TECHNICAL SUPPORT DOCUMENT
FOR ON-ROAD MOBILE SOURCES:
SUMMERTIME 2023 PROJECTION OZONE EMISSIONS INVENTORY
FOR THE NORTHERN WASATCH FRONT, UT NONATTAINMENT AREA
AND SURROUNDING MODELING DOMAIN WITHIN UTAH

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Utah Division of Air Quality
Planning Branch/Mobile Sources

Abstract

This report discusses the on-road mobile source summertime 2023 projection ozone emissions inventory for the Northern Wasatch Front, Utah (UT) Ozone Nonattainment Area (NA) covering Davis, Salt Lake, Tooele and Weber Counties and the remaining 25 counties within the state of Utah. On-road inventories were calculated using EPA MOVES 3 (Motor Vehicle Emission Simulator).

Agencies that developed the 2023 projection inventory:

Northern Wasatch Front, UT Ozone NA:
Wasatch Front Regional Council (WFRC): Davis, Salt Lake, Tooele and Weber Counties

Surrounding Modeling Domain:

Mountainland Association of Governments (MAG): Utah County (Southern Wasatch Front, UT Ozone NA)

Utah Department of Transportation: (UDOT): Duchesne and Uintah Counties
(Uintah Basin, UT Ozone NA)

Cache Metropolitan Planning Organization (CMPO): Cache County

Utah Division of Air Quality (UDAQ): Beaver, Carbon, Daggett, Duchesne, Emery, Garfield, Grand, Iron, Juab, Kane, Millard, Morgan, Piute, Rich, San Juan, Sanpete, Sevier, Summit, Uintah, Wasatch, Washington, and Wayne Counties

Wasatch Front Regional Council (WFRC): Box Elder County

Local activity travel data inputs were developed and implemented to characterize summertime travel conditions for a weekday Monday-Friday, Saturday, and Sunday expressed as Vehicle Miles of Travel (VMT).

Summary Table at the end of the TSD: On-Road Mobile Sources Summertime 2023 Projection Ozone emission inventories representing a Summer Weekday (Tons per Summer Weekday)

3.e.ii) ON-ROAD MOBILE SOURCES OZONEEMISSIONS INVENTORIES

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ii. Glossary of Acronyms:

Alternative Vehicle and Fuels & Technology: (AVFT)

Cache Metropolitan Planning Organization: (CMPO)

County Data Manager: (CDM)

Environmental Protection Agency: (EPA)

Mountainland Association of Governments: (MAG)

MOVES 3: (Motor Vehicle Emission Simulator)

Nonattainment Area: (NA)

Utah Division of Air Quality (UDAQ)

Utah Department of Transportation: (UDOT)

Vehicle Hours Traveled: (VHT)

Vehicle Miles Traveled: (VMT)

Utah: (UT)

Wasatch Front Regional Council (WFRC)

iii. Overview

The purpose of this document is to explain what emissions modeling assumptions were used to develop the on-road mobile source summertime 2023 projection ozone emissions inventory for the Northern Wasatch Front, UT Ozone Nonattainment Area (NA) covering Davis, Salt Lake, Tooele and Weber Counties and the remaining 25 counties within the state of Utah.

Emission estimates are confined to the EPA approved MOVES 3 (Motor Vehicle Emission Simulator). This model produces emissions daily estimates for on-road vehicles by providing emissions profiles for starts, exhaust, evaporative, and hot soak conditions. Inputs include speeds, vehicle fuel profiles and specifications, vehicle miles traveled (VMT), Inspection and Maintenance program (I/M) profiles, VMT mix, vehicle age distributions, and meteorological conditions.

The following agencies developed the 2023 projection on-road mobile source emissions inventories:

Northern Wasatch Front, UT Ozone NA:
WFRC: Davis, Salt Lake, Tooele, and Weber Counties

Surrounding Modeling Domain:
CMPO: Cache County (Ozone Attainment Area)

MAG: Utah County; (Southern Wasatch Front, UT Ozone NA)

UDAQ: Beaver, Carbon, Daggett, Emery, Garfield, Grand, Iron, Juab, Kane, Millard, Morgan, Piute, Rich, San Juan, San Pete, Sevier, Summit, Wasatch, Washington, and Wayne Counties. (Ozone Attainment Areas)

UDOT: Duchesne and Uintah Counties; (Uintah Basin, UT Ozone NA)

WFRC: Box Elder (Ozone Attainment Area)

iv. MOVES Modeling Procedure

The discussion below identifies the procedures followed to model the episodic inventories.

