
VDOT
Virginia Department of Transportation

MOVES REVIEW WORK GROUP
PROJECT-LEVEL ANALYSES

October 9, 2019 – 1 p.m.

Christopher Voigt, VDOT, *Vice-Chair, AASHTO Air Quality, Climate Change and Energy Subcommittee*

Overview

- **Key Project-Level Modeling Requirements (NEPA, Conformity and CMAQ) & Priorities**
- **Key Areas for Environmental Regulatory Model Improvement**
- **High Priority Recommendations**
  - **Preamble for road grades**
  - **Other (lower priority) recommendations provided in the trailer**

Key Project-Level Modeling Requirements

Regulation/ Key Elements	Traffic, Emission & Dispersion Modeling		Traffic & Emission Modeling			
	PM	*CO*	*MSATs (Note 1)*	*GHGs*	*NOx*	*VOC*
Conformity	x	x	-	-	-	-
NEPA *(includes transparency)*	*Note 2*	x	x	Proposed	-	-
CMAQ	x	x	-	-	x	x
Scale	P	P	P or R	TBD	P	P
Tests: Conf./ NEPA Results: CMAQ	Conf. & NEPA: NAAQS, B/NB CMAQ: Emission Reduction	Conf. & NEPA: NAAQS, B/NB CMAQ: Emission Reduction	Long-Term Trend wtih B/NB	TBD (Note 3)	Emission Reduction	Emission Reduction
Typical Margins (NAAQS-BCs)	**Small**	Large				
Future NAAQS Changes	**Possible, per EPA draft Policy Assessment (Sept.2019)**	TBD, but no change in last review.				
Level	**Refined**	Screening				
Priorities	**1**	2	3	4	5	5
Basis for assigned priority	**Need for improved MOVES accuracy @ high road grades & speeds, plus the risk of failing the NAAQS & B/NB tests**	Need improved MOVES accuracy @ high road grades & speeds	Efficiency, QA/QC, & MOVES project-level accuracy @ high road grades	MOVES accuracy @ high road grades?	NCHRP Simplified/ FHWA Toolkits (Note 4)	NCHRP Simplified/ FHWA Toolkits (Note 4)

BCs - Background Concentrations; CMAQ - Congestion Mitigation & Air Quality program; NAAQS - National Ambient Air Quality Standards; NEPA - National Environmental Policy Act

Notes:

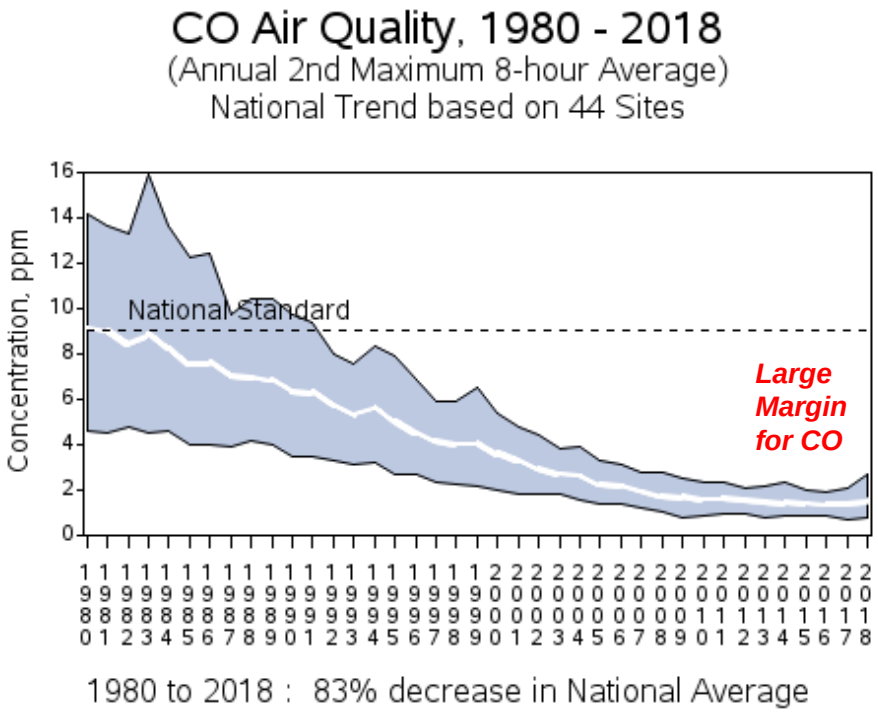
1. Mobile source air toxics (MSATs) specified in FHWA NEPA guidance include: 1,3-butadiene,acetaldehyde, acrolein, benzene, diesel particulate matter (diesel PM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter. See: https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/

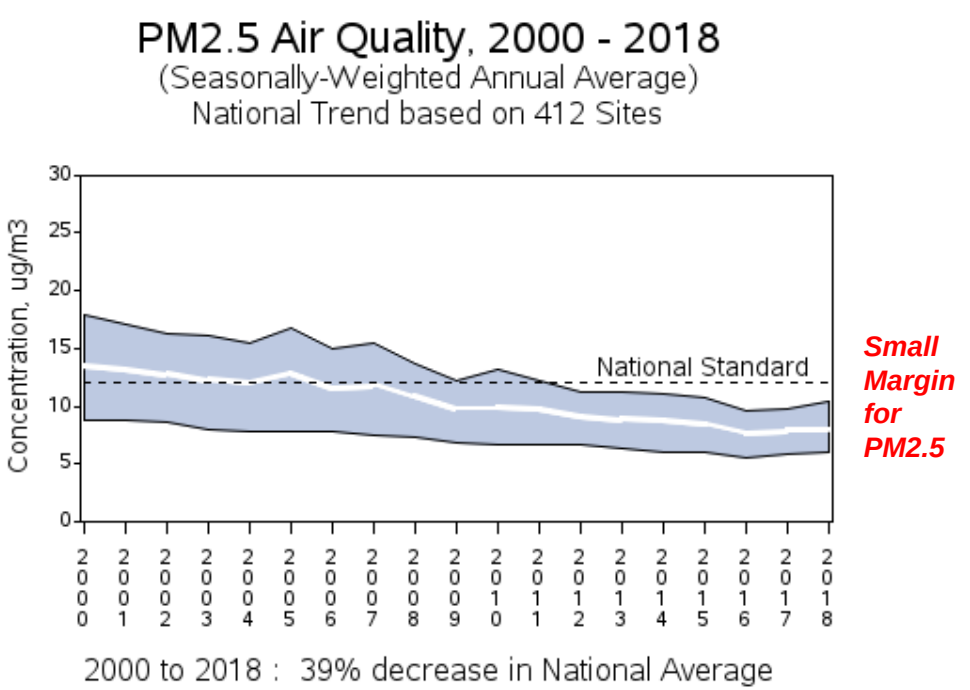
2. States may conduct PM analyses at their own discretion for NEPA, or to meet state requirements. They are not generally done for NEPA otherwise.

3. GHG analyses may be done more for purposes of transparency for NEPA than for emission testing, based on recent survey data (e.g., Robbins, 2017).

4. Project-specific MOVES modeling not needed to use these toolkits. See: NCHRP 25-25 Task 108 (2019): https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4104, & FHWA: https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/index.cfm

Relative Margins for CO and PM2.5





Sources: ***https://www.epa.gov/air-trends/carbon-monoxide-trends*****, https://www.epa.gov/air-trends/particulate-matter-pm25-trends***

** EPA draft Policy Assessment (2019) considering as low as 8 or 10 micrograms/m3 for the annual primary PM2.5 NAAQS (84 FR 47994, 9/11/2019). https://www.govinfo.gov/content/pkg/FR-2019-09-11/html/2019-19627.htm*

Key Areas for Env. Regulatory Model Improvement*

- **Life-Cycle Model Evaluation *(Accuracy/Uncertainty, QA/QC)***
  - "*Model evaluation is the process of deciding whether and when a model is suitable for its intended* [regulatory] *purpose*" (p.161, NRC 2007)
    - An ongoing rigorous and systematic process that includes the need for periodic model evaluation against field/test data, and the resulting potential need to limit regulatory applications of the model to those validated against field/test data for those applications
  - Quantifying and Communicating Uncertainty: Needed for NEPA transparency/ disclosure. Key for NAAQS & Build/No-Build (B/NB) tests (both NEPA & conformity).
  - Extrapolation: "*Extrapolating far beyond the available data for the model draws particular attention in the evaluation process to the theoretical basis of the model, the processes represented in the model, and the parameter values*."
- **Model Parsimony *(Proportionality & Need for Efficiency/Streamlining)***
  - "*Models used in the regulatory process should be no more complicated than is necessary to inform regulatory decisions*"
- **Peer Review**
  - Maintain consultation with DOTs & consultants *(even without FACA process)*

** See: "Models in Environmental Regulatory Decision Making" (National Research Council of the National Academies, 2007). http://dels.nas.edu/Report/Models-Environmental-Regulatory-Decision-Making/11972*

Background for the First Two Recommendations (1a & b)

- **Both address roadway grades**
- **AASHTO Green Book road grades**
  - **Useful reference for setting a preliminary minimum range of road grades that MOVES should cover (excepting mountainous areas)**
  - **A review of actual ranges is still needed (esp. areas subject to conformity for PM2.5)**
- **MOVES Runs**
  - **Based on the EPA 2018 PM Modeling Training examples**
    - EPA Files for PM2.5, Oct 12, AM
  - **Conducted for the full range of AASHTO 2011 Green Book road grades for each MOVES road type *(2018 version now available)***
  - **Focus for the presentation is on results for exhaust PM (total running exhaust & crankcase running exhaust).**
    - Slides for other pollutants in trailer.

