Tennessee
Area Designations for the
2008 Ozone National Ambient Air Quality Standards

The table below identifies the areas and associated counties or parts of counties in Tennessee that EPA intends to designate as nonattainment for the 2008 ozone national ambient air quality standards (2008 ozone NAAQS). In accordance with section 107(d) of the Clean Air Act, EPA must designate an area (county or part of a county) "nonattainment" if it is violating the 2008 ozone NAAQS or if it is contributing to a violation of the 2008 ozone NAAQS in a nearby area. The technical analyses supporting the boundaries for the individual nonattainment areas are provided below.

Intended Nonattainment Areas in Tennessee

Area	Tennessee's Recommended Nonattainment Counties	EPA's Intended Nonattainment Counties
Knoxville-Sevierville-La Follette, TN	Blount (partial) Cocke (partial) Sevier (partial)	Anderson Blount Cocke (partial) Knox Loudon Sevier
Memphis, TN-MS-AR*	None	Shelby

*Memphis, TN-MS-AR is a multi-state nonattainment area. Table 1 below identifies the counties in the other states that EPA intends to designate as part of the nonattainment area.

EPA intends to designate the remaining counties in Tennessee that are not listed in the table above as "unclassifiable/attainment" for the 2008 ozone NAAQS.

The analysis below provides the basis for intended nonattainment area boundaries. It relies on our analysis of whether and which monitors are violating the 2008 ozone NAAQS, based on certified air quality monitoring data from 2008-2010 and an evaluation of whether nearby areas are contributing to such violations. EPA has evaluated contributions from nearby areas based on a weight of evidence analysis considering the factors identified below. EPA issued guidance on December 4, 2008 that identified these factors as ones EPA would consider in determining nonattainment area boundaries and recommended that states consider these factors in making their designations recommendations to EPA.[1]

1. Air quality data (including the design value calculated for each Federal Reference Method monitor or Federal Equivalent Method (FEM) monitor in the area);
2. Emissions and emissions-related data (including location of sources and population, amount of emissions and emissions controls, and urban growth patterns);
3. Meteorology (weather/transport patterns);
4. Geography and topography (mountain ranges or other basin boundaries);
5. Jurisdictional boundaries (e.g., counties, air districts, existing nonattainment areas, Indian country, metropolitan planning organizations (MPOs))

[1] The December 4, 2008 guidance memorandum "Area Designations for the 2008 Revised Ozone National Ambient Air Quality Standards" refers to 9 factors. In this technical support document we have grouped the emissions-related factors together under the heading of "Emissions and Emissions-Related Data," which results in 5 categories of factors.

Ground-level ozone generally is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Because NOx and VOC emissions from a broad range of sources over a wide area typically contribute to violations of the ozone standards, EPA believes it is important to consider whether there are contributing emissions from a broad geographic area. Accordingly, EPA chose to examine the 5 factors with respect to the larger of the Combined Statistical Area (CSA) or Core Based Statistical Area (CBSA) associated with the violating monitor(s).[2] All data and information used by EPA in this evaluation are the latest available to EPA and/or provided to EPA by states or tribes.

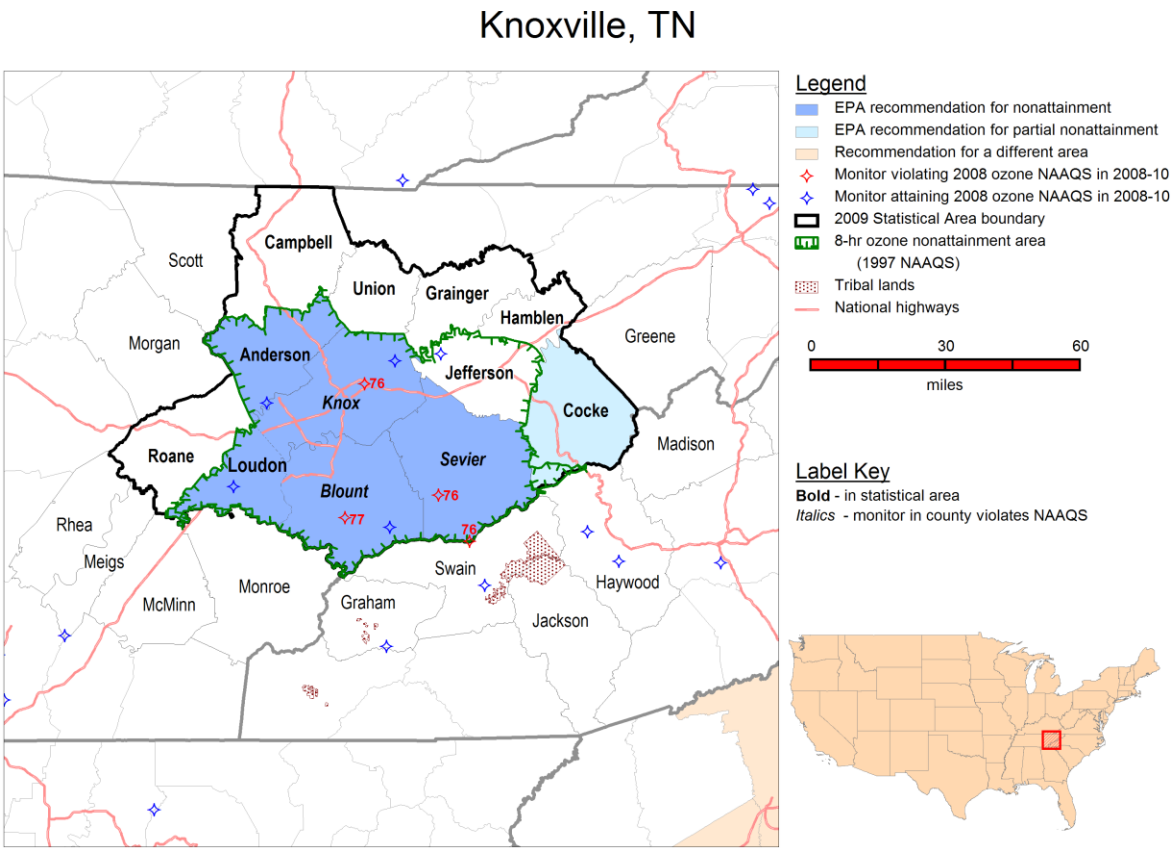
In EPA's designations guidance for the 2008 ozone NAAQS EPA recommended examining CSA/CBSAs because certain factors used to establish CSAs and CBSAs are similar to the factors EPA is using in this technical analysis to determine if a nearby area is contributing to a violation of the 2008 ozone NAAQS. Congress required a similar approach in 1990 for areas classified as serious or above for the 1-hour ozone standard, and EPA used the same basic approach in the designation process for the 1997 ozone NAAQS. Where a violating monitor is not located in a CSA or CBSA, EPA's guidance recommended using the boundary of the county containing the violating monitor as the starting point for considering the nonattainment area's boundary.

[2] Lists of CBSAs and CSAs and their geographic components are provided at www.census.gov/population/www/metroareas/metrodef.html. The lists are periodically updated by the Office of Management and Budget. EPA used the most recent update, based on 2008 population estimates, issued on December 1, 2009 (OMB Bulletin No. 10-02).

Technical Analysis for Knoxville-Sevierville-La Follette

Figure 1 is a map of the Knoxville-Sevierville-La Follette intended nonattainment area. The map also shows locations and design values of air quality monitors, county and other jurisdictional boundaries, the nonattainment area boundary for 1997 ozone NAAQS, and major transportation arteries.

Figure 1. Knoxville-Sevierville-La Follette CSA



For purposes of the 1997 8-hour ozone NAAQS, this area was designated nonattainment. The boundary for the nonattainment area for the 1997 ozone NAAQS included the entire counties of Anderson, Blount, Jefferson, Knox, Loudon, and Sevier in Tennessee, and a portion of Cocke County, Tennessee.

In March 2009, Tennessee recommended that Anderson, Blount, Knox, Loudon, and Sevier Counties in their entireties, and a portion of Cocke County be designated as the "Knoxville" nonattainment area for the 2008 8-hour ozone standard based on air quality data from 2006-2008. In March 2009, Tennessee also recommended that Jefferson County be designated as the "Morristown" nonattainment area, separate from a Knoxville nonattainment area, for the 2008 8-hour ozone standard based on air quality data from 2006-2008. Letter from James H. Fyke, Commissioner, State of Tennessee Department of Environment and Conservation to A. Stanley Meiburg, Acting Regional Administrator, US EPA Region 4 (March 10, 2009) (on file with US EPA Region 4). In November 2011, Tennessee provided an update to their 2009 original recommendation based on preliminary air quality data from 2009-2011. In its updated recommendation, Tennessee recommended that the portions of Blount, Cocke and Sevier Counties that comprise the Tennessee portion of the Great Smoky Mountains National Park be

designated “nonattainment” for the 2008 ozone NAAQS. Letter from Robert J. Martineau Jr, Commissioner, State of Tennessee Department of Environment and Conservation to Gwen Keyes Fleming, Regional Administrator, US EPA Region 4 (Nov. 8, 2011) (on file with US EPA Region 4). The March 2009 and November 2011 recommendations were based on data from FEM monitors sited and operated in accordance with 40 CFR Part 58.

After considering these recommendations and based on EPA's technical analysis described below, EPA intends to designate five entire counties and one partial county in Tennessee (identified in Table 1 below) as “nonattainment” for the 2008 ozone NAAQS as part of the Knoxville-Sevierville-La Follette nonattainment area.

Table 1. State's Recommended and EPA’s Intended Designated Nonattainment Counties for Knoxville-Sevierville-La Follette.

Knoxville-Sevierville-La Follette	State-Recommended Nonattainment Counties	EPA Intended Nonattainment Counties
Tennessee	Blount (partial) Cocke (partial) Sevier (partial)	Anderson Blount Cocke (partial) Knox Loudon Sevier

Factor Assessment

Factor 1: Air Quality Data

For this factor, we considered 8-hour ozone design values (in parts per billion (ppb)) for air quality monitors in counties in the Knoxville-Sevierville-La Follette area based on data for the 2008-2010 period (i.e., the 2010 design value, or DV), which are the most recent years with fully-certified air quality data. A monitor’s DV is the metric or statistic that indicates whether that monitor attains a specified air quality standard. The 2008 ozone NAAQS are met at a monitor when the annual fourth-highest daily maximum 8-hour average concentration, averaged over 3 years is 75 ppb or less. A DV is only valid if minimum data completeness criteria are met. See 40 CFR part 50 Appendix P. Where several monitors are located in a county (or a designated nonattainment area or maintenance area), the DV for the county or area is determined by the monitor with the highest level.

The 2010 DVs for the ozone NAAQS for counties in the Knoxville-Sevierville-La Follette and nearby surrounding area are shown in Table 2.

Table 2. Air Quality Data.

