APPENDIX A

TECHNICAL SUPPORT DOCUMENT

Technical Support Document

CLARK COUNTY CARBON MONOXIDE MODELING AND SIP UPDATE

Prepared for

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January 17, 2006

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1. INTRODUCTION

1.1 BACKGROUND

The Las Vegas Valley is a large desert basin at about 2000 feet elevation, surrounded by mountain ranges up to 11,900 feet, making it quite susceptible to air pollution problems. This area includes the City of Las Vegas, the City of North Las Vegas, and the City of Henderson. The remainder constitutes unincorporated areas of Clark County. Clark County has been the fastest growing areas of the United States over the past 50 years, with a current population of about 1,750,000. During the winter months, cold air masses stagnate over the region, and nightly temperature inversions trap pollutants within the valley. The overnight buildup of pollutants has historically caused violations of the national carbon monoxide standard in a limited area surrounding the East Charleston (Sunrise Acres) monitoring station. The East Charleston monitoring site in the vicinity of converging major transportation corridors named the “Five Points,” where three state highways intersect. Additionally, the site is located within a local depression where air pollution often collects.

The 1990 Clean Air Act Amendments (CAAA) established two National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO). The first sets a maximum allowable concentration of 35 parts per million (ppm) averaged over 1 hour, and the second sets a maximum concentration of 9 ppm averaged over 8 hours. Areas that exceed one or both of the ambient standards more than two times in a two-year period are in violation and are thus classified as non-attainment areas for carbon monoxide.

Although the Las Vegas Valley has never exceeded the 1 hour CO NAAQS, it has previously exceeded the 8 hour standard at least once per year on a seasonal basis. The last violation of the 8-hour standard occurred in January 1996 in the Five Points area and measured 10.2 ppm; this became the valley’s last CO Design Value. There have been no CO exceedances from 1999 through the most recent data year, 2004. This downtrend is the direct result of the implementation of local CO control measures and the tighter federal motor vehicle emission standards.

1.1.1 CO Regulatory History

The number and severity of 8-hour CO violations caused the U.S. Environmental Protection Agency (EPA) to automatically designate the Valley as a Moderate nonattainment area upon enactment of the 1990 CAAA on November 15, 1990. Moderate nonattainment areas were required to implement emission control measures as “expeditiously as practicable” in order to attain the CO NAAQS by December 31, 1995. Clark County implemented the set of controls required by the Clean Air Act for CO nonattainment areas, and made great strides towards attaining the NAAQS for carbon monoxide. However, due to phenomenal growth within the Las Vegas Valley, it fell short of meeting the NAAQS by the applicable date of December 31, 1995.

Based upon improved CO levels, which were attributed to the implementation of the aforementioned control measures, EPA granted Clark County a one year extension to demonstrate compliance with the NAAQS. However, the Las Vegas Valley was not successful in achieving compliance by December 31, 1996. According to CAAA requirements, the EPA reclassified the Las Vegas Valley as a "serious" nonattainment area for carbon monoxide on October 2, 1997. A deadline of May 1999 (18 months from the notice publication date) was set for submission of a State Implementation Plan (SIP) that demonstrates attainment by December 31, 2000.

On September 21, 1999, the Clark County Board of Commissioners adopted the *Las Vegas Valley Non-attainment Area Carbon Monoxide Air Quality Implementation Plan*. However, EPA Region IX found that the Plan's emissions budget was inadequate, and raised other issues that affected the Plan's approval. On August 1, 2000, the Clark County Board of Commissioners adopted a revised plan, and submitted supplemental CO SIP materials on January 30, 2002, and June 4, 2002 that addressed recently adopted vehicle inspection and wintertime fuel regulations. On January 28, 2003, EPA proposed to approve the CO SIP with the exception of two individual contingency measures. EPA gave final approval to the CO SIP revision on September 21, 2004, but did not take any action on the contingency measures. Finally, on June 1, 2005, EPA made a finding that the Las Vegas Valley had attained the CO NAAQS by the applicable date of December 31, 2000. This action removes the requirement for contingency measures and obligation under 187(g) of the CAAA to submit a SIP revision to assure a 5% per year reduction of CO emissions until attainment of the NAAQS.

1.1.2 Previous CO Modeling

Between 1996-2000, the Clark County Department of Comprehensive Planning developed computer models for valley-wide carbon monoxide to provide technical support for the control measures being evaluated for their CO SIP. This modeling was developed and conducted according to CAAA requirements and followed EPA modeling guidance specific to 8-hour CO SIP demonstrations. Modeling was conducted for three historical CO episodes in 1995-96 using a combination of numerical models, each focusing upon a specific scale and issue. The Urban Airshed Model (UAM) was used to simulate episodic urban-scale CO patterns on a grid with 1-km spacing over the entire developed portion of the Las Vegas Valley; the CAL3QHC intersection model was used to simulate micro-scale CO patterns at the "Five Points" intersections; and the EDMS airport model was used to simulate fine-scale emissions and CO concentration patterns at the three civil airports in the area, including McCarran International Airport. At the time, CO emissions from on-road mobile sources (by far the largest contributor to the overall emission inventory for Las Vegas) were estimated using a combination of MOBILE5b, DTIM, and volume/roadway link information provided by the Regional Transportation Commission (RTC) via their TRANPLAN transportation demand model (TDM).

In August 2000, Clark County submitted their revised CO SIP for Las Vegas to EPA Region IX. The CO plan was based on UAM/CAL3QHC/EDMS modeling for the single best performing episode of the three: the night of December 8-9 (Sunday-Monday), 1996. Technical documentation for the models, application methodologies, performance evaluation, and future year modeling assessments are provided in the 2000 CO SIP and its appendices.

1.2 MODELING UPDATES

The Clark County Department of Air Quality and Environmental Management has updated their UAM CO modeling and conformity analysis using the latest tools, data resources, and methodologies available to estimate CO emissions. From the revised modeling results, Clark County is submitting a revised CO SIP document. This section outlines the approach to incorporate emission updates into the UAM dataset, and to perform revised UAM urban-scale and CAL3QHC intersection modeling. Details for each component are provided in the following Sections.

Clark County has based their revised modeling upon the previous UAM/CAL3QHC/EDMS modeling datasets developed for the December 8-9, 1996 episode. Specific updates to the emission inventories are briefly listed below; they include modifications to on-road mobile, non-road mobile, civil airports, railroads and point sources. Emission estimates for all remaining categories (mainly stationary area sources and Nellis Air Force Base) were taken from the previous modeling detailed in the 2000 CO SIP submittal, although new spatial distributions were developed for area sources from updated land use projections. The future years modeled in this update include: 2006, 2010, 2015, 2020, and 2030.

1.2.1 On-Road Emission Estimates

The greatest effort in the CO modeling update has focused on the on-road mobile source inventory estimates. Section 2 details the specific methodologies employed to update the on-road emissions for the base and all future years. The original EPA vehicle emission factor model that was used in the previous SIP effort (MOBILE5b) was replaced by the latest version of the model, MOBILE6.2.03. This version has updated CO emission rates for LEV and Tier 2 vehicles from the previous version of MOBILE6.2. However, the Air Improvement Resource (AIR) version of this model was used because it provides the capability to create a condensed database of composite emission factors. This is important for applications such as this one where many MOBILE6 scenarios must be run to generate lookup factors for link-level emissions estimates.

For the 1996 base year, the RTC's original TRANPLAN output was used to define link-based volume (vehicle miles traveled, or VMT) and other traffic volume-related parameters. However, no trip tables were available, which allow for the separate estimation of start versus running emissions. Therefore, it was necessary to process base year start emissions differently than the future years by utilizing trip data from TransCAD TDM output from the year 2000 (as described in Section 2). All original ancillary information, including vehicle fleet mix, seasonal/day-of-week adjustment factors, and hourly activity profiles remain the same as in the original modeling.

Since output data and formats for MOBILE6 are significantly different from its predecessor, the original utility that was used to estimate link-level CO emissions (DTIM) was replaced by two new programs. The first processes the link-based emissions, and the other processes the emissions based on traffic analysis zones (TAZ). Both of the new programs produce inputs for the Emission Processing System, version 3 (EPS3). The EPS3 is the latest version of the EPS program suite used in the original CO SIP modeling to generate gridded, time-resolved, UAM-ready CO emission input files.

For all future years modeled in this update, the RTC provided output from their new TransCAD TDM, which includes link volumes and trip tables for each year. For the link-based data, the same program written for the base year was used to produce the link-based emissions for EPS3.

For the TAZ data, most of the same type of MOBILE6 output was used in the program developed for the base year; but start emissions were handled in a special way (see Section 2).

1.2.2 Other Emission Sources

Emission updates were also made to airports, railroad, non-road, and point source categories. Specific details are provided in Section 3.

1.2.2.1 Airports

In 1999, Clark County developed a detailed emissions inventory for the three county airports (McCarran, North Las Vegas, and Henderson), and performed airport-scale dispersion modeling, using the Federal Aviation Administration’s EDMS model. At the time, EDMS had Mobile5a embedded as the source of on-road mobile emissions generation, and used PAL2 and CALINE3 for dispersion calculations. EDMS was run for the 1996 base year, along with the future years of 2000, 2010, and 2020. However, airport emission estimates within the UAM were never updated to reflect the EDMS estimates, and instead relied on much older airport estimates from a 1992 study.

In 2003, Clark County sponsored an updated EDMS project for the three county airports. The latest version of EDMS was used, which introduced the AERMOD dispersion model. On-road mobile sources were estimated using Clark County runs of Mobile6.2. EDMS was run for 2000, 2005, 2010, 2015 and 2020 (the 1996 base year was skipped). Again, UAM airport emissions were not updated.

In this CO modeling update, the latest 2003 EDMS airport emission estimates have been included into the UAM emissions inventory. Details of emissions by projection year, and their spatial/temporal allocation to the UAM grid, are described in Section 3. The issue of double-counting airport emissions within the UAM and EDMS+UAM modeling results were carefully considered.