Maximum Roadway Grade by Road Class, for MOVES Modeling

AASHTO Green Book 2011*			MOVES	Maximum Grade (%) for MOVES Modeling
Road Class		*Maximum Grade (%)(**)*	*Road Type*	
Rural	Freeways	5 (1)	2 - Rural Restricted	6
	Local	12	3 - Rural Unrestricted	12
	Collectors	10 (2)		
	Arterials	6		
Urban	Freeways	5 (1)	4 - Urban Restricted	6
	Ramps	8 Upgrade		8
		8 (2) Downgrade		10
	Local	15 *Residential*	5 - Urban Unrestricted	15
		8 *Commerical & Industrial*		
	Collectors	12 (2)		
	Arterials	9		

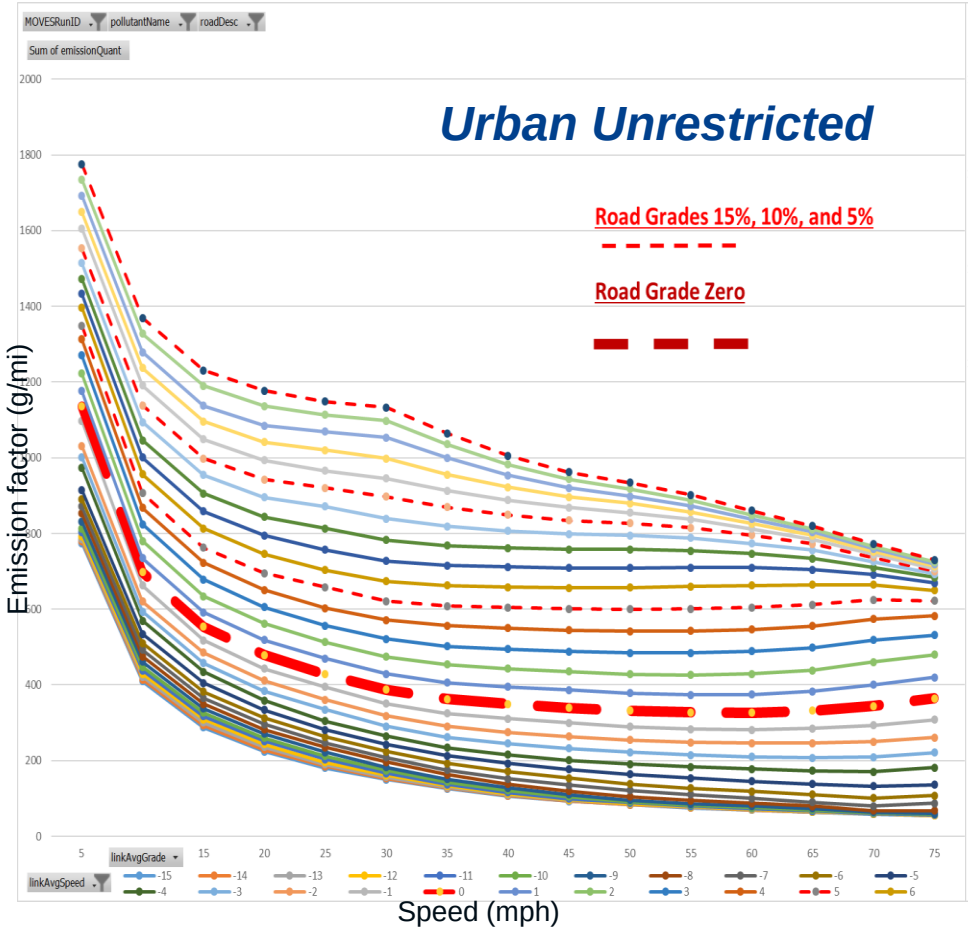
** For lowest speed specified, for level and rolling terrain. Higher grades are listed for mountainous terrain.*

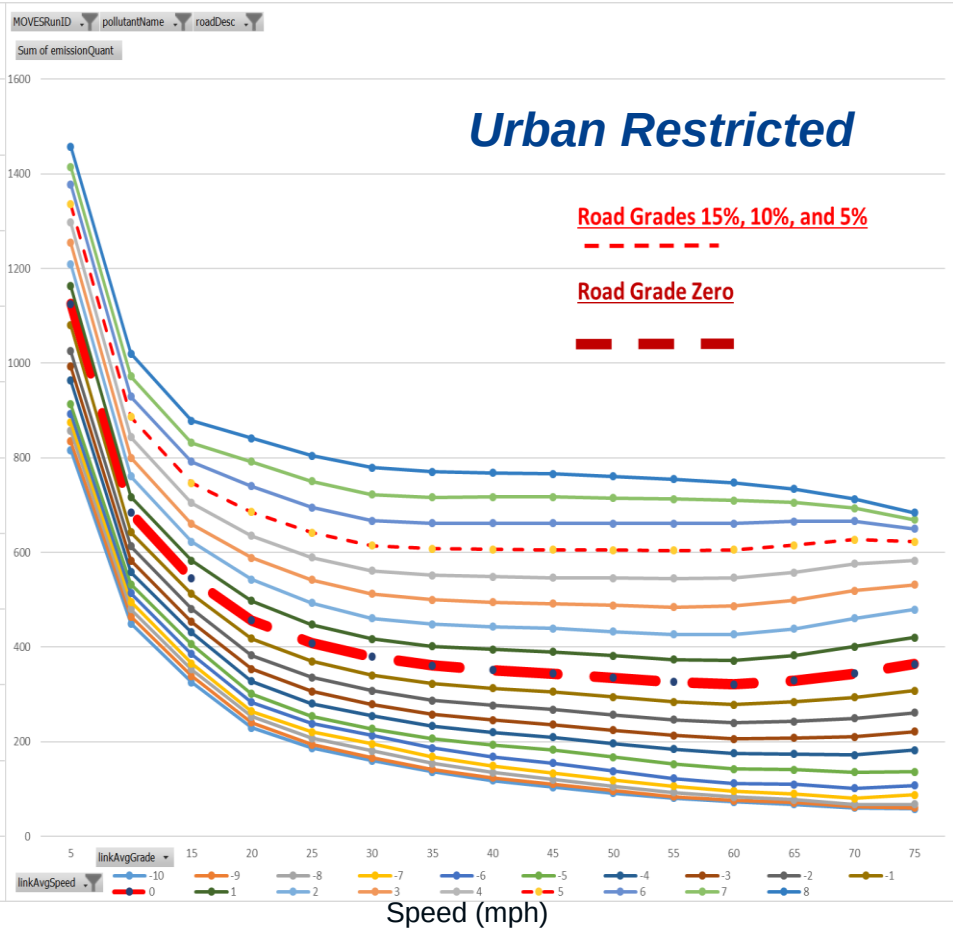
*** Additional amount provided for specified road classes and conditions. E.g., for rural and urban freeways the 2011 AASHTO Green Book provides that: "Grades 1% steeper than the value shown may be provided in urban areas with right-of-way constraints or where needed in mountainous terrain."*

AASHTO Greenbook: "A Policy on Geometric Design of Highways and Streets", 2011, 6th Edition

MOVES2014a Fleet Average EFs for 2020 Exhaust CO2E

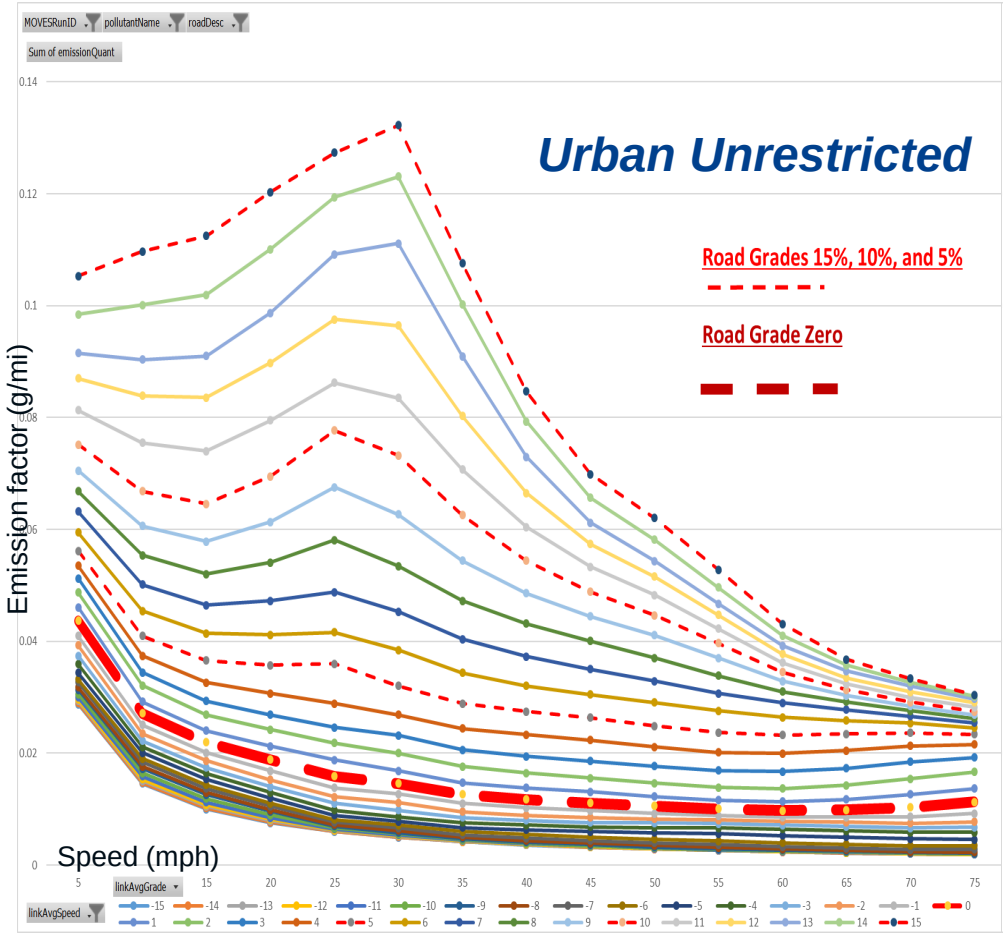
(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)

