U.S. Department of Transportation
Federal Highway Administration

Federal Highway Administration
RESOURCE CENTER

Technical Support

Two Approaches for Evaluating the Difference in Emissions Between Diesel and CNG Buses

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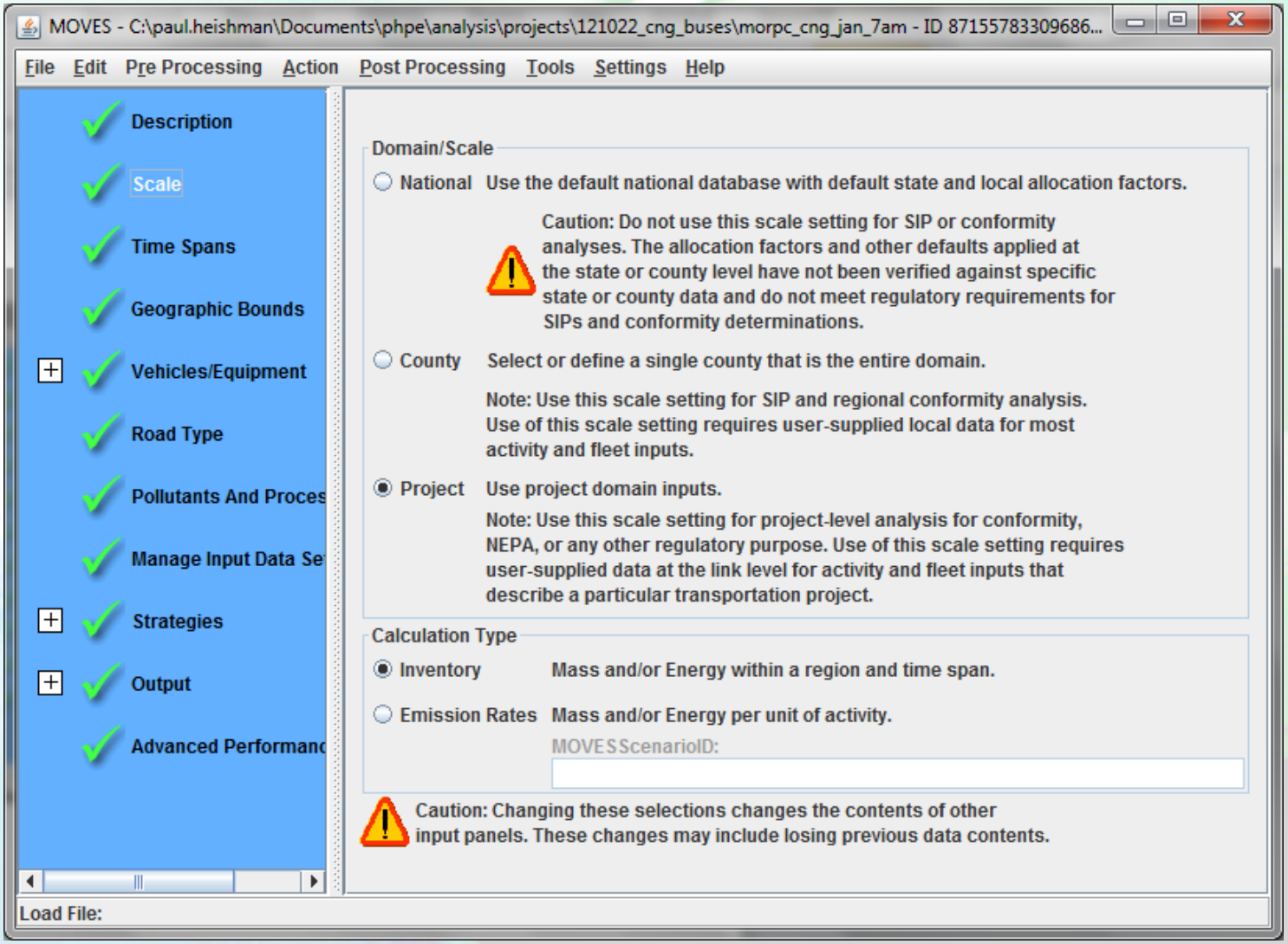
Shifting Gears Using MOVES Scaling Capabilities

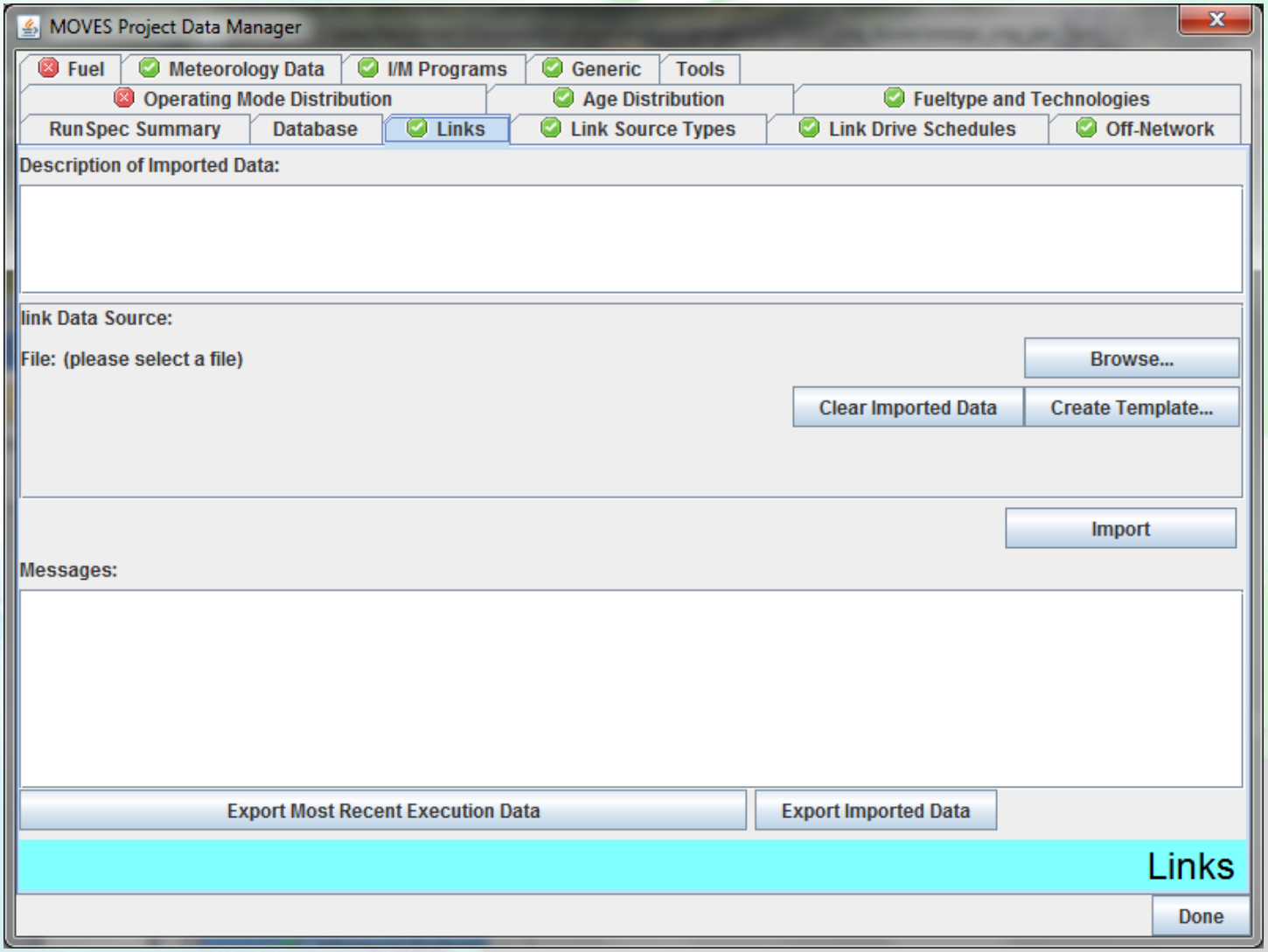
The first half looked at a telescopic approach

