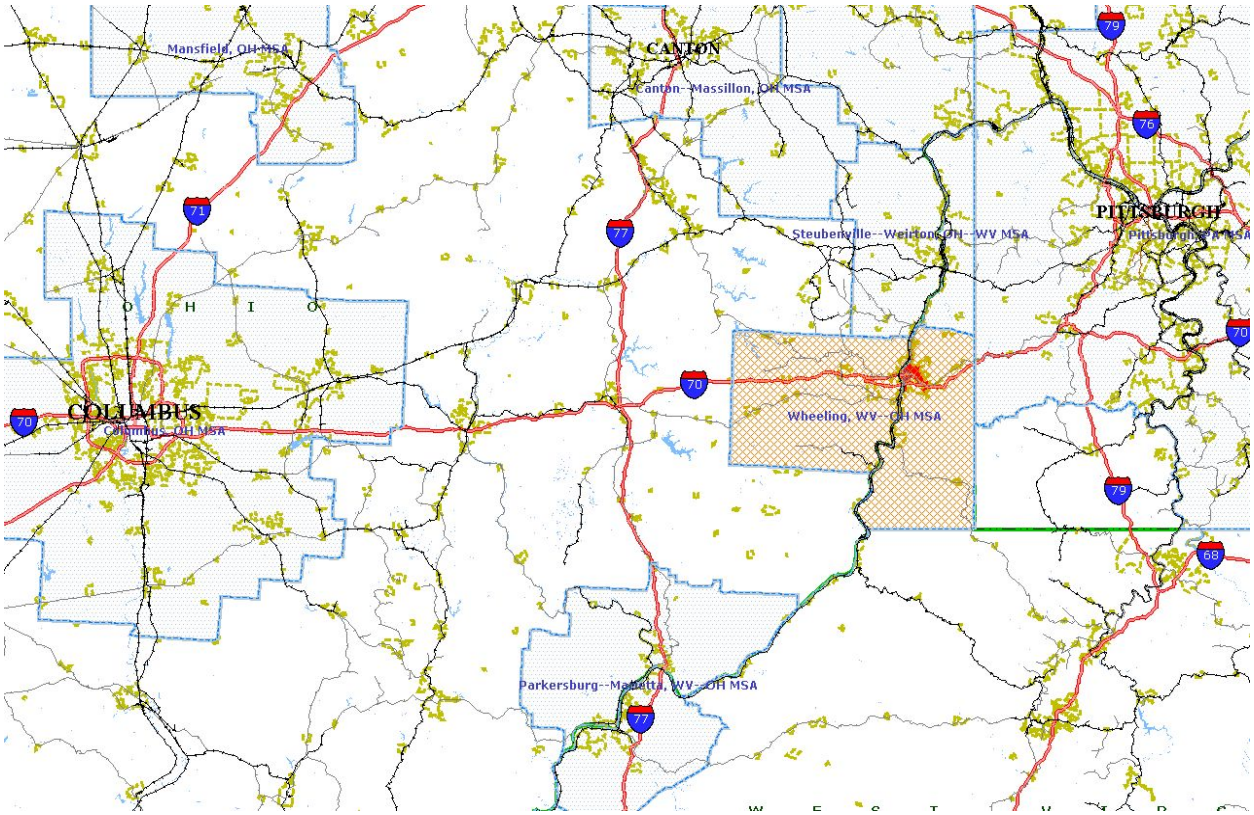
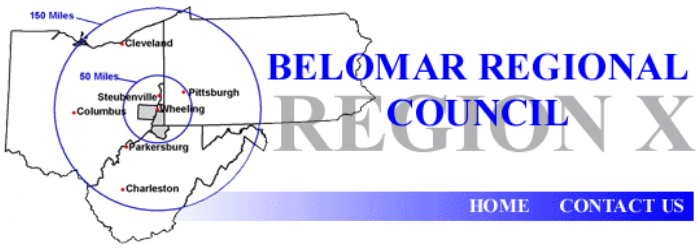
BELOMAR REGIONAL COUNCIL

Transportation Air Quality Analysis and Technical Documentation
State Implementation Plan Inventory Mobile Emission Estimates
For the U.S. EPA Daily Ozone National Ambient Air Quality Standard

Submitted: April 2012 Revised: August 2012





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SELECTED ABBREVIATIONS & ACRONYMS