1.2.2.2 Non-Road and Locomotive

In the previous modeling, non-road emissions were taken from NEVES estimates, and included only a few categories. Clark County has updated their railroad emissions estimates for 2001 based on a recent non-road study (Mactec, 2003), which include contributions from both line haul and switching. These have been incorporated into the updated UAM inventory.

EPA’s NONROAD2004 model, run with Clark County input data, estimates much higher non-road emission than the NEVES-based estimates used in the 2000 CO SIP. In this modeling update, the NONROAD model was used to generate emission inputs to EPS3 for each simulated future year. New spatial and temporal allocation factors were developed based on the latest land use projections from Clark County. Airport ground support equipment (GSE) were removed from the NONROAD estimates because they were included in the EDMS estimates; railroad maintenance emissions were left in since the Mactec emissions were estimated for locomotives only.

1.2.2.3 Point Sources

Clark County incorporated an updated point source emission inventory, which included revised stack parameters, and which defined Potential To Emit (PTE) levels for seven specific facilities. The UAM future year inventories included the PTE levels plus an additional 70 ton buffer (referred to as "PTE+70") for these sources. The original point source inventory was used, unchanged, for the 1996 base year simulation.

1.2.3 Model Application

UAM was provided the updated emission inventories for point, on-road mobile, and non-road mobile sources, and run for the December 8-9, 1996 historical CO event. All other environmental parameters were taken from the original modeling as documented in the 2000 CO SIP. A base-year model performance evaluation was conducted similarly. The UAM was then used with the updated future year inventories for 2006, 2010, 2015, 2020 and 2030 to determine peak 8-hour CO levels in the basin for the same December 8-9, 1996 conditions. UAM results, without airport emissions included in the inventory, were added to EDMS receptor concentrations from the 2003 updated airport modeling.

For hotspot modeling, the CAL3QHC model was used to model three intersections: Charleston/Eastern, Charleston/Fremont and Eastern/Fremont. EPA (1992, 1995) guidance for screening level modeling of these three intersections was followed. The ambient temperature for each hour of the episode (needed to estimate emissions with the MOBILE6 model), and the wind direction and speed (needed for the CAL3QHC estimates) were taken from the original UAM/CAL3QHC modeling. The CAL3QHC model output was added to the background UAM levels to estimate 8-hour CO concentrations for the duration of the episode.

All modeling results are detailed in Section 4.

2. ON-ROAD MOBILE EMISSIONS

2.1 OVERVIEW OF APPROACH

The greatest effort of the update to the CO modeling system focused on the on-road mobile source inventory estimates. The original vehicle emission factor model that was used in the previous SIP effort (MOBILE5b) was replaced by the EPA's latest version of the model, MOBILE6.2.03. This version has updated CO emission rates for LEV and Tier 2 vehicles from the previous version of MOBILE6.2. In addition, since output data and formats for MOBILE6 are significantly different from its predecessor, the original utility that was used to estimate link-level CO emissions (DTIM) was replaced by new programs written by ENVIRON.

For the 1996 base year, the original TRANPLAN transportation demand model (TDM) output provided daily total link-based volumes (number of vehicles on each link), link lengths, and other link-related parameters by traffic analysis zone (TAZ). The vehicle miles traveled (VMT) was calculated from the product of link volume and link length. The County provided the loaded network files, but no trip tables were available to process start emissions separately from running emissions. Therefore, trip data from the newer 2000 TransCAD TDM was used as a means to spatially allocate the 1996 start emissions for each period available in the daily TransCAD output. All other original ancillary information, including vehicle fleet mix, seasonal/day-of-week adjustment factors, and hourly activity profiles were the same as in the original modeling.

For the future years (2006, 2010, 2015, 2020, and 2030), the latest TransCAD TDM output was provided by the Regional Transportation Commission of Southern Nevada (RTC). The TransCAD output included link level activity, intrazonal trips, and origin/ destination trips by TAZ for several periods of the day (note that the number and distribution of TAZs, and the periods for which TransCAD was run, differed substantially from the original TRANPLAN configuration). Three separate programs were written for each of these to generate inputs to the Emission Processing System, version 3 (EPS3) [1]. The EPS3 is the latest version of the EPS program suite used in the original CO SIP modeling.

For both the base and future year link-level emissions, VMT was calculated from the transportation model output (link volume times link length) for each period of the day, and allocated to each hour using an hourly distribution for each day of the episode. VMT was then multiplied by hourly *running* exhaust emission factors (gram per mile) from MOBILE6.2. The total hourly emissions by link were spatially distributed according to the link end point coordinates using LBASE, a component of EPS3.

For both the base and future years, the start emissions were calculated by multiplying hourly estimates of link-level VMT by hourly MOBILE6.2 *start* emission factors (gram per mile). The link-level start emissions were then totaled over the entire network and spatially distributed using the period-specific transportation model trip origin data by TAZ. Note that for the 1996 base year there were no TRANPLAN trip data by TAZ available. Instead, the 1996 start emissions were spatially allocated using 2000 TransCAD trip data.

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[1] Note that we used hourly emission factors from the MOBILE6 database output, and M6LINC was not applicable for this work because it does not handle hourly emission factors.

The base year TRANPLAN intrazonal data were provided as volumes by TAZ with a trip length, from which VMT was calculated. The intrazonal running and start emissions were calculated as VMT times the MOBILE6.2 start and running emission factors, and then spatially allocated according to the centroid of each TAZ.

The future year TransCAD intrazonal data were provided as trips by TAZ only. The intrazonal trips were assumed to have a trip length of 1 mile, from which VMT was calculated. The VMT was then multiplied by the running emission factors, and then spatially distributed using gridded surrogates developed from the definition of the future year TransCAD TAZs.

2.2 BASE YEAR ESTIMATES

2.2.1 Base Year MOBILE6 Inputs

Base Year MOBILE6 inputs were compiled based on sample MOBILE6 input files for 1996 provided by Clark County. External files were also provided, and these were used as detailed in the Table 2-1 below. Eight input files were created, for each of the four roadway types (freeway, arterial, local, and ramp) and for weekday and weekend. For Freeway and Arterial, the model was run for speeds between 5 and 65 mph for every 1 mph increment. The Local roadway type was set at 12.9 mph, and the Ramp roadway type was set to 34.6 mph by MOBILE6 itself.

A first set of MOBILE6 runs was conducted using the start distribution contained in the “`sdist.lv`” file shown in Figure 2-1. These emission factors were applied to the whole domain except a small region around Las Vegas Boulevard.

A second set of MOBILE6 runs was conducted to better characterize the specific weekday start emission factors along the Las Vegas Boulevard (LVB), where the start activity is not centered around residential areas, but rather parking lots near casinos (and thus are not characteristic of typical commute activity profiles). A more representative start distribution was calculated as the fraction of 2000 TransCAD origin trips occurring over all the TAZs along the boulevard from all periods available in the 2000 TransCAD output. Figure 2-2 displays the original weekday start distributions (based on the distribution shown in Figure 2-1) against the LVB weekday start distributions for all future years. Given the similarity of the future year start distributions, we elected to apply the 2000 modified start distribution to the base year and all future years for the region around the Las Vegas Boulevard.

Note that MOBILE6 I/M effectiveness was set to 100%. Clark County has developed a white paper to justify this value for Las Vegas (Clark County, 2005), and this is included in Appendix C to the 2005 CO SIP revision.

Table 2-1. 1996 Base Year Las Vegas MOBILE6.2 input parameters.

M6.2 Input Command	Weekday Parameters	Weekend Parameters
HOURLY TEMPERATURES	42.0 44.0 49.0 51.0 55.0 58.0 64.0 66.0 66.0 66.0 62.0 58.0 55.0 53.0 51.0 50.0 48.0 47.0 45.0 44.0 44.0 43.0 42.0 42.0	42.0 44.0 49.0 51.0 55.0 58.0 64.0 66.0 66.0 66.0 62.0 58.0 55.0 53.0 51.0 50.0 48.0 47.0 45.0 44.0 44.0 43.0 42.0 42.0
REG DIST	LV_reg02.RDT	LV_reg02.RDT
VMT FRACTIONS	0.5067 0.0770 0.2562 0.0790 0.0363 0.0111 0.0011 0.0009 0.0006 0.0024 0.0029 0.0032 0.0113 0.0028 0.0013 0.0072	0.5067 0.0770 0.2562 0.0790 0.0363 0.0111 0.0011 0.0009 0.0006 0.0024 0.0029 0.0032 0.0113 0.0028 0.0013 0.0072
VMT BY HOUR	Hvmt_lv.wek	Hvmt_lv.wnd
START DIST	sdist.lv	sdist.lv
OXYGENATED FUELS	.240 .760 .027 .035 1	.240 .760 .027 .035 1
ANTI-TAMP PROG	83 81 50 22222 22222222 2 11 090. 22212112	83 81 50 22222 22222222 2 11 090. 22212112
Exhaust I/M program #1		same as weekday
I/M PROGRAM	1 1983 2050 1 TRC 2500/IDLE	
I/M MODEL YEARS	1 1968 2050	
I/M VEHICLES	1 22222 22222222 2	
I/M STRINGENCY	1 22	
I/M COMPLIANCE	1 90	
I/M WAIVER RATES	1 0.1 0.1	
I/M EFFECTIVENESS	1.00 1.00 1.00	
I/M GRACE PERIOD	1 2	
NO I/M TTC CREDITS	1	
CALENDAR YEAR *	1997	1997
EVALUATION MONTH *	1	1
FUEL RVP	9	9
FUEL PROGRAM	1	1

***** Since MOBILE6.2 models January and July periods, January 1997 was chosen because it is closest to the December 1996 episode.