County*	State Recommended Nonattainment?	2008-2010 Design Value (ppb)
Anderson, TN	No	70
Blount, TN	**Yes (Partial)**	**77**
Cocke, TN	**Yes (Partial)**	**N/A**
Jefferson, TN	No	74
Knox, TN	**No**	**76**
Loudon, TN	No	73

Sevier, TN	**Yes (Partial)**	**76**

*Counties with violating monitors are shown in bold.

Blount, Knox and Sevier Counties show violations of the 2008 ozone NAAQS, therefore these counties are included in the nonattainment area. A county (or partial county) must also be designated nonattainment if it contributes to a violation in a nearby area. Each county without a violating monitor that is located near a county with a violating monitor has been evaluated, as discussed below, based on the five factors and other relevant information to determine whether it contributes to the nearby violation.

Factor 2: Emissions and Emissions-Related Data

EPA evaluated emissions of ozone precursors (NOx and VOC) and other emissions-related data that provide information on areas contributing to violating monitors.

Emissions Data

EPA evaluated county-level emission data for NOx and VOC derived from the 2008 National Emissions Inventory (NEI), version 1.5. This is the most recently available NEI. (See http://www.epa.gov/ttn/chief/net/2008inventory.html) Significant emissions levels in a nearby area indicate the potential for the area to contribute to observed violations. We will also consider any additional information we receive on changes to emissions levels that are not reflected in recent inventories. These changes include emissions reductions due to permanent and enforceable emissions controls that will be in place before final designations are issued and emissions increases due to new sources. The precursor emission source-category percentages used below and throughout the document were derived from emissions data from the 2008 NEI version 1.5 referenced above.

Table 3 shows emissions of NOx and VOC (given in tons per year (tpy)) for violating and nearby counties in the Knoxville-Sevierville-La Follette, TN CSA that we considered for inclusion in the Knoxville-Sevierville-La Follette area.

Table 3. Total 2008 NOx and VOC Emissions.

County*	State Recommended Nonattainment?	NOx (tpy)	VOC (tpy)
Anderson, TN	**No**	**12,475**	**3,569**
Blount, TN	**Yes (Partial)**	**3,593**	**6,749**
Campbell, TN	No	2,964	1,773
Cocke, TN	**Yes (Partial)**	**1,761**	**2,273**
Grainger, TN	No	687	1,216
Hamblen, TN	No	6,612	4,719
Jefferson, TN	No	3,148	3,329
Knox, TN	**No**	**15,169**	**16,182**
Loudon, TN	**No**	**3,751**	**3,340**
Roane, TN	No	10,711	3,006
Sevier, TN	**Yes (Partial)**	**2,602**	**5,399**
Union, TN	No	432	959
	Areawide:	63,905	52,514

*Counties that EPA intends to designate as nonattainment are shown in bold.

Knox County is leading all counties with 24 percent of NOx and 31 percent VOC of the CSA's emissions. Anderson County emitted 19 percent of the CSA's NOx emissions with 77 percent from point sources. It is worth noting that the Bull Run Facility Electric Generating Unit (EGU) in Anderson County generated 1,086 tons of NOx with Selective Catalytic Reduction (SCR) control during the 2008 ozone season. Blount County was the second highest VOC contributor at 6,749 tons, 13 percent of the CSA total. Sevier County had the third highest VOC levels with 5,400 tons, about 10 percent of the CSA total. In addition, 18 percent of all VOC emissions from mobile sources originated from Blount and Sevier Counties.

Population density and degree of urbanization

EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. These include ozone-creating emissions from on-road and off-road vehicles and engines, consumer products, residential fuel combustion, and consumer services. Areas of dense population or commercial development are an indicator of area source and mobile source NOx and VOC emissions that may contribute to ozone formation. Rapid population or vehicle miles travelled (VMT) growth (see below) in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that it may be appropriate to include the area associated with the area source and mobile source emissions as part of the nonattainment area. Table 4 shows the population, population density, and population growth information for each county in the area.

Table 4. Population and Growth.

County*	State Recommended Nonattainment?	2010 Population	2010 Population Density (1000 pop/sq mi)	Absolute change in population (2000-2010)	Population % change (2000-2010)
Anderson	**No**	**75,129**	**0.22**	**3,897**	**+5%**
Blount	**Yes (Partial)**	**123,010**	**0.22**	**16,793**	**+16%**
Campbell	No	40,716	0.08	853	+2%
Cocke	**Yes (Partial)**	**35,662**	**0.08**	**2,035**	**+6%**
Grainger	**No**	22,657	0.07	1,920	+9%
Hamblen	No	62,544	0.36	4,301	+7%
Jefferson	No	51,407	0.16	6,825	+15%
Knox	**No**	**432,226**	**0.82**	**49,198**	**+13%**
Loudon	**No**	**48,556**	**0.20**	**9,342**	**+24%**
Roane	No	54,181	0.14	2,238	+4%
Sevier	**Yes (Partial)**	**89,889**	**0.15**	**18,190**	**+25%**
Union	No	19,109	0.08	1,250	+7%
	Areawide:	1,055,086	0.23	116,842	12%

*Counties that EPA intends to designate as nonattainment are shown in bold.

Sources: U.S. Census Bureau population estimates for 2010 as of August 4, 2011 (http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_PL_GCTPL2.STO5&prodType=table)

In terms of population growth, Sevier, Loudon and Blount Counties experienced the largest with 25 percent, 24 percent and 16 percent, respectively. Sevier County has the second highest absolute change in population with 18,190. Most of the urban area is in the center (Sevierville) with sparsely populated communities on the northwest side of the county adjacent to Knoxville. Loudon is mostly rural with

sparsely populated areas along the US Highway 11 corridor. Blount County's population grew 16 percent and is home to 11 percent of the CSA's population making it second to Knox County. Blount County's urban and agriculture development is in the northwestern half of the County. Knox County has highest population density, the largest absolute change in population, and, the largest population in the 12-county CSA. Anderson County has intermittent urbanization in Oak Ridge and Clifton on the southwestern part of the county, adjacent to Knoxville. Jefferson County is mostly rural with the center of the urban density in Jefferson City, and in closer proximity (compared to Knoxville) to the more urbanized area of Morristown in Hamblen County.

Traffic VMT data and commuting patterns

EPA evaluated the total VMT for each county. In combination with the population/population density data and the location of main transportation arteries (see above), this information helps identify the probable location of non-point source emissions. A county with high VMT is generally an integral part of an urban area and indicates the presence of motor vehicle emissions that may contribute to ozone formation that contributes to nonattainment in the area. Rapid population or VMT growth in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that the associated area source and mobile source emissions may be appropriate to include in the nonattainment area. Table 5 shows the total 2008 VMT for each county.

Table 5. Traffic and VMT Data.

County*	State Recommended Nonattainment?	2008 VMT** (million miles)
Anderson	**No**	**831**
Blount	**Yes (Partial)**	**1,105**
Campbell	No	656
Cocke	**Yes (Partial)**	**455**
Grainger	**No**	232
Hamblen	No	656
Jefferson	No	819
Knox	**No**	**5,304**
Loudon	**No**	**782**
Roane	No	743
Sevier	**Yes (Partial)**	**1,164**
Union	No	134
	Areawide:	12,881

*Counties that EPA intends to designate as nonattainment are shown in bold.
**MOBILE model VMTs are those inputs into the NEI version 1.5.

Knox County leads the CSA with the highest VMT followed by Sevier and Blount counties.

Factor 3: Meteorology (weather/transport patterns)

For this factor, EPA analyzed 30-years of National Weather Service (NWS) wind speed and wind direction data collected at the Knoxville/McGhee Tyson Airport (Station #13891) to help determine transport patterns and source contributions. EPA assessed wind direction and speed for the 2008-2010 "ozone season" (March through October) in the Knoxville-Sevierville-La Follette, TN CSA. The analysis was conducted to better understand the fate and transport of precursor emissions contributing to

ozone formation. EPA's analysis of the NWS data indicate predominate southwest, west-southwest and northern component for the Knoxville-Sevierville-La Follette, TN CSA

Factor 4: Geography/topography (mountain ranges or other air basin boundaries)

The geography/topography analysis evaluates the physical features of the land that might affect the air shed and, therefore, the distribution of ozone over the area.

Regional topography consists of linear ridge and parallel lowland valleys. The Area has predominantly high elevations in the northern regions and lower elevations further south ranging from 700 to 1,500 feet. The Knoxville-Sevierville-La Follette, TN area includes the Tennessee portion of the Great Smoky Mountains National Park (GSMNP). This area consists of densely forested high peaks and valleys. The highest point in the state is at Clingman's Dome with an elevation of 6,643 feet. There are three violating monitors in the Knoxville area that are at the higher elevations and within the GSMNP. These monitors are Look Rock (AQS ID: 47-009-0101, 2008-2010 DV of 77 ppb) in Blount County, Cove Mountain (AQS ID: 47-155-0101, 2008-2010 DV of 76 ppb) in Sevier County, and Clingman's Dome (AQS ID: 47-155-0102, 2008-2010 DV of 76 ppb), also in Sevier County.

Figure 2 shows a topographical map of Knoxville and the National Park. These two monitors are located at a significantly higher elevation than the Knox County monitors. High elevation ozone sites often measure elevated ozone levels overnight due to regional transport of tropospheric ozone formed during the daytime. The regional transport mechanisms that cause these events are related to downward transport by vertical mixing that concentrates the tropospheric ozone or by horizontal transport from surrounding areas (Eliasson et al, 2003). The long duration of these nocturnal events can also be attributed to a lack of local Nitric Oxide (NO) emissions which act to titrate the ozone and reduce the ambient ozone concentration as occurs in urban areas overnight (Eliasson et al, 2003)[3].

Figure 3 compares the hourly distribution of daily maximum hourly ozone values over 65 ppb for four sites: Look Rock, two urban Knox County Sites, and Blue Ridge Parkway, another high elevation site in North Carolina in the GSMNP that is further removed from urban areas. The Knoxville sites show a typical urban pattern of ozone events in the afternoon (approximately 12:00 pm to 6:00 pm). The Blue Ridge Parkway site is impacted primarily by regional transport and shows a typical high elevation site pattern of ozone events overnight (approximately 9:00 pm to 3:00 am). This site is not in the Knoxville Sevierville-La Follette CBSA and is only included as an example of another high elevation site. The Look Rock site shows a combination of these two signals, indicating that the site is impacted by both downwind afternoon ozone formation from Knoxville and high elevation ozone transport. In some cases, these two processes could be affecting the Look Rock monitor simultaneously.

Figure 4 shows the frequency of ozone hourly values greater than 75 ppb by wind direction and time of day for the Look Rock site. This figure illustrates two distinct groups of high ozone events: afternoon ozone from the south to southeast (Knoxville) and overnight ozone from the north to northwest (regional transport). The Cove Mountain site in Sevier County shows a similar pattern as the Look Rock, although with a slightly less pronounced urban signal.

[3] Ingegärd Eliasson, Sofia Thorsson, Yvonne Andersson-Sköld, Summer nocturnal ozone maxima in Göteborg, Sweden, Atmospheric Environment, Volume 37, Issue 19, June 2003, Pages 2615-2627.

