APPENDIX E

Documentation of Mobile Source Emission Calculations (post-processor)

MEMORANDUM

TO: Files

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DATE: May 26, 2009

SUBJECT: Mobile Emissions Post-Processor Description and Results

1.0 Introduction

This memorandum describes the mobile emissions post-processor used to support the Air Quality Conformity Determination of the_2009 CLRP and the FY2010-2015 TIP. The post-processor is a series of TP+ scripts that are used to calculate regional mobile source emissions. The emissions are developed on the basis of travel demand information produced by the regional travel demand model and emission rates produced from the EPA mandated Mobile model. The TPB's currently adopted travel model is known as the Version 2.2 (Spring 2009). The current Mobile program is version 6.2.03[1] (September 2003). The post-processor computes mobile emissions in terms of volatile organic compounds (VOC/HC), carbon monoxide (CO), oxides of nitrogen (NOx), and fine particulates ($PM_{2.5}$)[2] which include NOx precursors. The post-processor computes average *daily* VOC, CO, and NOx emissions for both wintertime and summer seasons. It is also used to compute *annual* NOx precursor and $PM_{2.5}$ emissions.

The post-processor computes mobile emissions attributable to *modeled* trips and VMT. It is also used to compute emissions of local, or off-network, traffic. These account for most, but not all, of mobile emissions that occur on a given day. Other off-network sources include vehicle-related (diurnal and resting loss) emissions as well as emissions relating to buses, and park-and-ride travel, which are computed using off-line procedures. These types of emission calculations are not addressed in this memorandum.

2.0 Post-Processor Overview

Mobile emissions are computed essentially by multiplying a unit of travel, as produced by the travel demand model, by an associated emission rate, as developed by the Mobile 6 model. The TPB emissions forecasts are based on computations for each stage of the trip cycle. In other words, *per trip* rates are developed to compute starting and soaking emissions, while *per mile* rates are developed to compute hot-stabilized (or running) emissions. Table 1 shows greater detail regarding the generalized emission calculation by trip cycle and pollutant. It is important to note that the emission rates are developed for specific seasons because weather conditions are important factors used in the emissions model. It is also important to note that emissions rates

[1] U.S. Environmental Protection Agency, Office of transportation and Air Quality. (2004). Technical Guidance on the Use of Mobile6.2 for Emission Inventory Preparation. U.S. Environmental Protection Agency.

[2] Airborne Particulate Matter (of size<2.5 μm) are air pollutants with a diameter of 2.5 micrometers or less, small enough to invade even the smallest airways.

are calculated by hour of the day, so the emissions post processor includes a peak spreading routine (see Table 12). Since the regional travel demand model develops forecasts in terms of average annual weekday (AAWT) conditions, seasonal factors are applied to the travel model data to be consistent with the seasonal emissions rate. Table 2 shows the conversion factors, which were developed based on local permanent count data. Seasonal adjustments are currently applied only to network link VMT. At present, there are no such conversion factors applied to modeled vehicle trips which are used to develop starting or soak emissions.

Table 1: Summary of Mobile Emissions Calculation by Emission Type and Pollutant

Emission Type	Pollutant	Emission Rate Description	Travel Unit Description	How Emissions are Computed
Running/ On-Network	VOC CO NOx	gm/mile, by jurisdiction, facility type and speed	Vehicle miles	Emission rate * travel unit, computed at network link level, by hour of day
	$PM_{2.5}$	gm/mile, by jurisdiction	vehicle miles	Emission rate * travel unit, computed at network link level
Start-Up	VOC CO NOx	gm/trip, by jurisdiction and engine condition (hot/cold)	Vehicle starts	Emission rate * travel unit, computed at TAZ level, by hour of day
Soak	VOC	gm/trip, by jurisdiction	Vehicle stops	Emission rate * travel unit, computed at TAZ level
Running / Local (Off-Network)	VOC CO NOx	gm/mile, by jurisdiction in urbanized areas; by jurisdiction and speed in rural areas	vehicle miles	Emission rate * travel unit, computed at jurisdiction level, stratified by urban and rural areas; rural areas are further stratified by speed ranges
	$PM_{2.5}$	gm/mile, by jurisdiction	vehicle miles	Emission rate * travel unit, Computed at jurisdiction level

Table 2: Conversion Factors for Converting AAWT to Seasonal Travel

Analysis Period	Pollutants Analyzed	Duration of Seasonal Period	Conversion Factor Applied to AAWT	Result of Conversion
Summer / Ozone Season	VOC NOx	May to September	1.05	Seasonal AAWT
Wintertime Season	CO	December to February	0.97	Seasonal AAWT
Annual Total (sum of 3 seasons)	$PM_{2.5}$ NOx precursor	January to April	0.92	Seasonal ADT
		May to September	0.99	Seasonal ADT
		October to December	0.93	Seasonal ADT

Table 2 also indicates the key pollutants of interest in the Washington, D.C. region vary by season. VOC and NOx emissions are most severe during the summer season while CO emissions are highest during the winter. $PM_{2.5}$ and NOx precursor emissions are developed as annualized figures based on the sum of three separate seasonal computations.

3.0 Mobile 6 Rates

Table 1 indicates that the emission rates are developed on a jurisdictional basis. This is done because many parameters used the Mobile 6 model vary by location, for example, inspection and maintenance programs, vehicle fleet mix, etc. Emission rates are currently prepared for 16 individual jurisdictions which are listed in Table 3. These include jurisdictions both in and around the non-attainment area. The table indicates that the 16 sets of modeled emission rates are ultimately applied to reflect 27 jurisdictions (or external stations) using 'nearest-neighbor' assumptions.

Table 3: Jurisdictional Emission Areas

Emission Area System Number	Jurisdiction / External Area	MSA Member Yes/No	Mobile Rates Modeled/Borrowed
1	Washington, DC	Yes	Modeled
2	Montgomery County	Yes	Modeled
3	Prince George's County	Yes	Modeled
4	Howard County	No	Borrowed (Prince George's Co.)
5	Anne Arundel County	No	Borrowed (Prince George's Co.)
6	Carroll County	No	Borrowed (Prince George's Co.)
7	Baltimore Area Externals	No	Borrowed (Prince George's Co.)
8	Calvert County	Yes	Modeled
9	Charles County	Yes	Modeled
10	Frederick County	Yes	Modeled
11	Frederick Co. Externals	No	Borrowed (Frederick Co.)
12	Arlington	Yes	Modeled
13	Fairfax County	Yes	Modeled
14	Loudoun County	Yes	Modeled
15	Prince William County	Yes	Modeled
16	Stafford County	Yes	Modeled
17	City of Alexandria	Yes	Modeled
18	St. Mary's County	No	Modeled
19	Washington Co. Externals	No	Modeled
20	Clarke County	No	Modeled
21	Fauquier County	No	Borrowed (Clarke Co.)
22	Jefferson Co, WVA	No	Borrowed (Clarke Co.)
23	Western External Area	No	Borrowed (Clarke Co.)
24	Spotsylvania County	No	Modeled
25	King George County	No	Borrowed (Spotsylvania Co.)
26	City of Fredericksburg	No	Borrowed (Spotsylvania Co.)
27	Southern External Area	No	Borrowed (Spotsylvania Co.)

Table 1 also indicates that, beyond jurisdictional considerations, the running emission rates are further specified by facility and speed, and starting emissions are further segmented by 'hot' and 'cold' engine conditions. In all, 179 Mobile model executions are prepared for each jurisdiction, for given season. These executions are currently run in batch. The sequence of scenarios generated by the batch of Mobile 6 executions is shown on Table 4. Each scenario represents a unique condition pertaining to the vehicle operating mode, facility type, and speed. Because annualized emissions are desired for the $PM_{2.5}$ pollutant, the generation of Mobile rates procedures is expanded to reflect multiple seasons. Annualized NOx and $PM_{2.5}$ emissions are currently developed on the basis of three seasonal periods. The associated Mobile 6 scenarios that are batched together for three seasons are listed shown on Table 5. Three utility programs have been developed to read the Mobile 6 output rate listings and create emission rate files that are readable by the TP+ scripts. These programs are named:

1) M6RATES.EXE (single season / VOC, CO, NOx rates)
2) M6RATES_3S_HCN.EXE (three-season VOC, CO, NOx rates)
3) M6RATES_3S_PM.EXE (three-season $PM_{2.5}$ rates)

Table 4: Sequence of Mobile Scenarios Generated for a Single Season

MOBILE6 'Scenarios'	Operating Mode	Facility Type	Speed Specifications
1- 65	Stabilized	Arterial	1 to 65 mph in 1 mph increments
66-130	Stabilized	Freeway, Non-Ramp	1 to 65 mph in 1 mph increments
131	Stabilized	Freeway Ramp	Single speed / 35.0 mph
132	Cold	Local	Single speed / 12.9 mph
133	Hot	Local	Single speed / 12.9 mph
134	Stabilized	Local	Single speed / 12.9 mph
135-179	Stabilized	Arterial(w/ Rural VMT Mix)	1 to 45 mph in 1 mph increments