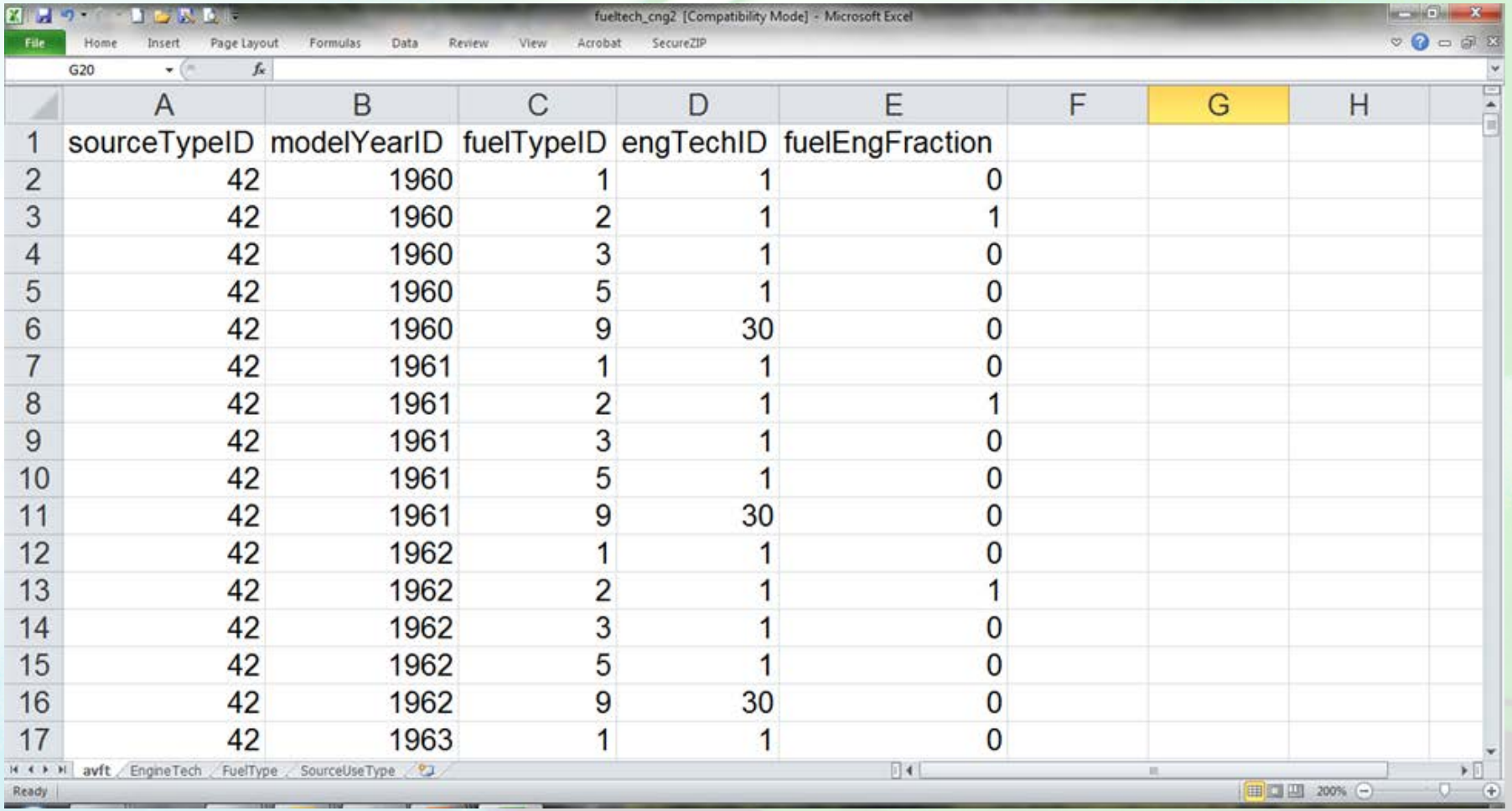
- Might use this approach to evaluate entire fleet
  - Referenced to average conditions across network
  - Might be used for TIP conformity analysis
  - Able to look at longer, multiple timeframes

Now we are looking at a microscopic approach

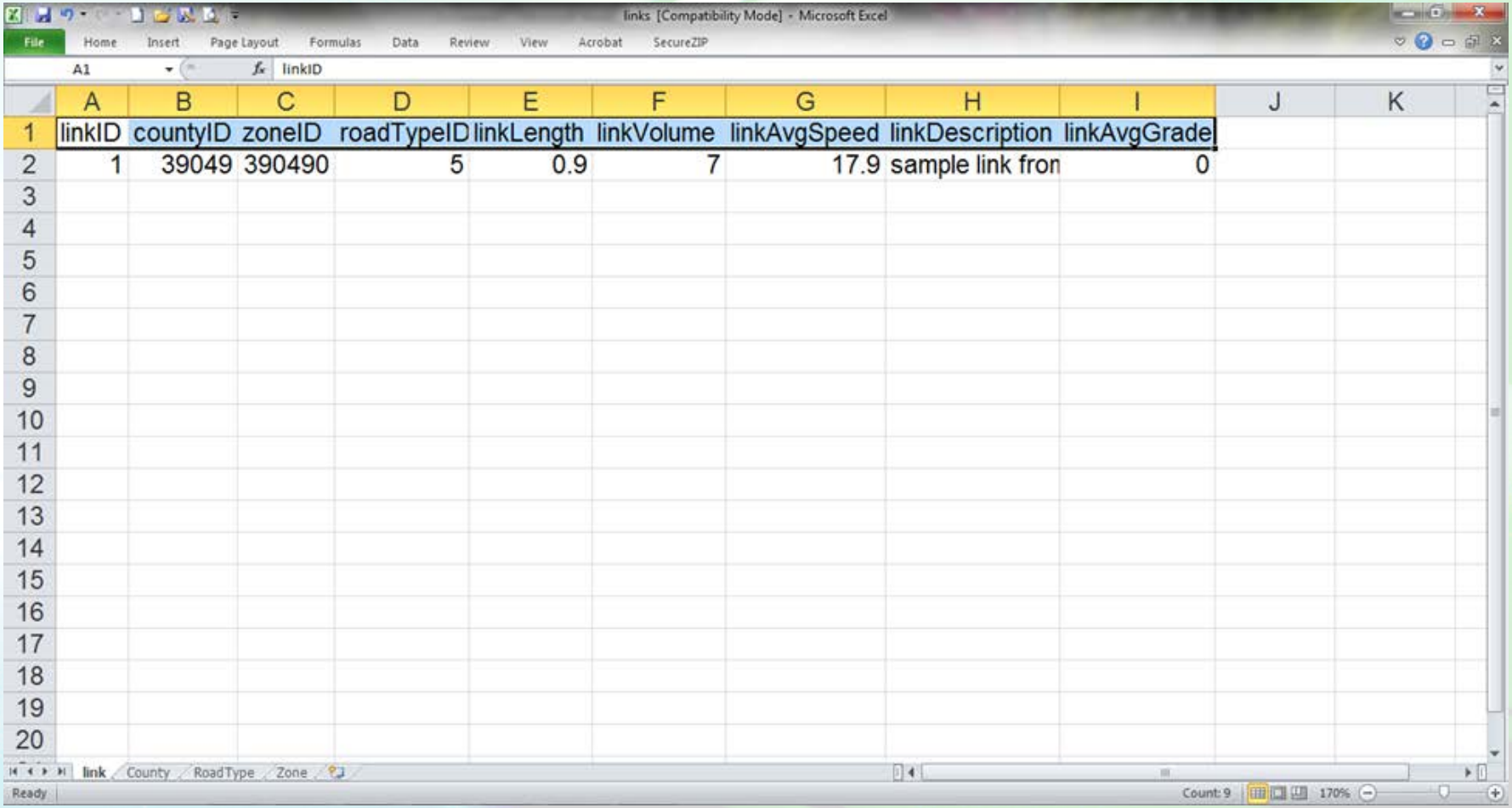
- Use more detail to look at specific roadway segments
- Use with dispersion model for NEPA or hot-spot conformity
- Might also be used for benefits of local CMAQ project
- Limited to one hour of one day of one year per run