As a result of these analyses, EPA has preliminarily concluded that both downwind urban ozone formation from Knoxville Knox County and high elevation regional transport of ozone contribute to the NAAQS violations at the Look Rock and Cove Mountain monitors.

Figure 2. Topographical map of Knoxville and the Great Smoky Mountains National Park

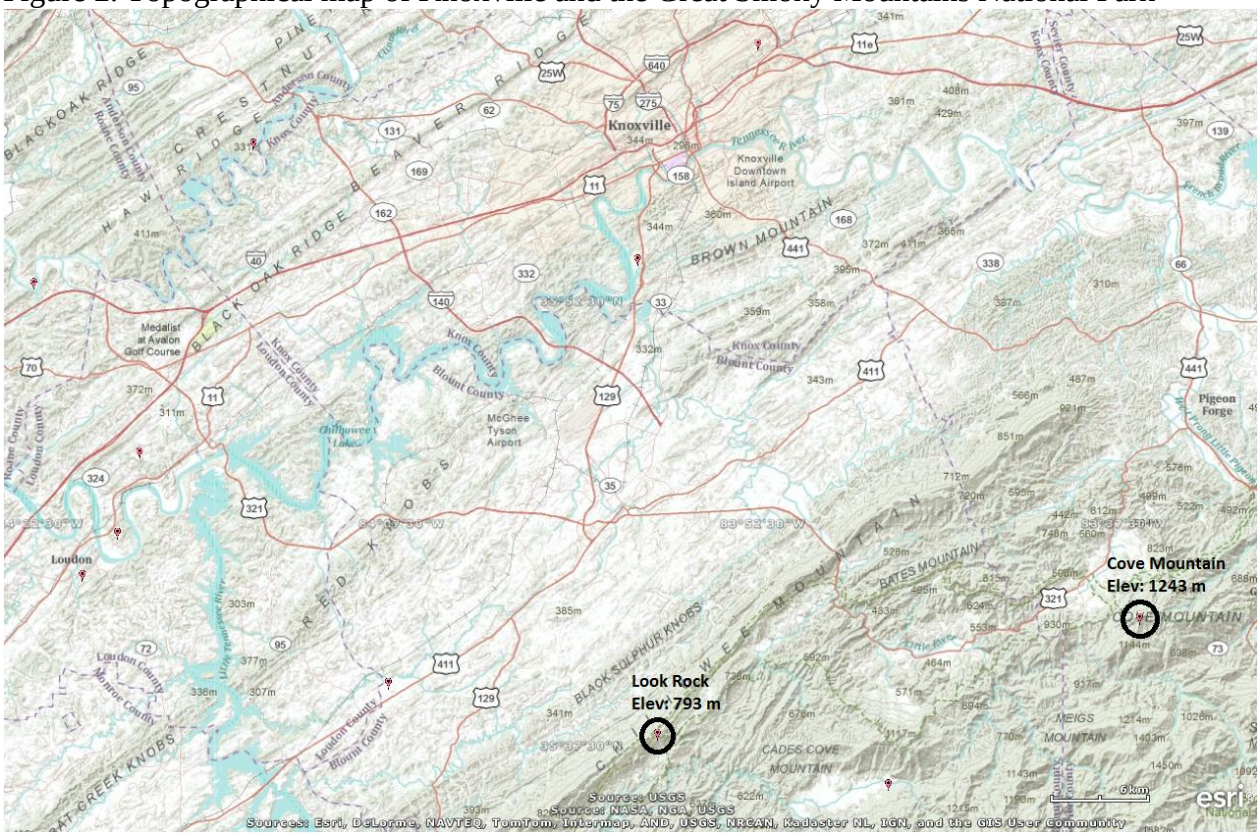


Figure 3. 2007-2010 Count of Daily Max Values > 65 ppb

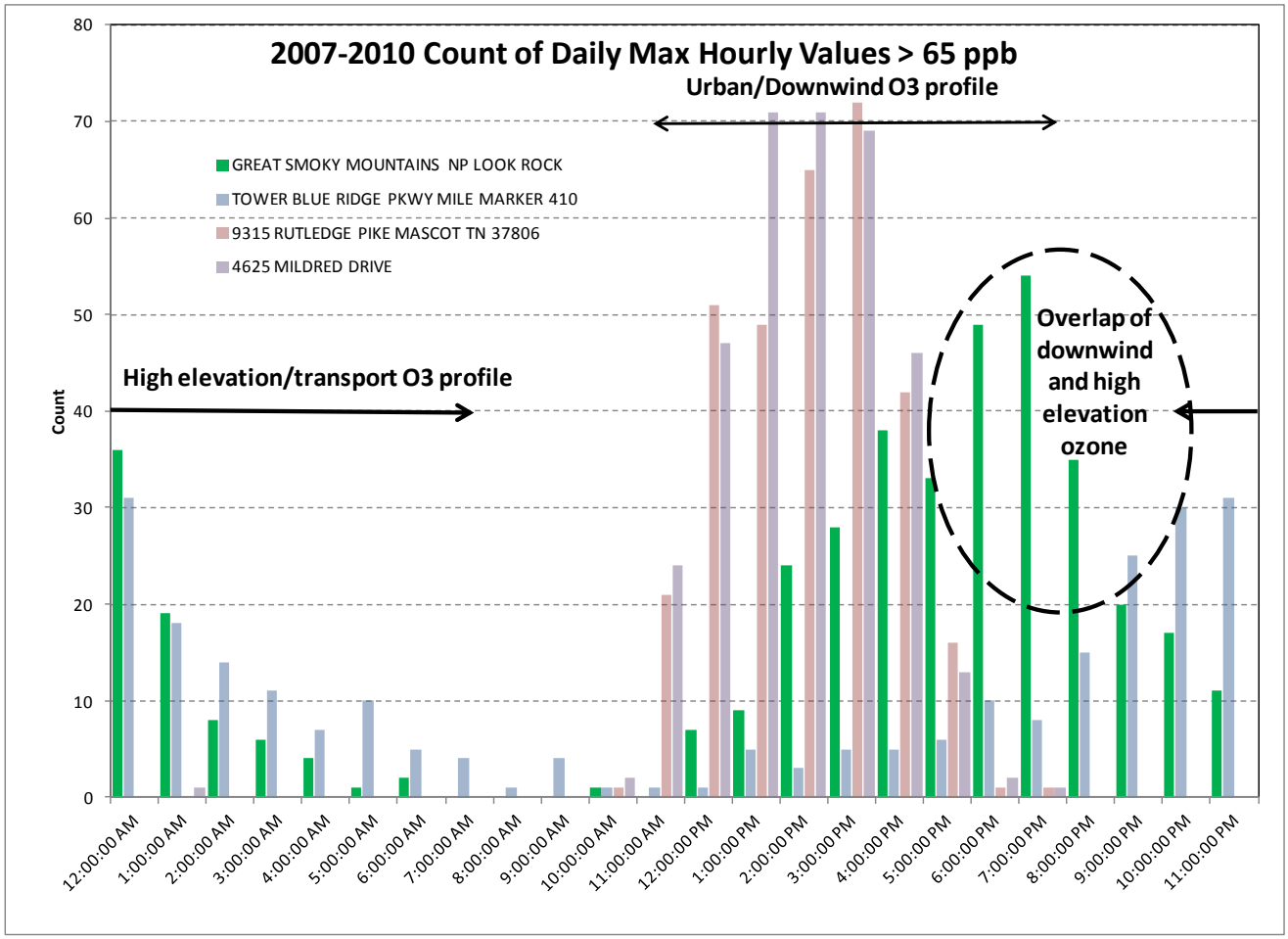
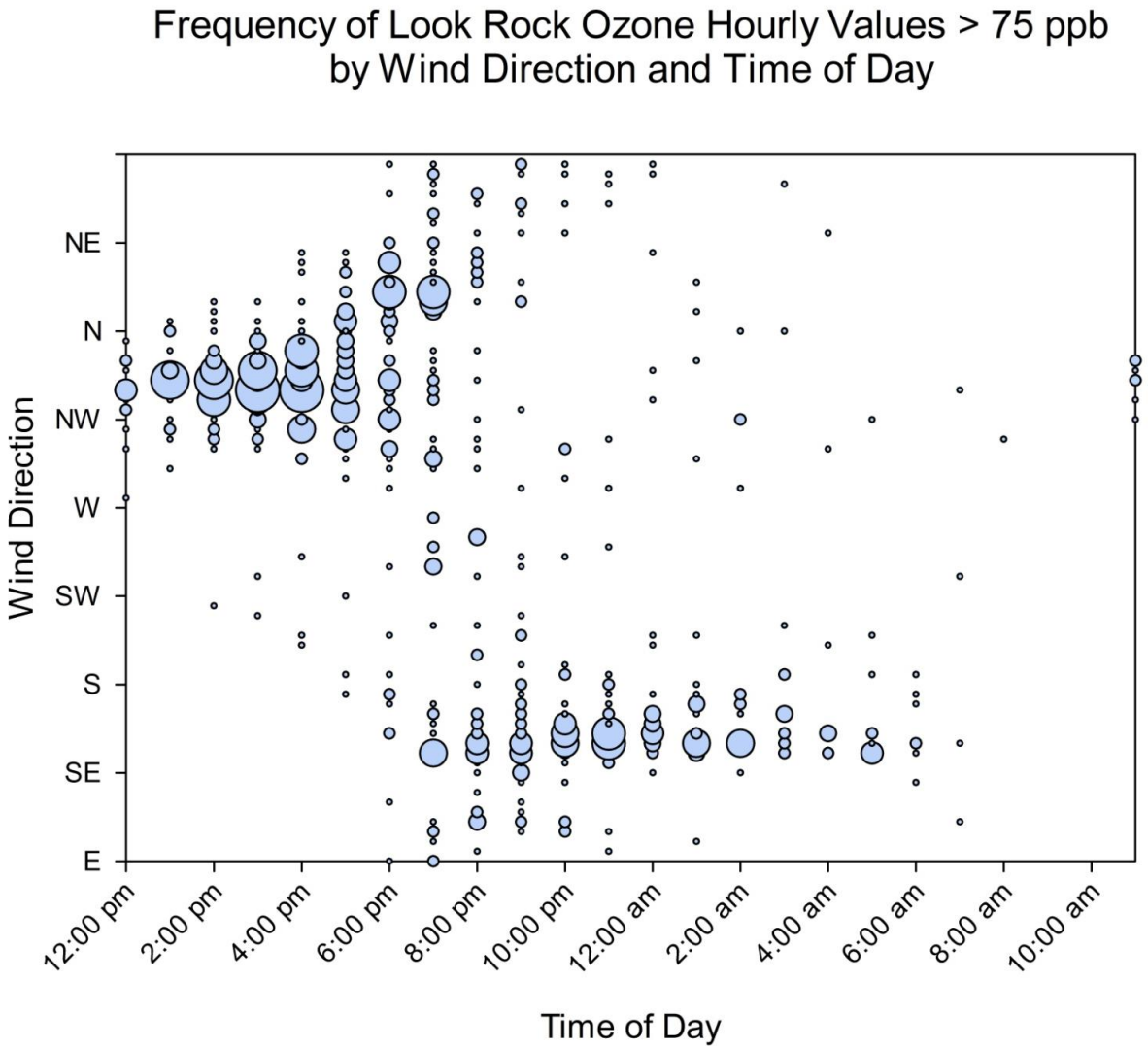


Figure 4. Frequency of Look Rock Ozone Hourly Values >75 ppb



Factor 5: Jurisdictional boundaries

Once we identified the general areas we anticipate recommending as nonattainment areas, we then considered existing jurisdictional boundaries for the purposes of providing a clearly defined legal boundary and to help identify the areas appropriate for carrying out the air quality planning and enforcement functions for nonattainment areas. Examples of jurisdictional boundaries include existing/prior nonattainment area boundaries for ozone or other urban-scale pollutants, county lines, air district boundaries, township boundaries, area covered by a MPOs, state lines, areas of Indian Country, and urban growth boundary. Where existing jurisdictional boundaries were not adequate or appropriate to describe the nonattainment area, other clearly defined and permanent landmarks or geographic coordinates were considered.