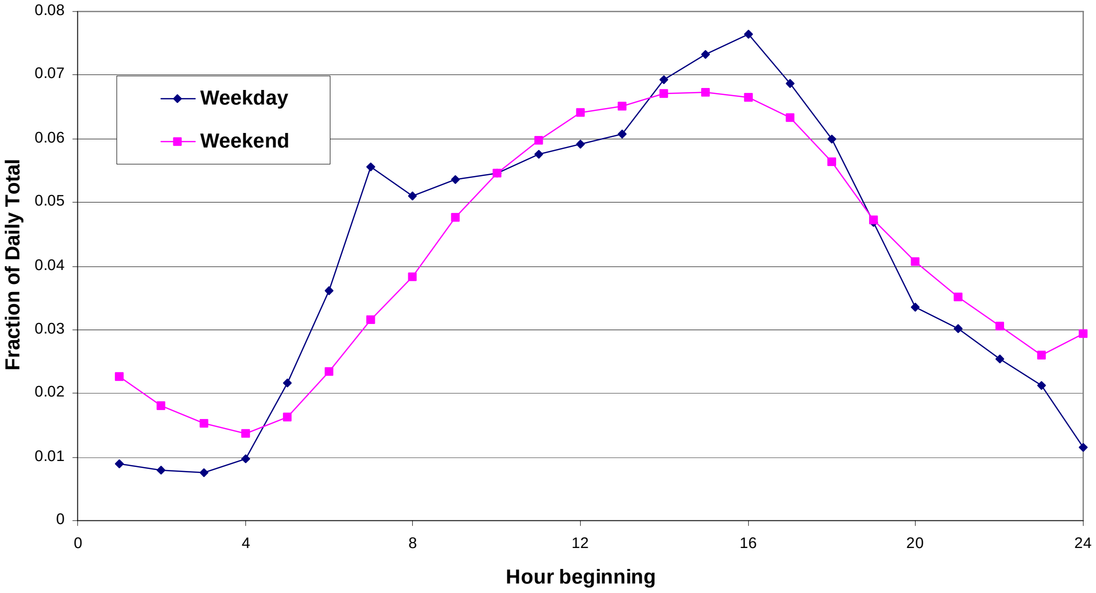


Figure 2-1. Hourly weekend and weekday start distributions (fraction) provided by Clark County, used to temporally allocate emissions derived from TRANPLAN and TransCAD.

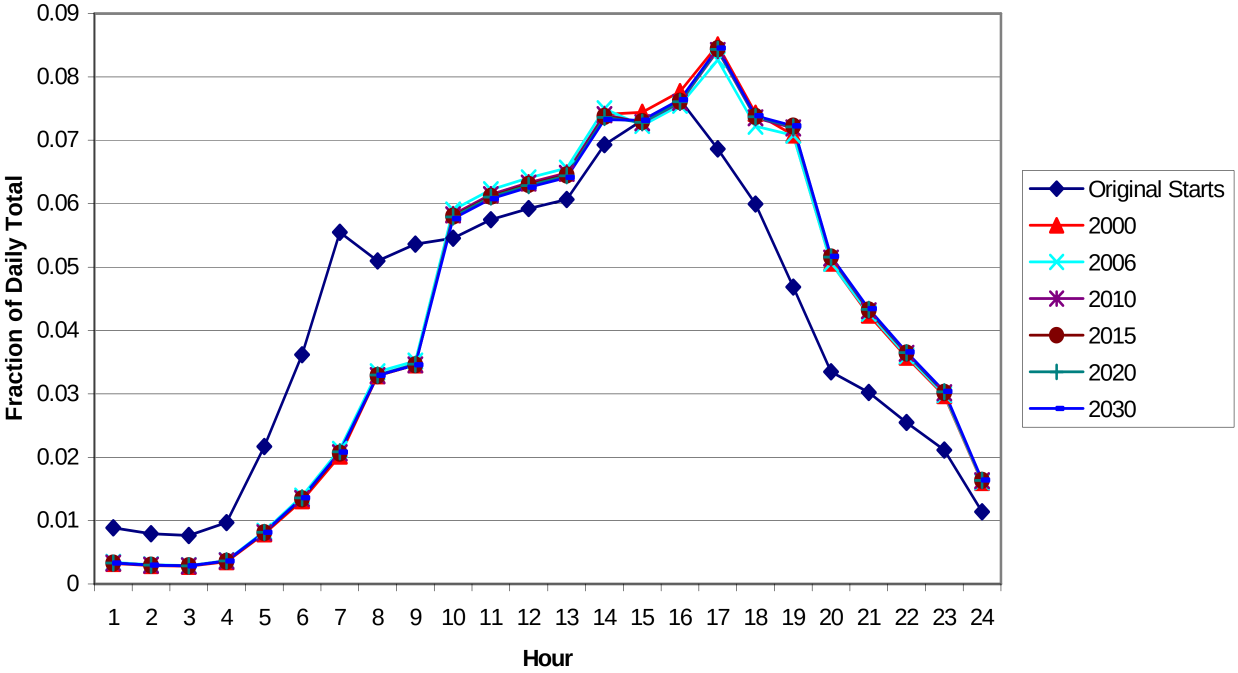


Figure 2-2. Fraction of original weekday start distribution and start distributions in all future years for the Las Vegas Boulevard area calculated from the TransCAD origin trips by TAZ.

2.2.2.3 Speed Adjustments

After the link data were temporally allocated to hourly values, the TRANPLAN hourly speed was calculated using the following Bureau of Public Roads (BPR) curve, where the volume to capacity ratio was capped at 1.25:

$$S_a = \frac{S_{ff}}{1 + \left[A * \left(V/C \right)^B \right]}$$

where:

S_a = adjusted link speed (mph)

S_{ff} = reported link free flow speed (mph)

V = total link volume (vehicles OR vehicles per hour)

C = total link capacity (vehicles OR vehicles per hour)

For freeways, interstates, system ramps, and expressways,

A = 0.66 B = 7.2

For major arterials, minor arterials, collectors, ramps, and other,

A = 0.76 B = 5.9

However, the resulting adjustment to the speeds using the BPR curve had no impact on the total base year emissions.

2.2.2.4 Transit Adjustments

The link-level emissions were adjusted upward by a factor of 1.00295 to include the contribution from public transit activity, which were not included in the TRANPLAN calculations.

2.2.3 Base Year Link-Level Running Exhaust Emissions

Emission factors were generated using the Air Improvement Resource, Inc. (AIR) version of MOBILE6, outputting hourly emission factors for 28 vehicle classes. A vehicle composite emission factor was calculated across all 28 classes using the vehicle class distribution shown in Table 2-2.

The TRANPLAN link activity data consisted of the annual daily average volume for each link in the network. The links were classified by the RTC facility type code. The cross-reference between the RTC facility type code and the MOBILE6.2 roadway types used is displayed in Table 2-3.

In summary, the link-level running exhaust emissions processing steps were as follows:

1) Adjust the daily volumes to hourly volumes (using profiles shown Figure 2-3);
2) Adjust the link speeds using the hourly volume to capacity ratio in the BPR curve;
3) Calculate the hourly link VMT as the hourly volume times the link length;

Table 2-2. MOBILE6 28 vehicle classes and their relative fraction of the overall fleet.

Class Number	Class	Description	Fraction
1	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)	0.504287
2	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)	0.076726
3	LDGT2	Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)	0.25529
4	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5750 lbs. ALVW)	0.077912
5	LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, 5751 lbs. and greater ALVW)	0.0358
6	HDGV2B	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR)	0.008055
7	HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)	0.000261
8	HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)	0.000197
9	HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)	0.000348
10	HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)	0.000773
11	HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)	0.000373
12	HDGV8A	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)	0.000002
13	HDGV8B	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)	0
14	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)	0.002413
15	LDDT12	Light-Duty Diesel Trucks 1 and 2 (0-6,000 lbs. GVWR)	0.001184
16	HDDV2B	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs. GVWR)	0.003045
17	HDDV3	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)	0.000839
18	HDDV4	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)	0.000703
19	HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)	0.000252
20	HDDV6	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)	0.001627
21	HDDV7	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)	0.002527
22	HDDV8A	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)	0.003198
23	HDDV8B	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR)	0.0113
24	MC	Motorcycles (Gasoline)	0.0072
25	HDGB	Gasoline Buses (School, Transit and Urban)	0.000832
26	HDDBT	Diesel Transit and Urban Buses	0.0013
27	HDDBS	Diesel School Buses	0.001968
28	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)	0.001588

4) Calculate the link emissions as the link VMT times the MOBILE6.2 composite emission factor for the link roadway type, hour, and adjusted link speed;
5) Spatially allocate the link emissions using LBASE; and
6) Adjust the emissions to average December day, Sunday or Monday, and for transit activity, in EPS3.

Table 2-4 presents tabulations of 1996 VMT by facility type, directly reported by TRANPLAN, and after various adjustments described above.