Table 5: Sequence of Mobile Scenarios Generated for Three Seasons

MOBILE6 'Scenarios'	Season	Op. Mode	Facility Type	Speed Specifications
1- 65	Jan-Apr	Stabilized	Arterial	1 to 65 mph in 1 mph increments
66-130		Stabilized	Freeway, Non-Ramp	1 to 65 mph in 1 mph increments
131		Stabilized	Freeway Ramp	Single speed / 35.0 mph
132		Cold	Local	Single speed / 12.9 mph
133		Hot	Local	Single speed / 12.9 mph
134		Stabilized	Local	Single speed / 12.9 mph
135-179		Stabilized	Arterial(w/ Rural VMT Mix)	1 to 45 mph in 1 mph increments
180- 244	May-Sep	Stabilized	Arterial	1 to 65 mph in 1 mph increments
245-309		Stabilized	Freeway, Non-Ramp	1 to 65 mph in 1 mph increments
310		Stabilized	Freeway Ramp	Single speed / 35.0 mph
311		Cold	Local	Single speed / 12.9 mph
312		Hot	Local	Single speed / 12.9 mph
313		Stabilized	Local	Single speed / 12.9 mph
314-358		Stabilized	Arterial(w/ Rural VMT Mix)	1 to 45 mph in 1 mph increments
359-423	Oct-Dec	Stabilized	Arterial	1 to 65 mph in 1 mph increments
424-488		Stabilized	Freeway, Non-Ramp	1 to 65 mph in 1 mph increments
489		Stabilized	Freeway Ramp	Single speed / 35.0 mph
490		Cold	Local	Single speed / 12.9 mph
491		Hot	Local	Single speed / 12.9 mph
492		Stabilized	Local	Single speed / 12.9 mph
493-537		Stabilized	Arterial(w/ Rural VMT Mix)	1 to 45 mph in 1 mph increments

The final emission rate files used in single-season post-processor runs and three-season post-processor runs are shown on Tables 5 and 6 respectively. The tables indicate the filename convention used for a given post-processor run. The first characters of the file name are user specified, but the end-characters of the name are standardized. Table 5 indicates that 96 rate files are used in a single-season run, while 320 rate files are used in three season post-processor runs.

Table 6: Listing of Emission Rate Filenames Prepared for the Post-Processor / Single-Season Post-Processor

Jurisdiction	Running Arterial Rates	Running Freeway Rates	Running Freeway Ramp Rates	Starting (Hot/Cold) Rates	Running Local Rates	Running Local -Rural Arterial Rates
	VOC, CO, Nx Rates by speed	*VOC, CO, Nx Rates by speed*	*VOC, CO, Nx Rates @ 35 mph*	*Hot VOC, CO, Nox / Cold VOC, CO, Nox Rates*	*VOC, CO, Nox Rates @ 12.9 mph*	*VOC, CO, Nx Rates by speed*
Alexandria	<prefix>AL.r_a	<prefix>AL.r_f	<prefix>AL.ram	<prefix>AL.stt	<prefix>AL.lcl	<prefix>AL.r_r
Arlington	<prefix>AR.r_a	<prefix>AR.r_f	<prefix>AR.ram	<prefix>AR.stt	<prefix>AR.lcl	<prefix>AR.r_r
Calvert	<prefix>CA.r_a	<prefix>CA.r_f	<prefix>CA.ram	<prefix>CA.stt	<prefix>CA.lcl	<prefix>CA.r_r
Charles	<prefix>CH.r_a	<prefix>CH.r_f	<prefix>CH.ram	<prefix>CH.stt	<prefix>CH.lcl	<prefix>CH.r_r
Calvert	<prefix>CL.r_a	<prefix>CL.r_f	<prefix>CL.ram	<prefix>CL.stt	<prefix>CL.lcl	<prefix>CL.r_r
DC	<prefix>DC.r_a	<prefix>DC.r_f	<prefix>DC.ram	<prefix>DC.stt	<prefix>DC.lcl	<prefix>DC.r_r
Frederick	<prefix>FR.r_a	<prefix>FR.r_f	<prefix>FR.ram	<prefix>FR.stt	<prefix>FR.lcl	<prefix>FR.r_r
Fairfax	<prefix>FX.r_a	<prefix>FX.r_f	<prefix>FX.ram	<prefix>FX.stt	<prefix>FX.lcl	<prefix>FX.r_r
Loudoun	<prefix>LD.r_a	<prefix>LD.r_f	<prefix>LD.ram	<prefix>LD.stt	<prefix>LD.lcl	<prefix>LD.r_r
Montgomery	<prefix>MC.r_a	<prefix>MC.r_f	<prefix>MC.ram	<prefix>MC.stt	<prefix>MC.lcl	<prefix>MC.r_r
Pr. George's	<prefix>PG.r_a	<prefix>PG.r_f	<prefix>PG.ram	<prefix>PG.stt	<prefix>PG.lcl	<prefix>PG.r_r
Pr. William	<prefix>PW.r_a	<prefix>PW.r_f	<prefix>PW.ram	<prefix>PW.stt	<prefix>PW.lcl	<prefix>PW.r_r
St. Mary's	<prefix>SM.r_a	<prefix>SM.r_f	<prefix>SM.ram	<prefix>SM.stt	<prefix>SM.lcl	<prefix>SM.r_r
Sprotsylvania	<prefix>SP.r_a	<prefix>SP.r_f	<prefix>SP.ram	<prefix>SP.stt	<prefix>SP.lcl	<prefix>SP.r_r
Stafford	<prefix>ST.r_a	<prefix>ST.r_f	<prefix>ST.ram	<prefix>ST.stt	<prefix>ST.lcl	<prefix>ST.r_r
Washington Co	<prefix>WE.r_a	<prefix>WE.r_f	<prefix>WE.ram	<prefix>WE.stt	<prefix>WE.lcl	<prefix>WE.r_r

Table 7: Listing of Emission Rate Filenames Prepared for the Post-Processor / Three – Season Post-Processor