1. MOVES 3

The EPA MOVES 3 model was used to produce summertime on-road emissions estimates for an average weekday, Saturday and Sunday.[4]

2. MOVES 3 Daily Pollutants

- Ammonia (NH3)
- Carbon Monoxide (CO)
- Oxides of Nitrogen (NOx)
- $PM^{2.5}$ Exhaust (PM25_Ex)
- Volatile Organic Compounds (VOC)

3. MOVES 3 Local Model Inputs

(a) County Data Manager Development
MOVES organizes data inputs into databases called County Data Manager (CDM) tables. CDMs were developed for 29 counties for each year: 2023 average weekday, Saturday, and Sunday in July.

(1) Average Speed Distribution and VMT

WFRC method:
The WFRC travel demand model has detailed highway and transit networks and socio-economic data for model years 2015, 2019 and 2024. For modeling the 2023 ozone attainment year, the WFRC used a modified version of the 2024 travel demand model. To allow for fluctuations in future VMT estimates of vehicle miles traveled, the WFRC increased the 2024 VMT by 10%. The 2023 VMT estimates were then interpolated between 2019 and 2024. In addition, to address the anticipated development of trucking operations at the Utah Inland Port, the VMT for single unit trucks was increased by 15%, and for combination trucks by 30%.

The speed distribution for 2023 used the 2024 travel model results as this parameter does not change dramatically from year to year.

Improvement to the WFRC travel demand model practice and procedure is an ongoing process. Version 8.3 of the travel demand model updates the former 2011 base year with socio-economic data and transportation networks for the new 2015 base year. The new model also incorporates the results of the 2012 Household Travel Survey conducted by WFRC. Version 8.3 of the model adds more traffic analysis zones, and the transit mode choice portion of the model has been enhanced.

The WFRC travel model is used to estimate and forecast highway Vehicle Miles Traveled (VMT) and vehicle speeds for Weber, Davis, and Salt Lake Counties. The Utah State Travel Model (USTM) is used to estimate VMT and speed in Box Elder County and Tooele County. The WFRC travel demand model is based on the latest available planning assumptions and a computerized representation of the transportation network of highways and transit service. The base data for the travel demand model is reviewed regularly for accuracy and updates.

Seasonal factors for highway VMT variations have been revised and refined by research commissioned by the UDOT. Seasonal factors are determined for each link of the highway system based on the functional class (freeway or arterial) and the area type (rural, transitional, suburban, and urban). Other considerations include traffic volume and recreational activity.

After validating the travel demand model volumes to reflect observed volumes at the highway segment level, the overall VMT by functional class and county is adjusted to match the corresponding VMT reported in the HPMS system for the 2015 base year. The various county and functional class adjustment factors for the 2015 base year are then applied to all future travel demand model VMT estimates. In most cases the HPMS adjustment factor is within +/- 10%.

Vehicle type VMT percentages, commonly referred to as VMT mix in the MOVES modeling domain, were estimated from UDOT vehicle type classification counts by county based on vehicle length. Weigh-in-motion data was used to distinguish longer vehicle types (particularly vehicle pulling trailers).

WFRC created a program titled TDM2MOVES to generate MOVES input files from the Cube 6.4 travel demand model output. The TDM2MOVES program creates speed profiles, road type distribution, ramp fractions, VMT by vehicle type, and vehicle population data files to be used in the MOVES model.

<u>MAG method:</u>
MAG utilized the 2024 Utah County Average Speed Distribution file the TDM produces in the format appropriate for use in the MOVES model, MAG interpolated year 2023 from 2017 and 2024 data. MAG then applied seasonal factors derived from seasonal traffic engineering area counts.

<u>UDOT and CMPO method:</u>
UDOT obtained average speed distributions and VMT from the UDOT State Travel Demand Model (TDM) for the Ozone nonattainment areas of Duchesne and Uintah Counties and surrounding rural counties. The CMPO obtained speed and VMT data from their own separate TDM. Both TDMs analyzes thousands of separate traffic segments called "links" that together comprise the network of roads. Each link is assigned, for each of the four major time periods during the day (AM peak, midday, PM peak and nighttime), an average speed, an increment of VMT and an increment of VHT (vehicle hours traveled). A specific number of

links are assigned to each of the UDOT Highway Performance Monitoring System (HPMS) functional classes (road types, e.g., rural local, urban local, rural minor arterial, urban minor arterial, and so on). In effect, average speeds, VMT and VHT for each of the functional classes are combined to obtain average speed, VMT and VHT for rural freeways, rural arterials, urban freeways, and urban arterials. 2024 TDM Speeds are used to represent 2023 and TDM vmt data is interpolated from 2015, 2019, 2024. Seasonal factors for highway VMT variations have been revised and refined by UDAQ with data supplied by the UDOT. Seasonal factors are determined by functional class (freeway or arterial) for each county.