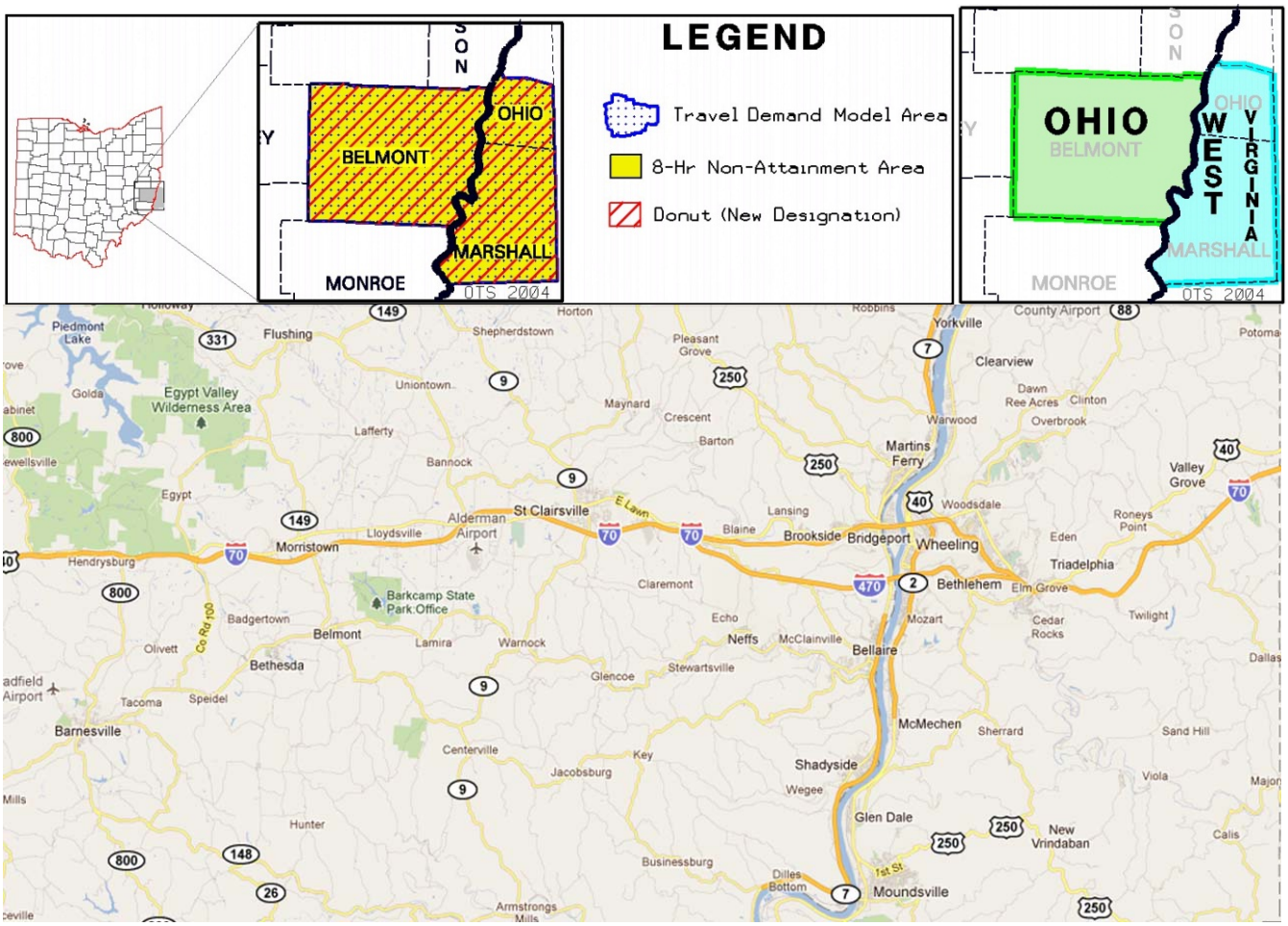
DOT – Department of Transportation
EPA – Environmental Protection Agency
FHWA – Federal Highway Administration;
FTA – Federal Transit Administration;
LRTP – Long Range Transportation Plan
MOBILE6 – Mobile Source Emission Factor Model
MOU – Memorandum of Understanding
MPO – Metropolitan Planning Organization
MVEB – Motor Vehicle Emissions Budget
NAAQS – National Ambient Air Quality Standard
NOx – Nitrogen Oxides
PM10 – Particulate Matter with an aerodynamic diameter less than 10 microns

SIP – State Implementation Plan
TIP – Transportation Improvement Program
TAZs – Traffic Analysis Zones
TCM – Transportation Control Measure
TDM – Travel Demand Model
TIP – Transportation Improvement Program
VMT – Vehicle Miles of Travel
VOC – Volatile Organic Compounds

INTRODUCTION

This memorandum documents the air quality analyses and underlying planning assumptions performed by the Ohio Department of Transportation (ODOT), Division of Statewide Planning- Modeling and Forecasting Section and the Belomar Regional Council for the Summer Ozone on-road mobile source emission inventories for the Wheeling-Bridgeport WV/OH Metropolitan area State Implementation Plan (SIP) in coordination with the Ohio Environmental Protection Agency (OEPA) and West Virginia Department of Environmental Protection (WVDEP). The Belomar Region is comprised of the counties of Ohio and Marshall in the northern panhandle of West Virginia and Belmont in east-central Ohio. On January 5, 2005, the USEPA designated all three counties as non-attainment for the Ozone air quality standard. The designation became effective on April 5, 2005; 90 days after USEPA published action in the *Federal Registry*. Figure 1 displays the geographic extent of the Belomar region non-attainment area.

Figure 1
NON-ATTAINMENT AREA BOUNDARY



ON ROAD MOBILE EMISSION SUMMARY

Table 1 presents a summary of the pollutant emissions including Hydrocarbons (HC) and Nitrogen Oxides (NOx modeled for each county that make up the Belomar Region. The Model Years for the demonstration includes the Base Year 2002, Attainment Year 2004, Interim Year 2009, and Maintenance Year 2018.

Table 1

BELOMAR REGION ON-ROAD MOBILE EMISSIONS BY STATE AND COUNTY (2002-04-09-18)