Pollutant	Jurisdiction	Running Arterial Rates	Running Freeway Rates	Running Freeway Ramp Rates	Starting (Hot/Cold) Rates	Running Local Rates	Running Local -Rural Arterial Rates
		Seasonal Rates by speed	*Seasonal Rates by speed*	*Seasonal Rates @ 35 mph speed*	*Seasonal Hot/Cold Rates*	*Seasonal Rates @ 12.9 mph speed*	*Seasonal Rates by speed*
	Alexandria	<prefix>COAL.arC	<prefix>COAL.frC	<prefix>COAL.rmC	<prefix>COAL.stC	<prefix>COAL.lcC	<prefix>COAL.rrC
CO	Arlington	<prefix>COAR.arC	<prefix>COAR.frC	<prefix>COAR.rmC	<prefix>COAR.stC	<prefix>COAR.lcC	<prefix>COAR.rrC
	Calvert	<prefix>COCA.arC	<prefix>COCA.frC	<prefix>COCA.rmC	<prefix>COCA.stC	<prefix>COCA.lcC	<prefix>COCA.rrC
	Charles	<prefix>COCH.arC	<prefix>COCH.frC	<prefix>COCH.rmC	<prefix>COCH.stC	<prefix>COCH.lcC	<prefix>COCH.rrC
	Calvert	<prefix>COCL.arC	<prefix>COCL.frC	<prefix>COCL.rmC	<prefix>COCL.stC	<prefix>COCL.lcC	<prefix>COCL.rrC
	DC	<prefix>CODC.arC	<prefix>CODC.frC	<prefix>CODC.rmC	<prefix>CODC.stC	<prefix>CODC.lcC	<prefix>CODC.rrC
	Frederick	<prefix>COFR.arC	<prefix>COFR.frC	<prefix>COFR.rmC	<prefix>COFR.stC	<prefix>COFR.lcC	<prefix>COFR.rrC
	Fairfax	<prefix>COFX.arC	<prefix>COFX.frC	<prefix>COFX.rmC	<prefix>COFX.stC	<prefix>COFX.lcC	<prefix>COFX.rrC
	Loudoun	<prefix>COLD.arC	<prefix>COLD.frC	<prefix>COLD.rmC	<prefix>COLD.stC	<prefix>COLD.lcC	<prefix>COLD.rrC
	Montgomery	<prefix>COMC.arC	<prefix>COMC.frC	<prefix>COMC.rmC	<prefix>COMC.stC	<prefix>COMC.lcC	<prefix>COMC.rrC
	Pr. George's	<prefix>COPG.arC	<prefix>COPG.frC	<prefix>COPG.rmC	<prefix>COPG.stC	<prefix>COPG.lcC	<prefix>COPG.rrC
	Pr. William	<prefix>COPW.arC	<prefix>COPW.frC	<prefix>COPW.rmC	<prefix>COPW.stC	<prefix>COPW.lcC	<prefix>COPW.rrC
	St. Mary's	<prefix>COSM.arC	<prefix>COSM.frC	<prefix>COSM.rmC	<prefix>COSM.stC	<prefix>COSM.lcC	<prefix>COSM.rrC
	Sprotsylvania	<prefix>COSP.arC	<prefix>COSP.frC	<prefix>COSP.rmC	<prefix>COSP.stC	<prefix>COSP.lcC	<prefix>COSP.rrC
	Stafford	<prefix>COST.arC	<prefix>COST.frC	<prefix>COST.rmC	<prefix>COST.stC	<prefix>COST.lcC	<prefix>COST.rrC
	Washington Co	<prefix>COWE.arC	<prefix>COWE.frC	<prefix>COWE.rmC	<prefix>COWE.stC	<prefix>COWE.lcC	<prefix>COWE.rrC
VOC	Alexandria	<prefix>HCAL.arH	<prefix>HCAL.frH	<prefix>HCAL.rmH	<prefix>HCAL.stH	<prefix>HCAL.lcH	<prefix>HCAL.rrH
	Arlington	<prefix>HCAR.arH	<prefix>HCAR.frH	<prefix>HCAR.rmH	<prefix>HCAR.stH	<prefix>HCAR.lcH	<prefix>HCAR.rrH
	Calvert	<prefix>HCCA.arH	<prefix>HCCA.frH	<prefix>HCCA.rmH	<prefix>HCCA.stH	<prefix>HCCA.lcH	<prefix>HCCA.rrH
	Charles	<prefix>HCCH.arH	<prefix>HCCH.frH	<prefix>HCCH.rmH	<prefix>HCCH.stH	<prefix>HCCH.lcH	<prefix>HCCH.rrH
	Calvert	<prefix>HCCL.arH	<prefix>HCCL.frH	<prefix>HCCL.rmH	<prefix>HCCL.stH	<prefix>HCCL.lcH	<prefix>HCCL.rrH
	DC	<prefix>HCDC.arH	<prefix>HCDC.frH	<prefix>HCDC.rmH	<prefix>HCDC.stH	<prefix>HCDC.lcH	<prefix>HCDC.rrH
	Frederick	<prefix>HCFR.arH	<prefix>HCFR.frH	<prefix>HCFR.rmH	<prefix>HCFR.stH	<prefix>HCFR.lcH	<prefix>HCFR.rrH
	Fairfax	<prefix>HCFX.arH	<prefix>HCFX.frH	<prefix>HCFX.rmH	<prefix>HCFX.stH	<prefix>HCFX.lcH	<prefix>HCFX.rrH
	Loudoun	<prefix>HCLD.arH	<prefix>HCLD.frH	<prefix>HCLD.rmH	<prefix>HCLD.stH	<prefix>HCLD.lcH	<prefix>HCLD.rrH
	Montgomery	<prefix>HCMC.arH	<prefix>HCMC.frH	<prefix>HCMC.rmH	<prefix>HCMC.stH	<prefix>HCMC.lcH	<prefix>HCMC.rrH
	Pr. George's	<prefix>HCPG.arH	<prefix>HCPG.frH	<prefix>HCPG.rmH	<prefix>HCPG.stH	<prefix>HCPG.lcH	<prefix>HCPG.rrH
	Pr. William	<prefix>HCPW.arH	<prefix>HCPW.frH	<prefix>HCPW.rmH	<prefix>HCPW.stH	<prefix>HCPW.lcH	<prefix>HCPW.rrH
	St. Mary's	<prefix>HCSM.arH	<prefix>HCSM.frH	<prefix>HCSM.rmH	<prefix>HCSM.stH	<prefix>HCSM.lcH	<prefix>HCSM.rrH
	Sprotsylvania	<prefix>HCSP.arH	<prefix>HCSP.frH	<prefix>HCSP.rmH	<prefix>HCSP.stH	<prefix>HCSP.lcH	<prefix>HCSP.rrH
	Stafford	<prefix>HCST.arH	<prefix>HCST.frH	<prefix>HCST.rmH	<prefix>HCST.stH	<prefix>HCST.lcH	<prefix>HCST.rrH
	Washington Co	<prefix>HCWE.arH	<prefix>HCWE.frH	<prefix>HCWE.rmH	<prefix>HCWE.stH	<prefix>HCWE.lcH	<prefix>HCWE.rrH
NOx	Alexandria	<prefix>NXAL.arN	<prefix>NXAL.frN	<prefix>NXAL.rmN	<prefix>NXAL.stN	<prefix>NXAL.lcN	<prefix>NXAL.rrN
	Arlington	<prefix>NXAR.arN	<prefix>NXAR.frN	<prefix>NXAR.rmN	<prefix>NXAR.stN	<prefix>NXAR.lcN	<prefix>NXAR.rrN
	Calvert	<prefix>NXCA.arN	<prefix>NXCA.frN	<prefix>NXCA.rmN	<prefix>NXCA.stN	<prefix>NXCA.lcN	<prefix>NXCA.rrN
	Charles	<prefix>NXCH.arN	<prefix>NXCH.frN	<prefix>NXCH.rmN	<prefix>NXCH.stN	<prefix>NXCH.lcN	<prefix>NXCH.rrN
	Calvert	<prefix>NXCL.arN	<prefix>NXCL.frN	<prefix>NXCL.rmN	<prefix>NXCL.stN	<prefix>NXCL.lcN	<prefix>NXCL.rrN
	DC	<prefix>NXDC.arN	<prefix>NXDC.frN	<prefix>NXDC.rmN	<prefix>NXDC.stN	<prefix>NXDC.lcN	<prefix>NXDC.rrN
	Frederick	<prefix>NXFR.arN	<prefix>NXFR.frN	<prefix>NXFR.rmN	<prefix>NXFR.stN	<prefix>NXFR.lcN	<prefix>NXFR.rrN
	Fairfax	<prefix>NXFX.arN	<prefix>NXFX.frN	<prefix>NXFX.rmN	<prefix>NXFX.stN	<prefix>NXFX.lcN	<prefix>NXFX.rrN
	Loudoun	<prefix>NXLD.arN	<prefix>NXLD.frN	<prefix>NXLD.rmN	<prefix>NXLD.stN	<prefix>NXLD.lcN	<prefix>NXLD.rrN
	Montgomery	<prefix>NXMC.arN	<prefix>NXMC.frN	<prefix>NXMC.rmN	<prefix>NXMC.stN	<prefix>NXMC.lcN	<prefix>NXMC.rrN
	Pr. George's	<prefix>NXPG.arN	<prefix>NXPG.frN	<prefix>NXPG.rmN	<prefix>NXPG.stN	<prefix>NXPG.lcN	<prefix>NXPG.rrN
	Pr. William	<prefix>NXPW.arN	<prefix>NXPW.frN	<prefix>NXPW.rmN	<prefix>NXPW.stN	<prefix>NXPW.lcN	<prefix>NXPW.rrN
	St. Mary's	<prefix>NXSM.arN	<prefix>NXSM.frN	<prefix>NXSM.rmN	<prefix>NXSM.stN	<prefix>NXSM.lcN	<prefix>NXSM.rrN
	Sprotsylvania	<prefix>NXSP.arN	<prefix>NXSP.frN	<prefix>NXSP.rmN	<prefix>NXSP.stN	<prefix>NXSP.lcN	<prefix>NXSP.rrN
	Stafford	<prefix>NXST.arN	<prefix>NXST.frN	<prefix>NXST.rmN	<prefix>NXST.stN	<prefix>NXST.lcN	<prefix>NXST.rrN
	Washington Co	<prefix>NXWE.arN	<prefix>NXWE.frN	<prefix>NXWE.rmN	<prefix>NXWE.stN	<prefix>NXWE.lcN	<prefix>NXWE.rrN

Pollutant	Jurisdiction	*Seasonal $PM_{2.5}$ Network and Local Rates*
$PM_{2.5}$	Alexandria	<prefix>pmAL.N_L
	Arlington	<prefix>pmAR.N_L
Seasonal Network /	Calvert	<prefix>pmCA.N_L
Seasonal Local	Charles	<prefix>pmCH.N_L
	Calvert	<prefix>pmCL.N_L
	DC	<prefix>pmDC.N_L
	Frederick	<prefix>pmFR.N_L
	Fairfax	<prefix>pmFX.N_L
	Loudoun	<prefix>pmLD.N_L
	Montgomery	<prefix>pmMC.N_L
	Pr. George's	<prefix>pmPG.N_L
	Pr. William	<prefix>pmPW.N_L
	St. Mary's	<prefix>pmSM.N_L
	Sprotsylvania	<prefix>pmSP.N_L
	Stafford	<prefix>pmST.N_L
	Washington Co	<prefix>pmWE.N_L

Pollutant	Jurisdiction	*Seasonal Soak Rates*
	Alexandria	<prefix>HCAL.SDR
Soak, Diurnal,	Arlington	<prefix>HCAR.SDR
Resting Loss	Calvert	<prefix>HCCA.SDR
Rates	Charles	<prefix>HCCH.SDR
	Calvert	<prefix>HCCL.SDR
Seasonal Soak,	DC	<prefix>HCDC.SDR
Seasonal Diurnal,	Frederick	<prefix>HCFR.SDR
Seasonal Rest Loss	Fairfax	<prefix>HCFX.SDR
	Loudoun	<prefix>HCLD.SDR
	Montgomery	<prefix>HCMC.SDR
	Pr. George's	<prefix>HCPG.SDR
	Pr. William	<prefix>HCPW.SDR
	St. Mary's	<prefix>HCSM.SDR
	Sprotsylvania	<prefix>HCSP.SDR
	Stafford	<prefix>HCST.SDR
	Washington Co	<prefix>HCWE.SDR

4.0 Post–Processor Computations

The post-processor computes three classes of mobile emissions: Trip-end emissions, comprised of starting and soaking types, running emissions, and local emissions. The computation procedures are described below, in turn.