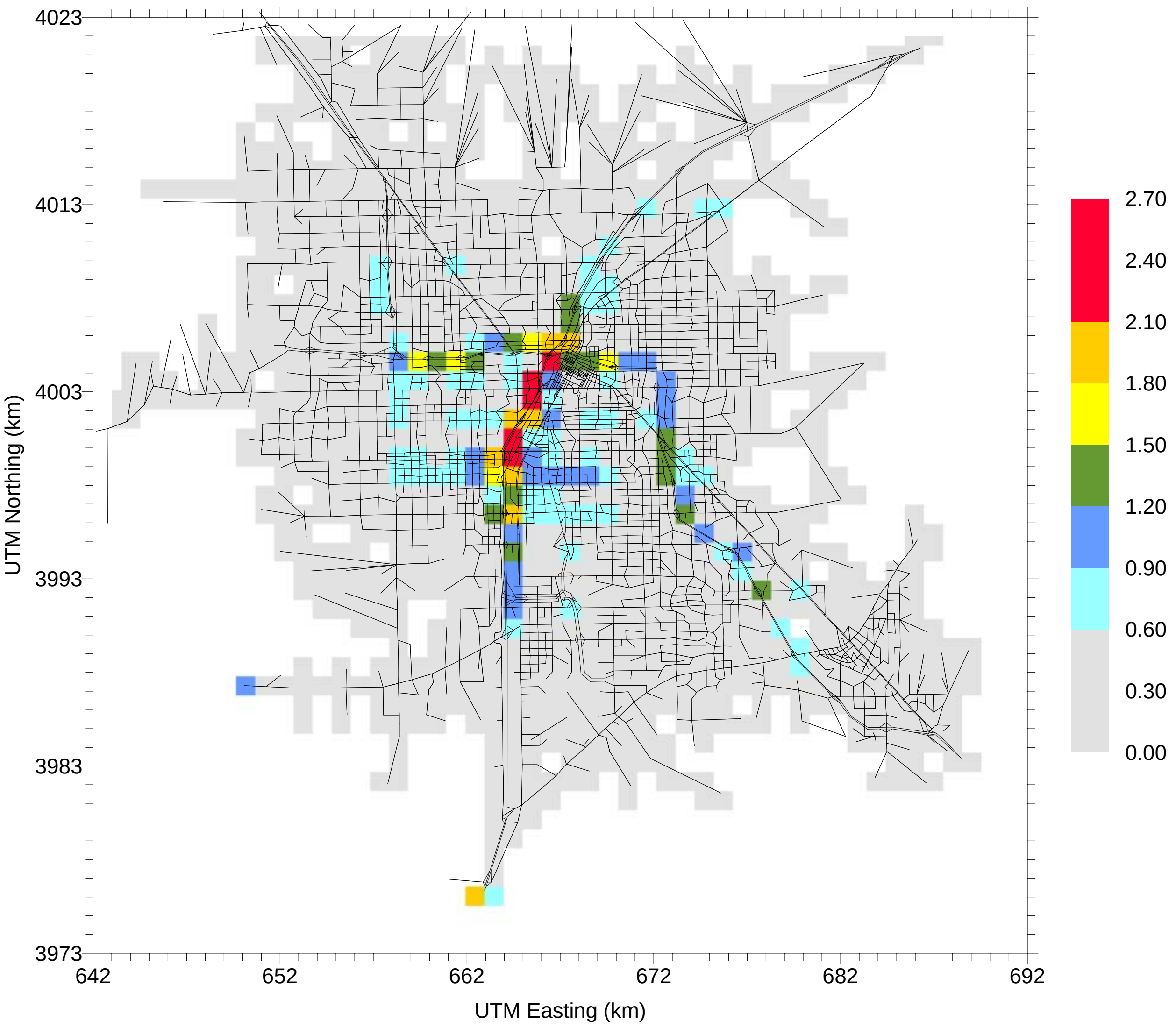
Figure 2-4 shows the spatial distribution of link-level running exhaust emissions for the 1996 base case.

Table 2-3. Cross-reference between RTC and MOBILE6.2 facility types.

RTC Facility Code	Description	MOBILE6.2 Roadway Type
0	Externals	Freeway
1	System Ramps	Ramp
2	Minor Arterials	Arterial
3	Major Arterials	Arterial
4	Freeway Ramps	Ramp
5	Interstates	Freeway
6	Freeways	Freeway
7	Expressways	Freeway
8	Collectors	Arterial
9	Centroid Connectors	Local
10	Intrazonal	Local

Table 2-4. 1996 VMT by facility type. Totals are shown as output by TRANPLAN, and after seasonal, day-of-week, and public transit adjustments.

Group Code	Facility Type	Modeled 1996 DVMT	DVMT Adjusted to December	DVMT Adjusted for Transit	Sunday DVMT	Monday DVMT
0	External Connctor	640,605	654,058	655,988	507,734	670,419
1	System Ramp	69,247	70,701	70,910	54,884	72,470
2	Minor Arterial	7,469,952	7,626,821	7,649,320	5,920,574	7,817,605
3	Major Arterial	3,655,890	3,732,664	3,743,675	2,897,605	3,826,036
4	Freeway on- or off-ramp	267,725	273,348	274,154	212,195	280,185
5	Interstate	3,825,715	3,906,055	3,917,578	3,032,205	4,003,764
6	Freeway	1,202,253	1,227,501	1,231,122	952,888	1,258,207
7	Expressway	214,096	218,592	219,237	169,690	224,060
8	Collector	2,776,772	2,835,084	2,843,448	2,200,828	2,906,003
9	Centroid Connector	2,185,691	2,231,591	2,238,174	1,732,347	2,287,414
	Intrazonal	87,303	89,136	89,399	69,195	91,366
Daily Total		**22,395,251**	**22,865,551**	**22,933,004**	**17,750,145**	**23,437,530**
Transit adjustment		1.00295				
December adjustment		1.021				
Sunday adjustment		0.774				
Monday adjustment		1.022				



Onroad Running Emissions
Base Year - Dec 9, 1996
CO (tons per day)

Figure 2-4. Spatial distribution of on-road mobile source running exhaust CO emissions for the 1996 Base Case.

2.2.2 Base Year TRANPLAN Link Activity Adjustments

The 1996 TRANPLAN activity data is representative of an average annual day. The following episode-specific adjustments were applied to the data, where the two-day episode modeled was Sunday, December 8 through Monday, December 9, 1996.

2.2.2.1 Month/Season, Day of Week

A factor of 1.021 was applied to adjust from average annual day to a typical December day. This adjustment factor was applied to all the running, start, and intrazonal emissions for both days of the episode. This value is the same as was used in the previous SIP modeling effort.

A factor of 0.774 and 1.022 were applied to adjust from a typical day to Sunday and Monday, respectively. These are the same factors as used in the 2000 SIP.

2.2.2.2 Hourly Temporal Adjustments

The same day-specific hourly VMT distribution factors used to generate hourly MOBILE6 emission factors were used to scale daily VMT from TRANPLAN to each hour of the episode, presented in Figure 2-3.

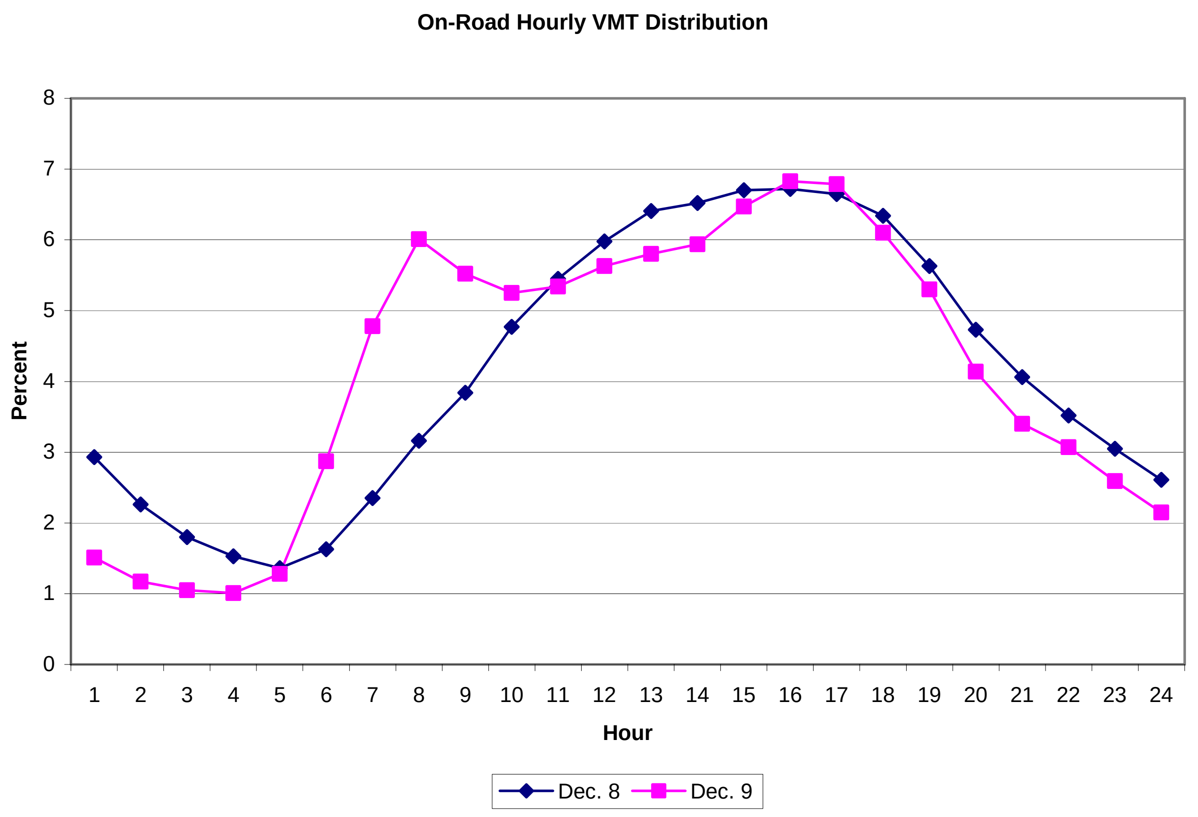


Figure 2-3. Weekday and Sunday hourly VMT distribution.

2.2.4 Base Year Start Emissions

The daily link-level VMT from TRANPLAN was allocated to hourly values using the day-specific hourly VMT profiles shown in Figure 2-3. The base year start emissions were calculated from the product of hourly link VMT and the hourly MOBILE6.2 start emission factors. To remain consistent with how the future year start emissions were to be developed, the base year start emissions were translated from link-level to TAZ level. Note that for the 1996 base year there were no TRANPLAN trip data by TAZ available. Instead, the 1996 start emissions were spatially allocated to TAZs using 2000 TransCAD trip data. For Monday, the hourly link start emissions were totaled over the entire network and redistributed to 2000 TransCAD TAZs based on the fraction of period-specific trip origins for each TAZ over the total number of trip origins over all TAZs. For Sunday, the TransCAD start activity is not representative of a typical weekday profile, so the start emissions for all hours were spatially distributed to each TAZ using a single ratio of the daily total TAZ trip origins to the daily total of all trip origins over the domain.