MOVES- BASED OZONE SIP		LOCATION:				
ANALYSIS FOR THE		BELMONT	OHIO	MARSHALL		METRO
WHEELING METRO AREA		COUNTY	COUNTY	COUNTY	WV	AREA
SCG 8-21-12		OHIO	WV	WV	TOTALS	TOTALS
BASED ON SUMMER DAY						
YEAR 2002 NETWORK VMT		2,566,569	1,245,798	796,940	2042738	4,609,307
YEAR 2002 INTRAZONAL VMT		108,616	45,458	49,012	94470	203,086
YEAR 2002 TOTAL VMT		2,675,185	1,291,256	845,952	2137208	4,812,393
YEAR 2002 VEHICLES		84,550	39,551	24,750	64301	148,851
NETWORK EMISSIONS:	VOC	2.2951	0.8972	0.6160	1.5132	3.8083
(TONS/DAY)	NOX	13.3234	5.8763	2.4462	8.3225	21.6459
INTRAZONAL EMISSIONS:	VOC	0.1383	0.0426	0.0459	0.0884	0.2267
(TONS/DAY)	NOX	0.3927	0.1321	0.1424	0.2745	0.6673
VEHICLE-BASED EMISSIONS:	VOC	2.9574	1.1743	0.7348	1.9091	4.8665
(TONS/DAY)	NOX	1.2752	0.6400	0.4005	1.0405	2.3157
TOTAL EMISSIONS:	VOC	5.3908	2.1141	1.3967	3.5107	8.9015
(TONS/DAY)	NOX	14.9913	6.6484	2.9891	9.6375	24.6289
YEAR 2004 NETWORK VMT		2,550,338	1,272,258	725,235	1997493	4,547,831
YEAR 2004 INTRAZONAL VMT		108,616	45,458	49,012	94470	203,086
YEAR 2004 TOTAL VMT		2,658,954	1,317,716	774,247	2091963	4,750,917
YEAR 2004 VEHICLES		84,857	39,646	24,811	64457	149,314
NETWORK EMISSIONS:	VOC	2.0991	0.7877	0.4838	1.2715	3.3706
(TONS/DAY)	NOX	12.2966	4.8675	1.9353	6.8028	19.0994
INTRAZONAL EMISSIONS:	VOC	0.1383	0.0426	0.0459	0.0884	0.2267
(TONS/DAY)	NOX	0.3927	0.1321	0.1424	0.2745	0.6673
VEHICLE-BASED EMISSIONS:	VOC	2.8062	1.1320	0.7085	1.8405	4.6467
(TONS/DAY)	NOX	1.2955	0.6367	0.3985	1.0352	2.3307
TOTAL EMISSIONS:	VOC	5.0436	1.9623	1.2382	3.2004	8.2440
(TONS/DAY)	NOX	13.9848	5.6363	2.4762	8.1125	22.0974
YEAR 2009 NETWORK VMT		2,614,482	1,698,805	771,844	2470649	5,085,131
YEAR 2009 INTRAZONAL VMT		105,846	44,299	47,762	92061	197,907
YEAR 2009 TOTAL VMT		2,720,328	1,743,104	819,606	2562710	5,283,038
YEAR 2009 VEHICLES		86,111	40,231	25,177	65408	151,519
NETWORK EMISSIONS:	VOC	1.3736	0.6007	0.2860	0.8867	2.2603
(TONS/DAY)	NOX	9.1101	3.7702	1.4192	5.1894	14.2995
INTRAZONAL EMISSIONS:	VOC	0.0813	0.0225	0.0242	0.0467	0.1280
(TONS/DAY)	NOX	0.2769	0.0825	0.0890	0.1715	0.4484
VEHICLE-BASED EMISSIONS:	VOC	2.3039	0.8781	0.5495	1.4276	3.7315
(TONS/DAY)	NOX	1.2522	0.5683	0.3556	0.9239	2.1761
TOTAL EMISSIONS:	VOC	3.7588	1.5013	0.8597	2.3610	6.1198
(TONS/DAY)	NOX	10.6392	4.4210	1.8638	6.2848	16.9240
YEAR 2018 NETWORK VMT		2,724,567	1,681,626	808,180	2489806	5,214,373
YEAR 2018 INTRAZONAL VMT		97,928	40,985	44,189	85173	183,101
YEAR 2018 TOTAL VMT		2,822,495	1,722,611	852,369	2574979	5,397,474
YEAR 2018 VEHICLES		87,907	41,071	25,705	66776	154,683
NETWORK EMISSIONS:	VOC	0.4967	0.2037	0.1037	0.3074	0.8041
(TONS/DAY)	NOX	3.2720	1.0939	0.4512	1.5451	4.8171
INTRAZONAL EMISSIONS:	VOC	0.0254	0.0073	0.0079	0.0152	0.0405
(TONS/DAY)	NOX	0.0894	0.0234	0.0252	0.0486	0.1379
VEHICLE-BASED EMISSIONS:	VOC	1.2002	0.4441	0.2779	0.7220	1.9222
(TONS/DAY)	NOX	0.7824	0.3408	0.2133	0.5541	1.3365
TOTAL EMISSIONS:	VOC	1.7223	0.6551	0.3895	1.0446	2.7668
(TONS/DAY)	NOX	4.1438	1.4581	0.6897	2.1478	6.2915

LATEST PLANNING ASSUMPTIONS

The summer Ozone inventory runs meet the latest planning assumption requirement. This report presents the latest population and land use data available that calibrated the modeling process used to calculate the vehicle emissions for the mobile emissions budgets as well as the input values for U.S. EPA's most recent emissions software (MOVES) for this attainment demonstration. (A series of conference calls held during the winter of 2010/2011 by the Interagency Consultancy Group established that this re-designation effort will require the use of MOVES software for all mobile source emission analyses.)

LAND USE DATA:

Travel analysis zones (269 in the 3-county area) and external roadway "stations" (31) are the basic geographic units for estimating travel patterns. Socioeconomic data used to forecast these patterns shown in Table 2 include household population, school enrollment, vehicle registrations, labor force participation, and employment by category and location. Sources for year 2000 data include the 2000 Census (primarily SF1 block data), state vehicle registration files, and QCEW/ES202 employment data. All data sources were geocoded to the zone level. Future year data for each variable were projected through various methods. More detailed explanation of base year and future year data generation for each of the above-mentioned categories of planning data follows. Figure 2 displays the zones boundaries in the region.