4.1 Trip-End Emissions

Starting emissions are developed by applying per-trip emission rates to modeled vehicle trips at the zone level, on an hour-by-hour basis. Starting pollutant rates are associated with VOC, CO, and NOx emissions, and are expressed in terms of *cold* and *hot transient* types. Cold starts relate to those auto trips with fully cooled engines (i.e., engines that have been turned off for at least one hour prior to the trip starting time). Alternatively, hot transient starts are those auto trips with warm engines (i.e., engines that have been turned off less than one hour prior to the trip start time). An hourly allocation of trip origins is necessary for the starting emission calculation since the proportion of cold and hot starts is dependent upon the time of day. The assumed hourly distribution of AM, PM, and Off-peak vehicle trips is shown on Table 8. The distribution shown was derived from the 1994 Household Travel Survey (HTS). The assumed hourly distribution for cold and hot transient starts is shown on Table 9. This table was also derived from the 1994 HTS.

Soaking emissions are associated with the evaporative VOC/HC emissions that result when the engine is turned off. The soak emissions consist of a single emission rate that is applied to trip destinations. There is no temporal component to the soaking emission computation.

It was stated earlier that emission rates are developed on a county-by-county basis. An averaged emission rate is used in the post-processor, as opposed to a single county-specific rate, because the vehicle starts in any given jurisdiction are realistically made by residents of that jurisdiction as well as by residents of many other jurisdictions. For example, the emission rate used within the District of Columbia is the average of all emission rates weighted by the proportion of daily vehicle trips from each jurisdiction to the District. The general equation for computing starting emissions for a specific TAZ and hour of the day is as follows:

$$StartEm_{ih} = Starts_h * \sum_{j=1}^{27} ((CSR_j * CPCT_h + HSR_j * HPCT_h) * Tprop_{ij})$$

Where:

$StartEm_{ih}$ = Zonal starting-up emissions (in grams) at hour h in jurisdiction i
$Starts_h$ = Zonal vehicle starts at hour h
CSR_j = Cold Start rate (gm/trip) for jurisdiction j
$CPCT_h$ = Cold start proportion at hour h
HSR_j = Hot Start rate (gm/trip) for jurisdiction j
$HPCT_h$ = Hot start proportion at hour h
$Tprop_{ij}$ = Proportion of daily trips between jurisdiction i/j

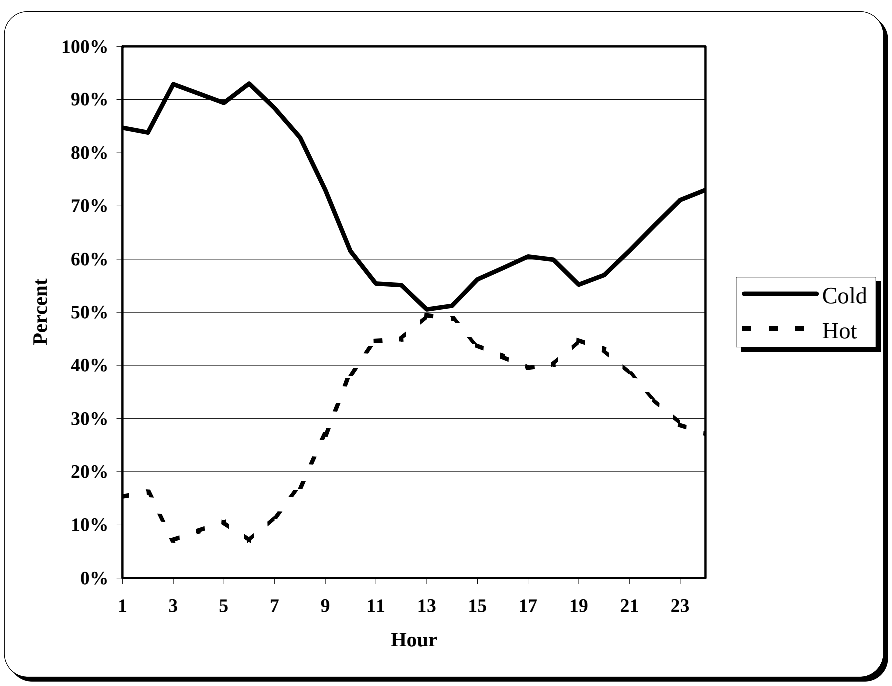
Table 8

Distribution of AM, PM, and Off-Peak Period Auto Driver Trips Among Hourly Periods

Hour No.		% AM	% PM	Off-Peak
1	12mid - 12:59AM			0.30%
2	1:00AM - 1:59AM			0.40%
3	2:00AM - 2:59AM			0.30%
4	3:00AM - 3:59AM			0.30%
5	4:00AM - 4:59AM			0.50%
6	5:00AM - 5:59AM			2.20%
7	6:00AM - 6:59AM	20.10%		
8	7:00AM - 7:59AM	39.80%		
9	8:00AM - 8:59AM	40.10%		
10	9:00AM - 9:59AM			9.70%
11	10:00AM - 10:59AM			8.20%
12	11:00AM - 11:59AM			9.20%
13	12noon - 12:59PM			10.10%
14	1:00PM - 1:59PM			8.90%
15	2:00PM - 2:59PM			9.00%
16	3:00PM - 3:59PM			11.60%
17	4:00PM - 4:59PM		31.40%	
18	5:00PM - 5:59PM		37.30%	
19	6:00PM - 6:59PM		31.30%	
20	7:00PM - 7:59PM			10.80%
21	8:00PM - 8:59PM			7.70%
22	9:00PM - 9:59PM			5.80%
23	10:00PM - 10:59PM			3.40%
24	11:00PM - 11:59PM			1.60%
Total		100.00%	100.00%	100.00%

Table 9
Distribution of Cold / Hot Transient Vehicle Starts by Hour

Hour No.		% Cold	% Hot	Total
1	12mid - 12:59AM	84.70%	15.30%	100.00%
2	1:00AM - 1:59AM	83.80%	16.20%	100.00%
3	2:00AM - 2:59AM	92.90%	7.10%	100.00%
4	3:00AM - 3:59AM	91.20%	8.80%	100.00%
5	4:00AM - 4:59AM	89.40%	10.60%	100.00%
6	5:00AM - 5:59AM	93.00%	7.00%	100.00%
7	6:00AM - 6:59AM	88.40%	11.60%	100.00%
8	7:00AM - 7:59AM	82.90%	17.10%	100.00%
9	8:00AM - 8:59AM	73.00%	27.00%	100.00%
10	9:00AM - 9:59AM	61.50%	38.50%	100.00%
11	10:00AM - 10:59AM	55.40%	44.60%	100.00%
12	11:00AM - 11:59AM	55.10%	44.90%	100.00%
13	12noon - 12:59PM	50.50%	49.50%	100.00%
14	1:00PM - 1:59PM	51.20%	48.80%	100.00%
15	2:00PM - 2:59PM	56.20%	43.80%	100.00%
16	3:00PM - 3:59PM	58.30%	41.70%	100.00%
17	4:00PM - 4:59PM	60.50%	39.50%	100.00%
18	5:00PM - 5:59PM	59.90%	40.10%	100.00%
19	6:00PM - 6:59PM	55.20%	44.80%	100.00%
20	7:00PM - 7:59PM	57.00%	43.00%	100.00%
21	8:00PM - 8:59PM	61.60%	38.40%	100.00%
22	9:00PM - 9:59PM	66.40%	33.60%	100.00%
23	10:00PM - 10:59PM	71.10%	28.90%	100.00%
24	11:00PM - 11:59PM	73.00%	27.00%	100.00%



Similarly, the equation for computing hot soak emissions is as follows:

$$SoakEm_{ih} = Stops_h * \sum_{j=1}^{27} (HSR_j * Tprop_{ij})$$

Where:

$SoakEm_{ih}$	= Zonal hot soak emissions (in grams) at hour h in jurisdiction i
$Stops_h$	= Vehicle stops at hour h
HSR_j	= Hot Soak rate (gm/trip) for jurisdiction j
$Tprop_{ij}$	= Proportion of daily trips between jurisdiction i and jurisdiction j

The regional total of starting/soaking emissions is, therefore, based on the result of the above equations accumulated over all TAZ's, over all hours of the day. Regional emissions in grams are converted to tons using a conversion factor of 907,184.74 gm/ton.