A month/season adjustment factor of 1.021 was applied to the start emissions. This adjustment is from average annual day to average December day. This adjustment factor was applied to all the running, start, and intrazonal emissions for both days of the episode. It is the same as was used in the previous SIP modeling effort.

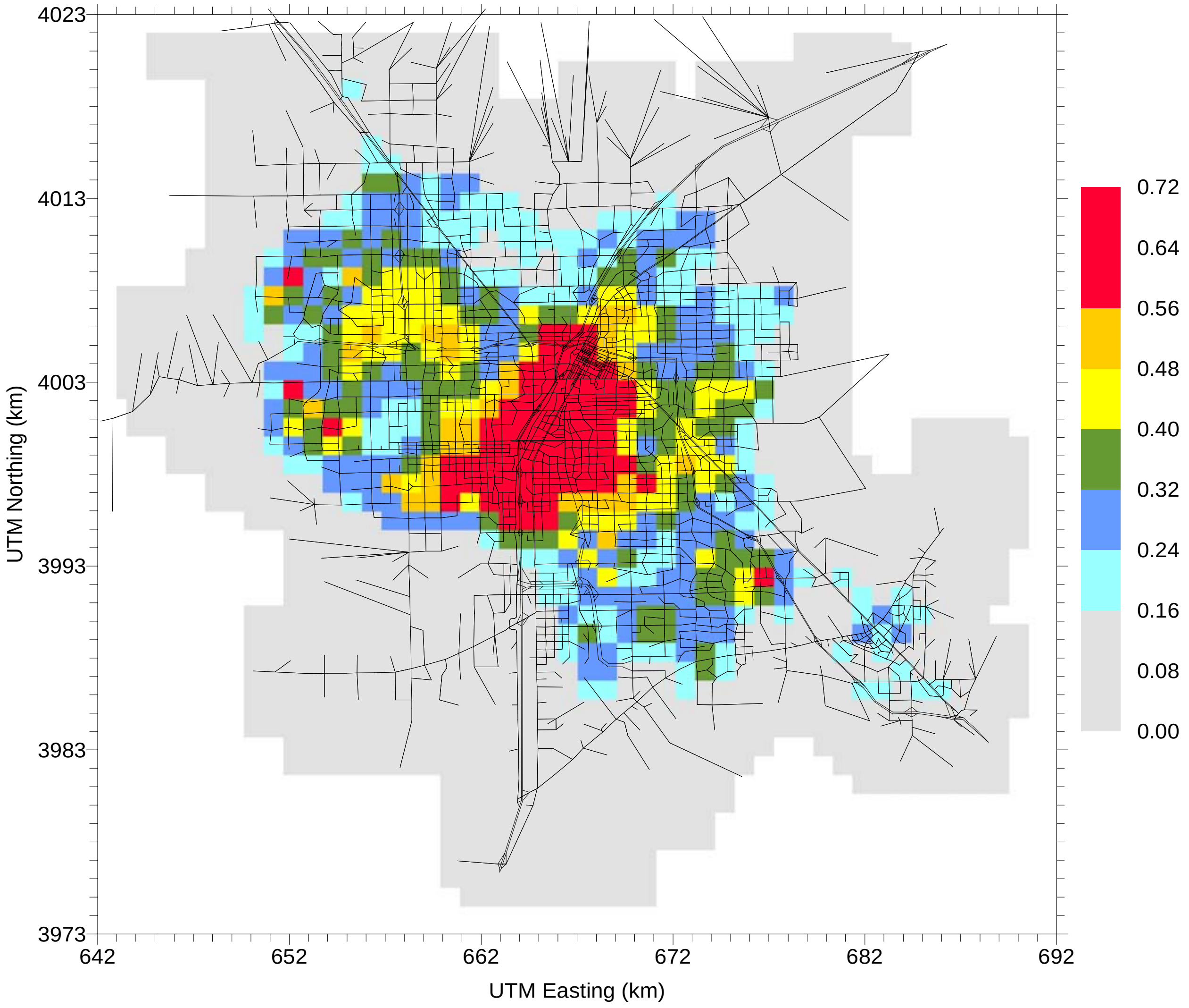
The day of week adjustments are from average annual day to Sunday and Monday. The factors used were 0.774 for Sunday and 1.022 for Monday. These are the same factors as used in the 2000 SIP.

The hourly TAZ start emissions were spatially allocated to the grid cell containing the TAZ centroid and the 24 surrounding cells in a “wedding cake” fashion: the grid cell containing a TAZ centroid receives 25% of the start emissions from that TAZ, the surrounding 8 grid cells receive 60% of the start emissions (7.5% per cell), and the outside 16 grid cells receive 15% of the start emissions (0.9375% per cell). The wedding cake approach is based on the duration of start emissions as defined from EPA’s vehicle testing cycle, which reports emissions during the first 505 seconds (Bag 1) of operation after a cold engine start. Emissions are highest during the first few minutes after a vehicle is started. As the vehicle travels from the start location, its catalytic converter warms and the emissions decrease. With the wedding cake approach, all engine starts occur within a given TAZ, so the grid cell containing that TAZ receives the highest fraction of those start emissions. Grid cells surrounding that TAZ receive progressively smaller fractions of emissions as engines warm and vehicles travel from the TAZ. Clark County believes that this is a very conservative method for allocating start emissions. Given the lack of any research data to improve upon this methodology, Clark County requested EPA Region IX and the Office of Transportation and Air Quality to review the wedding cake approach; both verbally agreed to allow its use for this modeling analysis (EPA Region IX, personal communication).

Figure 2-5 shows the spatial distribution of start exhaust emissions for the 1996 base case.

2.2.5 Base Year Intrazonal Activity

Intrazonal VMT was included in the previous modeling by locating their contribution at the centroid coordinates of each TAZ. The TAZ boundary information for the 1996 base year was



Onroad START Emissions
Base Year - Dec 9, 1996
CO (tons per day)

Figure 2-5. Spatial distribution of on-road mobile source start exhaust CO emissions for the 1996 Base Case.

not available, so these were allocated to the grid cells corresponding to each centroid coordinate as was performed in the previous modeling for the 2000 SIP submittal.

2.2.6 Base Year Total Emissions

Table 2-5 lists the component and total on-road mobile source emissions for the 1996 base year. Figure 2-6 presents the spatial distribution of the total on-road mobile source emissions for December 9, 1996.

Table 2-5. Component and total on-road mobile source CO emissions (TPD) for the 1996 base year.

	Links - Running	Starts	Intrazonals	Total
Sunday 12/8	202.75	126.42	0.78	329.95
Monday 12/9	269.31	241.09	1.03	511.43

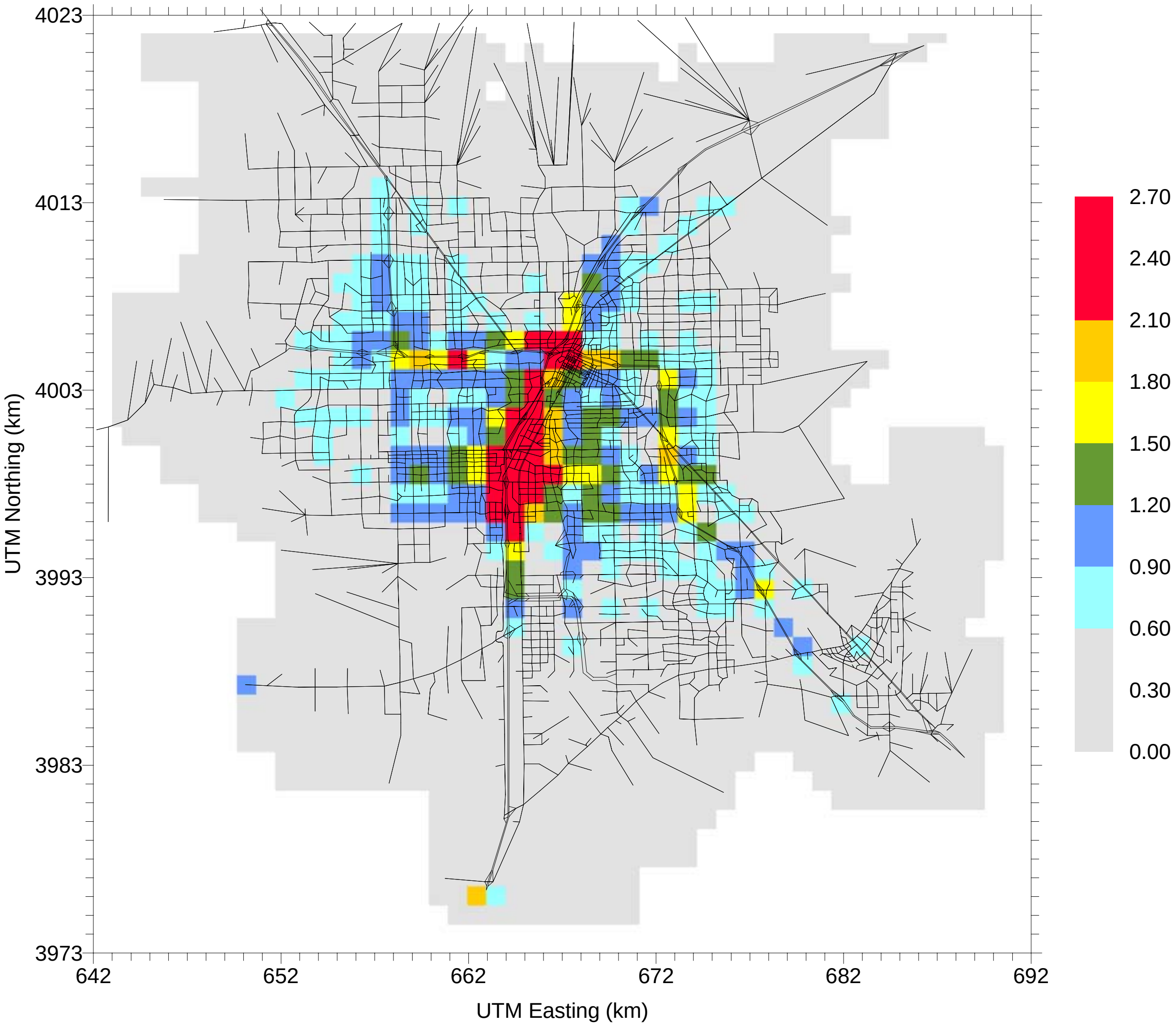
2.3 FUTURE YEAR ESTIMATES

The RTC provided TransCAD model output for each of the future years: 2006, 2010, 2015, 2020, and 2030. The TransCAD model output provided link-level volumes (number of vehicles) and trip origins and destinations for the following seven diurnal periods: midnight – 7 AM, 7 AM – 9 AM, 9 AM – 2 PM, 2 PM – 4 PM, 4 PM – 6 PM, 6 PM – 8 PM, 8 PM – midnight. When modeling Sunday, the period data were first summed together over all seven periods and then redistributed to hourly values using a weekend temporal distribution. When modeling Monday, the period totals were maintained as output by TransCAD. They were further disaggregated into hourly values by applying the fraction of each hour within each period from the weekday distribution.