Table 2

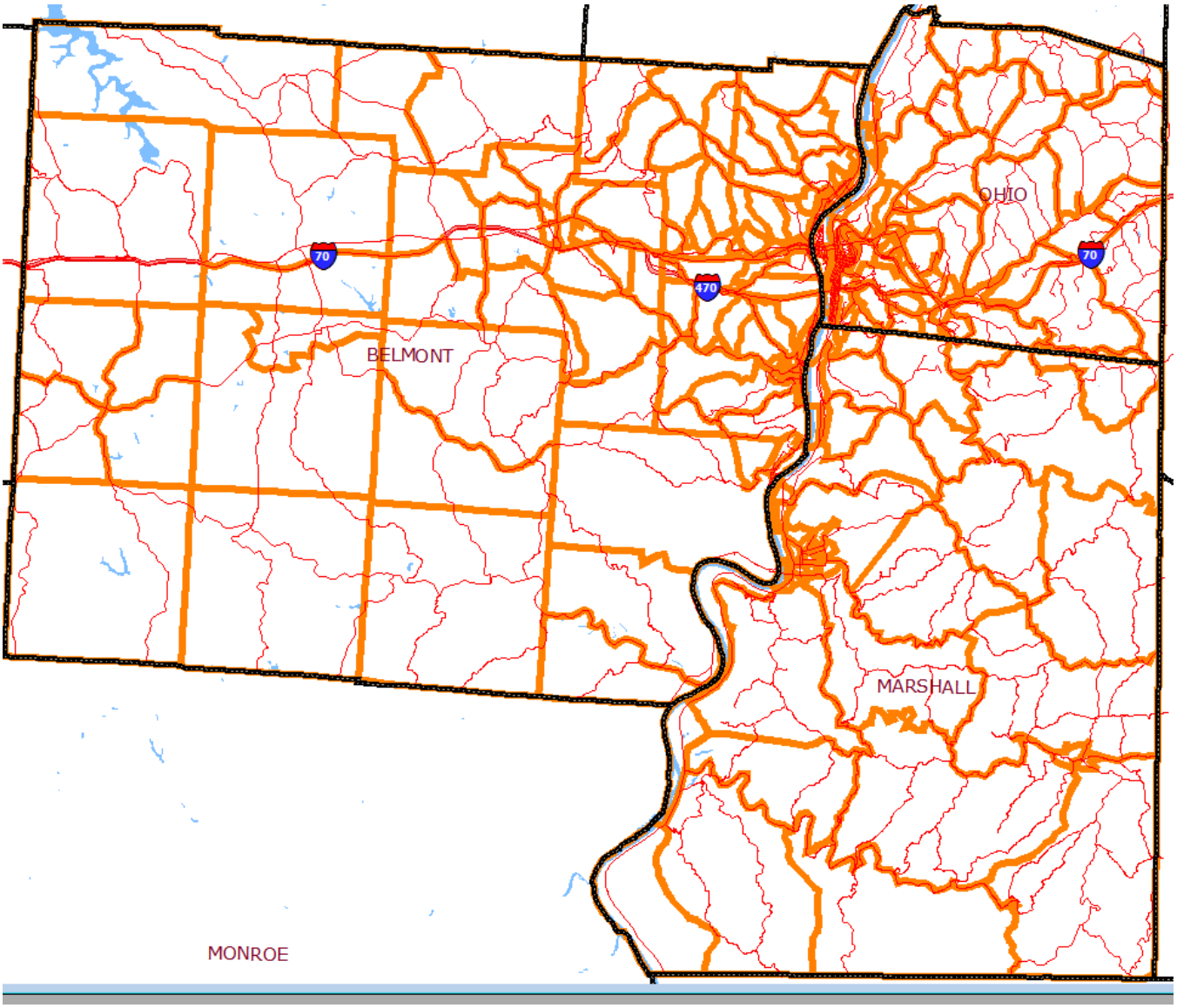
BELOMAR REGION LAND USE DATA USED FOR TRAFFIC FORECASTING

SOCIO-ECONOMIC DATA:	YEAR:	2000	2035
RETAIL EMPLOYEES (SIC 52-59):			
DOWNTOWN		615	689
MAJOR MALLS (OHIO VALLEY)		3,335	5,020
OTHER		12,798	15,312
SERVICE/GOVT. EMPLOYEES (SIC 60-99):			
PRIVATE SCHOOLS K-12:		374	374
PUBLIC ELEM/MID SCHOOLS:		2,161	2,161
PUBLIC HIGH SCHOOLS:		806	806
POST SEC./TECH COLLEGES		1,083	1,083
DTOWN/GOVT/MED/MAJOR SITES (>50 EMP):		21,094	42,291
OTHER:		19,012	13,925
OTHER EMPLOYEES (SIC 01-51):			
AG/MINING/CONST. (SIC 1-19)		7,757	5,910
MANUFACT/TCPU (SIC 20-49)		8,774	8,289
TRUCK TRANSPORTATION (SIC 42)		589	1,511
WHOLESALE TRADE (SIC 50-51)		3,547	3,980
TOTAL DWELLING UNITS:		68,740	72,628
VEHICLES PER DU:		1.64	1.77
PERSONS PER DU:		2.21	2.11
WORKFORCE PER DU:		1.02	1.02
SCHOOL ENROLLMENT PER DU:		0.47	0.45

For most future-year socio-economic data, Belomar staff uses county level projections as prepared by Woods and Poole. Allocations of county-level totals by zone are documented in the BOMTS report "BOMTS Traffic Zone Data for 2025" with modifications since the date of the report, based on plans submitted for major land developments (such as Cabela's, Center Wheeling, and properties near the Ohio Valley Mall). Woods and Poole's employment projections at the county level are used as control totals for developing TAZ level employment by service, retail and manufacturing. The Woods and Poole's projection at county level is disaggregated from a national level employment projection. The national projection is developed using an export base approach. Regional differences are considered before county level employment is disaggregated. In

assigning employment to zones, it is assumed that new sites with developed infrastructure will have a larger share of future employment. Given the topography of the region, it is assumed generally that new development will mostly occur in one east-west travel corridor (I-70/US40) and one north-south corridor (Ohio Route 7 and US250/WV Route 2 along the Ohio River). In Belmont County, however, additional development is expected along SR331 and in areas surrounding the urban core. Due to a scarcity of developable land in Ohio County, development will occur on sites that are generally flat and can be adequately serviced. In addition, over time, generally flat land in the valley will selectively go through planned land use changes to optimize economic development.