MOVES - C:\paul.heishman\Documents\phpe\analysis\projects\121022_cng_buses\morpc_cng_jan_7am - ID 87155783309686...
File Edit Pre Processing Action Post Processing Tools Settings Help
Description
Scale
Time Spans
Geographic Bounds
Vehicles/Equipment
Road Type
Pollutants And Proces
Manage Input Data Se
Strategies
Output
Advanced Performanc
Domain/Scale
National Use the default national database with default state and local allocation factors.
Caution: Do not use this scale setting for SIP or conformity analyses. The allocation factors and other defaults applied at the state or county level have not been verified against specific state or county data and do not meet regulatory requirements for SIPs and conformity determinations.
County Select or define a single county that is the entire domain.
Note: Use this scale setting for SIP and regional conformity analysis. Use of this scale setting requires user-supplied local data for most activity and fleet inputs.
Project Use project domain inputs.
Note: Use this scale setting for project-level analysis for conformity, NEPA, or any other regulatory purpose. Use of this scale setting requires user-supplied data at the link level for activity and fleet inputs that describe a particular transportation project.
Calculation Type
Inventory Mass and/or Energy within a region and time span.
Emission Rates Mass and/or Energy per unit of activity.
MOVESScenarioID:
Caution: Changing these selections changes the contents of other input panels. These changes may include losing previous data contents.
Load File:


MOVES Project Data Manager
Fuel
Meteorology Data
I/M Programs
Generic
Tools
Operating Mode Distribution
Age Distribution
Fueltype and Technologies
RunSpec Summary
Database
Links
Link Source Types
Link Drive Schedules
Off-Network
Description of Imported Data:
link Data Source:
File: (please select a file)
Browse...
Clear Imported Data
Create Template...
Import
Messages:
Export Most Recent Execution Data
Export Imported Data
Links
Done

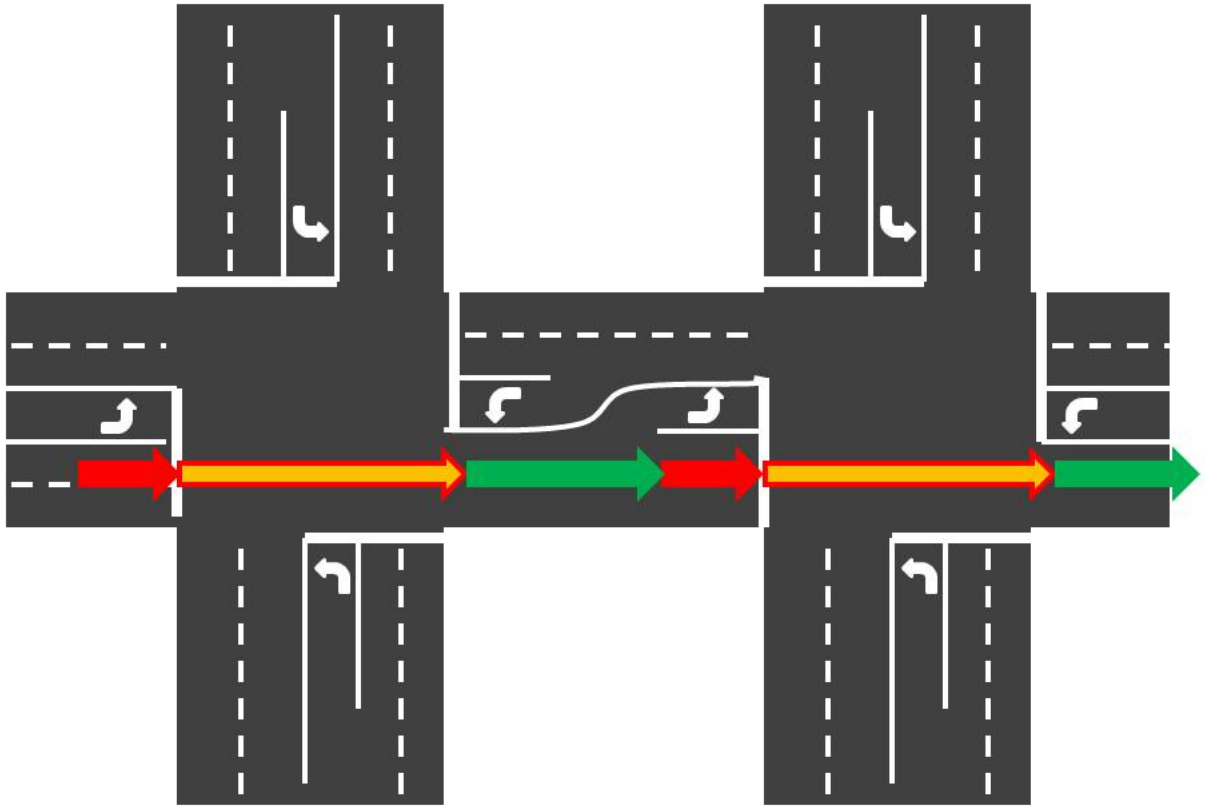


	A	B	C	D	E	F	G	H
1	sourceTypeID	modelYearID	fuelTypeID	engTechID	fuelEngFraction			
2	42	1960	1	1	0			
3	42	1960	2	1	1			
4	42	1960	3	1	0			
5	42	1960	5	1	0			
6	42	1960	9	30	0			
7	42	1961	1	1	0			
8	42	1961	2	1	1			
9	42	1961	3	1	0			
10	42	1961	5	1	0			
11	42	1961	9	30	0			
12	42	1962	1	1	0			
13	42	1962	2	1	1			
14	42	1962	3	1	0			
15	42	1962	5	1	0			
16	42	1962	9	30	0			
17	42	1963	1	1	0			



linkID	countyID	zoneID	roadTypeID	linkLength	linkVolume	linkAvgSpeed	linkDescription	linkAvgGrade
1	39049	390490	5	0.9	7	17.9	sample link fron	0