2.3.1 Future Year MOBILE6 Inputs

Future year MOBILE6 inputs were compiled based on sample MOBILE6 input files for 2010 provided by Clark County. External files were also provided, and these were used (as detailed in Table 2-6). For each future year (2006, 2010, 2015, 2020, 2030), eight input files were created, for each of the four roadway types (freeway, arterial, local, and ramp) both for weekday and weekend. For Freeway and Arterial, the model was run for speeds between 5 and 65 mph for every 1 mph increment. The Local roadway type was set at 12.9 mph, and the Ramp roadway type was set to 34.6 mph by MOBILE6 itself.

For the Natural Gas Vehicles Fractions external files, the following assumptions were made (by Clark County) in creating the files. CNG vehicles start with model year 1998, and are assumed to be a very small fraction of the fleet and comprised of government vehicles only. It is also assumed that the vehicles last seven years, and then are removed from service or sold to a consumer, who fuels them with gasoline.



ONROAD Emissions
Base Year - Dec 9, 1996
CO (tons per day)

Figure 2-6. Spatial distribution of total on-road mobile source CO emissions for the 1996 Base Case.

Table 2-6. MOBILE6.2 input parameters for future year Las Vegas runs.

M6 Input Parameter	Weekday Parameters	Weekend Parameters	Source
HOURLY TEMPERATURES	42.0 44.0 49.0 51.0 55.0 58.0 64.0 66.0 66.0 66.0 62.0 58.0 55.0 53.0 51.0 50.0 48.0 47.0 45.0 44.0 44.0 43.0 42.0 42.0	42.0 44.0 49.0 51.0 55.0 58.0 64.0 66.0 66.0 66.0 62.0 58.0 55.0 53.0 51.0 50.0 48.0 47.0 45.0 44.0 44.0 43.0 42.0 42.0	same temperatures used as in previous work
REG DIST	LV_reg02.RDT	LV_reg02.RDT	provided by Clark County
VMT FRACTIONS	0.5067 0.0770 0.2562 0.0790 0.0363 0.0111 0.0011 0.0009 0.0006 0.0024 0.0029 0.0032 0.0113 0.0028 0.0013 0.0072	0.5067 0.0770 0.2562 0.0790 0.0363 0.0111 0.0011 0.0009 0.0006 0.0024 0.0029 0.0032 0.0113 0.0028 0.0013 0.0072	provided by Clark County
VMT BY HOUR	Hvmt_lv.wek	Hvmt_lv.wnd	provided by Clark County
START DIST	sdist.lv	sdist.lv	provided by Clark County
NGV FRACTION	ngvfr06.lv, ngvfr10.lv, ngvfr15.lv, ngvfr20.lv, ngvfr30.lv	ngvfr06.lv, ngvfr10.lv, ngvfr15.lv, ngvfr20.lv, ngvfr30.lv	provided by Clark County
OXYGENATED FUELS	.001 .999 0.027 0.035 1	.001 .999 0.027 0.035 1	provided by Clark County
ANTI-TAMP PROG	83 81 50 22222 22222222 2 11 090. 22212112	83 81 50 22222 22222222 2 11 090. 22212112	provided by Clark County
> Exhaust I/M program #1			provided by Clark County
I/M PROGRAM	1 1983 2050 1 TRC 2500/IDLE	1 1983 2050 1 TRC 2500/IDLE	
I/M MODEL YEARS	1 1968 1995	1 1968 1995	
I/M VEHICLES	1 22222 22222222 2	1 22222 22222222 2	
I/M STRINGENCY	1 22	1 22	
I/M COMPLIANCE	1 90	1 90	
I/M WAIVER RATES	1 0.1 0.1	1 0.1 0.1	
I/M EFFECTIVENESS	1.00 1.00 1.00	1.00 1.00 1.00	
I/M GRACE PERIOD	1 2	1 2	
I/M CREDIT FILE	tech12.d	tech12.d	

Table 2-6 (continued).

M6 Input Parameter	Weekday Parameters	Weekend Parameters	Source
> Exhaust I/M program #2			
I/M PROGRAM	2 1983 2050 1 TRC OBD I/M	2 1983 2050 1 TRC OBD I/M	
I/M MODEL YEARS	2 1996 2050	2 1996 2050	
I/M VEHICLES	2 22222 22222222 2	2 22222 22222222 2	
I/M STRINGENCY	2 22	2 22	
I/M COMPLIANCE	2 90	2 90	
I/M WAIVER RATES	2 0.1 0.1	2 0.1 0.1	
I/M GRACE PERIOD	2 2	2 2	
> Evap I/M program #3			
I/M PROGRAM	3 1983 2050 1 TRC EVAP OBD	3 1983 2050 1 TRC EVAP OBD	
I/M MODEL YEARS	3 1996 2050	3 1996 2050	
I/M VEHICLES	3 22222 11111111 1	3 22222 11111111 1	
I/M COMPLIANCE	3 90	3 90	
I/M WAIVER RATES	3 0.1 0.1	3 0.1 0.1	
I/M GRACE PERIOD	3 2	3 2	
CALENDAR YEAR	2007, 2011, 2016, 2021, 2031	2007, 2011, 2016, 2021, 2031	
EVALUATION MONTH	1	1	
WE VEH US	no	yes	
FUEL RVP	9	9	provided by Clark County
FUEL PROGRAM	4	4	provided by Clark County
	Average Gasoline Fuel Sulfur Content = 30 ppm	Average Gasoline Fuel Sulfur Content = 30 ppm	
	Maximum Gasoline Fuel Sulfur Content = 80 ppm	Maximum Gasoline Fuel Sulfur Content = 80 ppm	
DIESEL SULFUR	250,15,15,15,15	250,15,15,15,15	provided by Clark County

Note that MOBILE6 I/M effectiveness was set to 100%. Clark County has developed a white paper to justify this value for Las Vegas (Clark County, 2005), and this is included in Appendix C to the 2005 CO SIP revision.

For the VMT mix, values generated from a 2002 traffic study conducted by RTC in Las Vegas (Orth-Rodgers and Associates, 2003) were used, which yielded VMT for 5 vehicle types that were further broken down into 16 vehicle types based on MOBILE6 default VMT mix for 2002. Clark County does not have future year forecasts for vehicle VMT mix, seasonal/day-of-week adjustments, or hourly activity profiles, so the 2002 vehicle VMT mix and other information from the base year were used for all future years.

A first set of MOBILE6 runs was conducted using the start distribution contained in the sdist.lv file (shown in Figure 2-1). These emission factors were applied to the whole domain except for a small region around Las Vegas Boulevard.

A second set of MOBILE6 runs was conducted to better estimate the specific weekday start emission factors along the Las Vegas Boulevard (LVB), where the start activity is not centered around residential areas, but rather parking lots near casinos (and thus are not characteristic of typical commute activity profiles). A more representative start distribution was calculated as the fraction of TransCAD origin trips occurring over all TAZs along the boulevard from all periods available in the TransCAD output. Figure 2-2 above shows the weekday start distributions for all future years along the Las Vegas Boulevard. Given the similarity of the future year start distributions, we elected to apply the 2000 modified start distribution to the base year and all future years for the region around the Las Vegas Boulevard. Figure 2-7 compares the hourly 2006 MOBILE6 start emission factor profiles for Sunday (entire domain), Monday (LVB area), and Monday (remainder of the domain).

2.3.2 Future Year TransCAD Link Activity Adjustments

2.3.2.1 Month/Season, Day of Week

The link-level activity was adjusted from annual average to December by a factor of 1.021, as was done for the base year.

The TransCAD volume data is representative of an average weekday. The data were scaled to Sunday estimates by weighting the Sunday day-of-week factor by the average weekday factor. The day of week factors are shown in Table 2-7.

The Sunday adjustment was therefore calculated as:

$$\text{Sunday Adjustment} = 0.774/[(1.022 + 1.047 + 1.060 + 1.062 + 1.109)/5] = 0.73$$

Monday was not adjusted.

Table 2-7. Volume scaling factors by day of week.