4.2 Running (Hot Stabilized) Emissions

Running emissions are associated with VOC/HC, CO, NOx, and $PM_{2.5}$ pollutants emitted on the regional highway network. They are computed by applying per-mile emission rates to VMT at the network link level, and are computed on an hour-by-hour basis. The calculation is applied on an hourly basis because the running emission rates are provided as a function of highway speed[3], which varies with congestion throughout the day. As with the trip-end emission calculation, the running emission rate for a given link is a weighted average of all jurisdictional rates based on the proportion of daily vehicle trips from each county to the specific county in which the network link is located.

The post-processor now incorporates global link volume adjustment factors used to adjust AAWT volume to the specific season that is appropriate. The current seasonal factors were shown on Table 2, above. Before link volumes are disaggregated among hourly periods, the total daily volume on the link is adjusted with the seasonal factor.

The allocation of link volumes among hourly periods is done in a two-step manner. First, an initial hourly distribution based on observed data for the Washington region is applied to the daily link volume, based on the facility class and *peaking* classification of the link. Facility classifications are defined as freeway, arterial, or local. COG has established three peaking types, AM-oriented, PM-oriented, and Even, based on the following *peaking percentage*[4]:

Peaking Percentage = ((AM Volume* PM scale factor) – PM Volume) / Daily Link Volume

Where:

Peaking Percentage > 7.5% indicates AM oriented class
Peaking Percentage < - 7.5% indicates PM oriented class
Peaking Percentage - 7.5% to 7.5% indicates Even oriented class

[3] The current $PM_{2.5}$ emission rate, however, does not vary by speed. Nonetheless, the $PM_{2.5}$ computation is still made on an hourly basis.
[4] See August 27, 2002 Memorandum from Michael Freeman to File, Subject: Development and Recommendations of Hourly Distributions of Daily Traffic Volumes.

The PM scale factor shown is applied to all AM period volumes so that the sum of regional AM link volumes will equal the sum of regional PM volumes. The scaled volume is used *only* for the purpose of computing the peaking index, and is necessary to ensure that a reasonable regional balance of AM and PM oriented links are attained. Default hourly distributions associated with specific facility and peaking classifications are shown on Table 10. The distribution selected for a given link is applied to the *daily seasonal* link volume to arrive at initial hourly volume estimates. Next, the initial hourly estimates are scaled on a gross time period basis so that the hourly link volumes in the AM peak, PM peak, and off-peak periods are consistent with the original (seasonally adjusted) link volumes produced by the traffic assignment process. The hourly link speed is developed from the volume–to-capacity ratio developed at this point based on the speed flow relationship shown on Table 11. The functions shown on Table 11 are based on observed speed and density data collected in the Washington region.

Table 10
Hourly Distribution of Daily Traffic by Orientation and Facility Type

Hour No.		AM			PM			EVEN		
		Freeway	Arterial	Collector	Freeway	Arterial	Collector	Freeway	Arterial	Collector
1	12mid - 12:59AM	0.77	0.49	0.34	1.11	0.76	0.62	1.07	0.67	0.52
2	1:00AM - 1:59AM	0.55	0.30	0.20	0.64	0.41	0.32	0.73	0.40	0.31
3	2:00AM - 2:59AM	0.52	0.25	0.18	0.48	0.28	0.24	0.61	0.30	0.24
4	3:00AM - 3:59AM	0.72	0.37	0.29	0.42	0.24	0.20	0.68	0.33	0.30
5	4:00AM - 4:59AM	1.88	1.09	0.96	0.58	0.38	0.32	1.24	0.72	0.70
6	5:00AM - 5:59AM	6.20	4.05	3.80	1.38	1.08	0.96	3.60	2.27	2.37
7	6:00AM - 6:59AM	8.66	8.75	9.19	3.24	2.70	2.58	4.99	4.58	4.83
8	7:00AM - 7:59AM	11.13	12.38	13.40	4.63	4.62	4.67	6.96	7.65	8.06
9	8:00AM - 8:59AM	8.04	9.82	10.92	4.71	5.15	5.07	5.44	6.90	7.27
10	9:00AM - 9:59AM	6.94	6.39	6.10	3.84	4.38	4.10	5.93	6.11	5.80
11	10:00AM - 10:59AM	5.14	4.71	4.50	3.90	4.19	3.94	5.18	5.15	4.80
12	11:00AM - 11:59AM	4.68	4.53	4.51	4.21	4.67	4.54	5.15	5.40	5.14
13	12noon - 12:59PM	4.65	4.72	4.81	4.61	5.25	5.25	5.34	5.80	5.50
14	1:00PM - 1:59PM	4.58	4.64	4.64	4.83	5.21	5.01	5.45	5.68	5.34
15	2:00PM - 2:59PM	4.66	4.80	4.85	5.95	5.87	5.76	6.10	5.97	5.89
16	3:00PM - 3:59PM	4.70	5.09	5.17	7.32	7.14	7.03	6.80	6.62	6.68
17	4:00PM - 4:59PM	4.56	5.26	5.24	9.95	9.58	10.06	5.94	6.26	6.61
18	5:00PM - 5:59PM	4.76	5.55	5.58	10.87	10.93	11.57	6.63	7.15	7.66
19	6:00PM - 6:59PM	4.32	4.98	4.92	8.55	9.03	9.65	5.35	5.92	6.44
20	7:00PM - 7:59PM	3.66	3.90	3.72	5.61	6.01	6.17	4.99	5.29	5.45
21	8:00PM - 8:59PM	2.95	2.97	2.70	4.25	4.44	4.60	3.89	4.05	4.09
22	9:00PM - 9:59PM	2.64	2.40	2.01	3.68	3.58	3.52	3.44	3.27	3.06
23	10:00PM - 10:59PM	2.06	1.64	1.30	2.80	2.41	2.20	2.70	2.21	1.90
24	11:00PM - 11:59PM	1.23	0.92	0.72	2.45	1.71	1.62	1.81	1.29	1.05
Total		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

In the second step, the initial hourly volume is compared to the hourly link capacity (Level-of-Service 'E') and adjusted if necessary. The adjustment procedure (see Table 12) begins with the comparison of AM peak hour traffic and PM peak hour traffic with the available capacity. If the initial peak hour volume exceeds capacity, then the peak hour volume is adjusted to equal the capacity and the portion of volume exceeding capacity is then apportioned in equal parts to the hour before and the hour after the peak hour. In the case of overly congested freeways, the capacity is moderated to reflect the fact that the 'through-put' volumes cannot be sustained at LOS 'E' service levels when the V/C ratio exceeds 1.0. Table 13 shows the assumed relationship between freeway capacities and congested V/C ratios. Because this adjustment could potentially cause the 'shoulder' hour volumes to exceed capacity, added steps are undertaken to compare the resulting volumes in each successive shoulder hour with the capacity. If a given shoulder hour volume exceeds capacity, then the volume is similarly adjusted to equal capacity and the 'overflow' volume is added to the volume of the adjacent hourly period. Traffic assignments on rare occasions produce severely overloaded link volumes to the point where a given link volume could exceed the capacity over *all* hours of the day. Because of this possibility, volume adjustments are *not* made for the first, noon, and last hours (hours 1, 13, and 24), even if a given link volume is determined to exceed capacity in those particular hours.

Subsequent to the development of 'final' hourly link volumes and restrained speeds, the general equation for computing running emissions is:

$$RunningEm_{ih} = VMT_h * \sum_{j=1}^{27} (RRate_j * Tprop_{ij})$$

<u>Where:</u>

$RunningEm_{ih}$	= Running link emissions at hour h in jurisdiction i
VMT_h	= Vehicle Miles Travel (after peak-spreading) at hour h
$RRate_j$	= Running rate (gm/mi) as a function of highway speed for jurisdiction j
$Tprop_{ij}$	= Proportion of daily trips between jurisdiction i/j

The regional running emissions are the accumulation of calculated hourly emissions over all network links in the study area. Emissions in grams are converted to tons using a conversion factor of 907,184.74 gm/ton.