The Knoxville-Sevierville-La Follette area has previously established nonattainment boundaries associated with the both the 1-hour ozone and 1997 8-hour ozone NAAQS. The Knoxville-Sevierville-La Follette nonattainment boundary for the 1-hour ozone NAAQS included Knox County, Tennessee in its entirety. Whereas the Knoxville-Sevierville-La Follette nonattainment boundary for the 1997 8-hour

ozone NAAQS included Anderson, Blount, Jefferson, Knox, Loudon, and Sevier Counties in Tennessee in their entireties, and a portion of Cocke County, Tennessee.

The Knoxville-Sevierville-La Follette CSA is composed of two MPOs, the Knoxville Regional Transportation Planning Organization (TPO) and Lakeway Area Metropolitan Transportation Planning Organization (MTPO). The Knoxville TPO includes Loudon, Blount, Knox and Sevier Counties. The Lakeway MTPO includes Jefferson and Hamblen Counties.

Jefferson County had a violating monitor based on air quality data used for the 2004 designation for the 1997 ozone NAAQS. It was included within the nonattainment area boundary based on the violation, not based on a determination that emissions from the county were contributing to a violation in a nearby area violating the standard. Current monitor reading shows Jefferson as attaining. In addition, a portion of Jefferson County (Jefferson City) falls under the Lakeway MTPO.

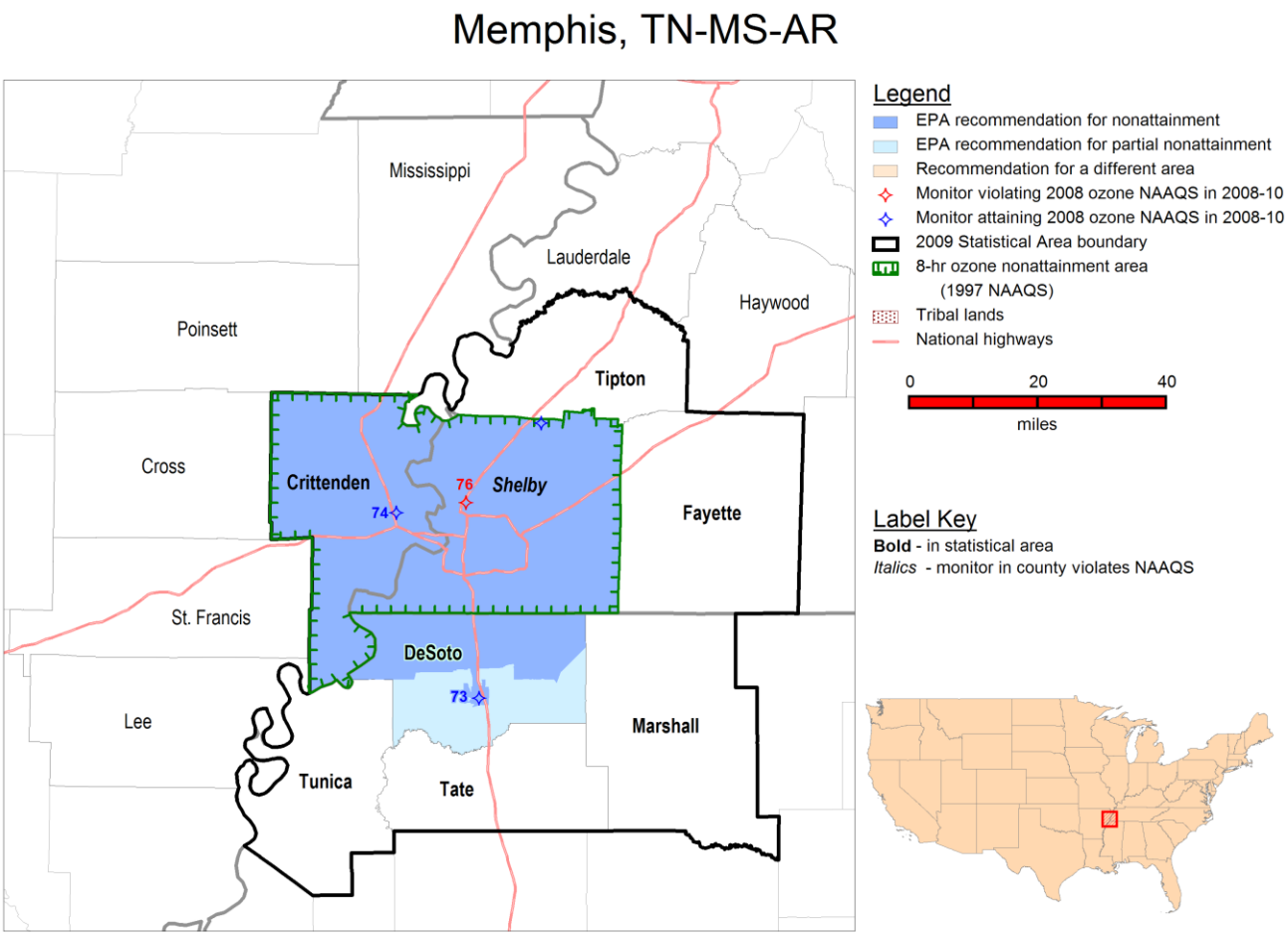
Conclusion

Based on the assessment of factors described above, EPA has preliminarily concluded that the following counties should be included as part of the Knoxville-Sevierville-La Follette nonattainment area because they are either violating the 2008 ozone NAAQS or contributing to a violation in a nearby area: Anderson, Blount, Knox, Loudon and Sevier Counties, in their entireties. A portion of Cocke County is brought in since it comprises the GSMNP. All of these counties are included in the Knoxville nonattainment area for the 1997 ozone NAAQS. The air quality monitors in Blount, Knox and Sevier Counties indicate violations of the 2008 ozone NAAQS based on 2010 DVs, therefore these counties are preliminarily included in the nonattainment area. Anderson and Loudon Counties, in their entireties, and a portion of Cocke County in Tennessee are nearby counties that do not have a violating monitor, but EPA has preliminarily concluded that these counties contribute to the ozone concentrations in violation of the 2008 ozone NAAQS through emissions from point sources and non-point sources (e.g., vehicles and other small area sources). Knox County, Tennessee has among the highest NOx and VOC emissions in the area. Anderson County ranked relatively high for large NOx emissions, contributing 19 percent of the CSA's total NOx. Given the prevalent wind (southwest, west-southwest and northern), Anderson County, which is adjacent to Knox County, is contributing to the violating monitor to Knox County and therefore is being brought in for contribution. While SCR controls were installed at the plant, there has been a steady increase in NOx emission levels since 2006.

Technical Analysis for Memphis, TN-MS-AR

Figure 1 is a map of the Memphis, TN-MS-AR intended nonattainment area. The map provides other relevant information including the locations and design values of air quality monitors, county and other jurisdictional boundaries, relevant statistical area boundaries, the nonattainment area boundary for 1997 ozone NAAQS, and major transportation arteries.

Figure 1. TN-MS-AR Nonattainment Area



For purposes of the 1997 8-hour ozone NAAQS, portions of this area were designated nonattainment. The boundary for the nonattainment area for the 1997 ozone NAAQS included the entire counties of Crittenden County, Arkansas, and Shelby County, Tennessee.

In March 2009, Tennessee recommended that Shelby County be designated "nonattainment" for the 2008 8-hour ozone standard based on air quality data from 2006-2008. Letter from James H. Fyke, Commissioner, State of Tennessee Department of Environment and Conservation to A. Stanley Meiburg, Acting Regional Administrator, US EPA Region 4 (March 10, 2009) (on file with US EPA Region 4). Tennessee provided an update to its original recommendation in November 2011 based on preliminary 2009-2011 air quality data. In Tennessee's updated recommendation, the state did not provide a specific update to its 2009 recommendation for the Memphis TN-MS-AR but stated that all

other counties (with the exception of those recommended for Knoxville) should be designated unclassifiable/attainment. Letter from Robert J. Martineau Jr, Commissioner, State of Tennessee Department of Environment and Conservation to Gwendolyn Keyes Fleming, Regional Administrator, US EPA Region 4 (November 8, 2011) (on file with US EPA Region 4).

Also, in March 2009, Mississippi recommended that DeSoto County, Mississippi be designated as a nonattainment area separate from the Memphis nonattainment area for the 2008 ozone NAAQS based on air quality data from 2006-2008. Mississippi provided an update to the original recommendation in October 2011 based on air quality data from 2008-2010, and preliminary data from 2009-2011. In its updated recommendation, Mississippi recommended that all counties in the State be designated attainment for the 2008 ozone NAAQS. Letter from Haley Barbour, Governor of the State of Mississippi to A. Stanley Meiburg, Acting Regional Administrator, US EPA Region 4 (March 3, 2009) and Gwendolyn Keyes Fleming, Regional Administrator US EPA Region 4 (October 27, 2011) (on file with US EPA Region 4). Additionally, in March 2009, Arkansas recommended that Crittenden County, Arkansas be designated nonattainment based on 2006-2008 air quality data. Arkansas did not update its 2009 ozone recommendation. These data are from FEM monitors sited and operated in accordance with 40 CFR Part 58. Letter from Mike Beebe, Governor of the State of Arkansas to Lawrence E. Starfield, Acting Regional Administrator, US EPA Region 6 (March 10, 2009) (on file with US EPA Region 6).

After considering these recommendations and based on EPA's technical analysis described below, EPA intends to designate one county in Arkansas, one county (partial) in Mississippi, and one county in Tennessee (identified in Table 1 below) as nonattainment for the 2008 ozone NAAQS as part of the Memphis, TN-MS-AR multi-state nonattainment area.

Table 1. State's Recommended and EPA's Intended Designated Nonattainment Counties for Memphis, TN-MS-AR.