Figure 2
GEOGRAPHIC AREA COVERED BY TRAVEL MODEL AND TRAFFIC ZONE STRUCTURE



TRAVEL MODELING:
A travel demand model (TDM) is the traditional forecasting tool used to examine potential changes in future travel patterns. The road networks within them include all planned federal-aid projects as well as any regionally significant projects found in the TIP and LRTP expected to be open for traffic by the end of each respective analysis year. All projects identified in the LRTP having an impact on travel time and/or vehicle carrying capacity regardless of funding source were included in the air quality analysis. Trip generation figures by zone, with some exceptions, are assumed to change linearly with time between 2000 and the Plan Horizon year of 2035.

The Wheeling area travel demand model network covers about 1500 miles of streets and highways in the 3-county area including all collector and arterial streets, and has been validated to observed traffic for year 2000. Land use data comes from the Census, ES202 employment reporting, and local vehicle registrations. A trip generation model was borrowed from another urban area and adjusted as needed for local land use data. The hourly distribution of trips by trip purpose and direction are constrained to match the hourly distribution of traffic counts. Trip distribution also begins with a trip-length distribution by purpose borrowed from another urban area and adjusted to ensure modeled VMT matched HPMS estimates of VMT within 1% in the model base year of 2000. (Home-based work trips were separately constrained to a target average value based on the 2000 Census.)

The 3-county major street network used in the modeling was developed from the local planning agency's digital street network (originating from the U.S. Geological Survey). The modeling software program utilizes hourly saturation flow rates that are calculated based on road inventory data, roadway type, and the 2000 version of the Highway Capacity Manual (HCM). Coded speeds by street segment are a function of road type and posted speed limits and are based on the Ohio statewide travel time study conducted in 2000 (available on the web at http://www.dot.state.oh.us/urban/data/statewid/report.doc) using the "run time" version of speeds without intersection delays. The model software program internally estimates additional travel times for vehicles that stop for traffic control (stop signs and red lights) based on HCM methods and modeled traffic patterns. The traffic assignment RMS (root mean square) error meets FHWA/ODOT standards for all specified volume groups. Overall modeled VMT for 2000 was less than 1% different than HPMS estimated VMT. Freeways (federal functional class codes 1, 11, and 12) were within 2% of estimated VMT.

The interagency consultation process, as previously discussed, established the following model years for Ohio and Marshall counties, WV and Belmont County, OH that reflected the most recent correspondence from the U.S. EPA:

Analysis Year 2002 – Baseline Emissions
Analysis Year 2009 – Interim Year
Analysis Year 2004 – Attainment Year
Analysis Year 2018 – Maintenance Year

EMISSION FACTOR GENERATION

The MOVES model generated the emission factor files for all analysis years representing the transportation improvement programs implemented in the WWW metro area. Table 3 summarizes the settings used in the MOVES run specification file and the MOVES County-Data Manager. The subsequent tables provide the specific inputs that are not using the MOVES default values.

Table 3 – MOVES Inputs

RunSpec Parameter Settings	
MOVES Version	MOVES2010A
Scale	Custom Domain
MOVES Modeling Technique	Emission Factor Method Rates per Profile (grams/vehicle) Rates per Distance (grams/mile) Rates per Vehicle (grams/vehicle)
Time Span	Time Aggregation: Hour 1 Month representing average summer temperatures All hours of day selected, 16 speed bins, Weekdays only
Geographic Bounds	Belmont county OH, Ohio and Marshall counties WV
Vehicles/Equipment	All source types, gasoline and diesel
Road Type	All road types including off-network
Pollutants and Processes	Total Gaseous Hydrocarbons, Non-Methane Hydrocarbons, Volatile Organic Compounds, NO_x, NO, NO_2, Total Energy Consumption
Strategies	None
General Output	Units = grams, joules and miles
Output Emissions	Time = hour, Location = custom area, on-road emission rates by road type and source use type.
Advance Performance	None
County Data Manager Sources	
Source Type Population	Combination of local and default data Local data (OH&WV) from motor vehicle registration Default data used for source types 41, 51, 54, 61, and 62 Future year growth rate MPO model Household growth rate.
Vehicle Type VMT	Combination of local and default data HPMSVTypeYear VMT = daily VMT from travel demand model, monthVMTFraction = default dayVMTFraction=default, hourVMTFraction=local
I/M Program	None
Fuel Formulation	Default
Fuel Supply	Default
Metereology Data	Local data obtained from NOAA National Climatic Data Center. Data will consist of monthly high and low temperatures and daily relative humidity for 2002.
Ramp Fraction	Using the base year travel demand model for VHT fractions.
Road Type Distribution	Use ODOT and WVDOH county summary VMT categorized by federal functional classes
Age Distribution	Combination of local and default data. Local data (2010) ODOT from motor vehicle registration Default data used for source types 41, 51, 54, 61, and 62 The same age distribution will be used for all analysis years
Average Speed Distribution	Default
Alternative Fuel Type	Default

TEMPERATURE AND RELATIVE HUMIDITY

The single season approach for temperature and relative humidity uses weather data collected by the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC). The data used in this report, taken from the Wheeling Airport collection center, is representative of 12 months in 2009. Data entered into a spreadsheet provided by U.S. EPA converted the Mobile6 to get the correct data for the MOVES model. Table 4 below contains the average annual hourly temperatures and relative humidity distribution profiles used for the Belomar region.