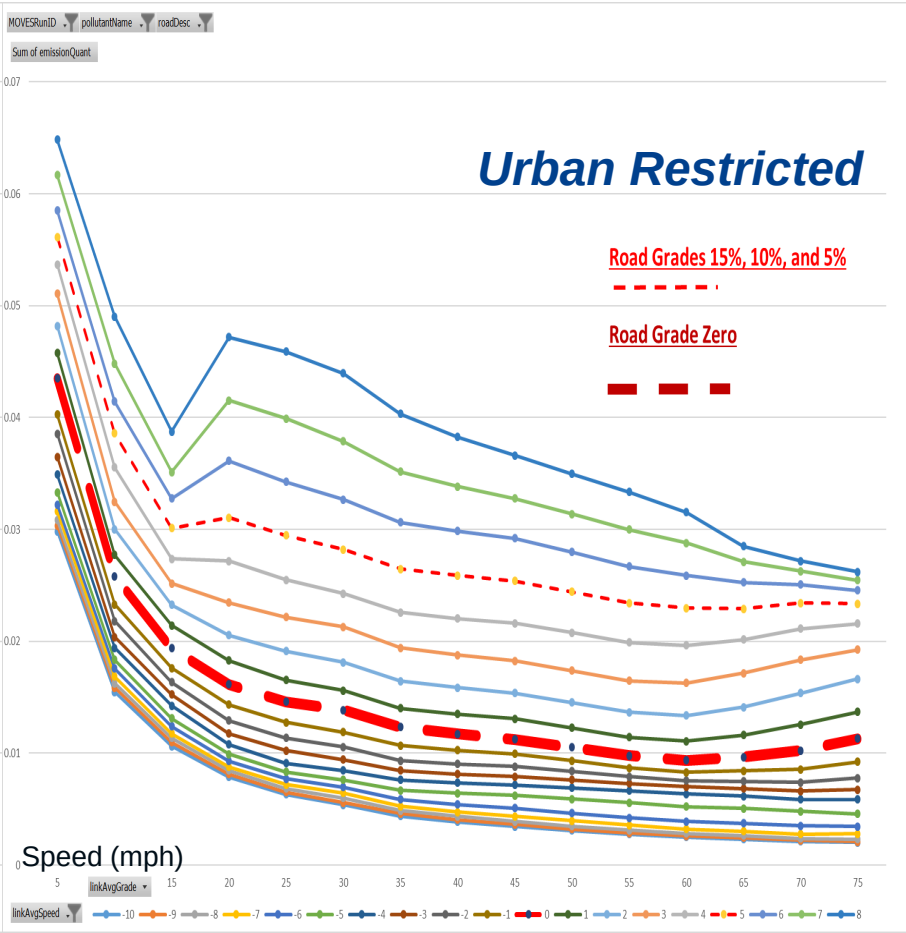




MOVES2014a Fleet Average EFs for 2020 Exhaust PM2.5

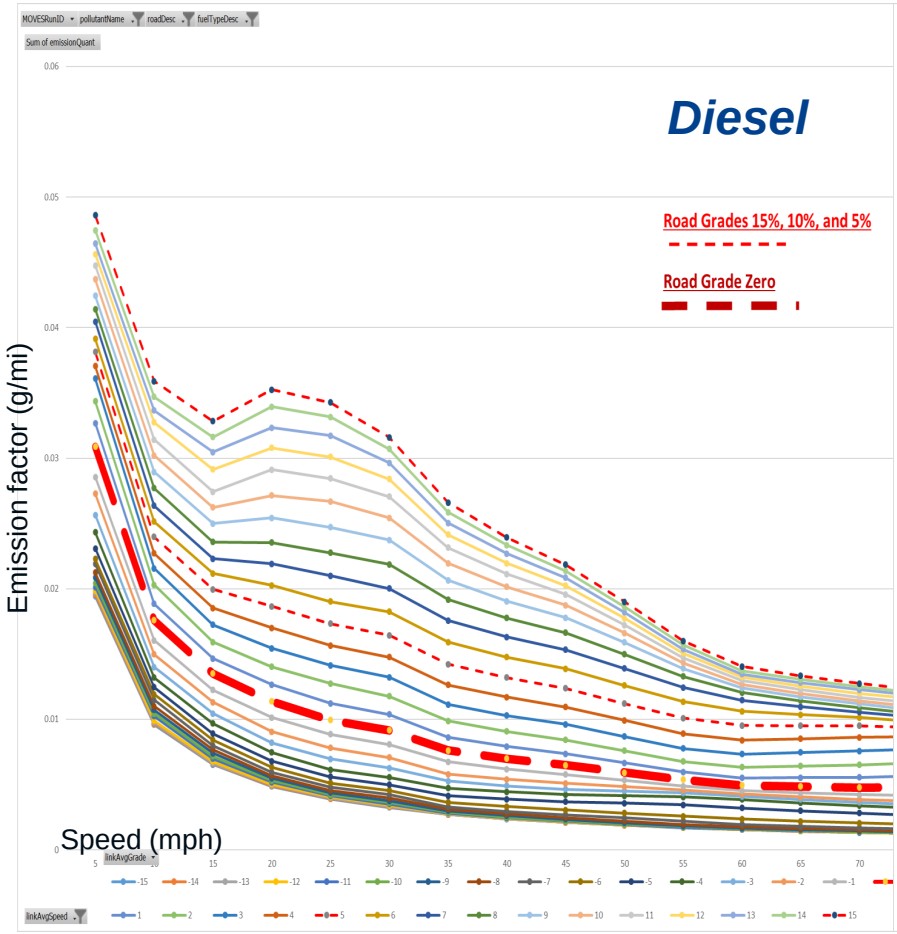
(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)

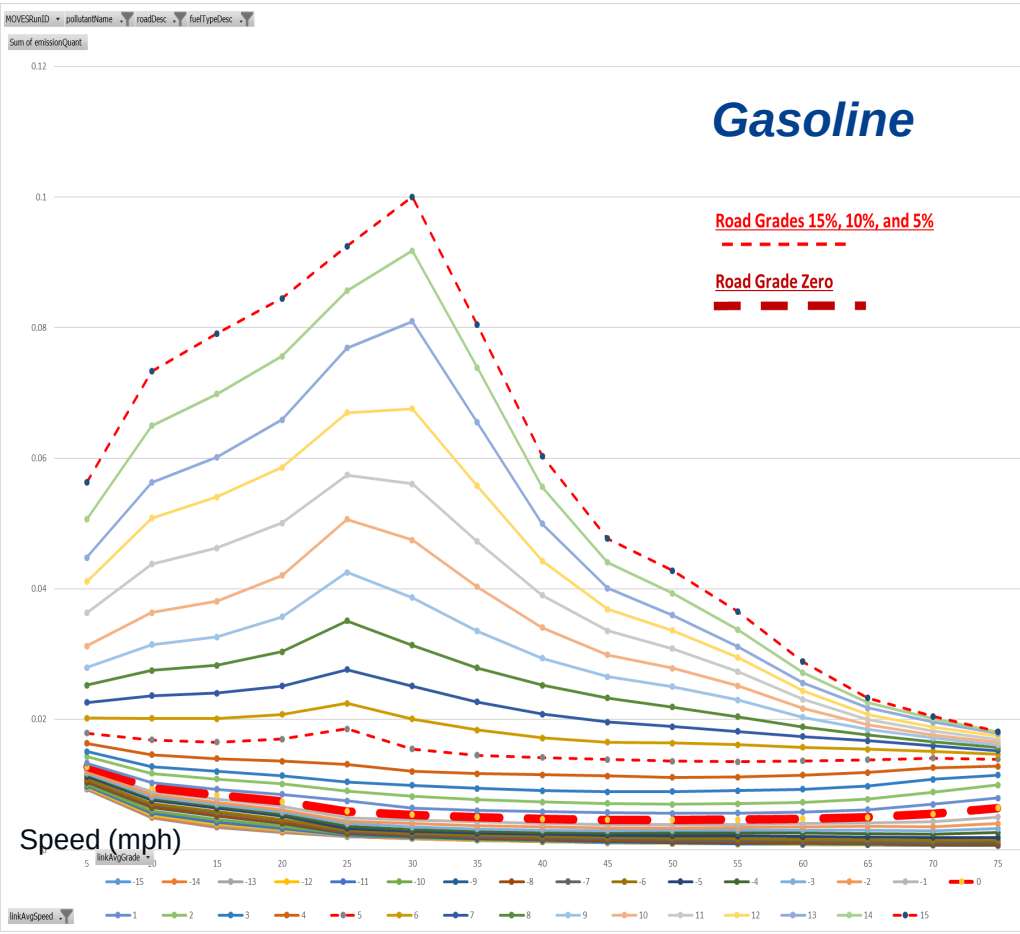




2020 Exhaust PM2.5 - Diesel v. Gasoline, Urban Unrestricted

(MOVES2014a, Based on EPA 2018 Training File for PM2.5, Oct 12, AM)





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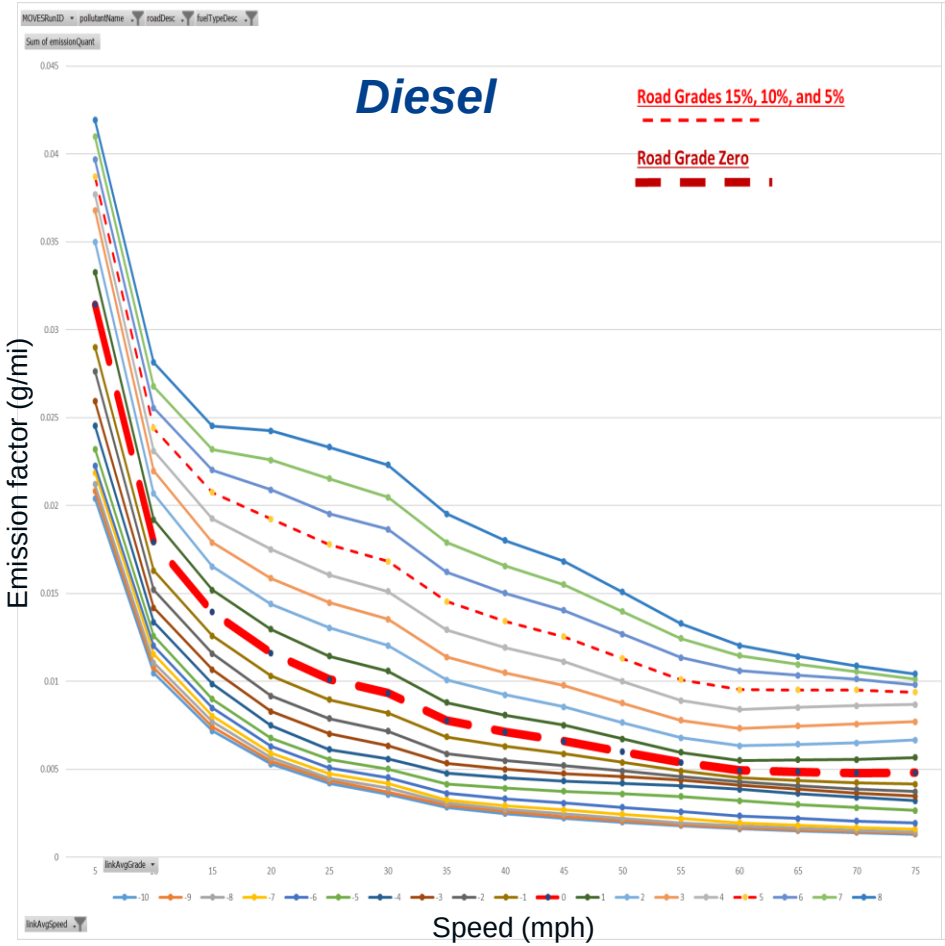