(2) AVFT (Alternative Vehicle and Fuels & Technology: Electric, Diesel and Gasoline Vehicle Fractions)

WFRC, CMPO, MAG, UDAQ and UDOT method:
The MOVES default file for AVFT was updated with 2019 State DMV registration data (dated January 1, 2019). This data is not by model year and is the only DMV data source that provide fuel type for registered light duty vehicles (passenger cars and light duty trucks).

DMV data	AVFT Model Years
2019	2060-2018
2018	2017
2017	2016
2016	2015
2015	2014-1960

MOVES 3 default AVFT values were used for all remaining source type vehicles.

(3) Fuel

WFRC, CMPO, MAG, UDAQ and UDOT method:
MOVES 3 default fuel parameters were used.

(4) HourVMTFraction

WFRC, CMPO, MAG, UDAQ and UDOT method:
MOVES 3 default Hour VMT Fraction values were used

(5) I/M Coverage: Cache, Davis, Salt Lake, Utah, and Weber Counties

UDAQ constructed I/M Program coverages in consultation with the local county health departments in Cache, Davis, Salt Lake, Utah, and Weber Counties. Vehicles older than 1995 undergo a Two Speed Idle (TSI) test and vehicles newer than 1996 undergo On Board Diagnostic Testing (OBD). Years that were covered include 2023. Davis, Salt Lake, Utah and Weber Counties I/M programs exempt the first two model years, biennially test the third through sixth model years, and perform an annual test on the remaining vehicles. The Cache County I/M program exempts the first six model years and perform a biennial test on vehicles beginning in the seventh model year. Below is a summary covering I/M programs in the year 2023.

Summary of the I/M Programs for Davis, Salt Lake, Utah, and Weber Counties covering 2023.

Year	Vehicle Type	Beg Model Year	End Model Year	Frequency	I/M Test
2023	Cars & Trucks	1968	1995	Annual	TSI
2023	Cars & Trucks	1996	2017	Annual	OBD
2023	Cars & Trucks	2018	2021	Biennial	OBD

Summary of the I/M Program for Cache County covering 2023

Year	Vehicle Type	Beg Model Year	End Model Year	Frequency	I/M Test
2023	Cars & Trucks	1996	2017	Biennial	OBD

Summary of additional I/M Program coverage test procedures

County	Beg Model Year	End Model Year	I/M Test
Davis	1990	2001	Gas Cap Pressure Test
Salt Lake	1968	2001	Gas Cap Pressure Test
Weber	1968	2001	Gas Cap Pressure Test

(6) Road Type Distribution

WFRC method:
The road type distribution for 2023 used the 2024 travel model results as this parameter does not change dramatically from year to year.

The TDM2MOVES program discussed in the Speed Profile section also generates road distribution files to be used in the MOVES model. Prior to this emission modeling effort for the 2017 baseline ozone inventory, WFRC modeling practice was to model local roads as a separate functional class with a modified default database. For the 2017 baseline ozone inventory and future emission modeling efforts, WFRC will include local road activity as part of arterial road activity when defining the road type distribution profile.

CMPO, MAG, UDAQ and UDOT method:
UDOT Program Development provided 2017 VMT travel fractions for FHWA vehicle classes grouped by Gross Vehicle Weight Rating (GVWR) ranges. The travel fractions were obtained by county from automated pneumatic counters that detect axle spacing and "weigh-in motion" (WIM) counters placed on arterial, interstate, and local roads. VMT and Vehicle Mix data were used to construct road type distribution and VMT by sourcetype.

(7) Source Type Age Distribution

WFRC method:
The vehicle age distribution data for vehicle types 11, 21, 31, 32, and 54 (motorcycles, passenger cars, passenger trucks, light duty commercial trucks, and motor homes) was based on DMV registration data for 2017. For other vehicle types the age distribution used MOVES default values because the state DMV data is an incomplete source for these vehicle types. The Age Distribution Projection Tool for MOVES 3 was used to project vehicle age profiles from 2017 data to all future years.