Table 11
Speed Delay Functions Used in the MWCOG Mobile Emissions Post-Processor
By
Facility Type and Area Type (1-7)

V/C	Freeway			Major Arterial				Minor arterial				Collector				Expressway		
Atp -->	1-2	3-4	5-7	1-2	3-4	5	6-7	1-2	3-4	5	6-7	1-2	3-4	5	6-7	1-2	3-5	6-7
0.000	55.000	60.000	67.000	25.000	35.000	40.000	45.000	20.000	30.000	35.000	40.000	15.000	20.000	25.000	30.000	45.000	50.000	55.000
0.100	54.783	59.764	66.736	24.774	34.683	39.638	44.593	19.762	29.643	34.583	39.523	14.630	19.506	24.383	29.259	44.649	49.610	54.571
0.200	54.479	59.431	66.365	24.464	34.250	39.143	44.036	19.441	29.161	34.022	38.882	14.171	18.895	23.619	28.342	44.166	49.074	53.981
0.300	54.174	59.099	65.994	24.155	33.817	38.648	43.479	19.120	28.680	33.460	38.240	13.713	18.284	22.855	27.426	43.683	48.537	53.390
0.400	53.645	58.522	65.350	23.646	33.105	37.834	42.563	18.611	27.916	32.569	37.222	13.093	17.457	21.822	26.186	42.878	47.642	52.406
0.500	53.116	57.945	64.705	23.138	32.393	37.020	41.648	18.102	27.152	31.678	36.203	12.473	16.631	20.789	24.947	42.073	46.747	51.422
0.600	51.976	56.701	63.316	22.165	31.031	35.465	39.898	17.193	25.790	30.088	34.387	11.631	15.508	19.385	23.262	40.485	44.984	49.482
0.700	50.835	55.456	61.926	21.193	29.670	33.909	38.147	16.285	24.427	28.499	32.570	10.789	14.385	17.982	21.578	38.898	43.220	47.542
0.800	48.329	52.722	58.873	19.427	27.198	31.083	34.969	14.789	22.183	25.880	29.577	9.762	13.016	16.270	19.524	35.880	39.867	43.853
0.900	42.731	46.616	52.054	16.595	23.233	26.552	29.871	12.669	19.003	22.171	25.338	8.643	11.524	14.405	17.286	30.702	34.113	37.524
1.000	27.500	30.000	33.500	12.500	17.500	20.000	22.500	10.000	15.000	17.500	20.000	7.500	10.000	12.500	15.000	22.500	25.000	27.500
1.100	22.610	24.665	27.543	11.200	15.681	17.921	20.161	9.155	13.733	16.022	18.311	7.141	9.521	11.901	14.282	19.893	22.103	24.313
1.170	19.187	20.931	23.373	10.291	14.407	16.465	18.524	8.564	12.846	14.987	17.129	6.889	9.186	11.482	13.779	18.068	20.075	22.083
1.200	17.719	19.330	21.585	9.901	13.861	15.842	17.822	8.311	12.466	14.544	16.622	6.782	9.042	11.303	13.563	17.286	19.206	21.127
1.300	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940
1.400	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940
1.500	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940
1.600	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940
1.800	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940
2.000	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940
2.250	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940
99.990	12.829	13.995	15.628	8.601	12.042	13.762	15.483	7.466	11.200	13.066	14.933	6.423	8.563	10.704	12.845	14.678	16.309	17.940

Table 12	
Peak Spreading Procedure ***Adjustment Process for Spreading Hourly Volumes When Initial Volumes Exceed Capacity***	
Step 1:	The AM peak hour (hour 8) initial volume is compared to the link capacity. If the initial hour 8 volume exceeds capacity, then the hour 8 volume is set to capacity (or a moderated capacity value in the case of freeways) and the excess volume portion is added to the volume in periods occurring before *and* after the AM peak hour (hours 7 and 9) on a 50/50 basis.
Step 2:	The PM peak hour (hour 18) initial volume is compared to the link capacity. If the initial volume exceeds capacity, then the hour 18 volume is set to capacity (or a moderated capacity value in the case of freeways) and the excess volume portion is added to the volume in periods occurring before *and* after the PM peak hour (hours 17 and 19) on a 50/50 basis.
Step 3:	The volume occurring during pre-AM peak hours (hours 1 to 7) are sequentially checked against the link capacity as in steps 1 and 2, and adjusted (if necessary) in a backward-moving fashion. If the volume occurring in hour 7 exceeds capacity then the hour 7 volume is set to capacity and the excess volume portion is added to the volume of hour 6 volume, and so on. There is no volume spreading at hour 1, even for rare cases where the resulting hour 1 volume exceeds capacity.
Step 4:	The volume occurring during post-AM peak hours (hours 9 to 13) are sequentially checked against the link capacity as in steps 1 and 2, and adjusted (if necessary) in a forward-moving fashion. If the volume occurring in hour 9 exceeds capacity then the hour 9 volume is set to capacity and the excess volume portion is added to the volume of hour 10 volume, and so on. There is no volume spreading at hour 13 (the midday hour), even for rare cases where the resulting hour 13 volume exceeds capacity.
Step 5:	The volume occurring during pre-PM peak hours (hours 13 to 17) are sequentially checked against the link capacity as in steps 1 and 2, and adjusted (if necessary) in a backward-moving fashion. If the volume occurring in hour 17 exceeds capacity then the hour 17 volume is set to capacity and the excess volume portion is added to the volume of hour 16 volume, and so on. There is no volume spreading at hour 13 (the midday hour), even for rare cases where the resulting hour 13 volume exceeds capacity.
Step 6:	The volume occurring during post-PM peak hours (hours 19 to 24) are sequentially checked against the link capacity as in steps 1 and 2, and adjusted (if necessary) in a forward-moving fashion. If the volume occurring in hour 19 exceeds capacity then the hour 19 volume is set to capacity and the excess volume portion is added to the volume of hour 20 volume, and so on. There is no volume spreading at hour 24, even for rare cases where the resulting hour 24 volume exceeds capacity.

Table 13
Freeway Through-Put Capacities Under Congested Conditions

V/C	Fwy AT1	Fwy AT2	Fwy AT3	Fwy AT4	Fwy AT5	FWY AT6	FWY AT7
1.00	1500	1600	1800	1800	2000	2000	2100
1.20	1433	1528	1719	1719	1911	1911	2006
1.40	1366	1457	1639	1639	1821	1821	1912
1.60	1366	1457	1639	1639	1821	1821	1912
1.80	1366	1457	1639	1639	1821	1821	1912
2.00	1366	1457	1639	1639	1821	1821	1912
2.25	1366	1457	1639	1639	1821	1821	1912
99.99	1366	1457	1639	1639	1821	1821	1912

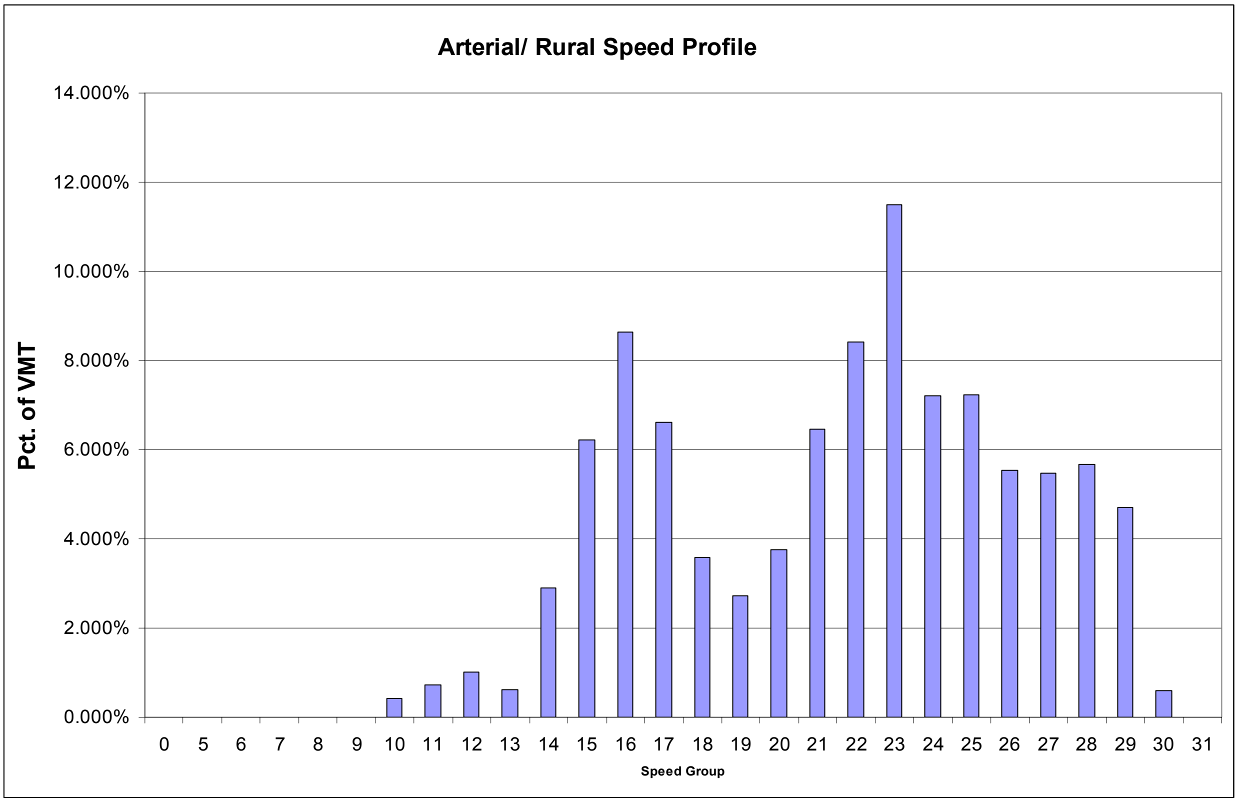
4.3 Local Emissions

Local (or off-network) emissions are those generated on smaller facilities that are not included in the regional network. Local emissions are associated with VOC/HC, CO, NOx, and $PM_{2.5}$ pollutants and are computed at jurisdiction level by applying per-mile emission rates to the local VMT. However, the local emission calculation requires that local VMT be further allocated among urban and rural categories, as the emission calculation is different. The calculation steps are listed below:

1) The small file containing base year jurisdictional modeled network VMT, observed local VMT, and base year urban/rural local VMT percentages is prepared.
2) Modeled network VMT for the analysis year is summarized at jurisdiction level and merged with the base year information, above.
3) Local urban and rural VMT is estimated for the analysis year. First, local VMT is estimated by applying a growth factor to the base year (2002) local VMT. The growth factor is based on modeled VMT change between the base year and analysis year. Next, the base year urban and rural percentages are applied to the local VMT computed for the analysis year.
4) Local $PM_{2.5}$ emissions are computed based on total (urban and rural) VMT.
5) Urban/local NOx, CO, and VOC emissions are computed using the single local/stabilized emission factor produced by Mobile. This factor is based on an assumed speed of 12.9 mph.
6) Rural/local NOx, CO, and VOC emissions are computed by first allocating the rural VMT among speed ‘bins’ using an assumed average speed profile. The profile reflects a VMT distribution for rural jurisdictions that was summarized from previous modeling files. The profile, shown on Figure 1, was determined to be a reasonable basis for local facilities speeds in rural areas. Secondly, rural arterial rates are applied to the VMT on the basis of speed.