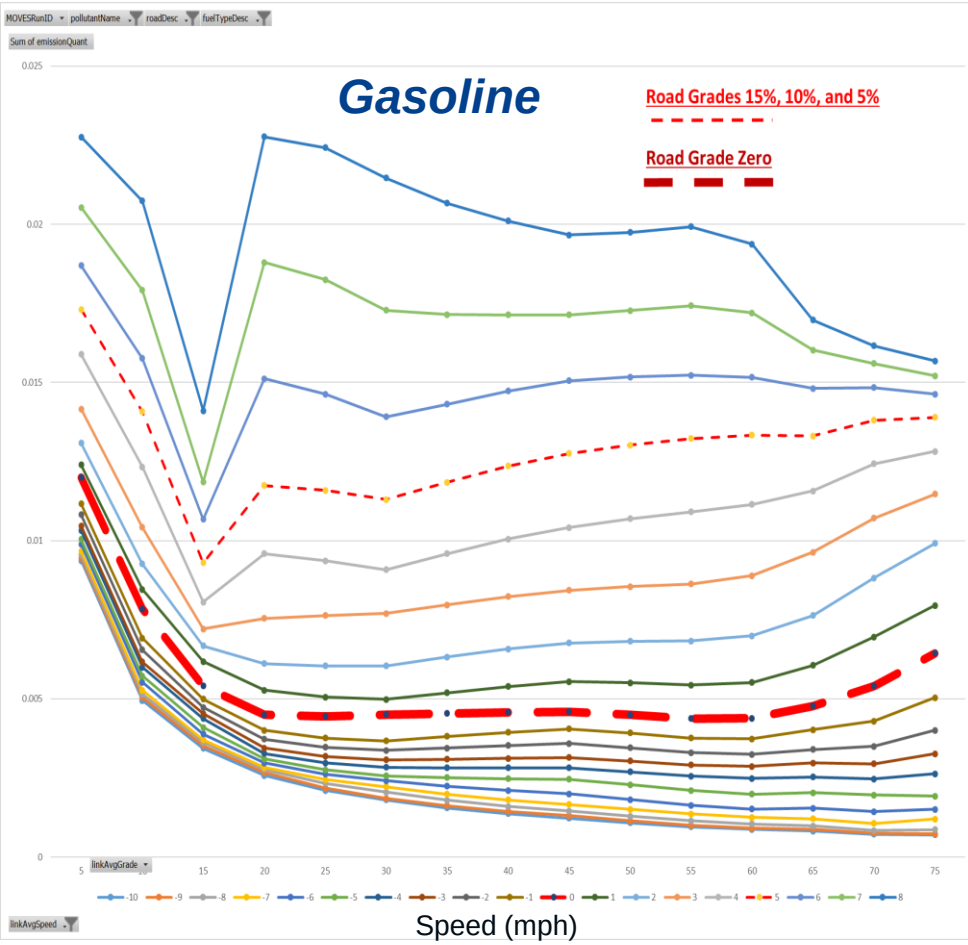

RECOMMENDED PROJECT-LEVEL IMPROVEMENTS FOR MOVES

No.	Priority	Timeframe	Category	Recommendation	Comment
1a	CRITICAL	Near-Term	Accuracy	Develop & implement as needed an "*Interim Policy on Limitations on Applications for MOVES for Higher Road Grades.*" Provide supporting charts showing the road grades for each pollutant, facility type etc. for which the model may be applied. Provide a statement on limitations in emission modeling and potential uncertainties that state DOTs can include in NEPA documentation for purposes of transparency and disclosure.	Needed to limit regulatory application of MOVES to where it has been validated (minimizing risk), and also for transparency. May recommend replacement by qualitative analyses, noting for conformity for PM that would be consistent with 40 CFR 93.123(b)(2). Terminate interim policy when underlying issue(s) addressed (Item 1b).
1b	CRITICAL	Medium- to Long-Term?	Accuracy	Validate MOVES emission factors (EFs) for higher road grades and speeds, covering the range of road grades typically expected in practice, and at a minimum those specified in the AASHTO Green Book by road type. Provide supporting charts with the final documentation showing the road grades for each pollutant, facility type etc. for which the model may be applied and provide text explaining how and why the curves vary with each chart. Priority: PM2.5, PM10, CO and MSATs.	Apparent issues with modeled EFs at higher road grades and speeds may be due to multiple factors TBD. The modeled results should be validated against field/test data for fleet average EFs as well as by source type, fuel type, and pollutant, all by road type. The actual range of road grades in place should be reviewed to cover existing roadways and not just those subject to design standards for future construction, with a priority for areas subject to conformity for PM. References: 1) Attached charts for PM, CO, etc., showing need for model validation. 2) AASHTO Green Book: *https://store.transportation.org/item/collectiondetail/180*

RECOMMENDED PROJECT-LEVEL IMPROVEMENTS FOR MOVES

No.	Priority	Timeframe	Category	Recommendation	Comment
2	High	Near-Term	Accuracy	Adjust project-level EFs based on mileage accumulation rates (MARs), as already done for regional modeling. Priorities: PM2.5, PM10 and CO, then other project-level pollutants.	Can start with MOVES default MARs, and later provide option of user-specified. Major benefit for PM where margins are small. Recommended in 2018 NCHRP 08-108 (*https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3860*) & 2009 NCHRP 25-38 *(https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1656*.
3a	High	Near-Term	Stream-lining & QA/QC	Provide check boxes to allow modelers to select defaults for all MOVES inputs for which defaults are available.	Very inefficient to export data from PDM and then re-import it for analyses involving multiple counties and alternatives. For example, no need for user to "inspect" the same fuel defaults multiple times for different alternatives. Would also be able to check consultant runs much easier to ensure fuel defaults were used, i.e., that the check box for default fuels was selected.
3b	High	Near-Term	Stream-lining & QA/QC	Provide check boxes for selecting running emissions, with the priority on PM and CO.	Exhaust and crankcase running exhaust for CO. For PM, also include brake and tire wear.
3c	High	Near-Term	Stream-lining & QA/QC	Provide check boxes for selecting FHWA-specified MSAT pollutants and processes (running emissions only). See: *https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/*	FHWA-specified MSATs to model: "*1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (diesel PM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter*." FHWA running emission processes to model: exhaust, crankcase exhaust, evap permeation, evap leaks

RECOMMENDED PROJECT-LEVEL IMPROVEMENTS FOR MOVES

No.	Priority	Timeframe	Category	Recommendation	Comment
4	High	Medium-Term	Accuracy & Stream-lining	*Prioritize inputs that contribute most cost-effectively to accuracy and reductions in uncertainty* : Conduct a study to rigorously and systematically identify inputs that are the most cost-effective to obtain or generate that will best serve to improve accuracy and reduce uncertainty.	*Uncertainty Study* : Also conduct a study with DOTs and other transportation stakeholders to address the NRC recommendation to assess & communicate uncertainty. Consider uncertainty from inputs as well as those from the model itself. Consider also the option of assessing uncertainty for the traffic, emission and dispersion modeling chain instead of just the emission model.
5	High	Ongoing	All	Continue consultation with DOTs and their consultants on needed model improvements, consistent with the recommendations of the 2007 NRC report, and placing a high priority on project-level modeling needs.	Recognizing the excellent work by EPA in consultation under the existing MOVES FACA process, and recommending it be continued as standard practice (even if/when MOVES FACA requirements may be removed)
6	Medium-High	Near-Term	Accuracy	Implement the recommendations of NCHRP Research Report 909 "*Guide to Truck Activity Data for Emissions Modeling (2019)* " to the extent feasible and appropriate.	RR 909: *http://www.trb.org/Main/Blurbs/178921.aspx* RR 909 Appendices: *http://www.trb.org/Main/Blurbs/178906.aspx* NCHRP 08-101 webpage: https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3860
7	Medium-High	Medium- to Long-Term	Accuracy & Stream-lining	Source Types: Converge with FHWA/HPMS vehicle types to extent feasible	

Questions or comments?

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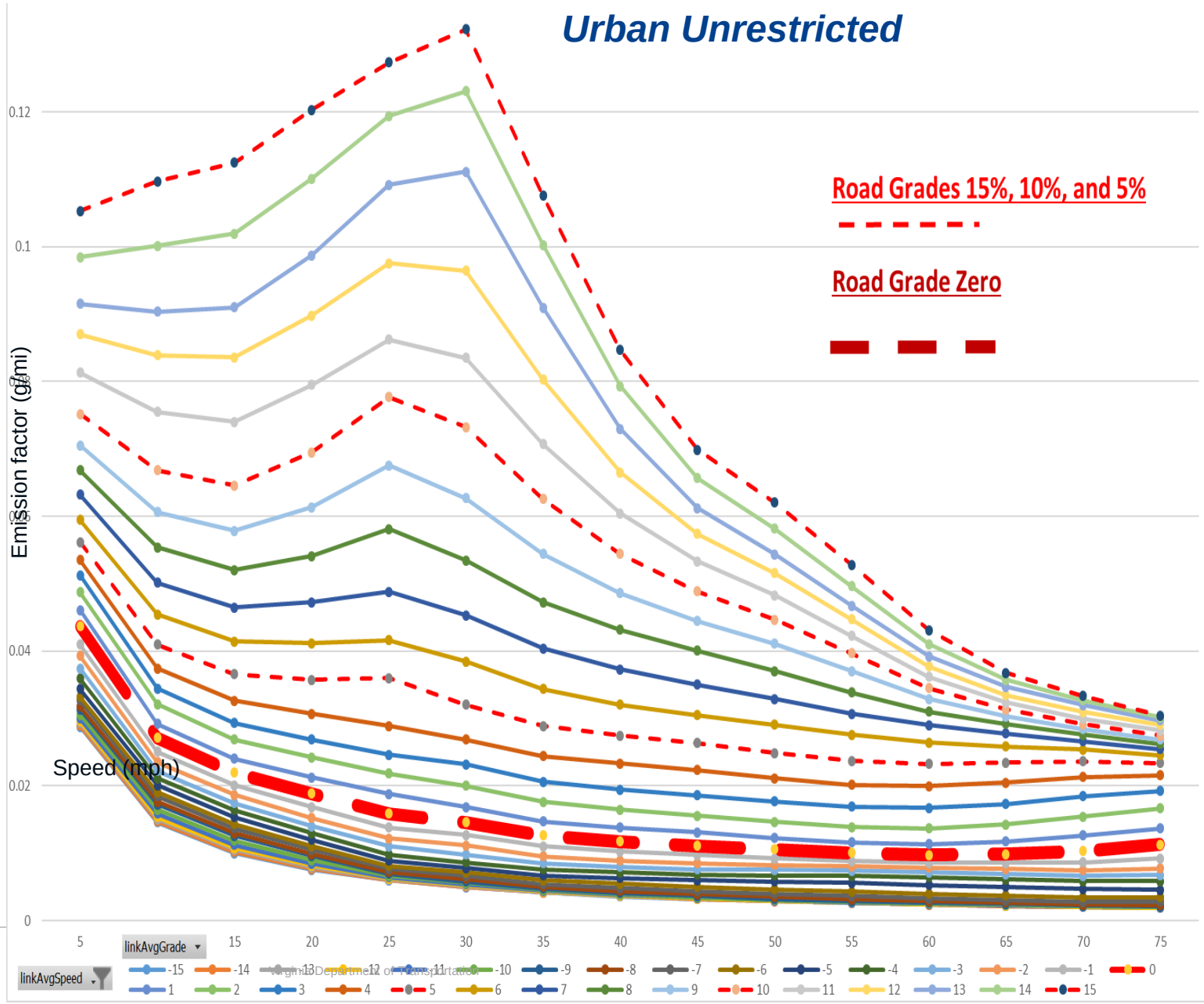
Trailer

