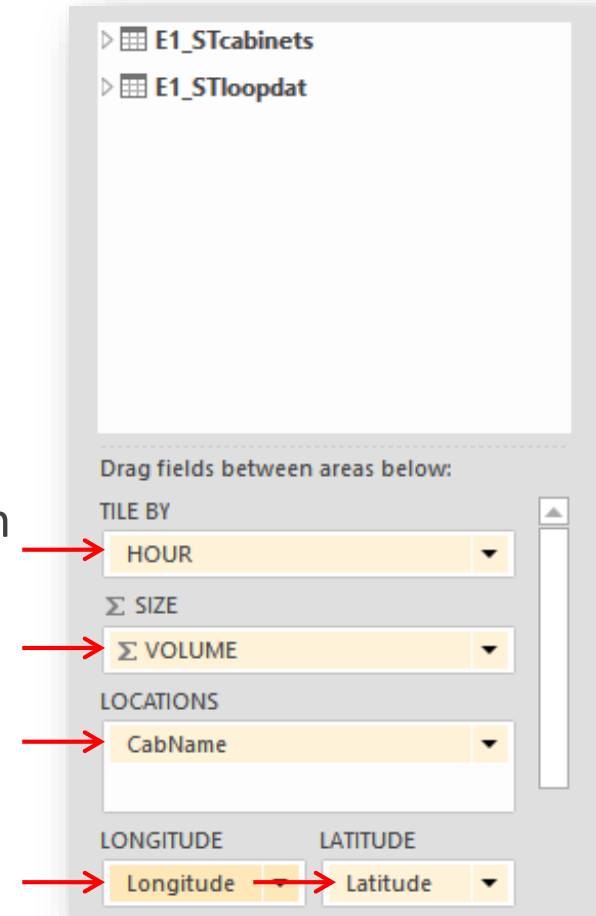
Step 4: Create a Map

- To add a map of your loop data, click inside the newly created table, and then click **Design** → **Map** as shown.
- Most likely your map will not come out as you planned, we will apply some changes to make it display right (next slide).