Previous local emissions calculations have been made using the single (12.9 mph-based) local rate. It is believed that the use of arterial rates at higher speed levels will yield a more accurate emission result for rural areas of the region.

Figure 1:



5.0 <u>Post-Processor Program Steps</u>

The post-processor is executed when provided with: 1) travel demand output files, 2) emission rate files by jurisdiction as described above, and 3) a small text file containing jurisdiction level VMT information. The travel demand output files include the final iteration loaded highway network (I6HWY.NET) and three vehicle trip tables corresponding to the AM, PM, and off peak periods (I6AM.VTT, I6PM.VTT, I6OP.VTT). The jurisdictional VMT file (Base_Juris_VMT.txt) is a pre-existing file containing base (2002) year estimates of network-based VMT, local (or off-network) VMT, and the estimated proportion of network VMT that is urban and rural. This information is used to develop future year local VMT that is urban and local. All VMT information corresponds only to jurisdictions within the MSA as defined above.

The post-processor is normally executed using batch files that are called in a command prompt window. A list of subdirectories established to execute post-processor work is shown on Table 14. The batch file used for a single-season post-processor execution (e.g., ozone or wintertime model runs) is named EMISS.BAT. The batch file used for a three-season post-processor execution is named 3_Season_EMISS.BAT. Single-season and three-season flowcharts are shown on Figures 2 and 3. The batch files contain environmental or global variables useful for executing different scenarios. A list defining those environmental variables is shown in Table 15.

The batch files call five TP+ scripts which are summarized below. The TP+ script names are in parenthesis:

1) Trip Table Formatting (AQTRIPS.S): AM, PM, and off-peak trip tables produced by the travel demand model are read. The program produces zonal trip-ends for each of the three time periods. It also produces a file containing the proportion of daily vehicle trips from/to each of the 27 emission areas. Since the trip proportions are developed with daily trips, the proportion in the *i/j* direction is generally the same as that in the *j/i* direction.

2) Time-of-Day Trip-Ends Program (ZONESPRD.S): The program reads the zonal origins and destinations, described above, and apportions them among discrete hourly periods.

3) Jurisdiction level VMT Formatting Program (Pre_Local.S): The program summarizes modeled VMT at the jurisdiction level and writes a summary file to be used in the LOCAL.S program.

4) Time-of-Day VMT and speeds program (PEAK_SPREAD.S for the single season post-processor or PEAK_SPREAD_Seasonal.S for the three-season post-processor): The program reads the AM, PM, and off-peak network link volumes produced by the travel demand model. It produces hourly volumes, VMT, and restrained speed for each highway link. The hourly VMT and highway speeds are sensitive to seasonal adjustment factors.

5) Running Emissions Program (RUNNING.S for the single season post-processor or RUNNING_Seasonal.S for the three-season post-processor): The program computes hot stabilized emissions on a link-by-link and hour-by-hour basis. It reads 1) the hourly link VMT and highway speed files developed above, 2) MOBILE6-based running emission rates which are provided on the basis of speed, and 3) the county level trip proportions file. VOC, CO, and NOx emissions are produced from the program ($PM_{2.5}$ emissions are additionally produced from the three-season run).

6) Start/Soak Emissions Program (STRT_SKR.S for the single season post-processor or STRT_SKR_Seasonal.S for the three season post-processor): The program applies emission rates to the trip- ends to compute start-up and soaking emissions on a zone-by-zone and hour-by-hour basis. The program reads: 1) hourly trip-ends, 2) the MOBILE6-generated cold/hot starting rates, and 3) the county-level trip proportions file. Note that trip tables are not affected by seasonal adjustments. VOC, CO, and NOx emissions are produced from the program.

7) Local Emissions Programs (LOCAL.S and pre-local.s for the single season post-processor or LOCAL_Seasonal.S for the three-season post-processor): The program computes hot stabilized

emissions on a link-by-link and hour-by-hour basis. It reads 1) a file containing forecasted local/urban and local/rural VMT at the jurisdiction level and 2) $PM_{2.5}$ and Arterial NOx stabilized rates specially developed for local roads. Note that the forecasted VMT is produced by a program called pre-local.s which, in turn, is based on 2002 observed data. VOC, CO, and NOx emissions are produced from the program ($PM_{2.5}$ emissions are additionally produced from the three-season run).

8) The post processor includes several TP+ programs which are used to facilitate the creation of technical documentation. The emission calculation scripts (Running.S, Strt_Skr.S, and Local.S) produce text files containing basic summaries. An additional script was added (Report.S) to read different summary files and to combine them into a single overall summary file.

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Table 14 Post-Processor Subdirectories

Description of Contents	Subdirectory
Locations of Post processor Executions / Outputs	
2002 Ozone Season VOC, CO, Nx	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2002_ozone
2002 Annual Nx Precursor, $PM_{2.5}$	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2002_annual
2010 Ozone Season VOC, CO, Nx	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2010_ozone
2010 Winter Season VOC, CO, Nx	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2010_WCO
2010 Annual Nx Precursor, $PM_{2.5}$	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2010_annual
2020 Ozone Season VOC, CO, Nx	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2020_ozone
2020 Winter Season VOC, CO, Nx	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2020_WCO
2020 Annual Nx Precursor, $PM_{2.5}$	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2020_annual
2030 Ozone Season VOC, CO, Nx	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2030_ozone
2030 Winter Season VOC, CO, Nx	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2030_WCO
2030 Annual Nx Precursor, $PM_{2.5}$	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\2030_annual
Emission Rate Inputs	
2002 VOC, CO, Nx rates Ozone Season	I:\CGV2_2_Aug_07_Conformity2008\EMISSIONS\M6RATES\2002\
2002 VOC, CO, Nx, PM rates–3 Seasons	I:\CGV2_1D_50_SEP_07_PM_SIP\M6RATES\2002\
2010 VOC, CO, Nx rates Ozone Season	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2010_ozone
2010 VOC, CO, Nx rates– Winter Season	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2010_WCO
2010 VOC, CO, Nx, PM rates–3 Seasons	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2010_annual
2020 VOC, CO, Nx rates Ozone Season	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2020_ozone
2020 VOC, CO, Nx rates– Winter Season	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2020_WCO
2020 VOC, CO, Nx, PM rates–3 Seasons	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2020_annual
2030 VOC, CO, Nx rates Ozone Season	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2030_ozone
2030 VOC, CO, Nx rates– Winter Season	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2030_WCO
2030 VOC, CO, Nx, PM rates–3 Seasons	I:\CGV2_2_May_09_Conformity2010\EMISSIONS\m6rates\2030_annual
Travel Model Inputs	
2002 Travel Model Files	M:\model_app\CGV2_2_Conformity2010\2002_Conf
2010 Travel Model Files	M:\model_app\CGV2_2_Conformity2010\2010_Conf
2020 Travel Model Files	M:\model_app\CGV2_2_Conformity2010_SA\2020_Final
2030 Travel Model Files	M:\model_app\CGV2_2_Conformity2010_SA\2030_Final

Figure 2

Ozone Season / Wintertime Emissions Data Processing Flowchart:
Job stream executed once with one set of environment variables.