RECOMMENDED PROJECT-LEVEL IMPROVEMENTS FOR MOVES

No.	Priority	Timeframe	Category	Recommendation	Comment
8	Medium	Medium-Term	QA/QC	Provide sample run-specs and input and output files for typical transportation projects (intersection, interchange etc.)	Similar to what is done by EPA for dispersion models, e.g., Sample input and output files for CAL3QHC. Serves to ensure model installed properly and any output processing is also done correctly. Also provides a template for beginning analyses (saving time) and improving quality (including implementing best practices for specifying links). May also serve as a training aid.
9	Medium	Medium-Term	QA/QC	Provide context-sensitive guidance, checks on input data, etc.	
10	Medium	Medium- to Long-Term	Accuracy	Support alternative OpMode Distributions (OMDs)	For conformity applications particularly, better define the process for using OMDs determined in research for typical transportation facility types, e.g., congested interchanges and intersections
11	Medium	Long-Term	Accuracy	Increase coverage of alternative fuels	CMAQ Simplified Toolkit (NCHRP 25-25 Task 108) uses AFLEET (US DOE) factors, as MOVES does not cover enough fuel types. Immediate need reduced w/ the provision of the CMAQ Simplified Toolkit.
12	Medium	Long-Term	Stream-lining & QA/QC	Improve linkages with EPA dispersion models.	Consider NCHRP 25-48 TRAQS open source code as a starting point.
13	Low	Near- to Medium Term	Stream-lining & QA/QC	Create a tool (spreadsheet or otherwise) to help specify links for intersections and interchanges, e.g., helping to specify link lengths using typical acceleration rates, Provide default configurations.	Related Example: Synchro (traffic/intersection model)
14	Low	Long-Term	Stream-lining & QA/QC	Scenario Manager: Allow users to better manage modeling, e.g., multiple runs and comparing incremental results (B/NB for multiple alternatives)	Example: Cube Voyageur (traffic model)

MOVES2014a Fleet Average EFs for 2020 Exhaust PM2.5

(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)



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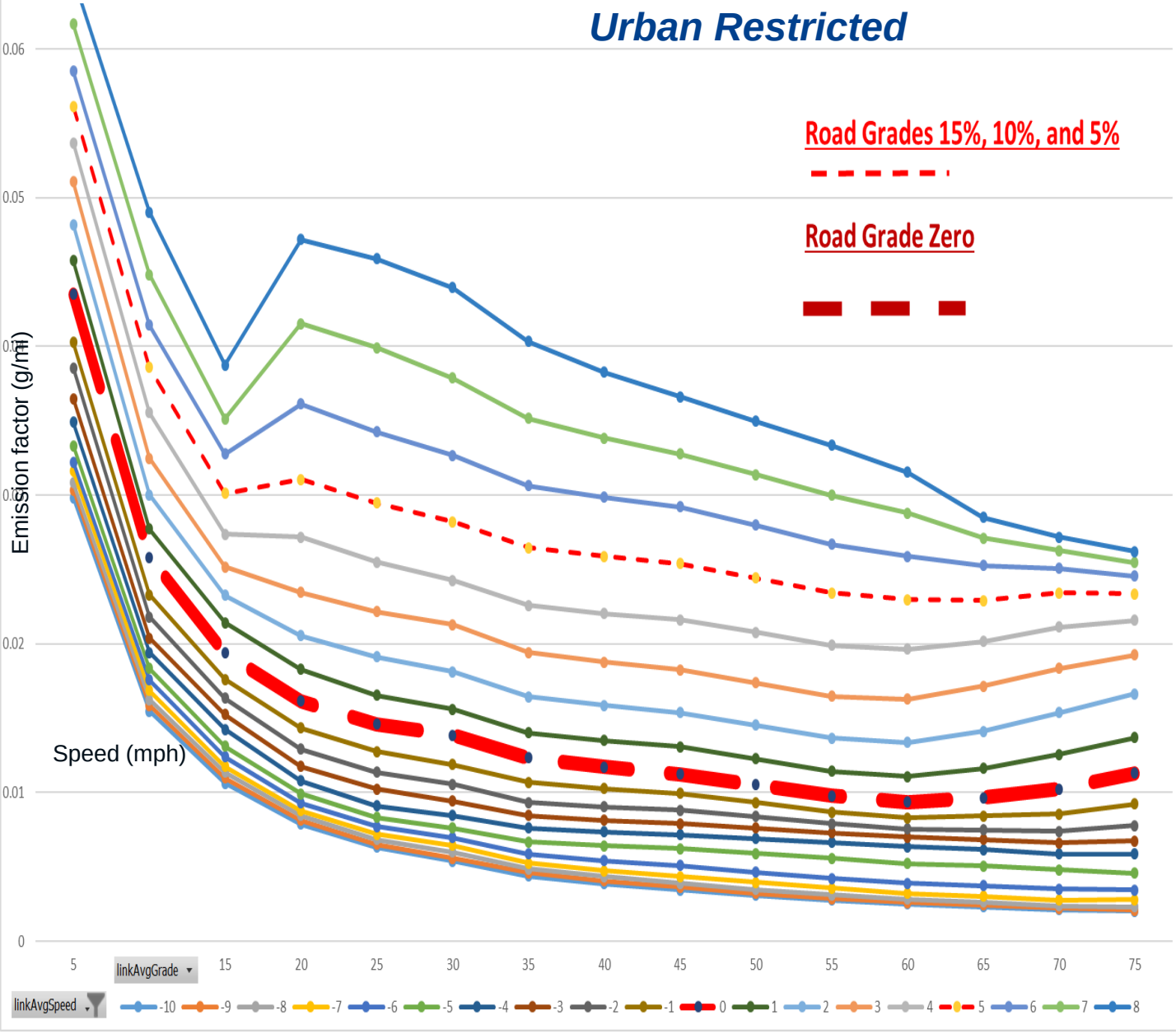
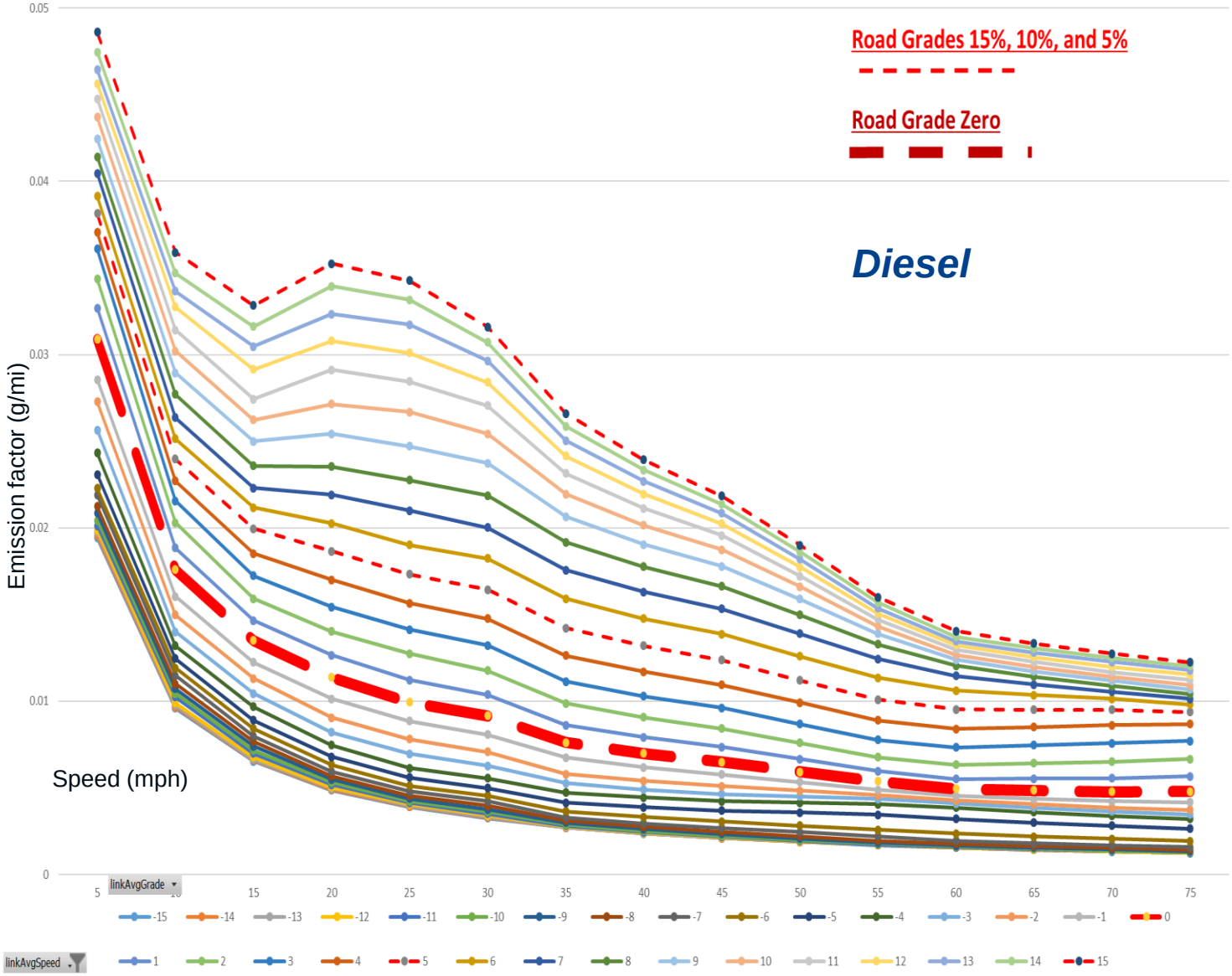