Traffic Activity



Queue Link

Accel Link

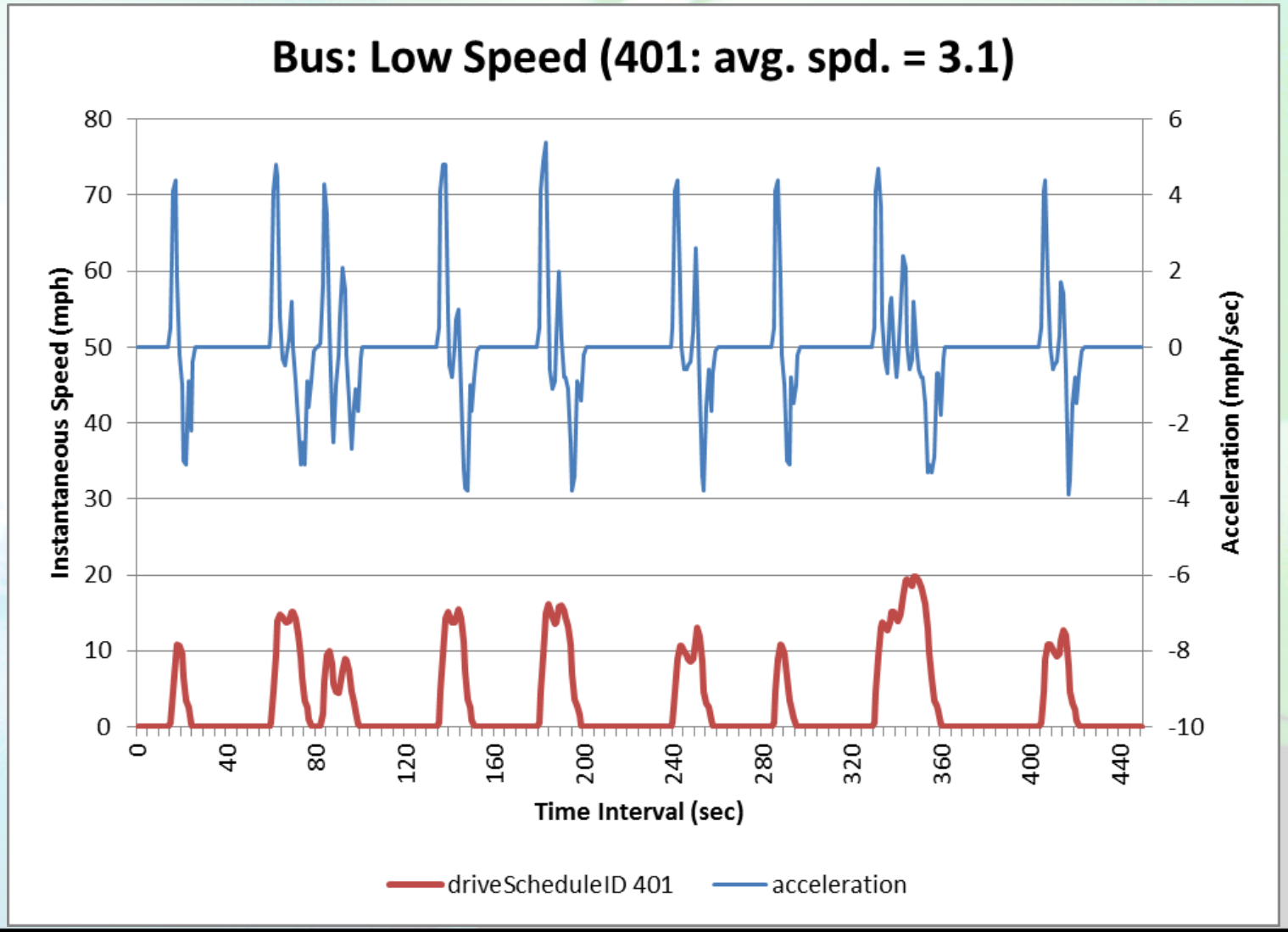
Cruise Link

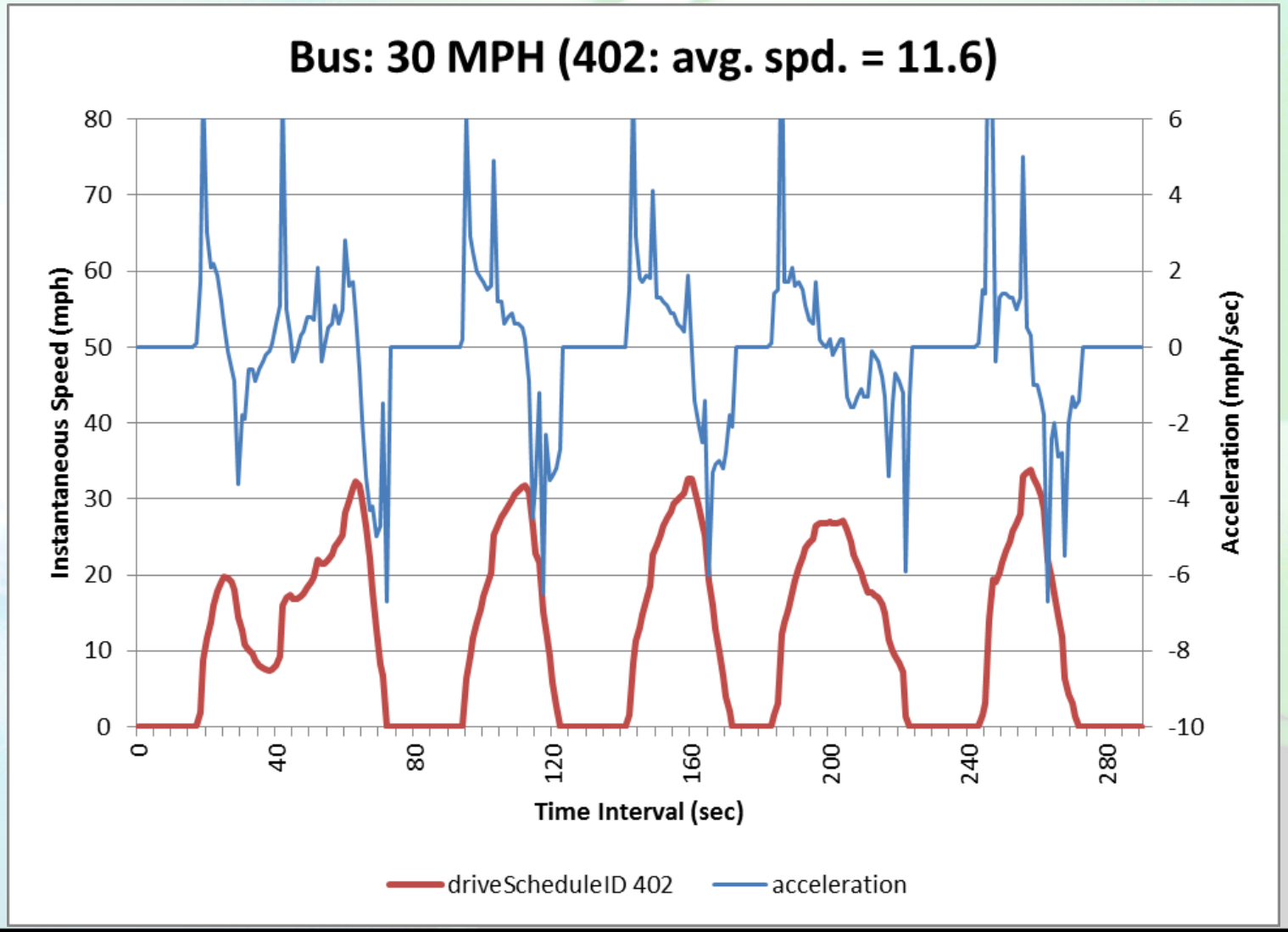
Traffic Activity

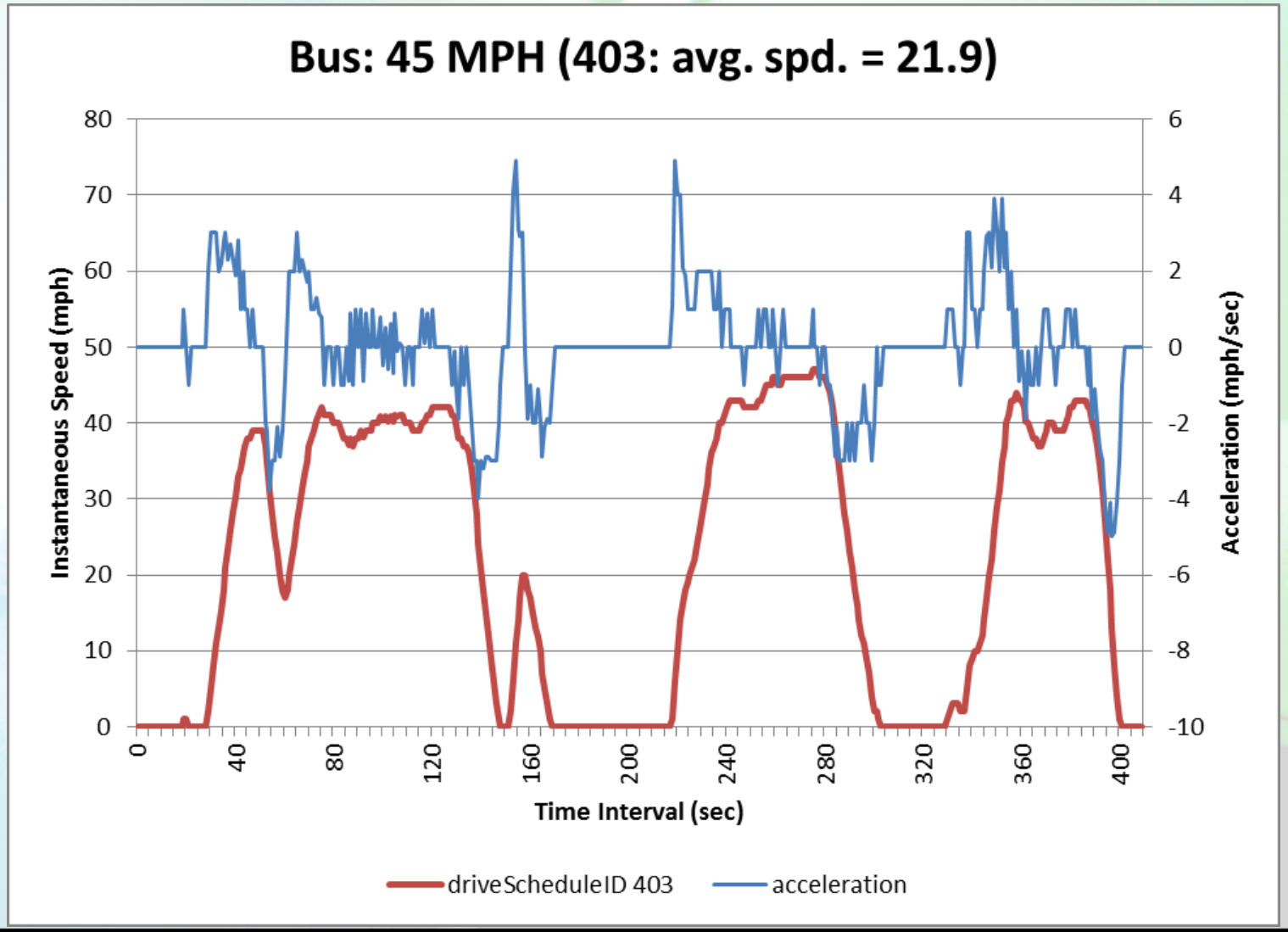
There are a several factors in defining separate links, such as:

Different Links Needed for Different Travel Activity Patterns

- Might Consider Three Link Types
  - Road Segment Characterized by ***Queuing***
  - Road Segment Characterized by ***Acceleration***
  - Road Segment Characterized by Steady ***Cruise***
- Possibly Consider a Fourth Type for ***Deceleration***
  - It's Factored into Queuing Link in the Example
- Different Activity Will Result in Different Emissions
  - MOVES Allows *Average Speed*, *Drive Schedule*, and *Operating Mode Distribution*