CMPO, MAG, UDAQ, and UDOT method:
The vehicle age distribution data for motorcycles, passenger cars, passenger trucks, and light duty commercial trucks up to 14,000 GVWR (11,21,31,32) are based on 2012-2019 DMV registration data (dated January 1, 2012-2019). Each year goes back to model year 1969. The DMV data provides a single age distribution for motorcycles (11) and a combined age for passenger cars (21) and light trucks (31,32). This calculation is used since Utah DMV data cannot discern between a passenger car (21) and light duty trucks (31,32). The age distribution from 2019 is used for all future modeling. MOVES default age distributions were used for heavy duty vehicles (41,42,43,51,52,53,54,61,62).

(8) Source Type Year (Vehicle Population)

WFRC method:
The WFRC travel demand model has detailed highway and transit networks and socio-economic data for model years 2015, 2019 and 2024. For modeling the 2023 ozone attainment year, the WFRC used a modified version of the 2024 travel demand model. To allow for fluctuations in future traffic, the WFRC increased the 2024 vehicle population estimates by 10%. The 2023 vehicle population estimates were then interpolated between 2019 and 2024. In addition, to address the anticipated development of trucking operations at the Utah Inland Port, the vehicle population for single unit trucks was increased by 15%, and for combination trucks by 30%.

WFRC estimates vehicle population as a function of estimated vehicle miles traveled (VMT). The WFRC estimates VMT using a sophisticated travel demand model which is based on projections for employment, population, land use, mode choice, and other factors. By associating vehicle population with travel demand model VMT estimates, the resulting vehicle population estimates will reflect to some degree the variations in future socio-economic factors, as well as shifts in mode choice resulting from transportation plans that emphasize alternative modes of travel. For example, a transportation plan that invests in an increase in transit mode choice should also result in some reduction in the number of vehicles.The WFRC compiled an inventory of 2017 vehicle population using State DMV data, State School bus reports, Utah Transit Authority annual reports, and MOVES defaults.

For MOVES vehicle types 21, 31, and 32 (passenger cars, and light duty trucks), the DMV total was multiplied by the MOVES default percentage for these vehicle types. This eliminates vehicle classification discrepancies between the MOVES default and the state classification. The vehicle population values were then divided by the 2017 VMT from HPMS to create a vehicle population factor for each vehicle type.

CMPO, MAG, UDAQ, and UDOT method:
The vehicle population data for motorcycles, passenger cars, passenger trucks, and light duty commercial trucks up to 14,000 GVWR (11,21,31,32) are based on 2012-2019 DMV registration data (dated January 1, 2019). Each year goes back to model year 1969. The weighted MOVES3 default population distributions for these vehicles was used to determine the fraction of cars and trucks since the DMV data cannot discern between a passenger car (21) and light duty trucks (31,32). MOVES3 weighted default population distributions for 2012-2019 were used to determine the heavy duty vehicle population. For future years the MOVES3 default vehicle population growth rates were applied specifically for motorcycles, light duty vehicles (21,31,32) and heavy duty vehicles (41,42,43,51,52,53,54,61,62) to construct a total vehicle population. Weighted MOVES3 default population distributions were applied to the total vehicle population.

(9) ZoneMonthHour (Meteorological Data)

WFRC, CMPO, MAG, UDAQ, and UDOT method:
The UDAQ Technical Analysis Section provided metrological conditions from multiple meteorological sites located throughout the state of Utah from MesoWest data archives. Meso West (mesowest.utah.edu) is a database of current and archived meteorological data from weather stations in the United States maintained by the University of Utah. The meteorological data is an hourly average temperature and relative humidity from ozone conditions from the month of July in 2017.

Table 1. On-road Mobile Sources Summertime 2023 Projection Ozone emissions inventory representing: Summer Weekday Emissions (Tons per Summer Weekday)

Year	Modeling Area	CO	NOx	VOC	VOC_refuel	NH3	PM25_Ex	vmt
2023*	Northern Wasatch Front, UT Ozone NA**	233.88	38.05	14.32	1.77	1.61	0.83	61,681,638
2023*	Southern Wasatch Front, UT Ozone NA***	52.45	10.40	3.37	0.45	0.40	0.24	15,226,871
2023*	Uintah Basin, UT Ozone NA#	10.64	2.78	0.71	0.11	0.07	0.06	2,371,051
2023*	Attainment Counties##	156.32	35.35	8.34	1.33	0.99	0.74	32,099,642

* Gasoline 10 ppm Sulfur

** Northern Wasatch Front, UT Ozone NA: Davis, Salt Lake, Tooele, and Weber Counties (WFRC)

*** Southern Wasatch Front, UT Ozone NA: Utah County (MAG)

Uintah Basin, UT OZONE Nonattainment Area: (Duchesne, Uintah)