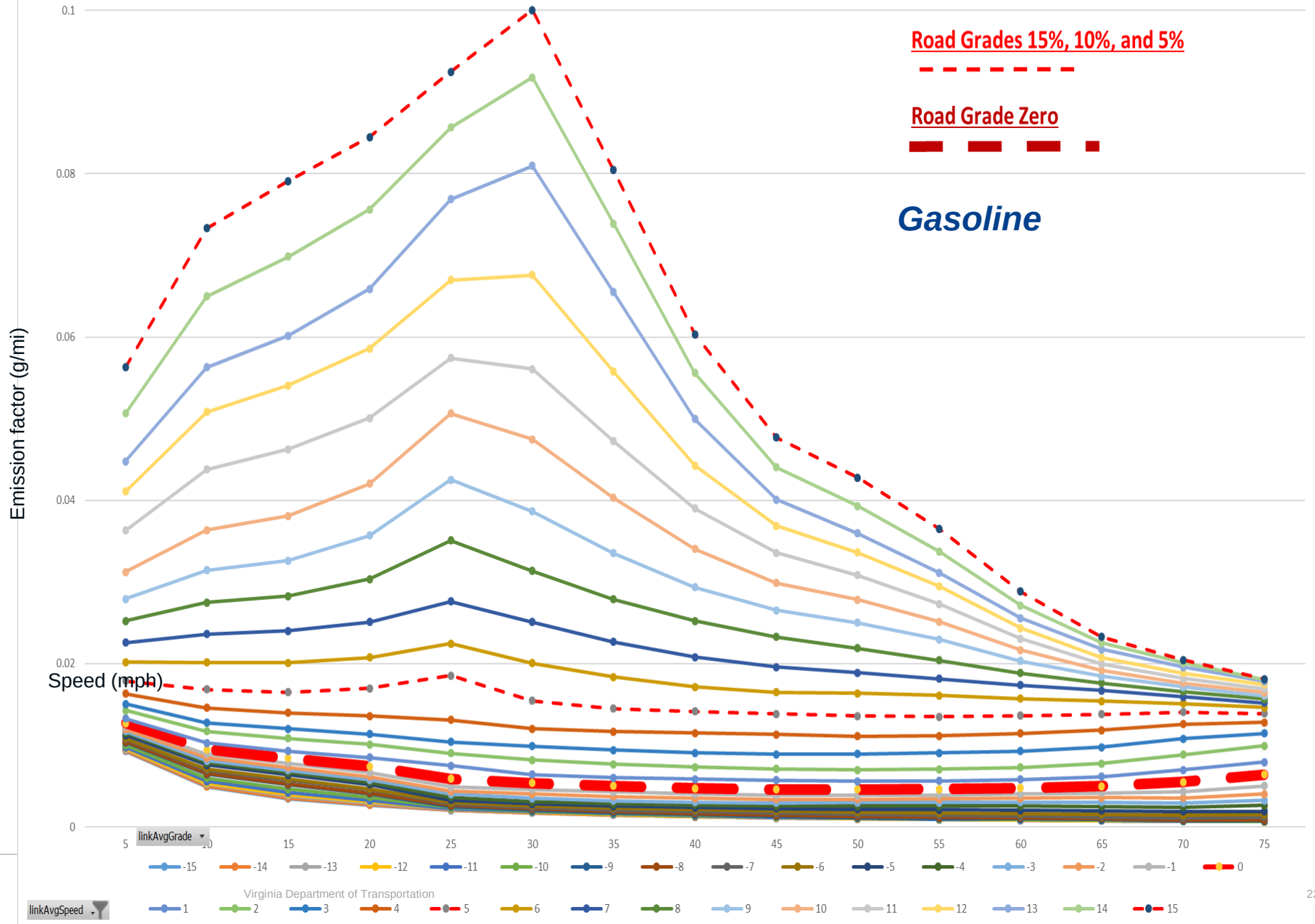
MOVES2014a 2020 Exhaust PM2.5 - Urban Unrestricted

(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)



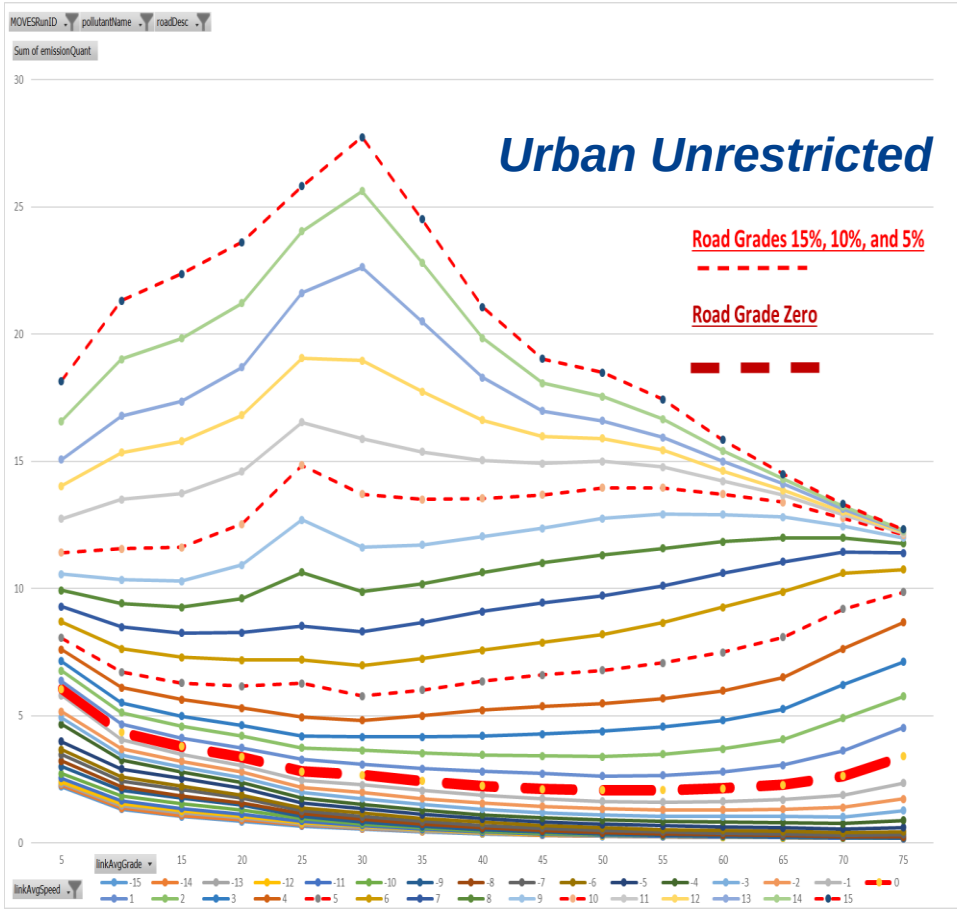
MOVES2014a 2020 Exhaust PM2.5 - Urban Unrestricted

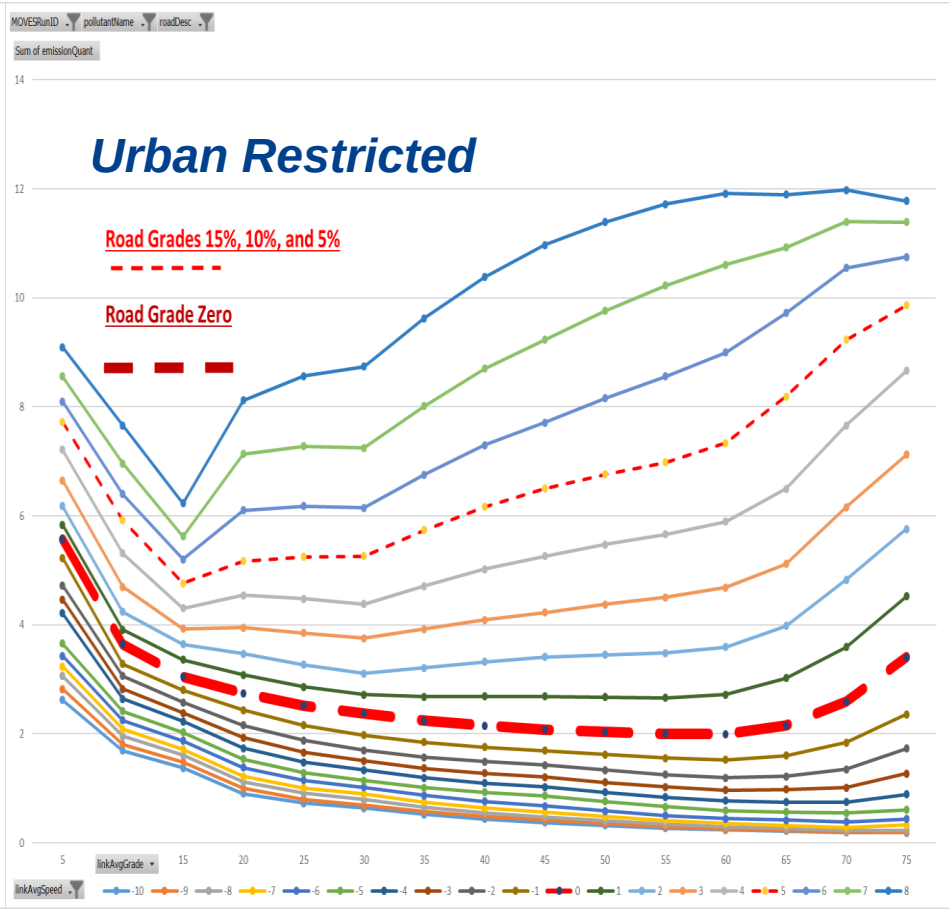
(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)



MOVES2014a Fleet Average EFs for 2020 Exhaust CO

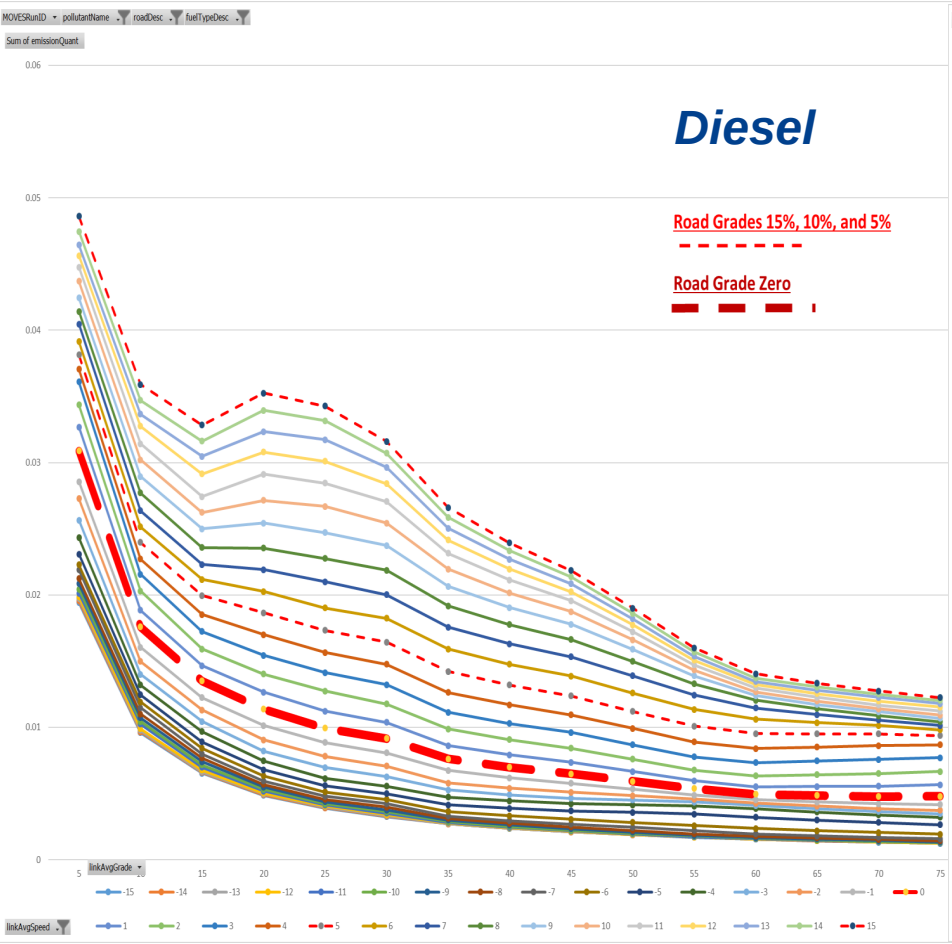
(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)