Table 4
AVERAGE TEMPERATURE AND RELATIVE HUMIDITY DATA

Time of Day	Average Temperature	Average Relative Humidity (%)
Midnight	47.2	79.7
1 AM	46.1	67.1
2 AM	45.2	80.7
3 AM	44.6	82.9
4 AM	44.1	83.8
5 AM	43.6	84.1
6 AM	43.1	82.6
7 AM	43.5	79.6
8 AM	45.9	74.8
9 AM	49.6	70.1
10 AM	53.5	65.7
11 AM	56.8	62.0
12 PM	59.7	59.8
1 PM	61.3	58.2
2 PM	61.9	57.4
3 PM	62.0	57.3
4 PM	61.6	58.3
5 PM	60.5	61.2
6 PM	58.6	65.3
7 PM	56.2	69.2
8 PM	53.7	66.1
9 PM	51.6	74.3
10 PM	50.1	75.7
11 PM	48.6	78.1

RAMP FRACTION

The Vehicles Hour of Travel (VHT) fractions from the travel demand model were used to derive the Ramp Fraction values needed for the MOVES model procedures (approximately 4% in Belmont county Ohio, 8% in Ohio county West Virginia, and 3% in Marshall county West Virginia).

SOURCE TYPE POPULATION

A combination of local and MOVES default data is the Source Type Population for vehicle classifications. The MOVES default values provided the data for vehicle Source Types 51, 52, 53, 61, and 62 while local data from Ohio and West Virginia motor vehicle registrations accounted for all other Source Type Populations needed to run the MOVES model. Table 5 shows the Source Type Population identifications, the corresponding Source Type Name, and the number of vehicles analyzed for Belmont County, OH and Ohio/Marshall County, WV combined.

Table 5

SOURCE TYPE POPULATION FOR YEAR 2005

year	Source Type	Belmont #	Marshall co #	Ohio co #
2005	11 MotorCycle	4724	937	1149
2005	21 Passenger Car	48706	9650	17852
2005	31 Passenger Truck	22592	9946	14061
2005	32 Light Commercial Truck	602	1755	2285
2005	41 Intercity Bus	58	5	16
2005	42 Transit Bus	2	3	9
2005	43 School Bus	127	99	51
2005	51 Refuse truck	35	8	14
2005	52 Single Unit Short-haul Truck	14	461	818
2005	53 Single Unit Long-haul Truck	55	53	93
2005	54 Motor Home	165	21	48
2005	61 Combination Short-haul Truck	786	78	245
2005	62 Combination Long-haul Truck	984	86	272

VEHICLE AGE DISTRIBUTION

A grouping of data from Ohio and West Virginia sources along with the MOVES model defaults make up the Vehicle Age Distribution. MOVES default values included Vehicle Type ID 41, 42, 51, 52, 53, 61, and 62. Local data from Ohio and West Virginia motor vehicle registrations accounted for all other Vehicle Type ID. Table 6 shows a sample Vehicle Age Distribution By Source Type for Belmont County, OH in 2005.

Table 6

VEHICLE AGE DISTRIBUTION BY SOURCE TYPE FOR BELMONT COUNTY, OHIO IN 2005

yearid	ageid	11	21	31	32	41	42	43	51	52	53	54	61	62
2005	0	0.003	0.004	0.006	0.010	0.000	0.000	0.023	0.000	0.000	0.000	0.003	0.003	0.011
2005	1	0.025	0.020	0.022	0.028	0.053	0.000	0.031	0.000	0.000	0.000	0.018	0.012	0.033
2005	2	0.052	0.033	0.047	0.069	0.026	0.000	0.047	0.000	0.000	0.000	0.033	0.024	0.018
2005	3	0.068	0.039	0.051	0.066	0.026	0.000	0.055	0.286	0.286	0.286	0.039	0.028	0.096
2005	4	0.085	0.042	0.061	0.068	0.316	0.000	0.047	0.000	0.000	0.000	0.030	0.037	0.079
2005	5	0.083	0.048	0.076	0.025	0.079	0.000	0.016	0.000	0.000	0.000	0.037	0.049	0.064
2005	6	0.068	0.047	0.066	0.015	0.053	0.000	0.063	0.000	0.000	0.000	0.041	0.047	0.030
2005	7	0.079	0.048	0.065	0.045	0.000	0.000	0.070	0.214	0.214	0.214	0.028	0.047	0.038
2005	8	0.064	0.057	0.068	0.048	0.079	0.000	0.070	0.000	0.000	0.000	0.033	0.043	0.033
2005	9	0.051	0.054	0.056	0.035	0.053	0.000	0.070	0.000	0.000	0.000	0.034	0.043	0.052
2005	10	0.042	0.062	0.063	0.069	0.026	0.000	0.063	0.000	0.000	0.000	0.043	0.057	0.085
2005	11	0.032	0.060	0.056	0.041	0.105	0.000	0.086	0.000	0.000	0.000	0.043	0.051	0.083
2005	12	0.027	0.056	0.054	0.055	0.053	0.000	0.141	0.000	0.000	0.000	0.035	0.045	0.080
2005	13	0.020	0.055	0.045	0.030	0.000	0.000	0.078	0.000	0.000	0.000	0.024	0.045	0.041
2005	14	0.020	0.050	0.041	0.031	0.000	0.000	0.008	0.071	0.071	0.071	0.020	0.038	0.053
2005	15	0.014	0.051	0.048	0.055	0.026	0.000	0.047	0.071	0.071	0.071	0.032	0.048	0.053
2005	16	0.015	0.043	0.043	0.040	0.000	0.500	0.000	0.071	0.071	0.071	0.027	0.051	0.027
2005	17	0.012	0.038	0.031	0.028	0.000	0.000	0.008	0.071	0.071	0.071	0.025	0.035	0.011
2005	18	0.012	0.034	0.020	0.036	0.026	0.000	0.000	0.000	0.000	0.000	0.028	0.030	0.029
2005	19	0.009	0.031	0.017	0.031	0.000	0.500	0.031	0.000	0.000	0.000	0.020	0.033	0.005
2005	20	0.007	0.022	0.013	0.028	0.026	0.000	0.000	0.071	0.071	0.071	0.014	0.028	0.006
2005	21	0.008	0.019	0.012	0.025	0.000	0.000	0.023	0.000	0.000	0.000	0.029	0.029	0.017
2005	22	0.006	0.015	0.009	0.033	0.000	0.000	0.000	0.071	0.071	0.071	0.024	0.032	0.015
2005	23	0.010	0.010	0.008	0.018	0.000	0.000	0.016	0.000	0.000	0.000	0.025	0.021	0.015
2005	24	0.018	0.007	0.006	0.018	0.027	0.000	0.008	0.072	0.072	0.072	0.024	0.023	0.005
2005	25	0.019	0.006	0.005	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.016	0.006
2005	26	0.014	0.006	0.004	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.014	0.008
2005	27	0.016	0.002	0.002	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.008	0.003
2005	28	0.017	0.001	0.001	0.002	0.026	0.000	0.000	0.000	0.000	0.000	0.013	0.007	0.000
2005	29	0.018	0.002	0.001	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.007	0.000
2005	30	0.088	0.038	0.006	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.201	0.054	0.006