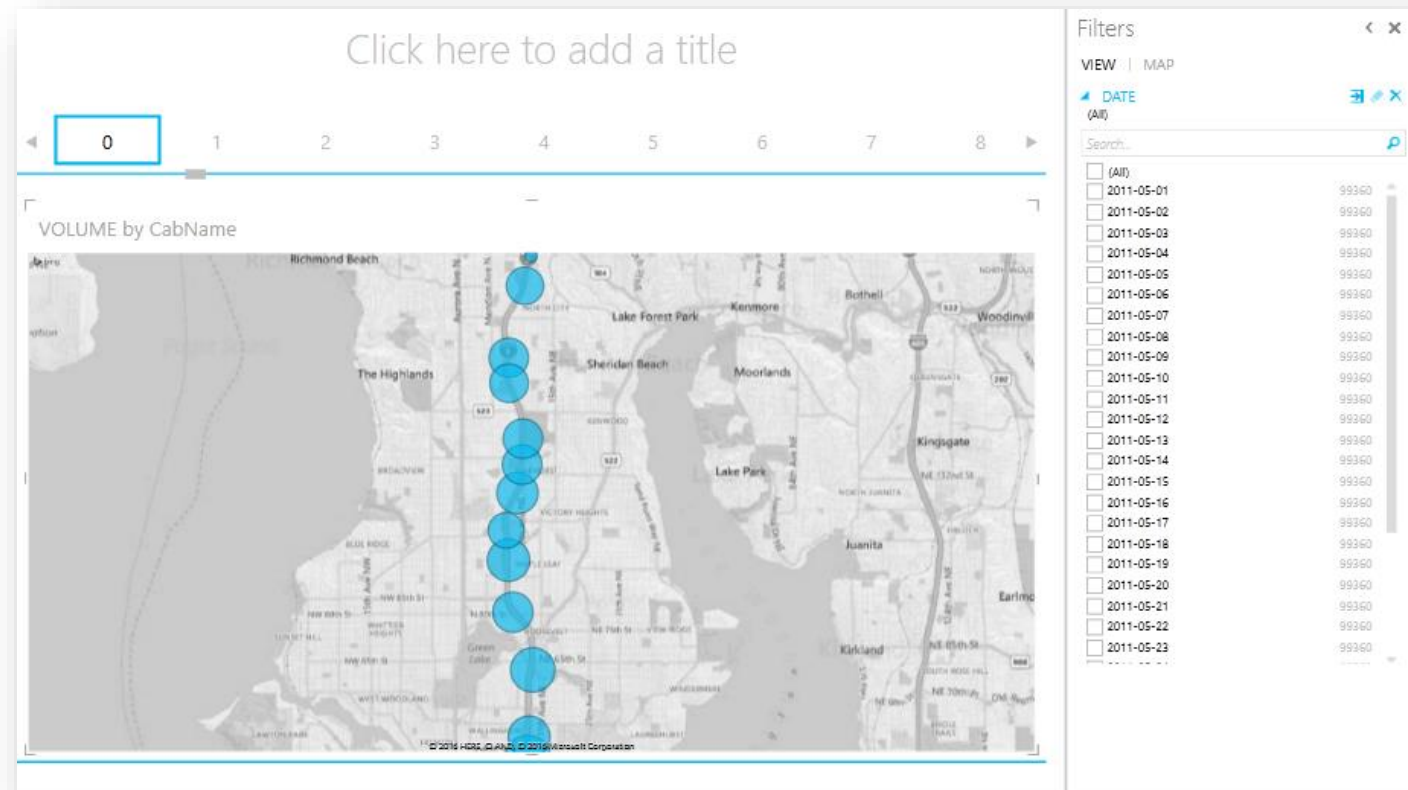
Step 5: Format Map

- Start by moving the CabName field to the LOCATIONS area. Next, move Sum of VOLUME to the SIZE area, and HOUR to the TILE BY area. Latitude and Longitude should be assigned to LATITUDE and LONGITUDE automatically. This is illustrated on the right.
- What we are doing is: each unique CabName should be associated with a single location, so this is the location field. The size of the symbols on the map will be the sum VOLUME over each unique combination of HOUR and CabName. The HOUR field will show up as a selectable set of buttons at the top of the map, so that we can look at the sum hourly volume for each hour individually.
- The DATE field is not visible in the Power View Field List, instead it is present in the Filters area of the Power View Report.