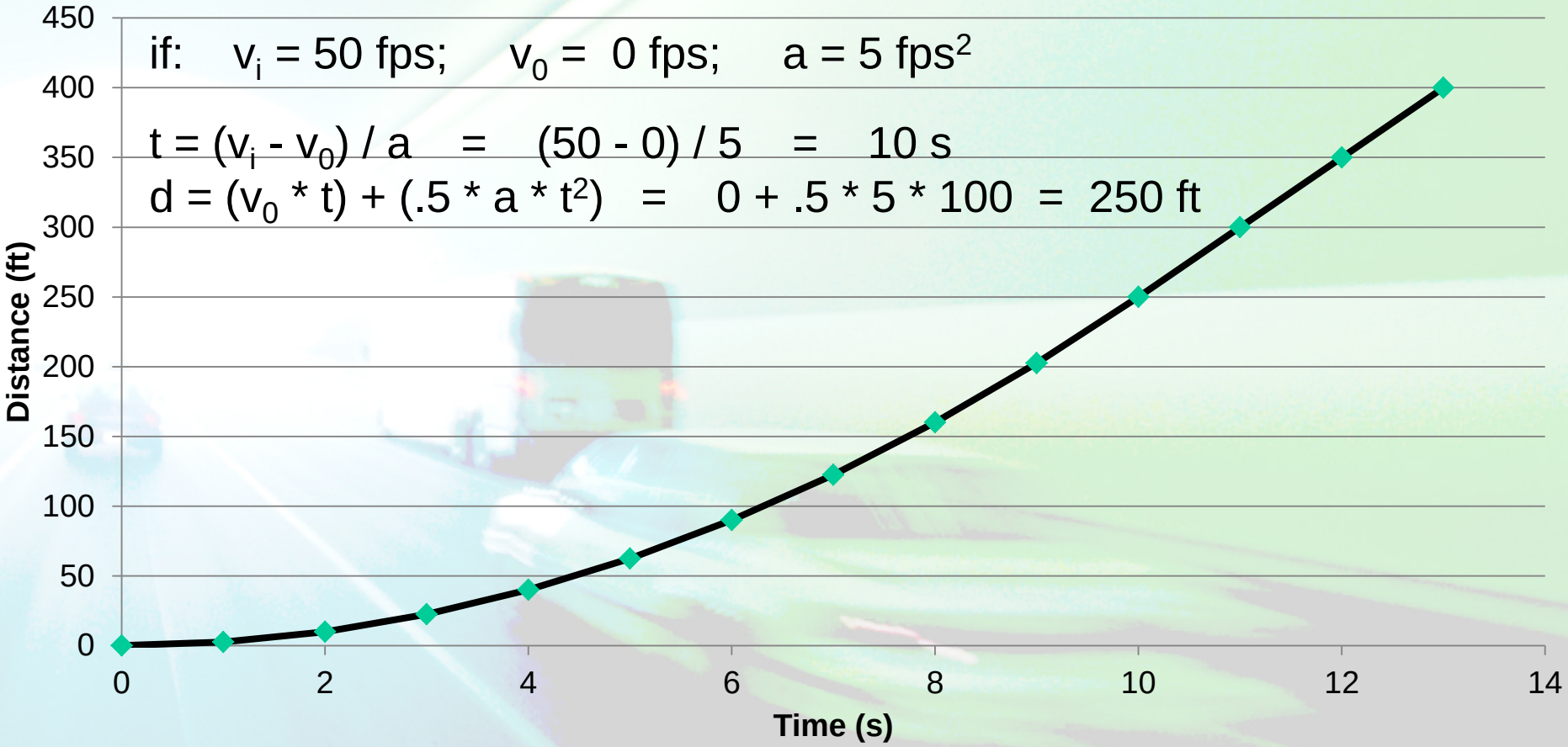

Bus: Low Speed (401: avg. spd. = 3.1)
Instantaneous Speed (mph)
Acceleration (mph/sec)
Time Interval (sec)
0
10
20
30
40
50
60
70
80
-10
-8
-6
-4
-2
0
2
4
6
0
40
80
120
160
200
240
280
320
360
400
440
driveScheduleID 401
acceleration

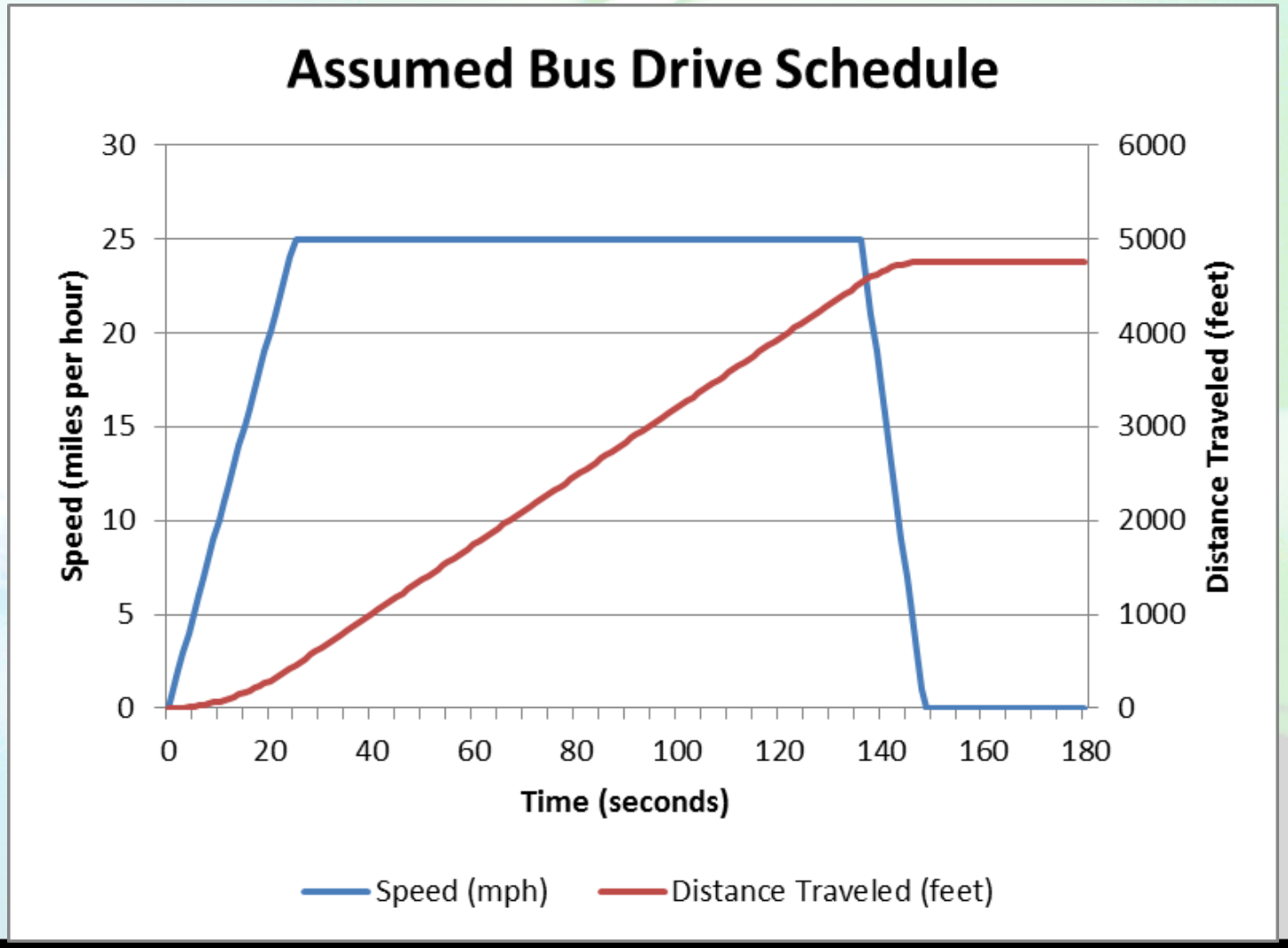

Bus: 30 MPH (402: avg. spd. = 11.6)
Instantaneous Speed (mph)
Acceleration (mph/sec)
Time Interval (sec)
0
10
20
30
40
50
60
70
80
-10
-8
-6
-4
-2
0
2
4
6
0
40
80
120
160
200
240
280
driveScheduleID 402
acceleration


Bus: 45 MPH (403: avg. spd. = 21.9)
Instantaneous Speed (mph)
Acceleration (mph/sec)
Time Interval (sec)
0
10
20
30
40
50
60
70
80
-10
-8
-6
-4
-2
0
2
4
6
0
40
80
120
160
200
240
280
320
360
400
driveScheduleID 403
acceleration

Traffic Activity

Example: Acceleration Link Length




Assumed Bus Drive Schedule
Speed (miles per hour)
Distance Traveled (feet)
Time (seconds)
0
5
10
15
20
25
30
0
1000
2000
3000
4000
5000
6000
0
20
40
60
80
100
120
140
160
180
Speed (mph)
Distance Traveled (feet)