ROAD TYPE DISTRIBUTION

The ODOT and WV Division of Highway county summary Vehicle Miles Traveled (VMT) data categorized by federal functional class for the three county non-attainment areas is the basis for Road Type Distribution Fraction. Table 7 illustrates Road Type Distribution.

Table 7

ROAD TYPE DISTRIBUTION FOR THE BELOMAR REGION

sourceTypeID	roadTypeID	roadTypeVMTFraction	sourceTypeID	roadTypeID	roadTypeVMTFraction
11	1	0	51	1	0
11	2	0.25	51	2	0.25
11	3	0.24	51	3	0.24
11	4	0.18	51	4	0.18
11	5	0.33	51	5	0.33
21	1	0	52	1	0
21	2	0.25	52	2	0.25
21	3	0.24	52	3	0.24
21	4	0.18	52	4	0.18
21	5	0.33	52	5	0.33
31	1	0	53	1	0
31	2	0.25	53	2	0.25
31	3	0.24	53	3	0.24
31	4	0.18	53	4	0.18
31	5	0.33	53	5	0.33
32	1	0	54	1	0
32	2	0.25	54	2	0.25
32	3	0.24	54	3	0.24
32	4	0.18	54	4	0.18
32	5	0.33	54	5	0.33
41	1	0	61	1	0
41	2	0.25	61	2	0.25
41	3	0.24	61	3	0.24
41	4	0.18	61	4	0.18
41	5	0.33	61	5	0.33
42	1	0	62	1	0
42	2	0.25	62	2	0.25
42	3	0.24	62	3	0.24
42	4	0.18	62	4	0.18
42	5	0.33	62	5	0.33
43	1	0	roadTypeID	roadDesc	
43	2	0.25	2	Rural Restricted Access	
43	3	0.24	3	Rural Unrestricted Access	
43	4	0.18	4	Urban Restricted Access	
43	5	0.33	5	Urban Unrestricted Access	

OUTPUT EMISSION FACTORS

Table 8 shows the first record in a MOVES sample output (rate per distance) emission file for year 2005 with I/M programs. For any given month, day of week, hour of the day, pollutant, and source type; the rate per distance varies by road type and speed bin. Rates per distance emissions are applied to link and intrazonal VMT.

Table 8 – Sample Emission File (Rate per Distance) for year 2005

Heading:	MOVESScenarioID	MOVESRunID	yearID	monthID	dayID	hourID
Record:			2005	7	5	1
Heading:	linkID	pollutantID	processID	sourceTypeID	SCC	fuelTypeID
Record:		87	0	1		0
Heading:	modelYearID	roadTypeID	avgSpeedBinID	temperature	relHumidity	ratePerDistance
Record:	0	2	1			6.90740776

Table 9 shows the first record in a MOVES sample output (rate per vehicle) emission file for year 2005 with I/M programs. The rate per vehicle varies for any combinations of month, day of week, hour of the day, pollutant, and process. Rates per vehicle emissions are applied to the vehicle source type population.

Table 9 – Sample Emission File (Rate per Vehicle) for year 2005

Heading:	MOVESScenarioID	MOVESRunID	yearID	monthID	dayID
Record:			2005	7	5
Heading:	hourID	zoneID	pollutantID	processID	sourceTypeID
Record:	1		87		1
Heading:	SCC	fuelTypeID	modelYearID	temperature	ratePerVehicle
Record:		0	0		0.27257887

Table 10 shows the first record in a MOVES sample output (rate per profile) emission file for year 2005 with I/M programs. The rate per vehicle varies for any combinations of month, day of week, hour of the day, pollutant, and process. Rates per profile emissions are applied to the vehicle souce type population.