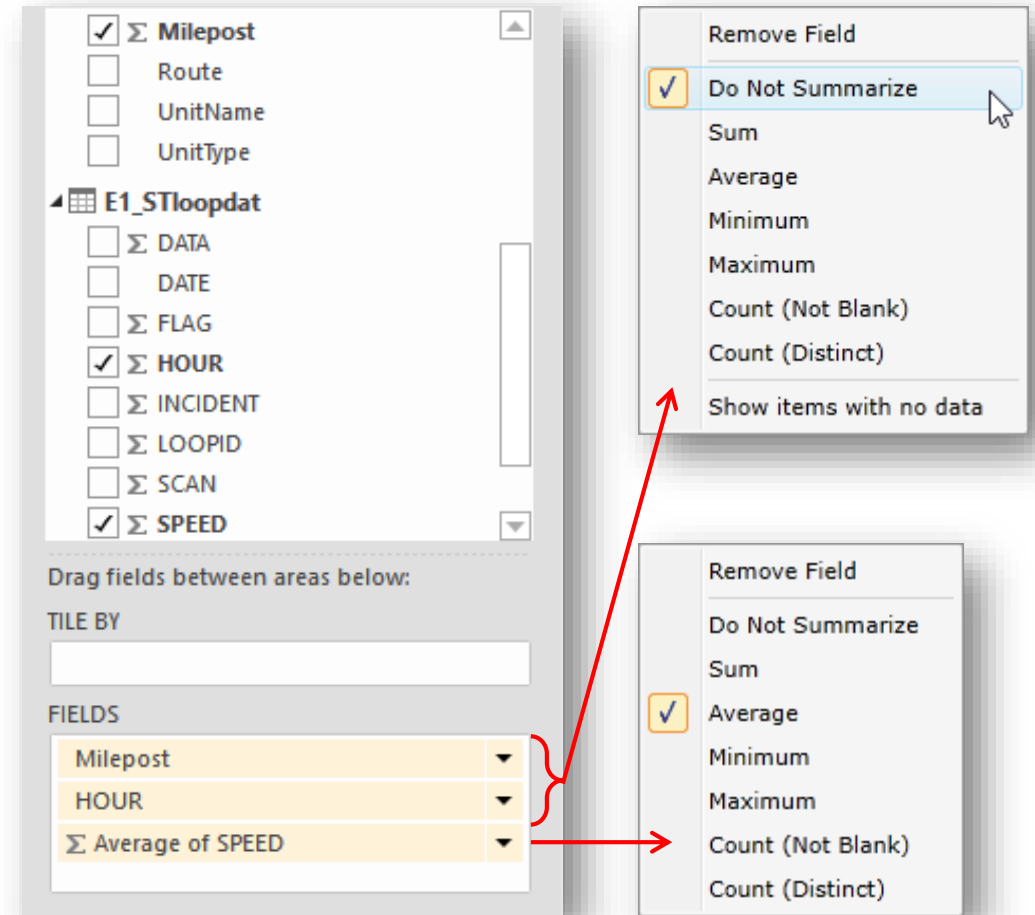
Step 5: Format Map

- Your map should look something like this. You can zoom in and navigate around the map to look at individual volume measures, and click different hours at the top of the map to look at different time periods.
- You can also select individual days in to filter out a single day or take the sum over multiple days if desired.