Day of Week	Day of Week Factors
Sunday	0.774
Monday	1.022
Tuesday	1.047
Wednesday	1.060
Thursday	1.062
Friday	1.109
Saturday	0.925

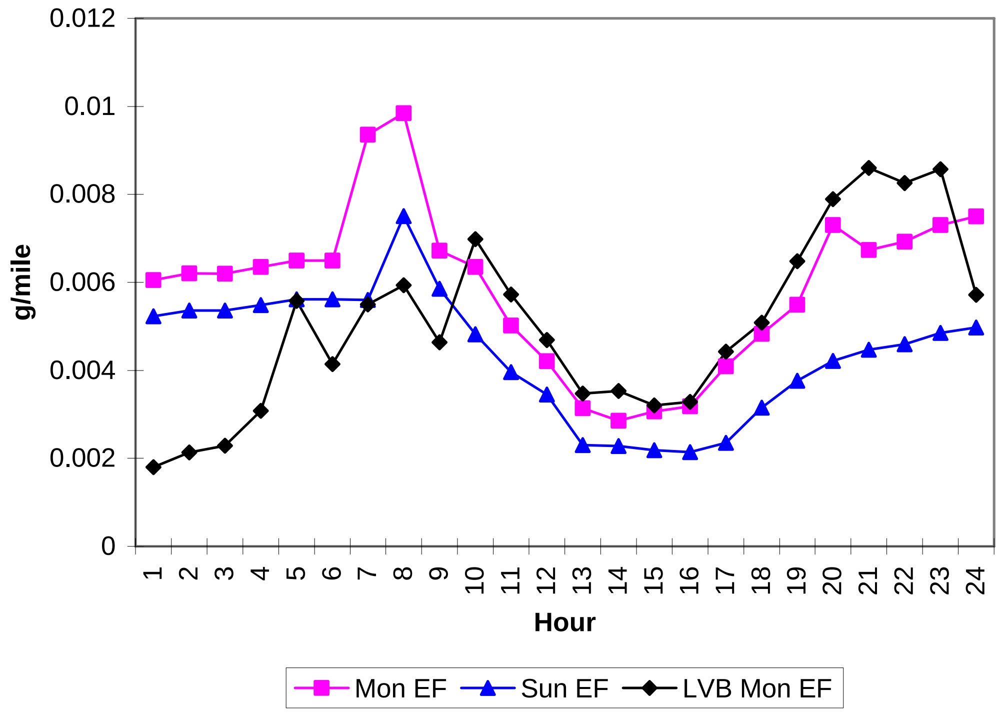


Figure 2-7. Hourly start emission factors from the 2006 MOBILE6 run: "Sun EF" is the Sunday profile used for all start emissions; "Mon EF" is the Monday profile used for start emissions outside of the LVB area; and "LVB Mon EF" is the Monday profile used for start emissions within the LVB area.

2.3.2.2 Link Volume Adjustments

Prior to calculating the link-based emissions, the link volumes were first adjusted to observed traffic counts by facility type. Then, the adjusted link volumes were adjusted to bring the total volume into agreement with the VMT reported through the Highway Performance Monitoring System (HPMS). Table 2-8 shows the adjustment factors to observed traffic counts by facility type.

The overall HPMS adjustment was a single factor multiplied uniformly to the volumes to bring the total into agreement with HPMS. The HPMS adjustment factor used was 1.0145.

Table 2-8. Adjustment factors to observed traffic counts by facility type.

Facility Type	Count Correction Factor
external connector	0.9880
system ramp	0.9880
minor arterial	1.0917
major arterial	1.0917
service ramp	0.9880
interstate	0.9880
freeway	0.9880
beltway	0.9880
collector	1.0917
centroid	1.0917

2.3.2.3 Hourly Temporal Adjustments

The TransCAD volume data is representative of an average weekday. Within each of the seven periods, the data were further disaggregated using the default weekday (Dec. 9) distribution for Monday. For Sunday, the data were summed to obtain the daily total before re-distributing into the hours using the default weekend (Dec. 8) distribution. The same VMT distributions that were used for the 1996 base year were used for the future years, as illustrated in Figure 2-3.

2.3.2.4 Speed Adjustments

After the link data were temporally allocated to hourly values, the hourly speeds were adjusted using the following Bureau of Public Roads (BPR) curve, where the volume to capacity ratio was capped at 1.25:

$$S_a = \frac{S_{ff}}{1 + \left[A * \left(V/C \right)^B \right]}$$

where:

S_a = adjusted link speed (mph)

S_{ff} = reported link free flow speed (mph)

V = total link volume (vehicles OR vehicles per hour)

C = total link capacity (vehicles OR vehicles per hour)

For freeways, interstates, system ramps, and expressways,

A = 0.66 B = 7.2

For major arterials, minor arterials, collectors, ramps, and other,

A = 0.76 B = 5.9

2.3.2.5 Transit Adjustments

The link-level emissions were adjusted upward by the factors shown in Table 2-9 to capture transit activity (interpolated to the model years from transit fractions from the RTP-TIP). The link-level emissions were also adjusted slightly downward as shown in Table 2-9 to capture impacts from TCMs.

Table 2-9. Adjustment factor to scale link-level emissions to account for mass transit.

Year	Transit Adjustment Factor	TCM Adjustment Factor
2006	1.004962	0.9996
2010	1.003913	0.9996
2015	1.003553	0.9995
2020	1.003192	0.9995
2030	1.002471	0.9995

2.3.3 Future Year Link-Level Running Emissions

The TransCAD link level volumes were first adjusted by the count correction factor and the HPMS adjustment. Then, they were disaggregated to hourly volumes. The speed was adjusted using the hourly volume to capacity ratio in the BPR curve. The MOBILE6 emission factor for that hour and adjusted speed was multiplied by the hourly link volume to get hourly emissions. The hourly emissions were further adjusted to December, day of week, transit activity, and TCM's in CNTLEM within the EPS3 processing. Figure 2-8 shows the resulting hourly 2006 VMT.

Tables 2-10 through 2-14 present tabulations of VMT by facility type for each future year, as directly reported by TransCAD, and after the adjustments described above. Figure 2-9 displays the evolution of the TransCAD link network on the UAM modeling grid for each future year.

2.3.4 Future Year Start Emissions

The start emissions were calculated in the same manner as was done for the base year. For Monday, the hourly VMT was estimated by disaggregating the period VMT to hourly VMT using the weekday VMT distribution show in Figure 2-3. The start emissions were calculated by multiplying the hourly VMT by the hourly MOBILE6 start emission factors. The hourly link start emissions were then totaled over the entire network and redistributed to TAZ, based on the fraction of period-specific trip origins for each TAZ over the total number of trip origins over all TAZs. For Sunday, the TransCAD data is not representative of a typical weekend profile, so the hourly VMT was estimated by first totaling all the period VMT to a daily value, then it was distributed to hourly values using the weekend profile in Figure 2-3. The Sunday start emissions were then calculated by multiplying the hourly VMT by the MOBILE6 hourly emission factors for all hours. The emissions were totaled over the entire network and then spatially distributed to

Table 2-10. 2006 VMT by facility type. Totals are shown as output by TransCAD, and after seasonal, day-of-week, and public transit adjustments.

Group Code	Facility Type	Modeled 2006 DVMT	DVMT Corrected to Count	DVMT Corrected to HPMS	DVMT Adjusted to December	DVMT Adjusted for Transit	Sunday DVMT	Monday DVMT
0	External Connector	621,151	613,697	622,596	635,671	638,825	466,342	638,825
1	System Ramp	288,128	284,671	288,798	294,863	296,326	216,318	296,326
2	Minor Arterial	2,777,828	3,032,555	3,076,527	3,141,134	3,156,721	2,304,406	3,156,721
3	Major Arterial	16,612,275	18,135,621	18,398,587	18,784,958	18,878,169	13,781,063	18,878,169
4	Freeway on- or off-ramp	962,346	950,798	964,585	984,841	989,728	722,501	989,728
5	Interstate	8,341,200	8,241,106	8,360,602	8,536,174	8,578,531	6,262,328	8,578,531
6	Freeway	3,088,561	3,051,499	3,095,745	3,160,756	3,176,440	2,318,801	3,176,440
7	Expressway	142,816	141,103	143,149	146,155	146,880	107,222	146,880
8	Collector	1,416,105	1,545,961	1,568,378	1,601,314	1,609,259	1,174,759	1,609,259
9	Centroid Connector	2,738,699	2,989,838	3,033,191	3,096,888	3,112,255	2,271,946	3,112,255
	Intrazonal	87,303	87,303	88,569	90,429	90,878	66,341	90,878
Daily Total		**37,076,414**	**39,074,152**	**39,640,727**	**40,473,182**	**40,674,010**	**29,692,028**	**40,674,010**
Transit adjustment		1.004962						
HPMS adjustment		1.0145						
December adjustment		1.021						
Sunday adjustment		0.73						
Monday adjustment		1						

Table 2-11. 2010 VMT by facility type. Totals are shown as output by TransCAD, and after seasonal, day-of-week, and public transit adjustments.

Group Code	Facility Type	Modeled 2010 DVMT	DVMT Corrected to Count	DVMT Corrected to HPMS	DVMT Adjusted to December	DVMT Adjusted for Transit	Sunday DVMT	Monday DVMT
0	External Connector	611,100	603,767	612,521	625,384	627,831	458,317	627,831
1	System Ramp	427,211	422,084	428,204	437,197	438,907	320,402	438,907
2	Minor Arterial	3,472,785	3,791,239	3,846,212	3,926,982	3,942,349	2,877,915	3,942,349
3	Major Arterial	19,347,711	21,121,896	21,428,164	21,878,155	21,963,765	16,033,548	21,963,765
4	Freeway on- or off-ramp	1,264,307	1,249,136	1,267,248	1,293,860	1,298,923	948,214	1,298,923
5	Interstate	10,176,081	10,053,968	10,199,750	10,413,945	10,454,695	7,631,927	10,454,695
6	Freeway	5,650,830	5,583,020	5,663,974	5,782,917	5,805,546	4,238,049	5,805,546
7	Expressway	525,996	519,684	527,219	538,291	540,397	394,490	540,397
8	Collector	2,013,021	2,197,615	2,229,481	2,276,300	2,285,207	1,668,201	2,285,207
9	Centroid Connector	3,525,078	3,848,327	3,904,128	3,986,115	4,001,712	2,921,250	4,001,712
	Intrazonal	156,061	156,061	158,324	161,649	162,281	118,465	162,281
Daily Total		**47,170,180**	**49,546,797**	**50,265,226**	**51,320,795**	**51,521,614**	**37,610,778**	**51,521,614**
Transit adjustment		1.003913						
HPMS adjustment		1.0145						
December adjustment		1.021						
Sunday adjustment		0.73						
Monday adjustment		1						

Table 2-12. 2015 VMT by facility type. Totals are shown as output by TransCAD, and after seasonal, day-of-week, and public transit adjustments.