Table 10 – Sample Emission File (Rate per Profile) for year 2005

Heading:	MOVESScenarioID	MOVESRunID	yearID	monthID	dayID
Record:			2005	0	5
Heading:	hourID	zoneID	pollutantID	processID	sourceTypeID
Record:	1		87	0	1
Heading:	SCC	fuelTypeID	modelYearID	temperature	ratePerVehicle
Record:		0	0		0.01774139

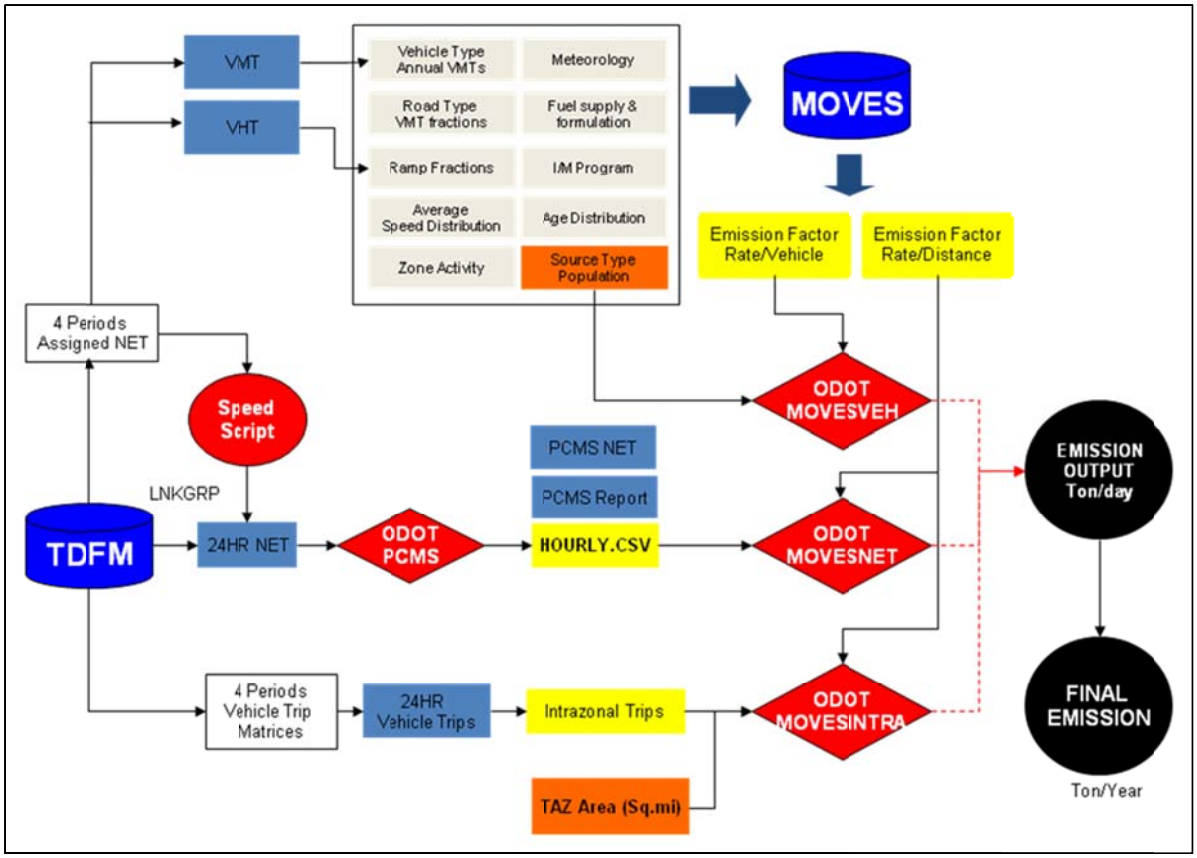
POST PROCESSING

Several custom programs created by ODOT staff were used to compute the total emissions. The process uses data on daily and directional traffic distributions as well as more up to date volume/delay functions from the 2000 Highway Capacity Manual (HCM). This process also uses rewritten code able to handle the newer model network formats and MOVES generated emission factors.

The first step in the process involves running postcms.exe to calculate hourly link volumes based on the percentage of the daily volume (travel demand model output) determined by a link's facility and area type. The analysis does not use the link speeds from the travel demand model. Using a link's volume-to- capacity ratio and link group code, a post-process to the model based on HCM methods estimates the link speeds. The second step (mmoves.exe) uses a combination of the MOVES emission factors and the hourly link volumes that are output of the postcms.exe program. The hourly volumes multiplied by the MOVES emission factor for the corresponding hour of day, speed bin, and road type; calculate emissions for every network link for each hour. The final link on road vehicle emissions for the area is the sum of all individual link-hour emissions. The third step, (vehcalm.exe), calculates vehicle-based emissions for each source type for each hour of the day. A combination of local and default data is the source for the vehicle source type. The final vehicle emissions for each county are the sum of all individual hourly emissions for all vehicle types. Since the intrazonal trips are not loaded onto the network, the fourth step in the process requires a separate method to account for those trips that use local roads to travel within a zone. The intracalm.exe program uses intrazonal trips to estimate VMT using the area in square miles and intrazonal trips of each zone. The computer program assumes that the zone is circular and uses the radius of the circle as the average trip length for these intrazonal trips. By combining MOVES generated emissions with estimated intrazonal VMT, the intrazonal emissions are then calculated. The emission rates are the same as those used to calculate link based emissions. The final step is to summarize link, vehicle, and intrazonal emissions for each county, pollutant, and analyzed year.

See Figure 3 below for the general schematic of the process. More details are provided at http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Documents/cmaqr6_revised_jan_2012.pdf (note that the "non-CUBE" option is used as described in Appendix B)

Figure 3 – Emission Calculation Process



APPENDIX A

INTERAGENCY CONSULTATION DOCUMENTATION