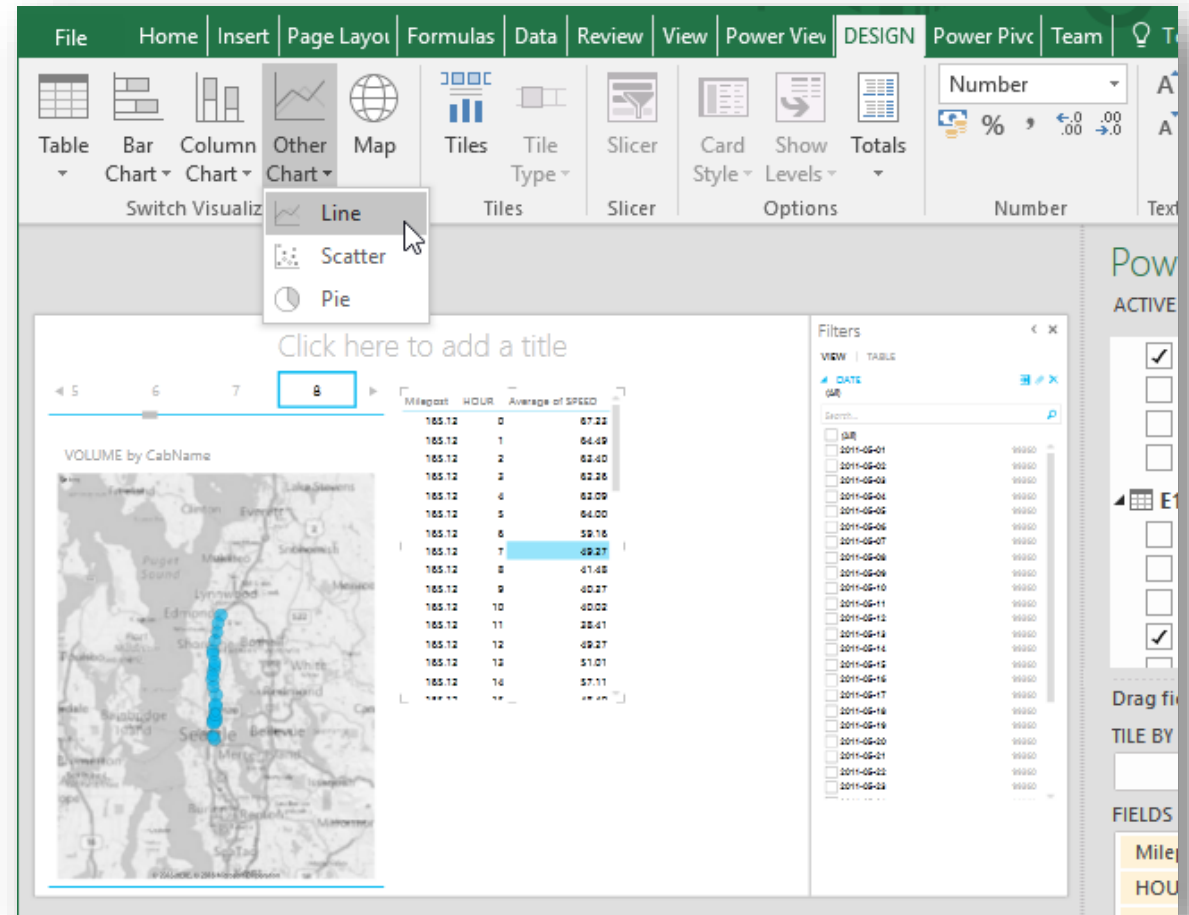
Step 6: Add a Speed Plot

- Next we will create a line plot such that you can view the daily speed profile for each detector cabinet. To do this, start by clicking in the blank area of the Power View Report (to de-select the map).
- Add the MILEPOST field from the E1_STcabinets table, and then add the SPEED and HOUR fields from the E1_STloopdat table.
- Make sure that MILEPOST and HOUR are set to **Do Not Summarize** and that SPEED is set to **Average** as shown.