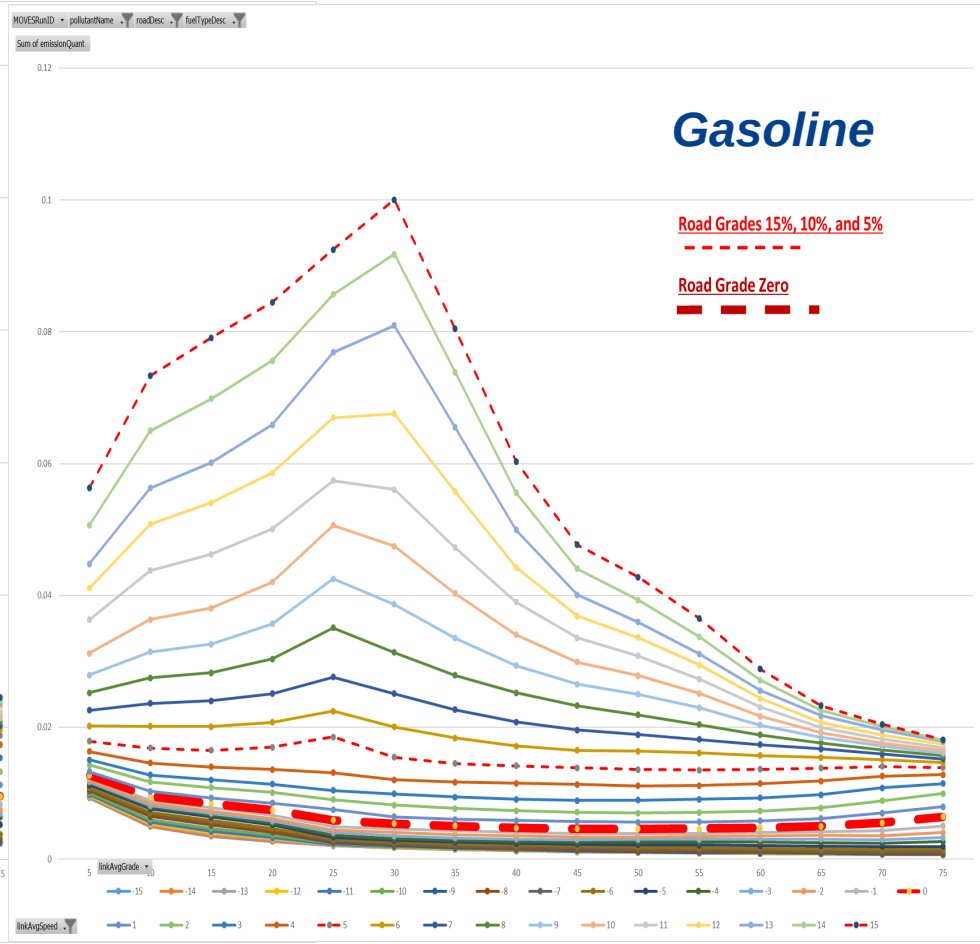




2020 Exhaust CO - Diesel v. Gasoline, Urban Unrestricted

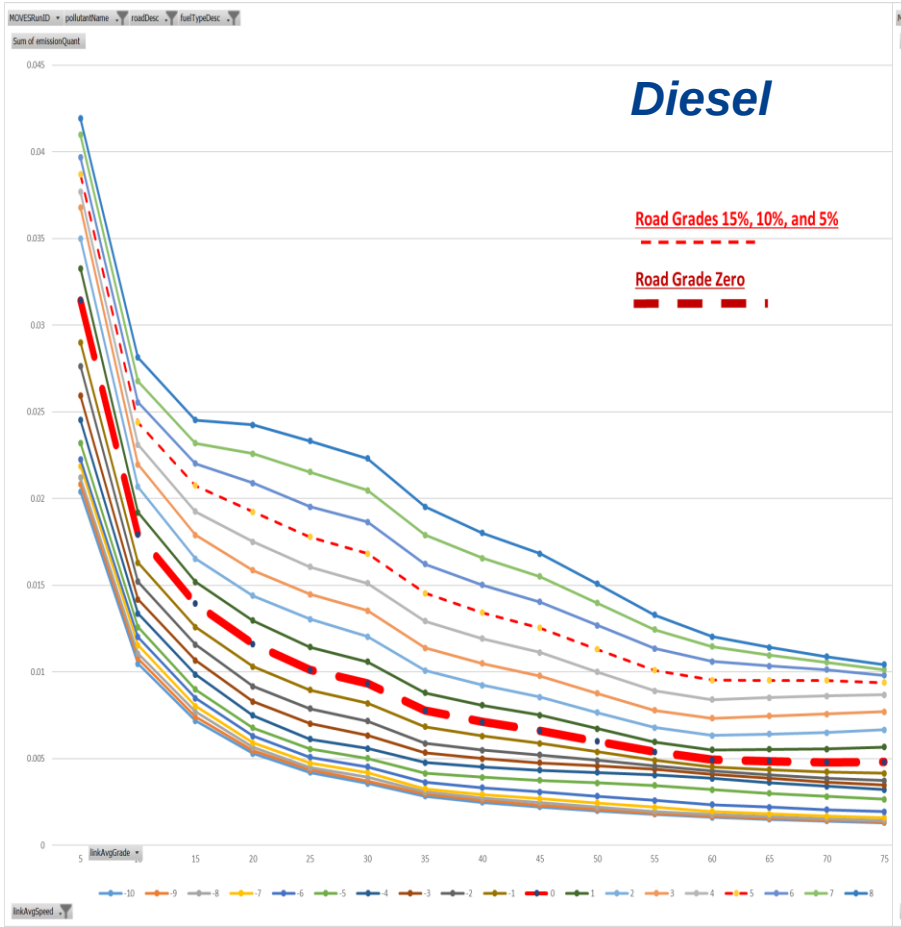
(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)

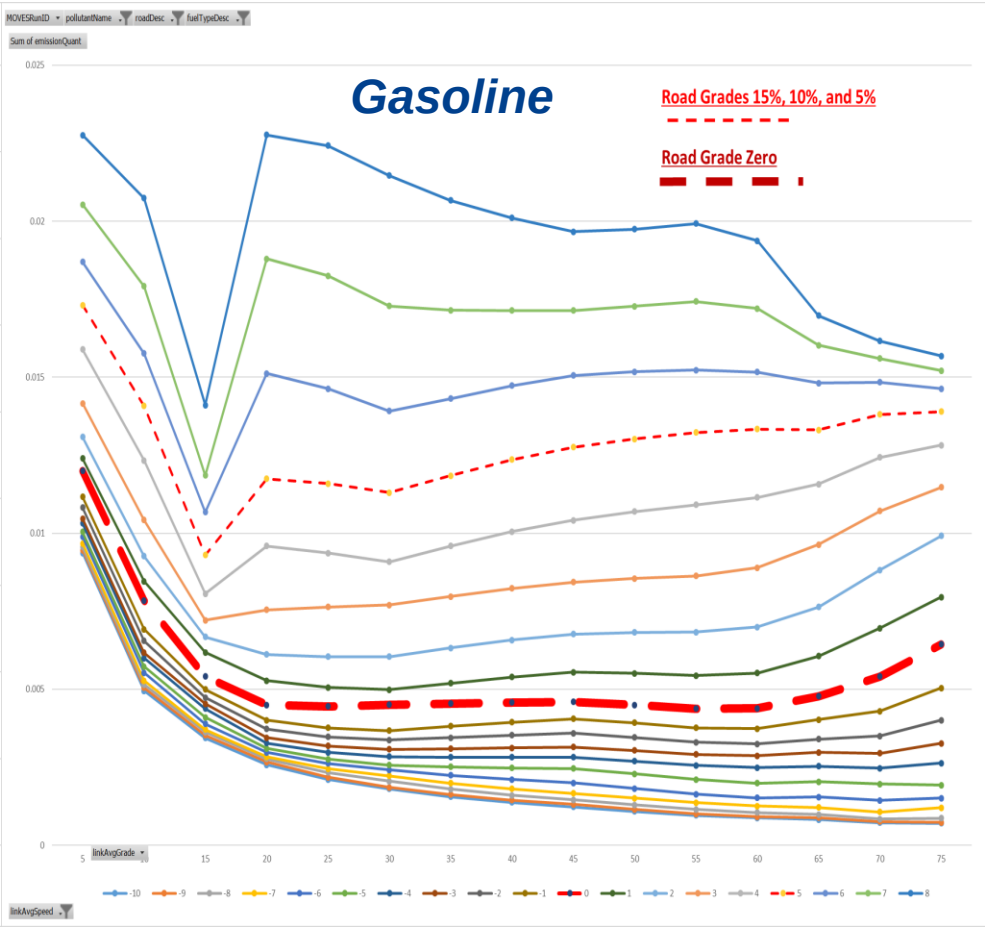




2020 Exhaust CO - Diesel v. Gasoline, Urban Restricted

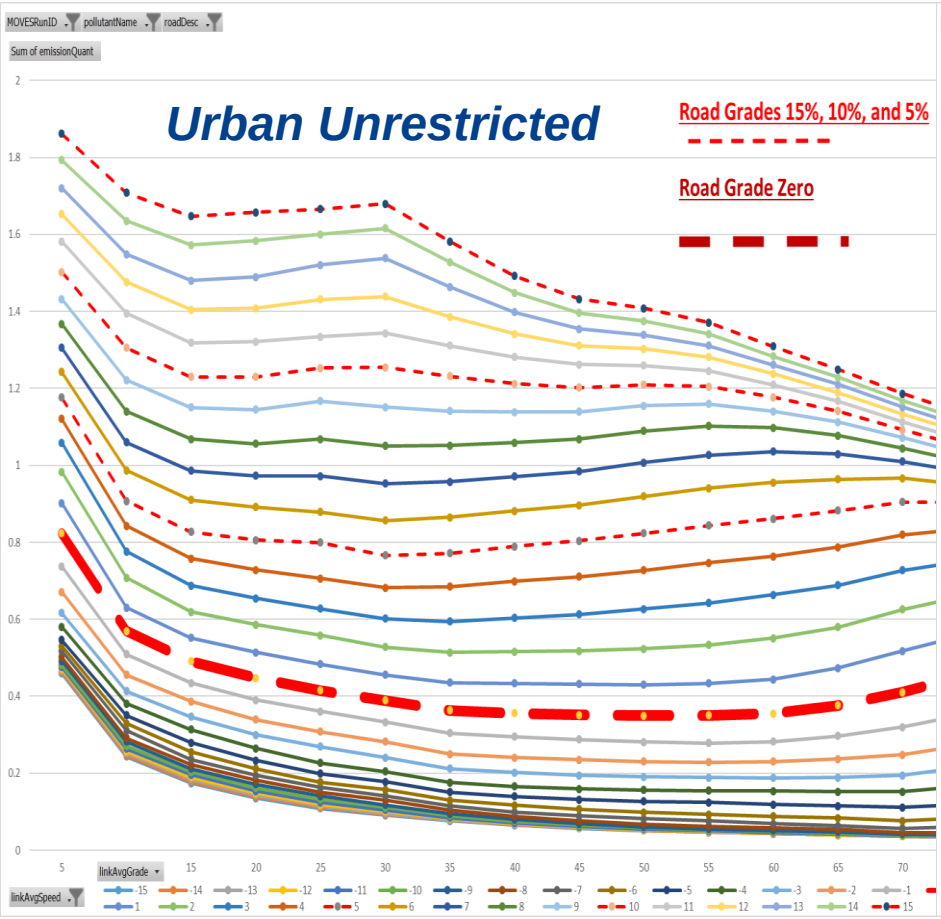
(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)