Memphis, TN-MS-AR	State-Recommended Nonattainment Counties	EPA Intended Nonattainment Counties
Arkansas	Crittenden	Crittenden
Mississippi	None	DeSoto (partial)
Tennessee	None	Shelby

Factor Assessment

Factor 1: Air Quality Data

For this factor, we considered 8-hour ozone design values (in parts per billion (ppb)) for air quality monitors in counties in the Memphis, TN-MS-AR area based on data for the 2008-2010 period (i.e., the 2010 design value, or DV), which are the most recent years with fully-certified air quality data. A monitor's DV is the metric or statistic that indicates whether that monitor attains a specified air quality standard. The 2008 ozone NAAQS are met at a monitor when the annual fourth-highest daily maximum 8-hour average concentration, averaged over 3 years is 75 ppb or less. A DV is only valid if minimum data completeness criteria are met. See 40 CFR part 50 Appendix P. Where several monitors are located in a county (or a designated nonattainment area or maintenance area), the DV for the county or area is determined by the monitor with the highest level.

The 2010 DVs for the ozone NAAQS for counties in the Memphis and nearby surrounding area are shown in Table 2.

Table 2. Air Quality Data[4].

County	State Recommended Nonattainment?	2008-2010 Design Value (ppb)
Crittenden, AR	Yes	74
DeSoto, MS	No	73
Shelby, TN	**No**	**76**

Shelby County, Tennessee shows a violation of the 2008 ozone NAAQS, therefore this county is included in the nonattainment area. A county (or partial county) must also be designated nonattainment if it contributes to a violation in a nearby area. Each county without a violating monitor that is located near a county with a violating monitor has been evaluated, as discussed below, based on the five factors and other relevant information to determine whether it contributes to the nearby violation.

Factor 2: Emissions and Emissions-Related Data

EPA evaluated emissions of ozone precursors (NOx and VOC) and other emissions-related data that provide information on areas contributing to violating monitors.

Emissions Data

EPA evaluated county-level emission data for NOx and VOC derived from the 2008 National Emissions Inventory (NEI), version 1.5. This is the most recently available NEI. (See http://www.epa.gov/ttn/chief/net/2008inventory.html) Significant emissions levels in a nearby area indicate the potential for the area to contribute to observed violations. We will also consider any additional information we receive on changes to emissions levels that are not reflected in recent inventories. These changes include emissions reductions due to permanent and enforceable emissions controls that will be in place before final designations are issued and emissions increases due to new sources. The precursor emission source-category percentages used below and throughout the document were derived from emissions data from the 2008 NEI version 1.5 referenced above.

Table 3 shows emissions of NOx and VOC (given in tons per year (tpy)) for violating and nearby counties that we considered for inclusion in the Memphis, TN-MS-AR area.

[4] Only counties in the Memphis CBSA that have ozone monitors are included in this table.

Table 3. Total 2008 NOx and VOC Emissions.

County	State Recommended Nonattainment	NO_x (tpy)	VOC (tpy)
Crittenden, AR	**Yes**	**4,047**	**3,805**
DeSoto, MS	**No**	**5,080**	**5,222**
Fayette, TN	No	2,385	1,406
Marshall, MS	No	1,769	1,527
Shelby, TN	**No**	**39,519**	**27,929**
Tate, MS	No	3,102	1,392
Tipton, TN	No	2,119	2,251
Tunica, MS	No	1,598	1,096
	Areawide:	59,619	44,628

*Counties that EPA intends to designate as nonattainment are shown in bold.

Shelby County contributes about 66 percent of the NOx and 63 percent of the VOC precursor emissions in the CBSA. Shelby makes up 23 percent of the entire CBSA NOx emissions and 22 percent of the area's VOC emissions. Of the county's 39,519 NOx emissions, 35 percent are from point and mobile emissions and 20 percent from area source emissions. The County's 27, 929 VOC emissions include 36 percent mobile sources and 32 percent area sources.

DeSoto County contributes about 9 percent NOx and 12 percent VOC precursor emissions in the CBSA. The County's 5,080 NOx emissions are mostly comprised of 45 percent area sources, 35 percent mobile sources. DeSoto County's total VOC emissions include 44 percent area sources and 34 percent mobile sources.

Crittenden County contributes less than 10 percent of the precursor CBSA emissions. Of the County's total NOx emissions listed in Table 1, 45 percent are from mobile sources and 34 percent from area sources. The County's total VOC emissions include 35 percent from area sources and 31 percent from mobile sources. Only 5 percent of the County's NOx emissions are from point sources. Both Crittenden and DeSoto Counties represent less than 1 percent of the entire area's NOx and VOC point source emissions

Fayette and Tipton Counties in Tennessee and Marshall, Tate, and Tunica counties in Mississippi all contribute 5 percent or less NOx and VOC precursor emissions in the CBSA.

Together, Crittenden, DeSoto and Shelby Counties account for 82 percent of the NOx emissions and 83 percent of the VOC emissions for the 8-county area. The emissions from Fayette and Tipton Counties in Tennessee and Marshall, Tate and Tunica Counties in Mississippi are not thought to contribute to the violations of the 2008 ozone NAAQS that have been observed by monitors in Shelby County, Tennessee and Crittenden County, Arkansas.

Population density and degree of urbanization

EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. These include ozone-creating emissions from on-road and off-road vehicles and engines, consumer products, residential fuel combustion, and consumer services. Areas of dense population or commercial development are an indicator of area source and mobile source NOx and VOC emissions that may contribute to ozone formation. Rapid population or VMT growth (see below) in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that it may be appropriate to include the area associated with the area source and mobile source emissions as part of the nonattainment area. Table 4 shows the population, population density, and population growth information for each county in the area.

Table 4. Population and Growth.

County	State Recommended Nonattainment?	2010 Population	2010 Population Density (1000 pop/sq mi)	Absolute change in population (2000-2010)	Population % change (2000-2010)
Crittenden, AR	**Yes**	**50,902**	**0.08**	**(75)**	**<1%**
DeSoto, MS	**No**	**161,252**	**0.32**	**52,584**	**+48%**
Fayette, TN	No	38,413	0.05	9,313	+32%
Marshall, MS	No	37,144	0.05	2,093	+6%
Shelby, TN	**No**	**927,644**	**1.18**	**29,393**	**+3%**
Tate, MS	No	28,886	0.07	3,444	+14%
Tipton, TN	No	61,081	0.13	9,545	+19%
Tunica, MS	No	10,778	0.02	1,557	+17%
	Areawide:	1,316,100	0.28	107,854	+9%

*Counties that EPA intends to designate as nonattainment are shown in bold.
Sources: U.S. Census Bureau population estimates for 2010 as of August 4, 2011 (http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_PL_GCTPL2.STO5&prodType=table)

Shelby County, Tennessee is densely populated containing 70 percent of the CBSA population. From 2000-2010, the County only had 3 percent growth in population. Fayette and Tipton County in Tennessee had moderate growth from 2000-2010 but are sparsely populated.

DeSoto County, Mississippi is moderately populated in the northern portion of the county and mostly rural in the remaining portion of the County. DeSoto County contains 12 percent of the CBSA population, but experienced 48 percent growth from 2000-2010. Tate, Tunica and Marshall Counties in Mississippi all make up 3 percent or less of the CBSA population and are sparsely populated.

Crittenden County, Arkansas had less than 1 percent population growth from 2000-2010 and contains only 4 percent of the CBSA population. The County is mostly rural with little urbanization.

The attachment to this document contains Figure 2, Memphis Area Ozone and Ozone Precursor Monitoring Network, and Figure 3, Population Density Change Percentage Between 2000 and 2010

Census for Memphis Ozone and Ozone Precursor Monitoring Network, which present graphical information on population density and growth for the Memphis area.

Traffic VMT data and commuting patterns

EPA evaluated the total VMT for each county in the Memphis CBSA. In combination with the population/population density data and the location of main transportation arteries (see above), this information helps identify the probable location of non-point source emissions. A county with high VMT is generally an integral part of an urban area and indicates the presence of motor vehicle emissions that may contribute to ozone formation that contributes to nonattainment in the area. Rapid population or VMT growth in a county on the urban perimeter signifies increasing integration with the core urban area, and indicates that the associated area source and mobile source emissions may be appropriate to include in the nonattainment area. Table 5 shows total 2008 VMT for each county.

Table 5. Traffic and VMT Data.

County	State Recommended Nonattainment?	2008 VMT** (million miles)
Crittenden, AR	**Yes**	**903**
DeSoto, MS	**No**	**1,629**
Fayette, TN	No	573
Marshall, MS	No	725
Shelby, TN	**No**	**8,789**
Tate, MS	No	376
Tipton, TN	No	401
Tunica, MS	No	337
Areawide:		13,733

*Counties that EPA intends to designate as nonattainment are shown in bold.
**MOBILE model VMTs are those inputs into the NEI version 1.5.

Shelby County is the only county in the Memphis CBSA violating the 2008 ozone NAAQS with 2008-2010 air quality data and is considered the core CBSA county, with 64 percent of the VMT in the Memphis CBSA; Approximately 35 percent of Shelby County's NOx emissions and 34 percent VOC emissions are from mobile sources.

DeSoto County has the second highest VMT in the Memphis CBSA (12% of the total Memphis CBSA). Additionally, DeSoto County has a 48 percent growth in population from 2000-2010 with approximately 35 and 34 percent of the County's NOx and VOC emissions (respectively) deriving from mobile sources.

Crittenden County, has less than 10 percent of the CBSA VMT (third highest in the Memphis CBSA). From 2000-2010, Crittenden County had less than 1 percent population growth with 45 percent and 31 percent of the County's NOx and VOC emissions(respectively) deriving from mobile sources.

The remaining counties in the Memphis CBSA all have low total population and population growth with little urbanization and low precursor emission contribution suggesting negligible contribution of population-based emissions.

Factor 3: Meteorology (weather/transport patterns)

For this factor, EPA analyzed 30-years of National Weather Service (NWS) wind speed and wind direction data collected at the Memphis International Airport (NWS Station 13893) to help determine transport patterns and source contributions. EPA assessed wind direction and speed for the 2008-2010 "ozone season" (March through October) in the Memphis CBSA as well as on days when area ozone monitors exceeded the 2008 ozone NAAQS. Additionally, EPA evaluated wind back trajectories (which are an analysis of meteorological patterns) specifically on days when the current ozone design value monitor in Shelby County (Frayser monitor) exceeded the 2008 NAAQS. These analyses were conducted to better understand the fate and transport of precursor emissions contributing to ozone formation.

EPA's analysis of the NWS data indicate predominate south and south-southwest component for the Memphis CBSA. However, an examination on days when monitors in DeSoto County (Hernando) exceeded the 2008 ozone NAAQS suggested a northerly component. Additionally, on days when monitors in Shelby County exceeded the 2008 NAAQS, the data indicated a southerly wind component.