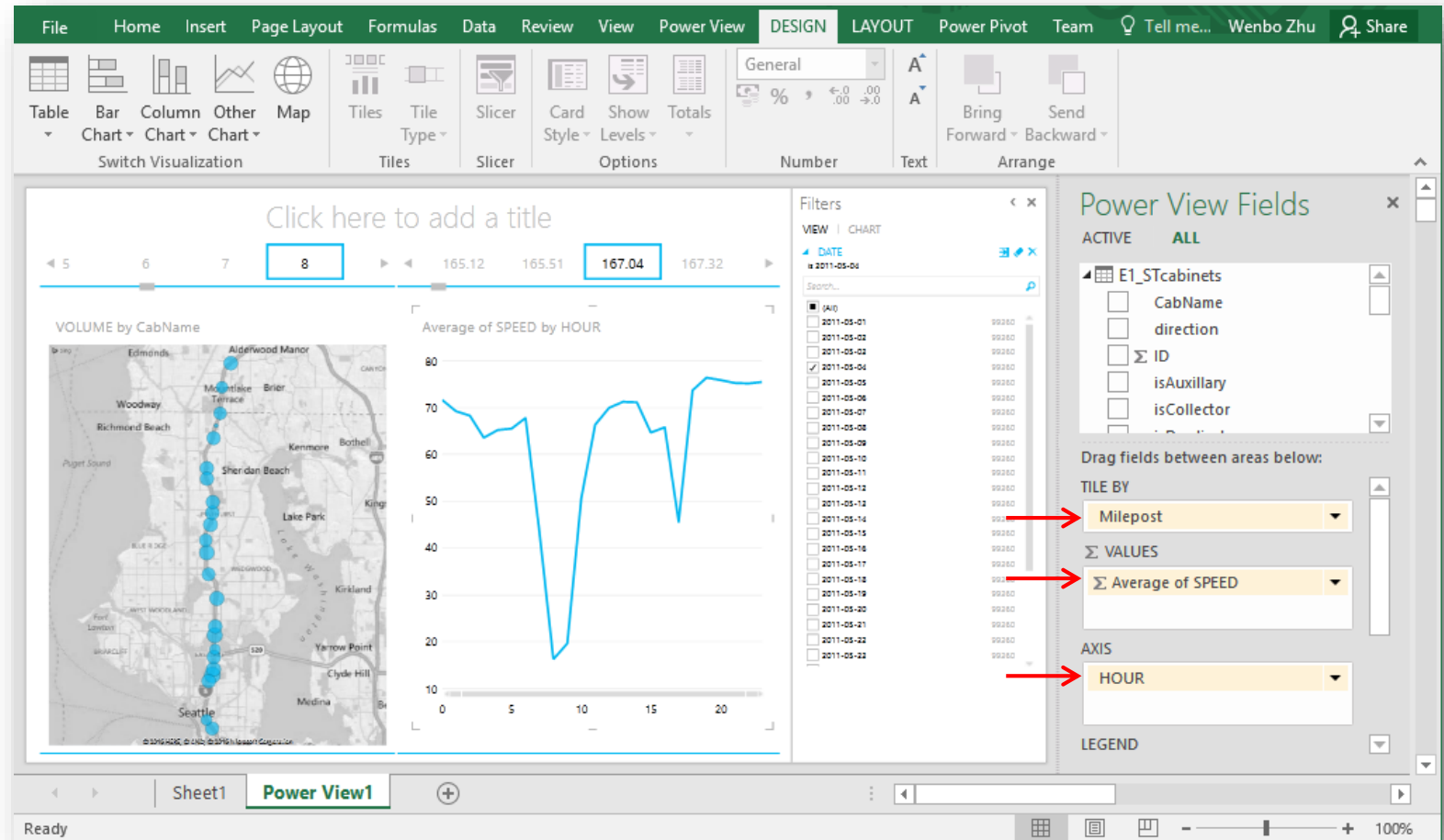
Step 6: Add a Speed Plot

- To insert a speed plot, click inside the newly created table and then click **Design** → **Other Chart** → **Line** as shown.
- Your line chart will probably not look right (as usual), let's change things around to make it look correct (next slide)