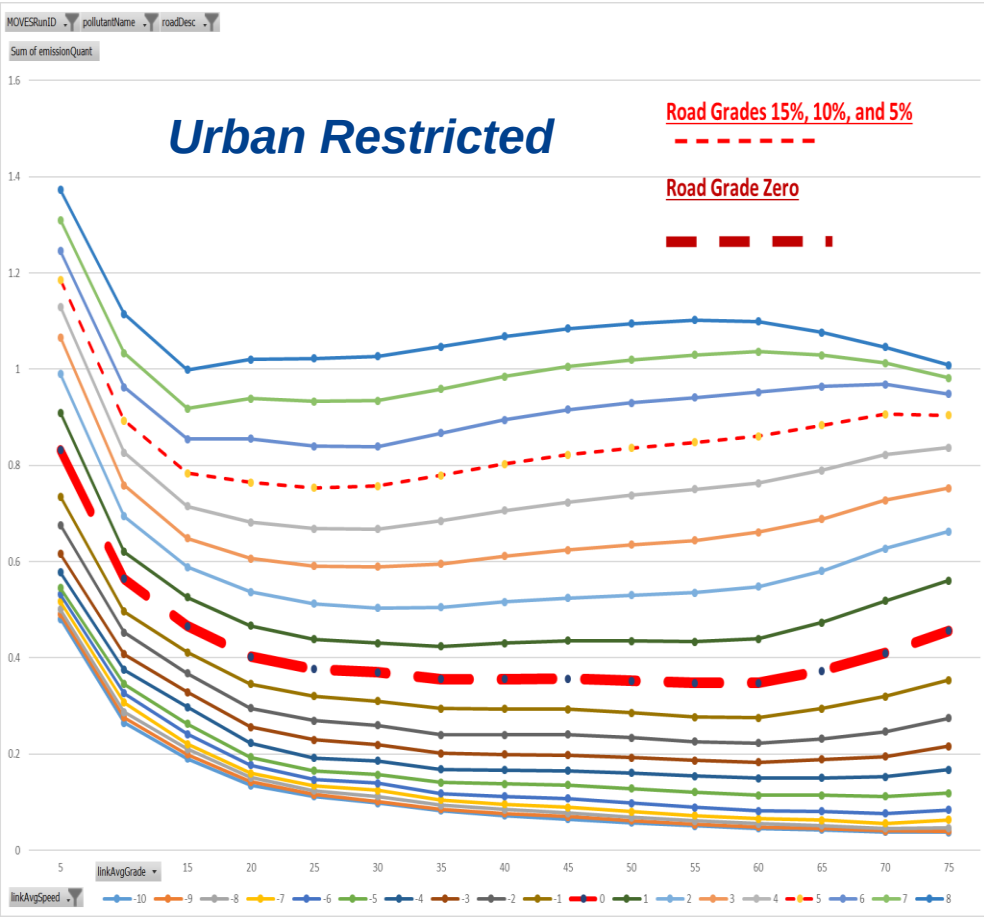




MOVES2014a Fleet Average EFs for 2020 Exhaust NOx

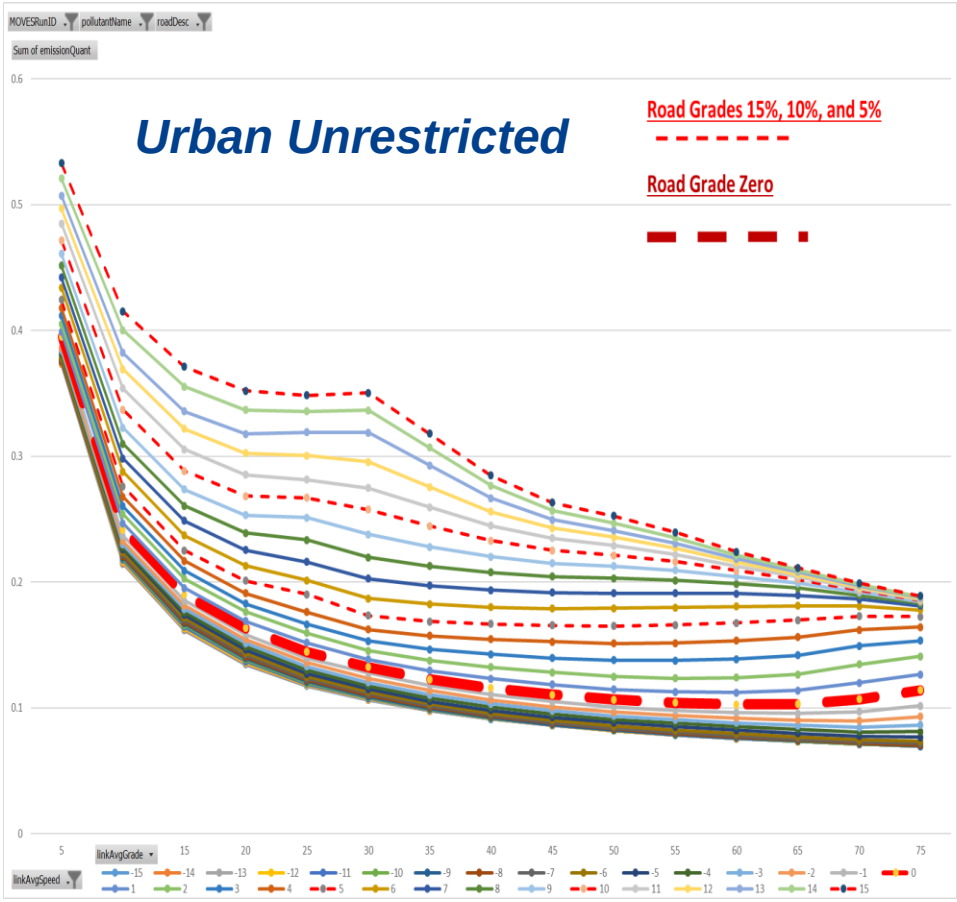
(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)

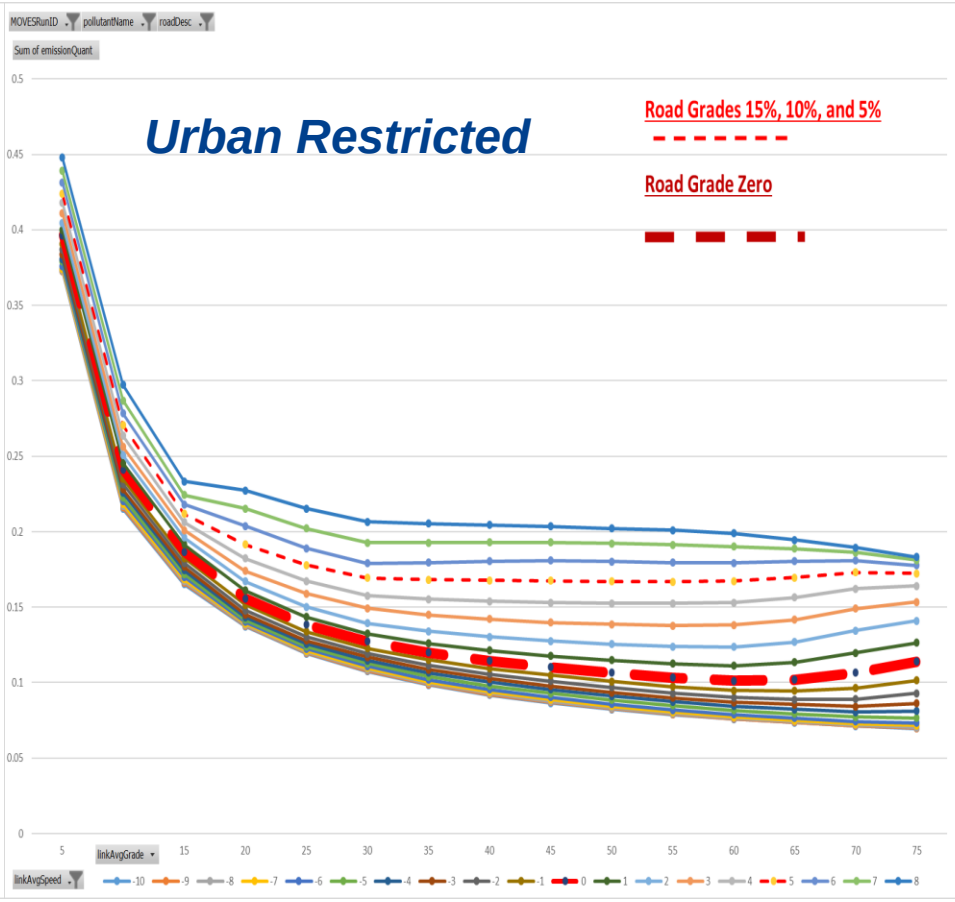




MOVES2014a Fleet Average EFs for 2020 Exhaust VOC

(Based on EPA 2018 Training File for PM2.5, Oct 12, AM)





EPA Transportation Conformity Rule (emphasis added)

40 CFR 93.123 CO, PM10, and PM2.5 concentrations (hot-spot analysis).

...

(b) PM10 and PM2.5 hot-spot analyses.

...

(2) Where quantitative analysis methods are not available, the demonstration required by § 93.116 for projects described in paragraph (b)(1) of this section must be based on a qualitative consideration of local factors.