EMISS.BAT

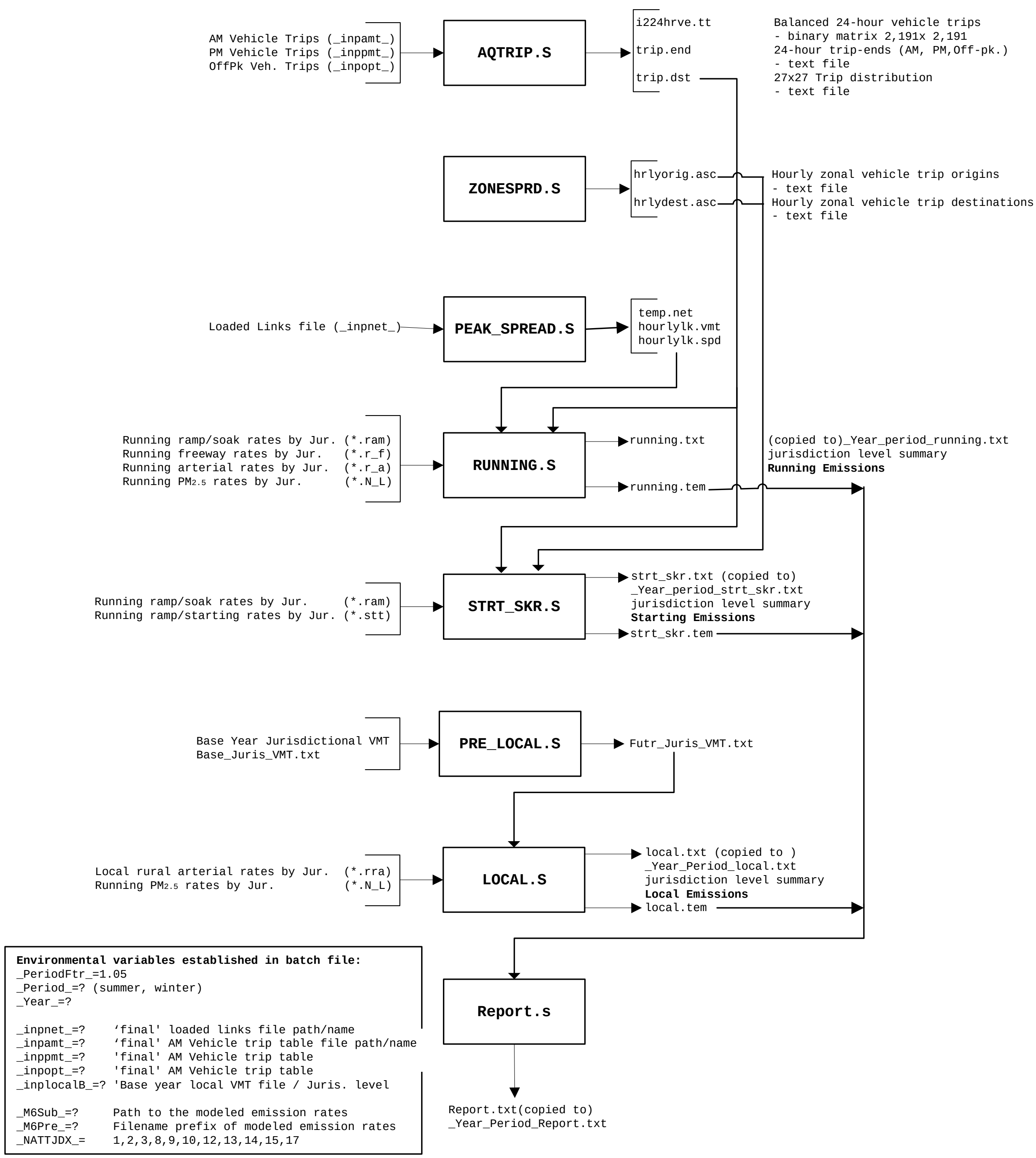

Figure 3

Multiple Season Emission Data Processing Flowchart
Job stream executed 3 times with altered environment variables

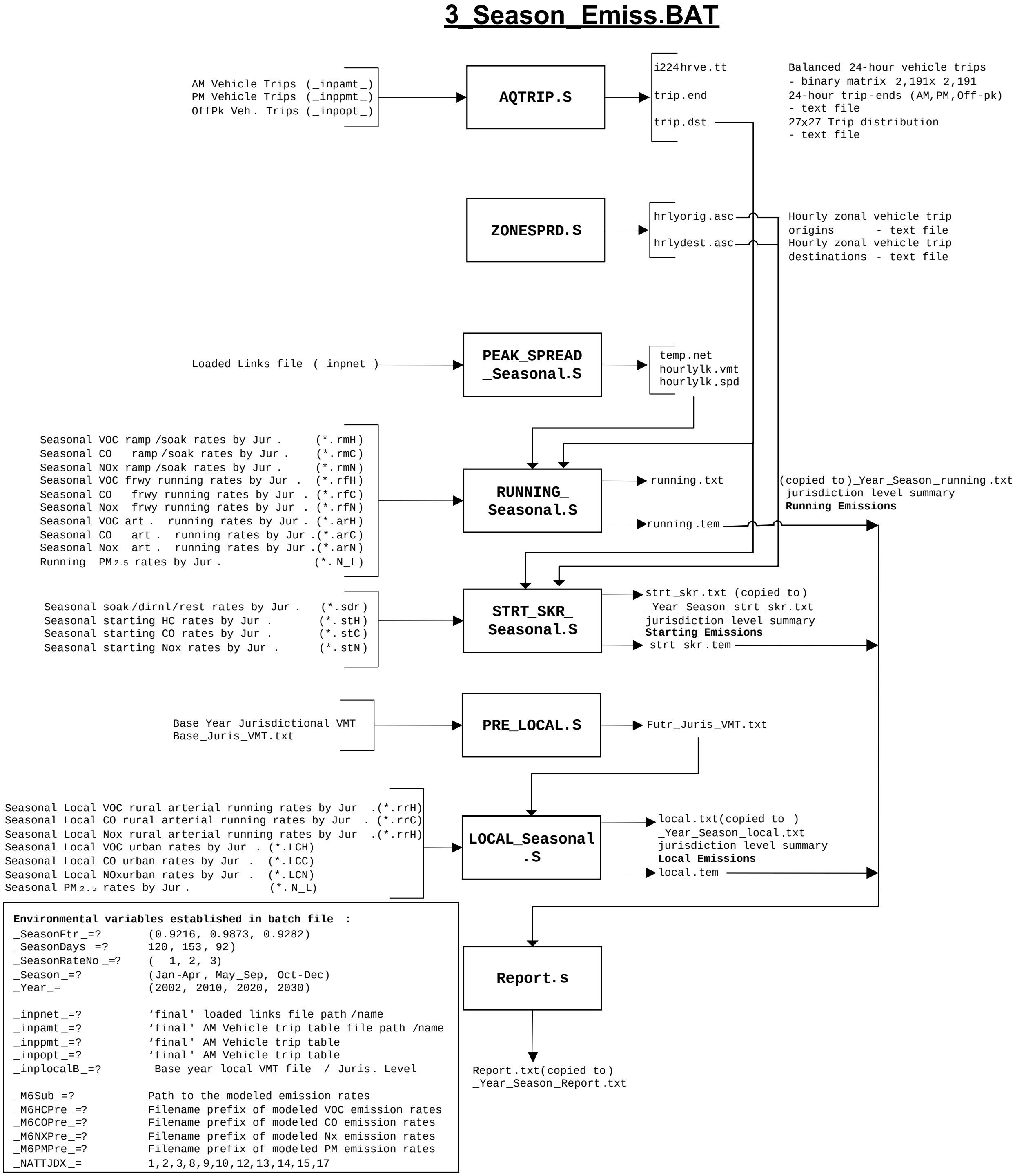

Table 15: List of Environmental/Global variables

Global Variable	Application	Description
NATTJDX	Single Season & Annual	Designate jurisdiction to be included in the final summaries (27 jur numbering system.
INPnet	Single Season & Annual	Location of input subdirectory - Network
INPamt	Single Season & Annual	Location of input subdirectory - AM peak vehicle trips
INPpmt	Single Season & Annual	Location of input subdirectory - PM peak vehicle trips
INPopt	Single Season & Annual	Location of input subdirectory - Off-Peak peak vehicle trips
INPlocalB	Single Season & Annual	Location of Base Jurisdiction VMT text file - provided by user
INPlocalF	Single Season & Annual	Location of future year Jurisdiction VMT text file - computed by pre_local.s program
M6Sub	Single Season & Annual	Location of Mobile 6 Emission rates file subdirectory
M6Pre	Single Season Only	File naming prefix for Mobile 6 Emission rates
M6HCPre	Annual Only	File naming prefix for Mobile 6 Emission rates for Hydrocarbons and Volatile Organic Compounds
M6COPre	Annual Only	File naming prefix for Mobile 6 Emission rates for Carbon Monoxide
M6NXPre	Annual Only	File naming prefix for Mobile 6 Emission rates for Nitrogen Oxides
M6PMPre	Annual Only	File naming prefix for Mobile 6 Emission rates for Particulate Matter size < 2.5 micrometers
Season	Annual Only	Define season of analysis: Jan-Apr, May-Sep, Oct-Dec
SeasonFtr	Annual Only	Seasonal conversion factor applied to AAWT to make it consistent with the seasonal emission rates. (Jan-Apr: 0.9216, May-Sep: 0.9873, Oct-Dec: 0.9282)
SeasonDays	Annual Only	Number of days in each season. (Jan-Apr: 120, May-Sep: 153, Oct-Dec: 92)
SeasonRateNo	Annual Only	An index used in rate lookups. (1=Jan-Apr, 2=May-Sep, 3=Oct-Dec)
PeriodFtr	Single Season Only	Seasonal conversion factor applied to network link VMT to make it consistent with the seasonal emission rates.
Period	Single Season Only	Period label in summary reports. For example Summer (Ozone), Winter or