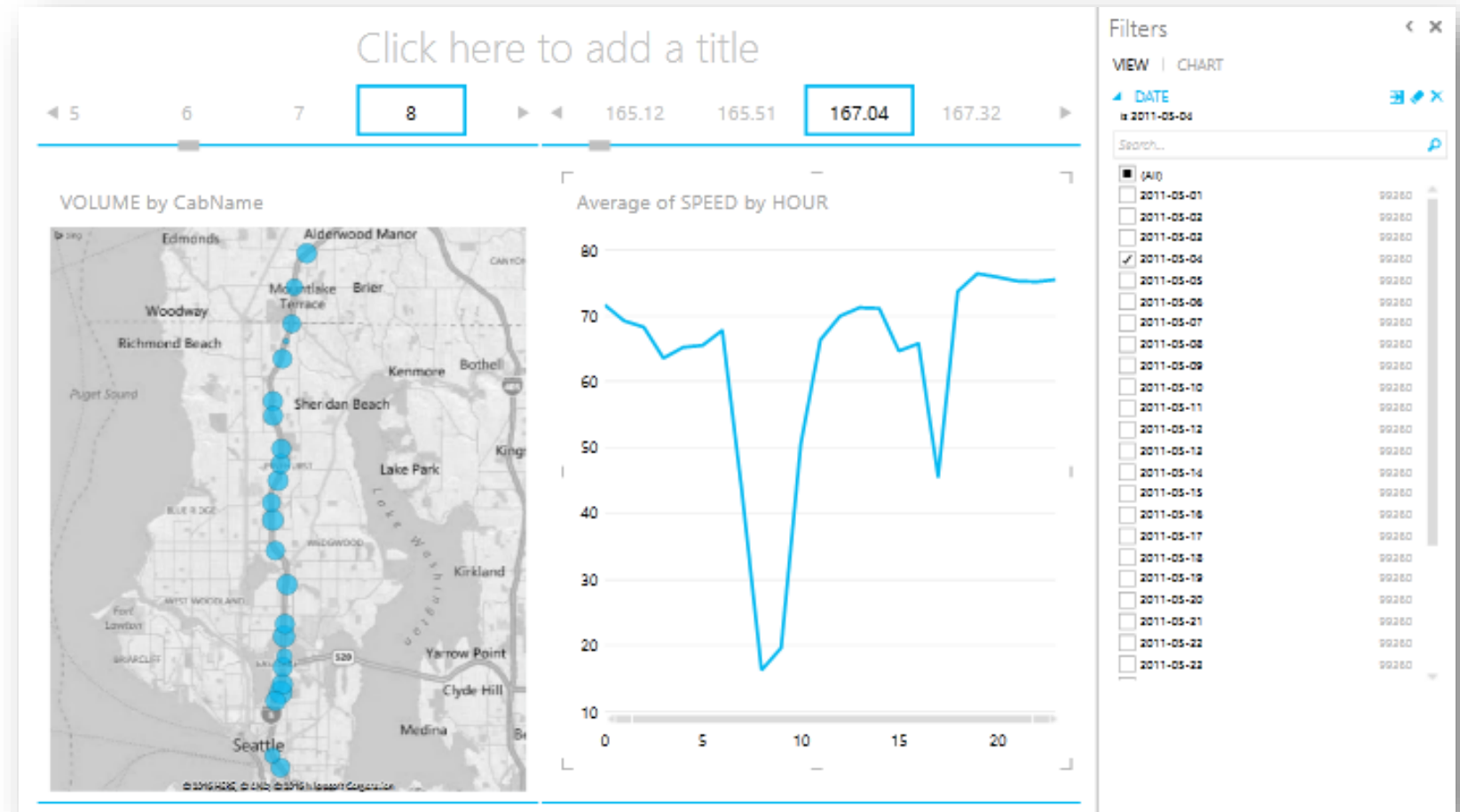
Step 6: Add a Speed Plot

- Move things around so that MILEPOST is in the TILE BY area, Average of SPEED is in the VALUES area, and HOURS is in the AXIS area as shown.
- Next you can resize the two visuals you created to make them fit on the page and make them look good.



Step 6: Add a Speed Plot

- After resizing your plots, you might have something similar to what is shown on the right.
- Note that you can change the speed plot in one of the three ways:
 - Click on the tile buttons at the top of the plot
 - Click on an individual detector cabinet in the map
 - Change the date filter.



Step 7: What Else?

- Here is what we did: First, we made a connection to a relational database, such that the data is queried from the database each time we open the Excel workbook. It would not have been possible to open this data in regular Excel, because it is much more than a million rows.
- Next, we created a relationship between two data tables, one containing the location of the observations and the other containing the observations themselves. This way, we can manage information about the loop data cabinets separate from the loop data itself, and then combine the information to perform analysis.
- Next, we created a simple dashboard to visualize the loop data for a single day. Note that, because the worksheet connects to the database each time it is opened, we could use Power View to create a performance dashboard that is updated with the most current data each time it is opened.
- Finally, we used the tools in Power View to both map and visualize spatially aware data in Excel. Mapping tools are available in regular Excel (see the Bing Maps add-on), but Power View provides additional tools that can make it easier to create compelling visuals.
- Now: try some other plots, maps, or visuals with this dataset and Power View.