Figure 2, Memphis Area Ozone and Ozone Precursor Monitoring Network, and Figure 4 present graphical information on 24-hour back trajectories for exceedances in 2008-2010 at the Frayser monitor, locations of major stationary sources, and locations of ambient monitors with their design values. An examination of the meteorological data indicates that, for the 2008-2010 days with ozone concentrations above 75 ppb at the Memphis 2008-2010 Design Value site (Frayser monitor), the wind back trajectories primarily go back through Shelby County, TN (on 10 out of 10 days) and DeSoto County, MS (on 7 out of 10 days), with back trajectories going back through Crittenden County, AR on only 1 out of 10 days. As mentioned in Factor 1, the Shelby County monitor is the only monitor in the Memphis CBSA with a 2008-2010 violation of the 2008 ozone NAAQS.

Since the 2008-2010 data is only for three years and has only 10 exceedance days, we evaluated more years to better understand the meteorological transport conditions that exist during ozone exceedances. Normally when we are developing a conceptual model understanding of what yields ozone exceedances in an area we will evaluate 5 to 10 years worth of meteorological data. Therefore we decided to evaluate all days that had ozone exceedances at the Design Value monitor (Frayser) for the 2006-2010 period. The 2006 and 2007 years had more meteorology that was conducive for ozone formation than the years of 2008, 2009, and 2010. Figure 5 in the attachment to this document includes 72-hour back trajectories for 2006-2010 ozone exceedances at the Frayser monitor using the National Oceanic and Atmospheric Administration Hybrid Single Particle Lagrangian Integrated Trajectory Model (NOAA HYSPLIT). To further understand the meteorological transport conditions within the regional area around Memphis, we also evaluated24-hour back trajectories for the 2006-2010 time-periods using the NOAA HYSPLIT model. The results of these back trajectories are included in the attachment to this document as Figure 6 with a further zoom in view in Figure 7.

Evaluation of Figures 6 and 7 further supports our previous conclusions based on the 2008-2010 back trajectories when the Memphis area Frayser monitor has ozone exceedances. The 2006-2010 data further supports that most of the centerlines of the back trajectories passes through Shelby County TN, and many of the back trajectory centerlines pass through DeSoto county in northern Mississippi with smaller percentage passing through Crittenden County, Arkansas.

EPA's meteorological assessment of the area monitors ozone exceedances and specifically the wind back trajectory analysis at the Frayser monitor indicate that Shelby County is likely an emission

contributor to exceedances of the 2008 NAAQS at the Frayser monitor. Furthermore, the assessment also suggests that DeSoto and Crittenden Counties should be considered for potential inclusion in the intended Memphis nonattainment area.

Factor 4: Geography/topography (mountain ranges or other air basin boundaries)

The geography/topography analysis evaluates the physical features of the land that might affect the airshed and, therefore, the distribution of ozone over the area.

The Memphis area does not have any geographical or topographical barriers limiting air pollution transport within its air shed. Therefore, this factor did not play a significant role in this evaluation.

Factor 5: Jurisdictional boundaries

Once we identified the general areas we anticipated we would recommend for nonattainment, we then considered existing jurisdictional boundaries for the purposes of providing a clearly defined legal boundary and to help identify the areas appropriate for carrying out the air quality planning and enforcement functions for nonattainment areas. Examples of jurisdictional boundaries include existing/prior nonattainment area boundaries for ozone or other urban-scale pollutants, county lines, air district boundaries, township boundaries, area covered by an MPO, state lines, Reservation boundaries, and urban growth boundaries. Where existing jurisdictional boundaries were not adequate or appropriate to describe the nonattainment area, other clearly defined and permanent landmarks or geographic coordinates were considered.

The Memphis Area MPO is comprised of two study areas; the Memphis Urban Area MPO and the West Memphis MPO. Both organizations are considered multi-jurisdictional agencies responsible for the implementation and coordination of urban transportation planning and establishing transportation conformity infrastructure within their respective boundaries. The Memphis Urban jurisdiction is comprised of all of Shelby County, Tennessee, the western four miles of Fayette County, Tennessee and the northern twelve miles of DeSoto County. The portion of the Memphis Urban MPO in DeSoto County captures the more urbanized portion of the county that has experience continuous growth as well as the ozone air quality monitor. The West Memphis jurisdiction is comprised of the current and potential future urbanized portion of Crittenden County (including the ozone air quality monitor) with the following legal description:

> That area west from the Mississippi River along the southern right of way line of County Road 18 (Miller Road and Caldwell Road) to the western right of way line of County Road 205 (Hinkley Road); then north along said right of way line and continuing north to the intersection of the southern right of way line of the St. Louis-Southwestern Railroad; then in a southwesterly direction along said right of way line to the intersection of eastern right of way line of State Highway 147; then north along said right of way to the intersection of the southern right of way line of State Highway 131; then west along said right of way line to the western right of way line of County Road 51(Eubank Road); then north along said right of way line to U.S. 70; then continuing north along the western right of way line of County Road 25 (Katie Goodhope) to the northern right of way line of County Road 12 (Buck Lake Road); then east along said northern right of way line to State Road 306; then continuing east along the northern right of way line of State Road 306 to the western right of way line of County Road 165; then north along said right of way line to the northern right of way line of County Road 168; then northeasterly along said

right of way line to the intersection of the northern right of way of County Road 172; then east along said right of way line to the intersection of the western right of way line of County Road 5; then north along said right of way line to the intersection of the northern right of way line of James Mill Road; then east along said northern right of way line to the Mississippi River being the eastern boundary of the study area.

Memphis, TN-MS-AR Area has previously established nonattainment boundaries associated with both the 1-hour ozone and 1997 8-hour ozone NAAQS. The Memphis nonattainment boundary for the 1-hour ozone NAAQS included Shelby County, Tennessee in its entirety. Whereas the Memphis nonattainment boundary for the 1997 8-hour ozone NAAQS included Crittenden County, Arkansas and Shelby County, Tennessee in their entireties. Tennessee has recommended a different boundary for the 2008 ozone NAAQS for their portion of this Area. Arkansas recommended the same as the previous boundary for their portion of this Area. In addition, there is current infrastructure for meeting the transportation conformity requirements in Shelby County and the urbanized portions of DeSoto County and Crittenden County since both the Memphis Urban area and West Memphis MPO are currently implementing these requirements for the 1997 8-hour ozone standard.

Even though, DeSoto and Crittenden Counties do not have violating monitors for the 2008 ozone NAAQS based on air quality data from 2008-2010, our analysis suggest that both are likely contributing to the violation in Shelby County due to potential population-based emissions from mobile sources (VMT) and area source, meteorology and population growth.

Conclusion

Based on the assessment of the factors described above, EPA has preliminarily concluded that the following counties should be included as part of the intended Memphis nonattainment area because they are either violating the 2008 ozone NAAQS or contributing to a violation in a nearby area: Crittenden County, Arkansas, and Shelby County, Tennessee in their entireties, and the portion of DeSoto County that is included in the Memphis MPO boundary. Two of these counties (i.e., Crittenden County, Arkansas and Shelby County, Tennessee) are included in the Memphis nonattainment area for the 1997 ozone NAAQS. One of the air quality monitors in Shelby County indicates violation of the 2008 ozone NAAQS based on 2010 DVs, therefore this county is preliminarily included in the nonattainment area. Crittenden County, Arkansas, and DeSoto County, Mississippi are nearby counties that do not have monitors indicating a violation of the standard based on 2010 DVs. However, EPA has preliminarily concluded that these counties (or portions thereof) contribute to the ozone concentrations in violation of the 2008 ozone NAAQS through population-based emissions from mobile and area sources (e.g., vehicles and other small area sources) and county VMT.

Source category emissions data indicate that mobile sources and area sources are the primary contributors to ozone formation in the Memphis CBSA. Thus, population-based emissions such as total population or population growth, and precursor emission transport would indicate a county with contribution in the Memphis Area.

Shelby County, Tennessee dominates the CBSA in terms of urbanization, precursor emission contribution and transport which indicate population-based emission (mobile and area sources) contribution to its own violating monitor. Although the County population growth was less than 5 percent from 2000-2010, it is densely populated with 70 percent of the CBSA population and five times DeSoto County's population. Shelby County makes up over 60 percent of the Area's NOx and VOC

emissions. The County's has over 30 percent of the County's NOx and VOC emission coming from mobile sources and point sources. Meteorological analysis also indicates that Shelby County is contributing to its own violation as well as other monitors in the Memphis CBSA.

The population in DeSoto County, Mississippi has grown steadily from 2000-2010 (particularly the northern portion) with a 48 percent increase, even though it only makes up 12 percent of the total population in the CBSA. The County also has the CBSA's second highest VMT. More than 30 percent of the County's NOx and VOC emissions are from mobile sources and over 40 percent from area sources. In addition, meteorology suggests that DeSoto County is likely contributing to the violation in Shelby County due to potential southerly transport of mobile and area emissions.

Crittenden County, Arkansas makes up less than 5 percent of the CBSA population with less than a 1 percent population growth from 2000-2010. Crittenden County is mostly rural with the least urbanization compared to Shelby and DeSoto Counties. The County contributes less than 10 percent of the CBSA NOx and VOC precursor emissions. However, Crittenden County has over 40 percent of its NOx emission deriving from area sources which is considered a primary contributor to the formation of ozone in the Memphis area. EPA is proposing to include all of Crittenden County in the 2008 ozone Memphis nonattainment area because the county was included in its entirety in the 1997 ozone Memphis nonattainment area and because Arkansas recommended inclusion of the county in its entirety.

The remaining Tennessee (Tipton, Fayette) and Mississippi (Marshal, Tate, and Tunica) counties all have low population and urbanization, and precursor emission contribution and transport suggesting negligible contribution to the violating county. With the exception of those counties that comprise the Memphis, TN-MS-AR 1997 8-hour ozone boundary and the portion of DeSoto County, Mississippi discussed in this TSD for inclusion, EPA preliminarily concludes that the remainder of the counties in the CBSA do not contribute to the violations at the monitors in the CBSA and therefore are not being considered as part of the nonattainment area.

ATTACHMENTS

Figure 2. Memphis Ozone and Ozone Precursor Monitoring Network, with Population Density.

Figure 3. Population Density Change Percentage Between 2000 and 2010 Census for Memphis Ozone and Ozone Precursor Monitoring Network.