Traffic Activity

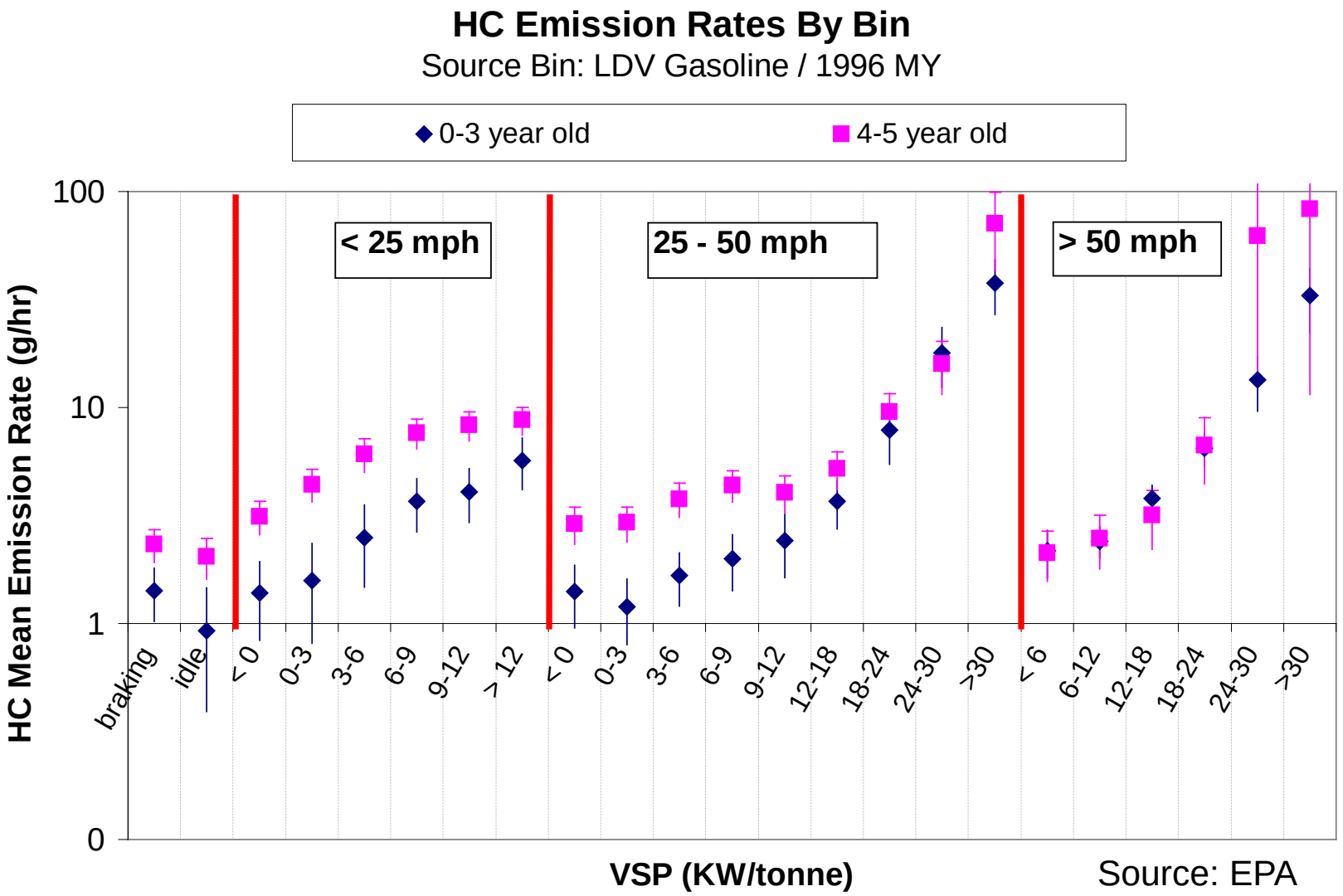
VSP Class (kW/tonne)	Speed Class (mph) 1-25	25-50	50 +
30 +	16	30	40
27-30			
24-27		29	39
21-24		28	38
18-21			
15-18			37
12-15		27	
9-12	15	25	
6-9	14	24	35
3-6	13	23	
0-3	12	22	33
< 0	11	21	

Vehicle Specific Power (VSP)

A measure of the energy the moving vehicle is using at a moment in time

Braking = Op Mode Bin 0
Idle = Op Mode Bin 1

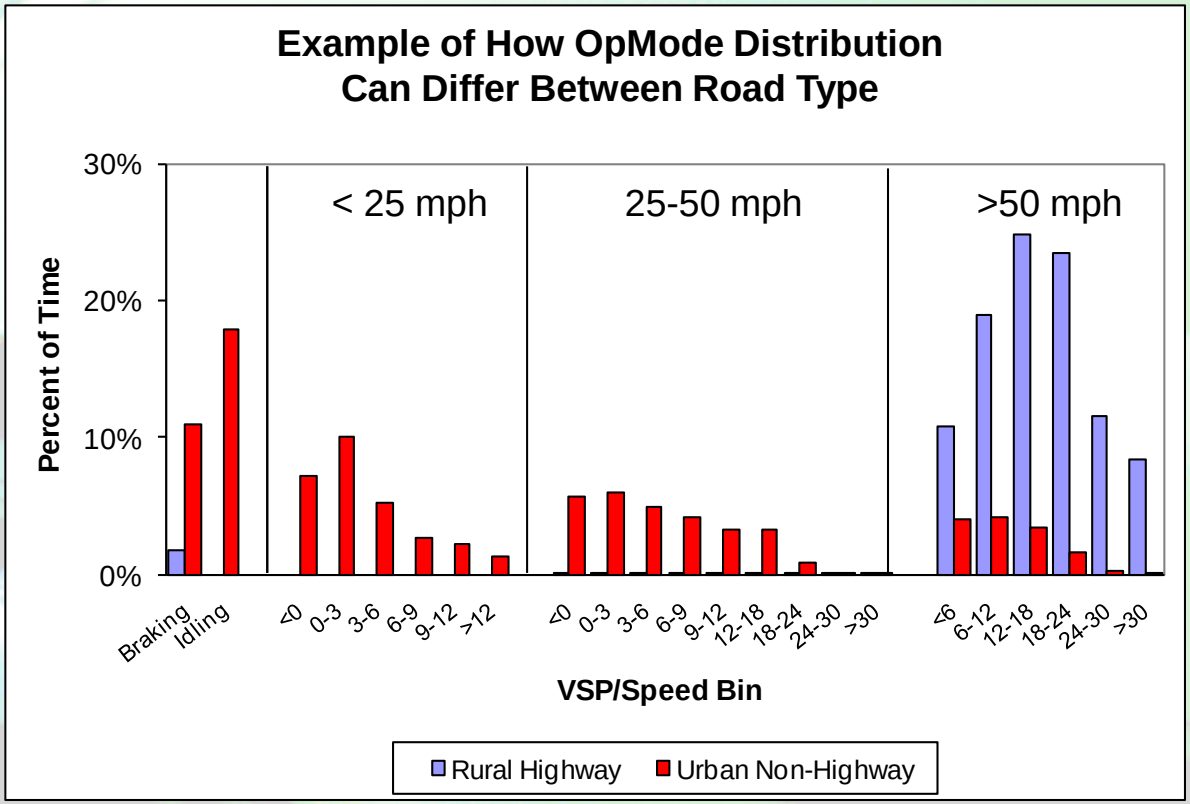
Source: EPA


HC Emission Rates By Bin
Source Bin: LDV Gasoline / 1996 MY
0-3 year old
4-5 year old
HC Mean Emission Rate (g/hr)
100
10
1
0
< 25 mph
25 - 50 mph
> 50 mph
braking
idle
< 0
0-3
3-6
6-9
9-12
> 12
< 0
0-3
3-6
6-9
9-12
12-18
18-24
24-30
>30
< 6
6-12
12-18
18-24
24-30
>30
VSP (KW/tonne)
Source: EPA