Attainment Counties: Beaver, Cache, Carbon, Daggett, Duchesne, Emery, Garfield, Grand, Irion, Juab, Kane, Millard, Morgan, Piute, Rich, San Juan, Sanpete, Sevier, Summit, Uintah, Wasatch, Washington, Wayne Counties (UDAQ & UDOT); Box Elder (WFRC); Cache (CMPO);

Table 2. On-road Mobile Sources Summertime 2023 July Projection Ozone emissions inventory representing: Summer Weekday Emissions (Tons per Summer Weekday) by County

	CO	NOx	VOC	VOC Refuel	NH3	PM2.5 Exhaust	VMT
Beaver	4.65	1.28	0.17	0.04	0.03	0.03	895,331
Box Elder	15.50	3.55	0.72	0.13	0.10	0.07	3,451,153
Cache	16.56	2.49	1.11	0.12	0.10	0.06	3,379,754
Carbon	5.36	1.43	0.34	0.05	0.04	0.03	1,081,384
Daggett	0.42	0.13	0.03	0.01	0.00	0.00	96,724
Davis	46.65	7.42	2.78	0.34	0.32	0.17	11,841,622
Duchesne	4.32	1.13	0.29	0.04	0.03	0.02	1,008,713
Emery	5.21	1.69	0.23	0.06	0.04	0.04	1,231,367
Garfield	1.73	0.37	0.11	0.02	0.01	0.01	374,870
Grand	6.65	1.81	0.28	0.07	0.04	0.04	1,226,631
Iron	14.79	3.24	0.66	0.12	0.09	0.07	2,817,761
Juab	6.83	1.57	0.25	0.05	0.04	0.03	1,323,210
Kane	2.47	0.52	0.15	0.02	0.02	0.01	507,162
Millard	8.78	2.47	0.33	0.08	0.06	0.05	1,661,953
Morgan	1.87	0.45	0.13	0.02	0.01	0.01	489,698
Piute	0.47	0.15	0.03	0.01	0.00	0.00	90,257
Rich	0.65	0.12	0.04	0.01	0.00	0.00	144,523
Salt Lake	144.10	20.98	8.53	1.04	0.99	0.46	39,084,988
San Juan	3.93	1.01	0.18	0.04	0.03	0.02	1,022,084
Sanpete	4.42	0.94	0.36	0.04	0.03	0.02	781,984
Sevier	5.78	1.67	0.35	0.05	0.04	0.04	1,087,100
Summit	8.54	2.69	0.50	0.09	0.07	0.06	2,542,169
Tooele	13.73	3.78	0.88	0.13	0.10	0.08	3,476,298
Uintah	6.32	1.65	0.42	0.06	0.04	0.03	1,362,338
Utah	52.45	10.40	3.37	0.45	0.40	0.24	15,226,871
Wasatch	4.85	1.08	0.33	0.04	0.04	0.02	1,294,220
Washington	36.10	6.53	1.98	0.27	0.19	0.13	6,444,646
Wayne	0.75	0.17	0.05	0.01	0.01	0.00	155,661
Weber	29.40	5.87	2.13	0.26	0.20	0.13	7,278,730

v. Appendix: On-road 2023 Projection Ozone emissions inventories

Input files will be furnished upon request:

vi. References

The following documents were used as references in creating the on-road mobile source OZONESIP emissions inventories:

1. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, "MOVES3 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity", EPA-420-B-20-052, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010LY2.pdf

2. I/M Programs

a. Davis County Health Department, Environmental Health Services Division, Davis County Testing Center, 20 North 600 West, Kaysville, UT 84037, 801-546-8860.

b. Salt Lake County Health Department, Environmental Health, Air Pollution Control, I/M Tech Center, 788 East Woodoak Lane (5380 South), Murray, UT 84107-6369, 385-468-4837.

c. UT County Health Department, UT County Environment Health, Bureau of Air Quality, I/M Tech Center, 3255 North Main Street, Spanish Fork, UT, 84660, 801-851-7600.

d. Weber-Morgan Health Department, Environmental Health, 477 23rd Street, 2nd floor, Ogden, UT 84401, 801-399-7160.

e. Bear River Health Department, 655 East 1300 North. Logan, UT 84341, 801-792-6500

3. MESOWEST UT, (met data archive), University of UT, Department of Atmospheric Sciences, http://mesowest.UT.edu/

4. WFRC and MAG utilized movesdb20210209 MOVES 3.0.1,
UDAQ utilized movesdb20201105 MOVES 3.0.0:
MOVES3 and subsequent minor releases and “patches”, are documented at
https://www.epa.gov/moves/moves3-update-log and https://github.com/USEPA/EPA_MOVES_Model.