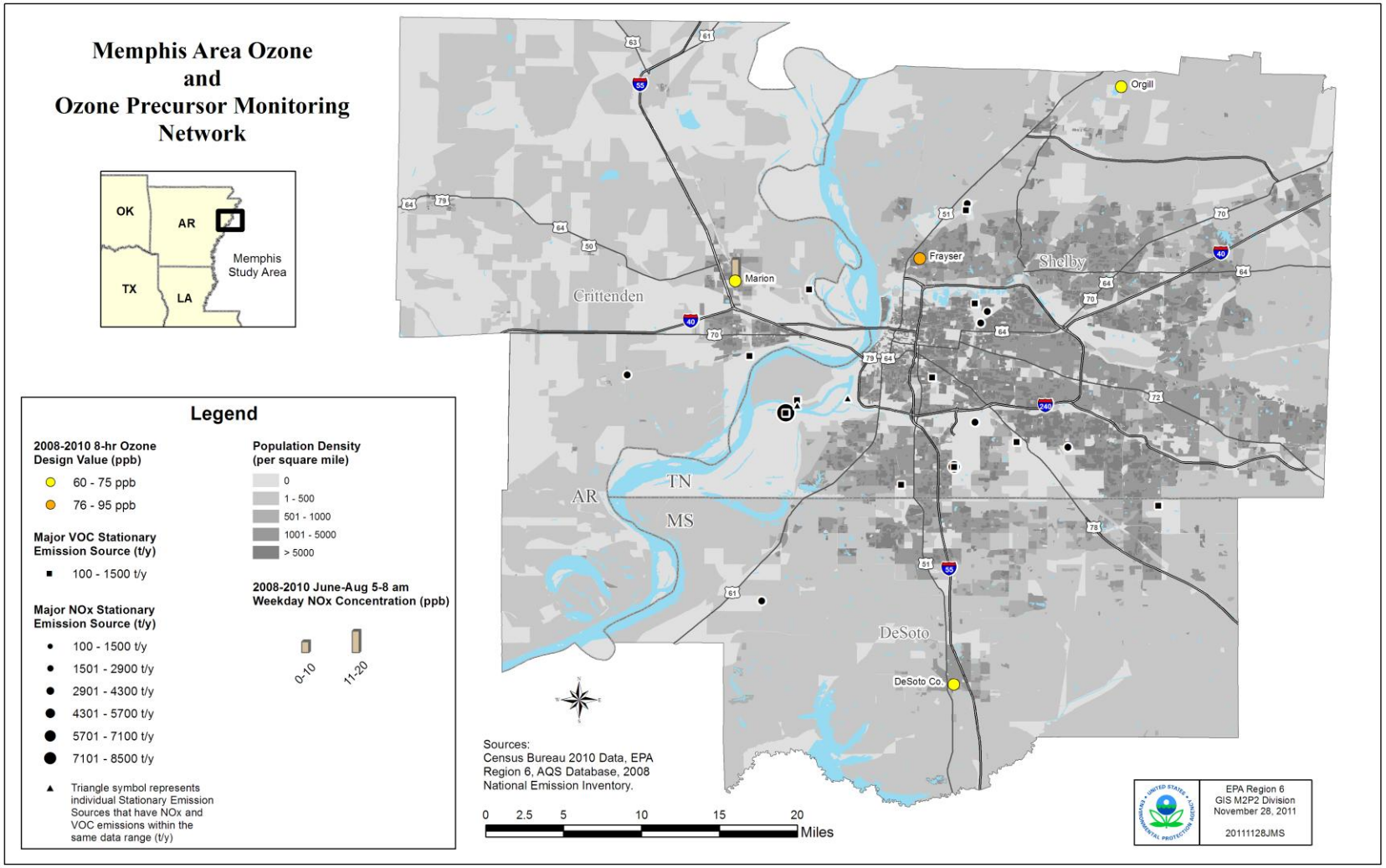
Figure 4. Overlay of 24-hour HYSPLIT back trajectories of all 75 ppb exceedances at the Frayser monitor for the 2008-2010 period.

Figure 5. NOAA HYSPLIT MODEL 72-Hour Back Trajectory Frayser Exceedances (2006-10).

Figure 6. NOAA HYSPLIT MODEL 24-Hour Back Trajectory Frayser Exceedances (2006-10).

Figure 7. NOAA HYSPLIT MODEL 24-Hour Back Trajectory Frayser Exceedances (2006-10) - Zoom View.

Figure 2. Memphis Ozone and Ozone Precursor Monitoring Network, with Population Density



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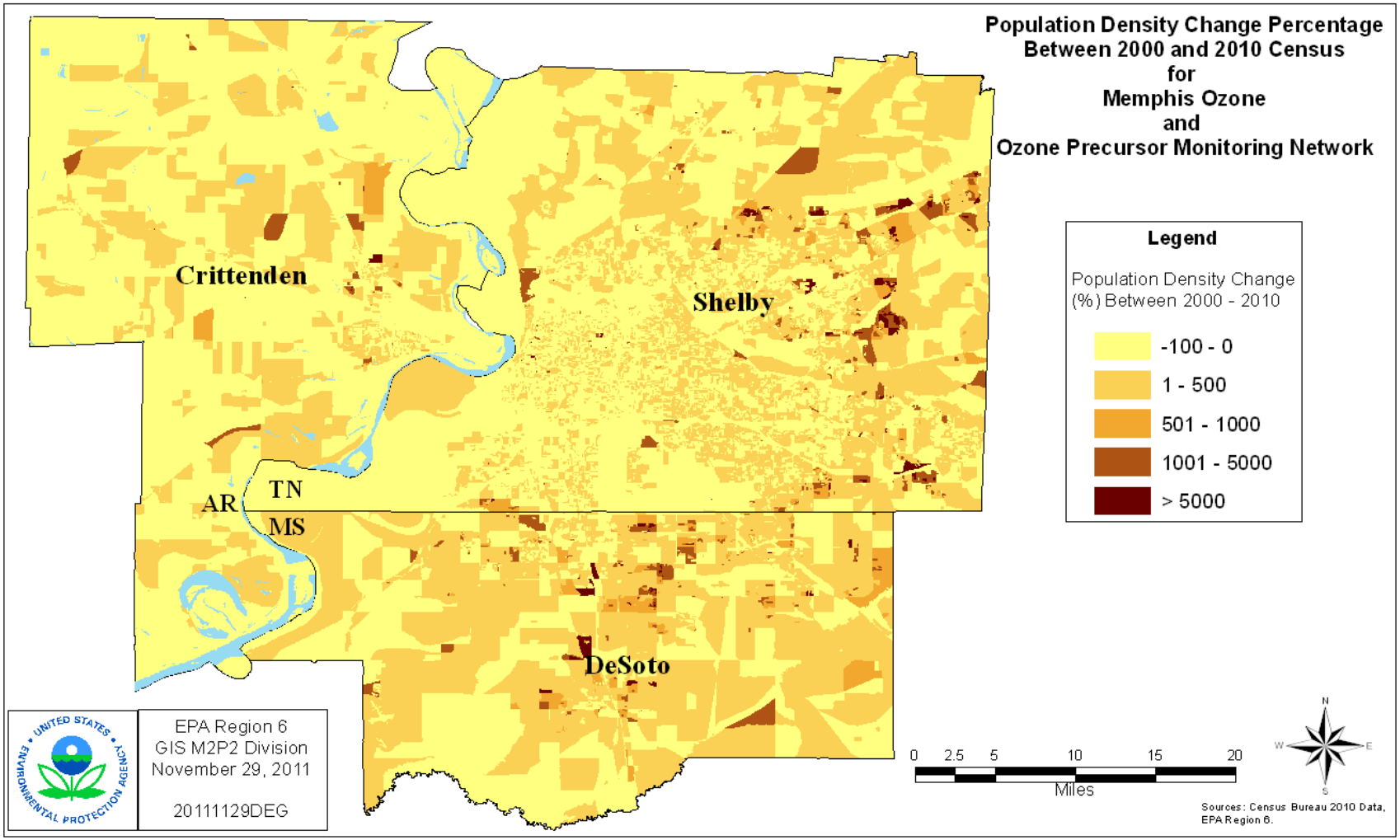

Figure 4 - Overlay of 24-hour HYSPLIT back trajectories of all 75 ppb exceedances at the Frayser monitor for the 2008-2010 period.

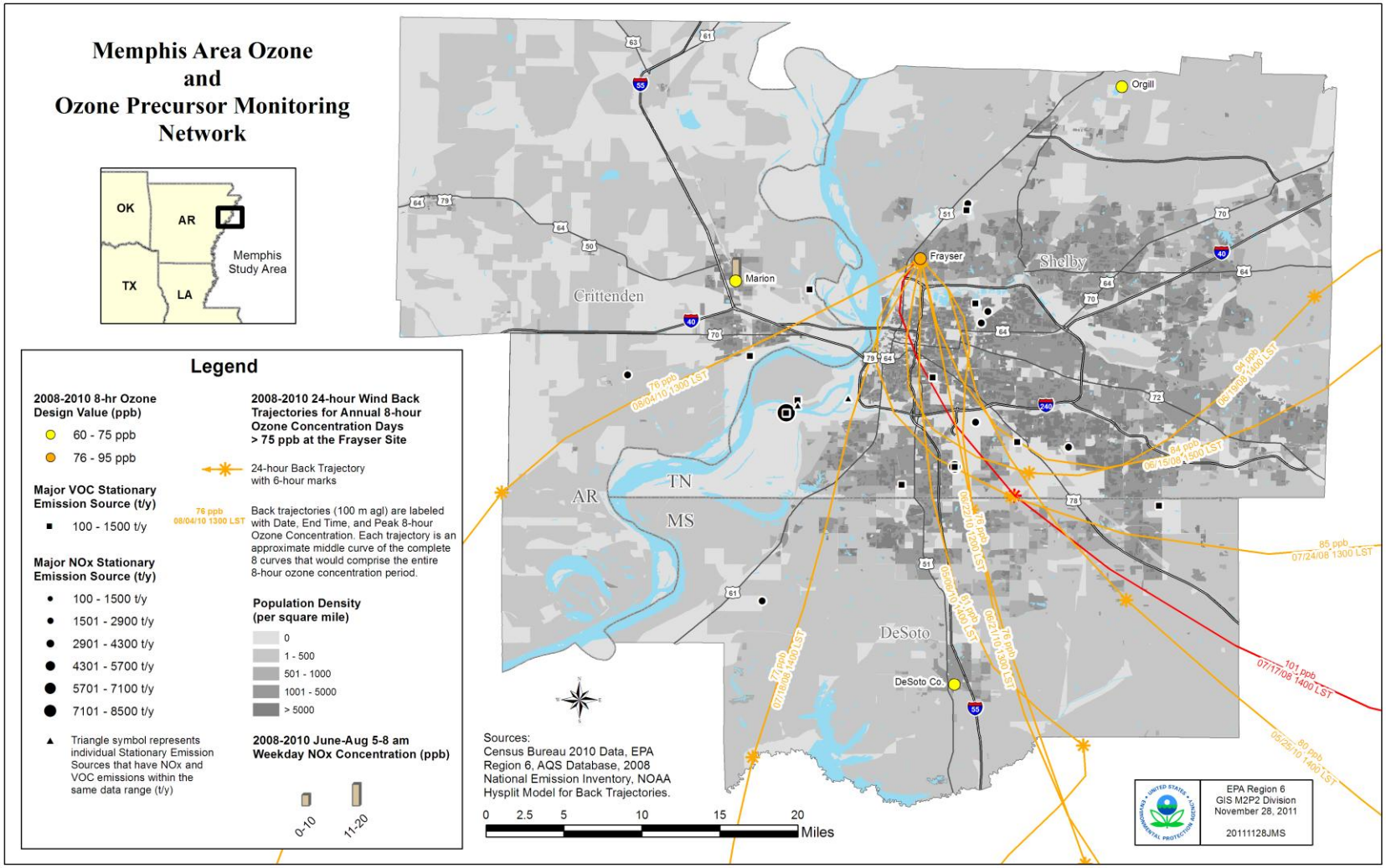

Figure 5. NOAA HYSPLIT MODEL 72-Hour Back Trajectory Frayser Exceedances (2006-10)