Vehicle Activity

All Running Links have an OpMode distribution (i.e., fraction of time spent in each operating mode)

- This can be explicitly defined by the user or…
- MOVES can calculate an OpMode distribution based on either an average speed or vehicle trajectory provided by the user



Source: EPA

Project-Level Analysis with MOVES

Make assumptions about treating travel activity

- Assume that travel would be the same regardless of fuel
  - Can use default link drive schedules from MOVES
  - Alternatively, develop drive schedules to reflect local conditions

Identify the inputs in MOVES that directly reflect fuel effects

- In MOVES Run Specification, select bus - fuel combination
- In Project Data Manager (PDM), fuel based on Run Spec
- PDM Age Distribution tab should reflect fleet differences
- PDM Fueltype & Technology to reflect correct distribution

Final approach will depend on study objectives (e.g., CMAQ)

MOVES Run Specification

You will need multiple runs to account for a full year

- Different times of day (typically 4 representative periods)
- Different months of the year (typically 4 seasons)
- Perhaps repeat for multiple years for life cycle benefits

Also separate runs to account for different cases (e.g., fuel)

- One set of runs for diesel fuel; rerun with CNG

Propose using inventory at Project Scale, but not required

- In part depends on study objective
- You can derive the rates in post-processing

MOVES Project Data Manager (PDM)

Only change data to reflect cases being compared

- Review assumption that links, operations, etc. are constant

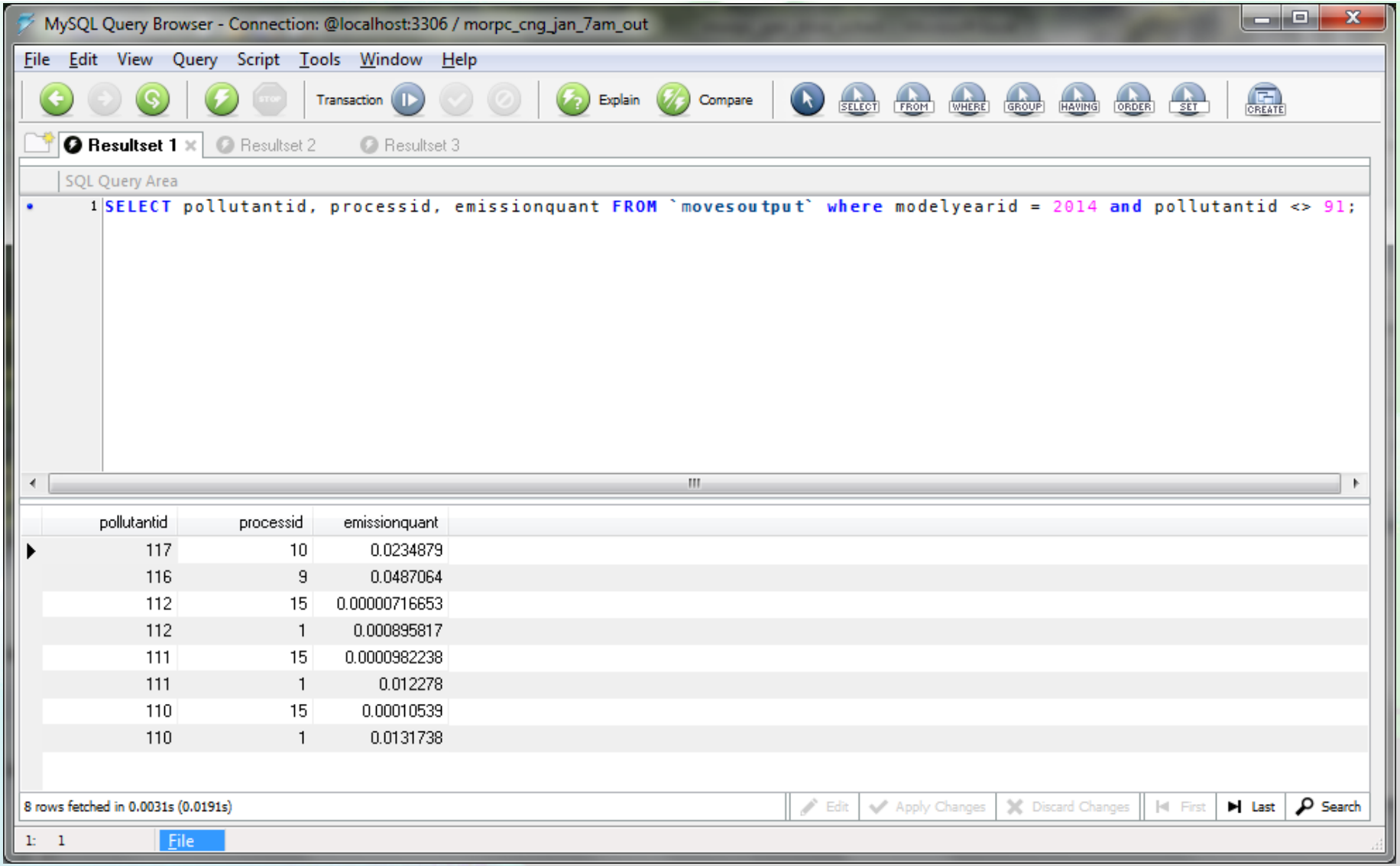
Key tables for this analysis:

- Fuel Supply and Formulation tables (match current fuel)
- Fueltype and Technology table (set 100% for current fuel)
- Met table (vary for both cases to match hour of analysis)
- Links table (may need to vary traffic volumes for time of day)
- Age distribution table (if replacing old fleet with new fleet)

May need to expand run data to account for full annual VMT

Note that in this procedure only comparing running emissions

- Review assumption that start emissions aren't critical


MySQL Query Browser - Connection: @localhost:3306 / morpc_cng_jan_7am_out
File Edit View Query Script Tools Window Help
Transaction
Explain
Compare
SELECT FROM WHERE GROUP HAVING ORDER SET CREATE
Resultset 1
Resultset 2
Resultset 3
SQL Query Area
1 SELECT pollutantid, processid, emissionquant FROM `movesoutput` where modelyearid = 2014 and pollutantid <> 91;
pollutantid processid emissionquant
117 10 0.0234879
116 9 0.0487064
112 15 0.00000716653
112 1 0.000895817
111 15 0.0000982238
111 1 0.012278
110 15 0.00010539
110 1 0.0131738
8 rows fetched in 0.0031s (0.0191s)
Edit
Apply Changes
Discard Changes
First
Last
Search
1: 1
File

In Closing

MOVES offers users flexibility

- We have seen options for working at different scales
- Can be applied to different kinds of projects
- But it also has large data demands
- In general, use data that is consistent with regional analyses

We are in a period of transition with implementation

- In new conformity work, MOVES is required (or will be soon)
  - EPA has specific guidance for these analyses
- Other studies (NEPA, CMAQ) may have optional procedures
  - Document your assumptions and decisions
  - Seek agency concurrence

Questions

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