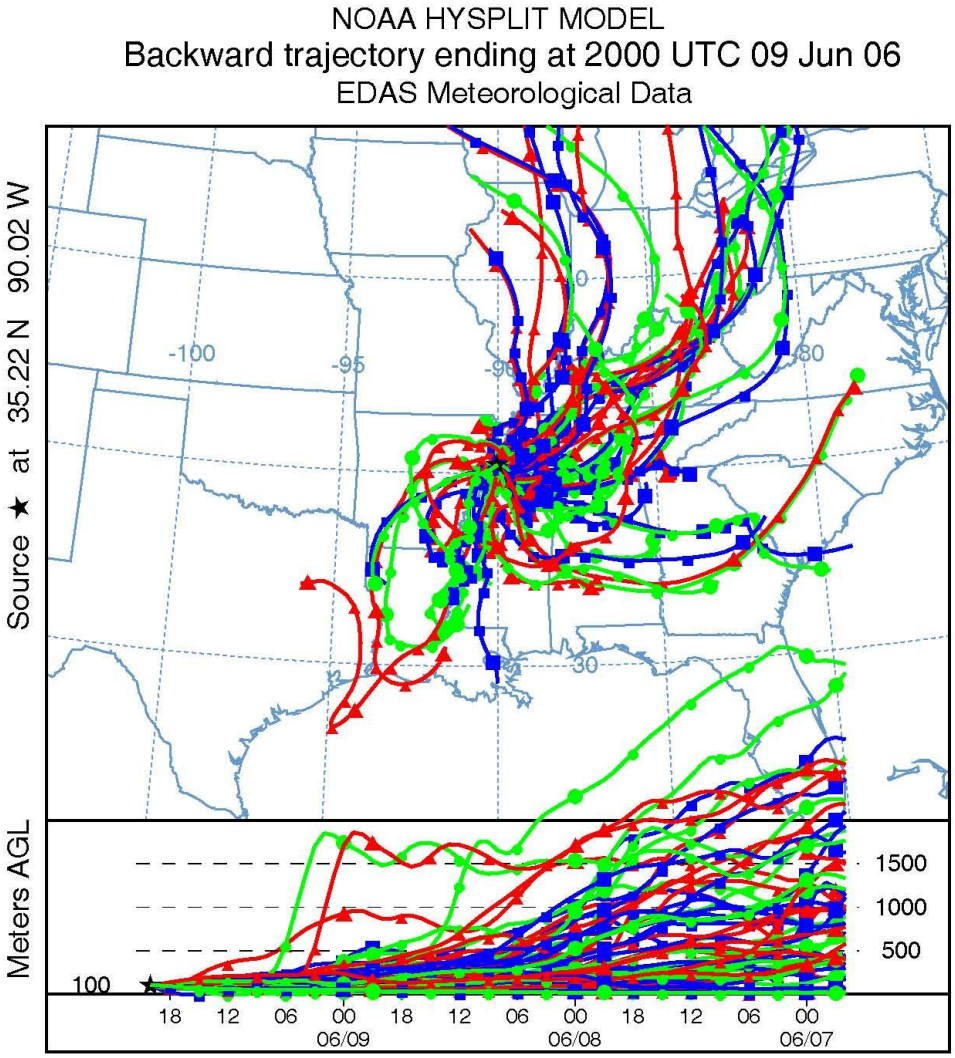

Figure 6. NOAA HYSPLIT MODEL 24-Hour Back Trajectory Frayser Exceedances (2006-10)

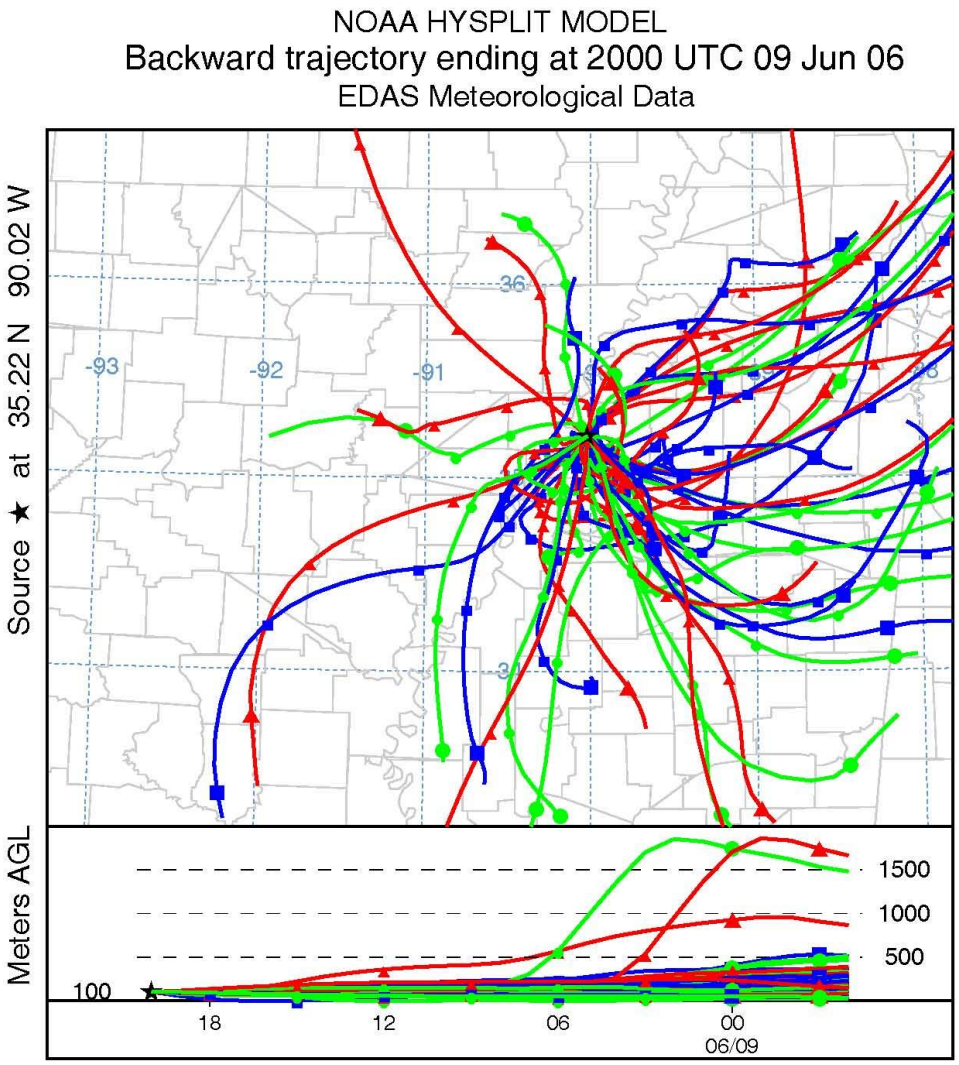
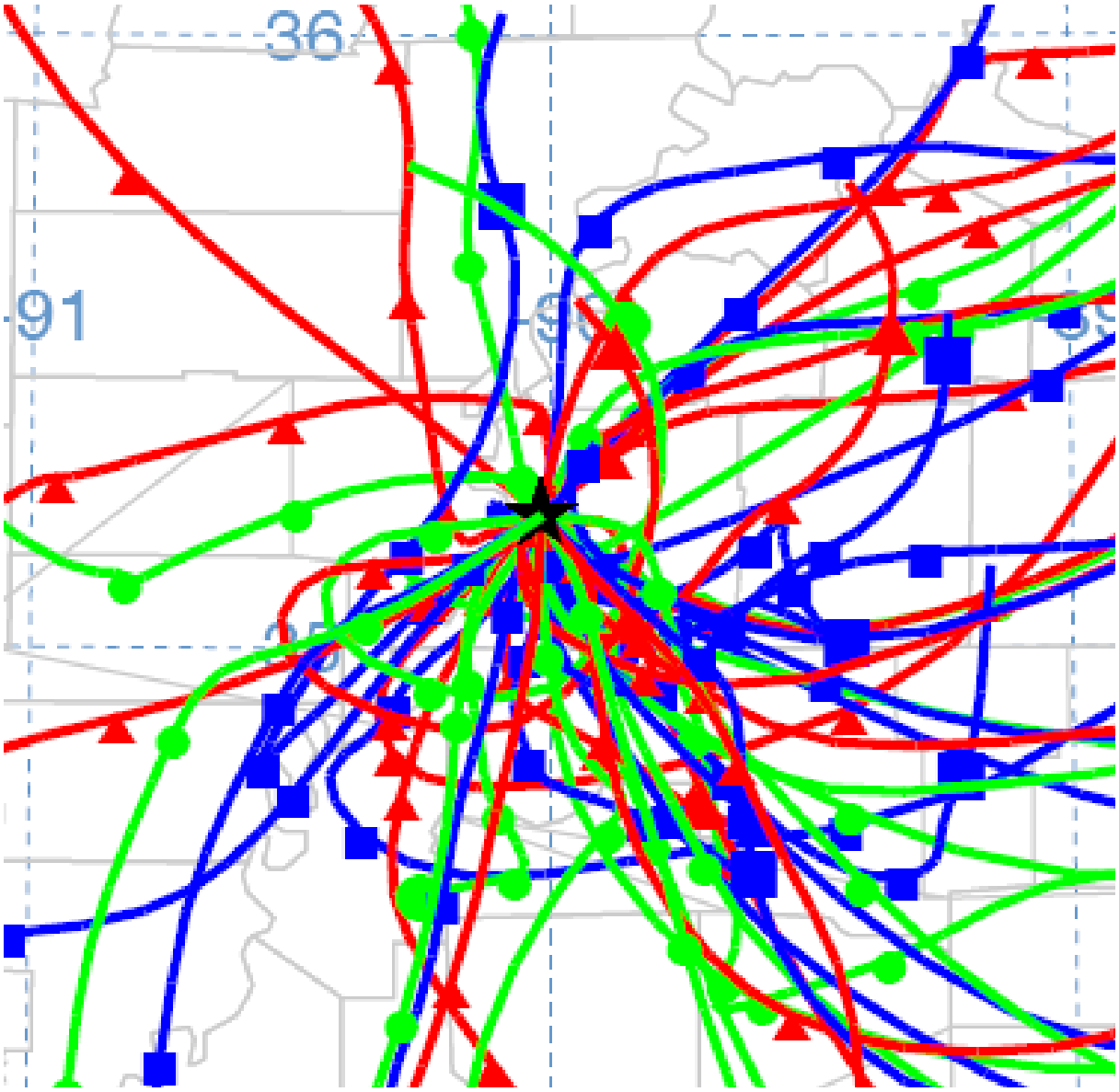
Figure 7. NOAA HYSPLIT MODEL 24-Hour Back Trajectory Frayser Exceedances (2006-10) - Zoom View