Group Code	Facility Type	Modeled 2015 DVMT	DVMT Corrected to Count	DVMT Corrected to HPMS	DVMT Adjusted to December	DVMT Adjusted for Transit	Sunday DVMT	Monday DVMT
0	External Connector	621,151	613,697	622,596	635,671	637,929	465,688	637,929
1	System Ramp	476,926	471,203	478,035	488,074	489,808	357,560	489,808
2	Minor Arterial	3,964,841	4,328,417	4,391,179	4,483,394	4,499,323	3,284,506	4,499,323
3	Major Arterial	21,843,415	23,846,456	24,192,229	24,700,266	24,788,026	18,095,259	24,788,026
4	Freeway on- or off-ramp	1,313,314	1,297,554	1,316,369	1,344,013	1,348,788	984,615	1,348,788
5	Interstate	11,023,875	10,891,588	11,049,516	11,281,556	11,321,639	8,264,797	11,321,639
6	Freeway	6,542,175	6,463,669	6,557,392	6,695,097	6,718,885	4,904,786	6,718,885
7	Expressway	1,599,742	1,580,545	1,603,463	1,637,136	1,642,953	1,199,356	1,642,953
8	Collector	2,354,214	2,570,095	2,607,361	2,662,116	2,671,574	1,950,249	2,671,574
9	Centroid Connector	4,088,071	4,462,947	4,527,660	4,622,740	4,639,165	3,386,590	4,639,165
	Intrazonal	145,409	145,409	147,517	150,615	151,150	110,340	151,150
Daily Total		**53,973,132**	**56,671,581**	**57,493,319**	**58,700,678**	**58,909,242**	**43,003,747**	**58,909,242**
Transit adjustment		1.003553						
HPMS adjustment		1.0145						
December adjustment		1.021						
Sunday adjustment		0.73						
Monday adjustment		1						

Table 2-13. 2020 VMT by facility type. Totals are shown as output by TransCAD, and after seasonal, day-of-week, and public transit adjustments.

Group Code	Facility Type	Modeled 2020 DVMT	DVMT Corrected to Count	DVMT Corrected to HPMS	DVMT Adjusted to December	DVMT Adjusted for Transit	Sunday DVMT	Monday DVMT
0	External Connector	641,546	633,848	643,039	656,542	658,638	480,806	658,638
1	System Ramp	491,767	485,866	492,911	503,262	504,869	368,554	504,869
2	Minor Arterial	4,433,933	4,840,525	4,910,712	5,013,837	5,029,841	3,671,784	5,029,841
3	Major Arterial	23,282,398	25,417,394	25,785,946	26,327,451	26,411,488	19,280,386	26,411,488
4	Freeway on- or off-ramp	1,403,726	1,386,881	1,406,991	1,436,538	1,441,123	1,052,020	1,441,123
5	Interstate	12,148,354	12,002,574	12,176,611	12,432,320	12,472,004	9,104,563	12,472,004
6	Freeway	7,019,517	6,935,283	7,035,844	7,183,597	7,206,527	5,260,765	7,206,527
7	Expressway	1,612,455	1,593,105	1,616,205	1,650,146	1,655,413	1,208,452	1,655,413
8	Collector	2,596,741	2,834,862	2,875,968	2,936,363	2,945,736	2,150,387	2,945,736
9	Centroid Connector	4,383,208	4,785,148	4,854,533	4,956,478	4,972,299	3,629,778	4,972,299
	Intrazonal	167,472	167,472	169,900	173,468	174,022	127,036	174,022
Daily Total		**58,181,118**	**61,082,958**	**61,968,661**	**63,270,003**	**63,471,961**	**46,334,532**	**63,471,961**
Transit adjustment		1.003192						
HPMS adjustment		1.0145						
December adjustment		1.021						
Sunday adjustment		0.73						
Monday adjustment		1						

Table 2-14. 2030 VMT by facility type. Totals are shown as output by TransCAD, and after seasonal, day-of-week, and public transit adjustments.

Group Code	Facility Type	Modeled 2030 DVMT	DVMT Corrected to Count	DVMT Corrected to HPMS	DVMT Adjusted to December	DVMT Adjusted for Transit	Sunday DVMT	Monday DVMT
0	External Connector	678,697	670,552	680,275	694,561	696,277	508,283	696,277
1	System Ramp	548,440	541,859	549,716	561,260	562,647	410,732	562,647
2	Minor Arterial	5,394,312	5,888,971	5,974,361	6,099,822	6,114,895	4,463,873	6,114,895
3	Major Arterial	26,825,037	29,284,892	29,709,523	30,333,423	30,408,377	22,198,115	30,408,377
4	Freeway on- or off-ramp	1,580,942	1,561,971	1,584,619	1,617,896	1,621,894	1,183,983	1,621,894
5	Interstate	13,368,302	13,207,882	13,399,396	13,680,784	13,714,589	10,011,650	13,714,589
6	Freeway	8,306,442	8,206,765	8,325,763	8,500,604	8,521,609	6,220,775	8,521,609
7	Expressway	598,066	590,889	599,457	612,046	613,558	447,898	613,558
8	Collector	3,079,919	3,362,348	3,411,102	3,482,735	3,491,341	2,548,679	3,491,341
9	Centroid Connector	5,034,875	5,496,573	5,576,273	5,693,375	5,707,443	4,166,433	5,707,443
	Intrazonal	171,308	171,308	173,792	177,442	177,880	129,852	177,880
Daily Total		**65,586,340**	**68,984,010**	**69,984,278**	**71,453,948**	**71,630,511**	**52,290,273**	**71,630,511**
Transit adjustment		1.002471						
HPMS adjustment		1.0145						
December adjustment		1.021						
Sunday adjustment		0.73						
Monday adjustment		1						

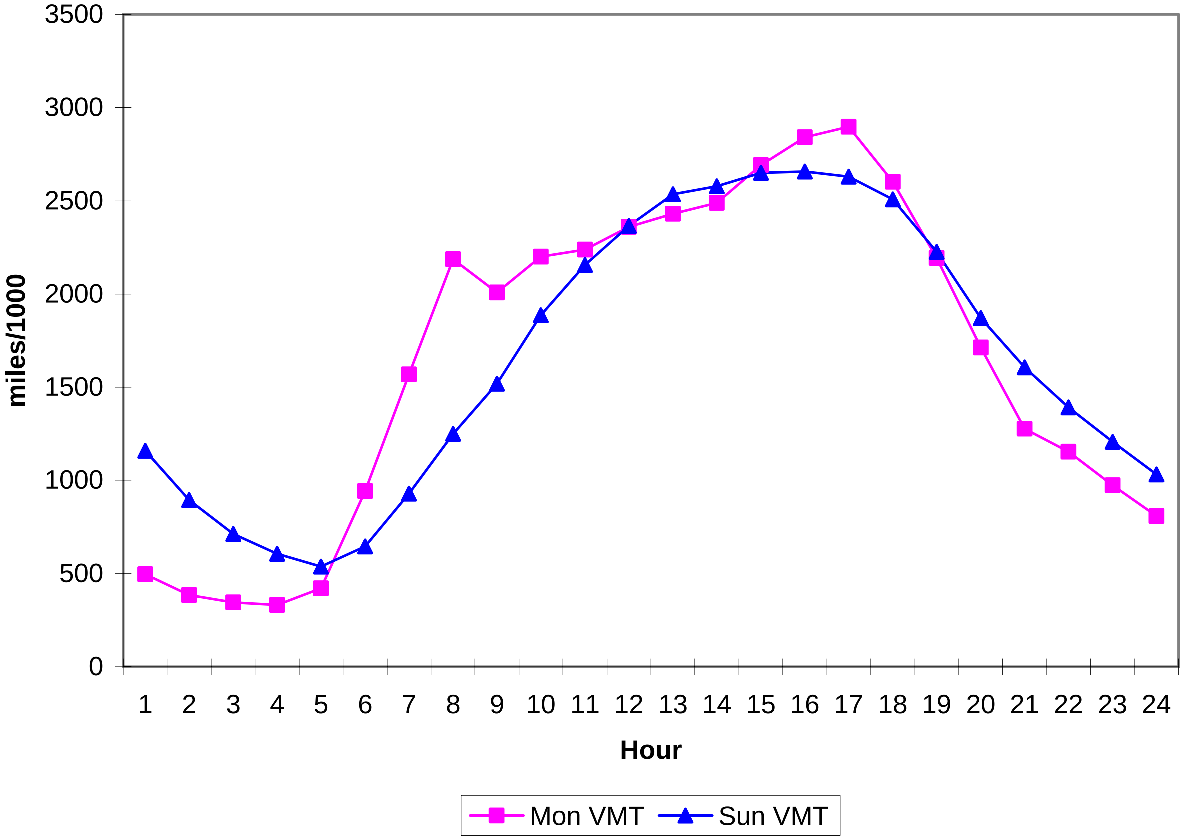


Figure 2-8. 2006 hourly vehicle miles traveled (VMT) for Sunday and Monday.

each TAZ using a single ratio of the daily total TAZ trip origins to the daily total of all trip origins over the domain.

The future year start emissions were calculated twice; once using the MOBILE6 emission factors generated using the sdist.lv hourly start distribution (Figure 2-1), and once using the MOBILE6 emission factors generated using the modified start distribution discussed above to reflect the activity along the Las Vegas Boulevard.

The hourly TAZ start emissions were spatially allocated to the grid cell containing the TAZ centroid and the 24 surrounding cells in a “wedding cake” fashion: the grid cell containing a TAZ centroid receives 25% of the start emissions from that TAZ, the surrounding 8 grid cells receive 60% of the start emissions (7.5% per cell), and the outside 16 grid cells receive 15% of the start emissions (0.9375% per cell). This approach was reviewed by EPA Region IX and the Office of Transportation and Air Quality (EPA Region IX, personal communication).

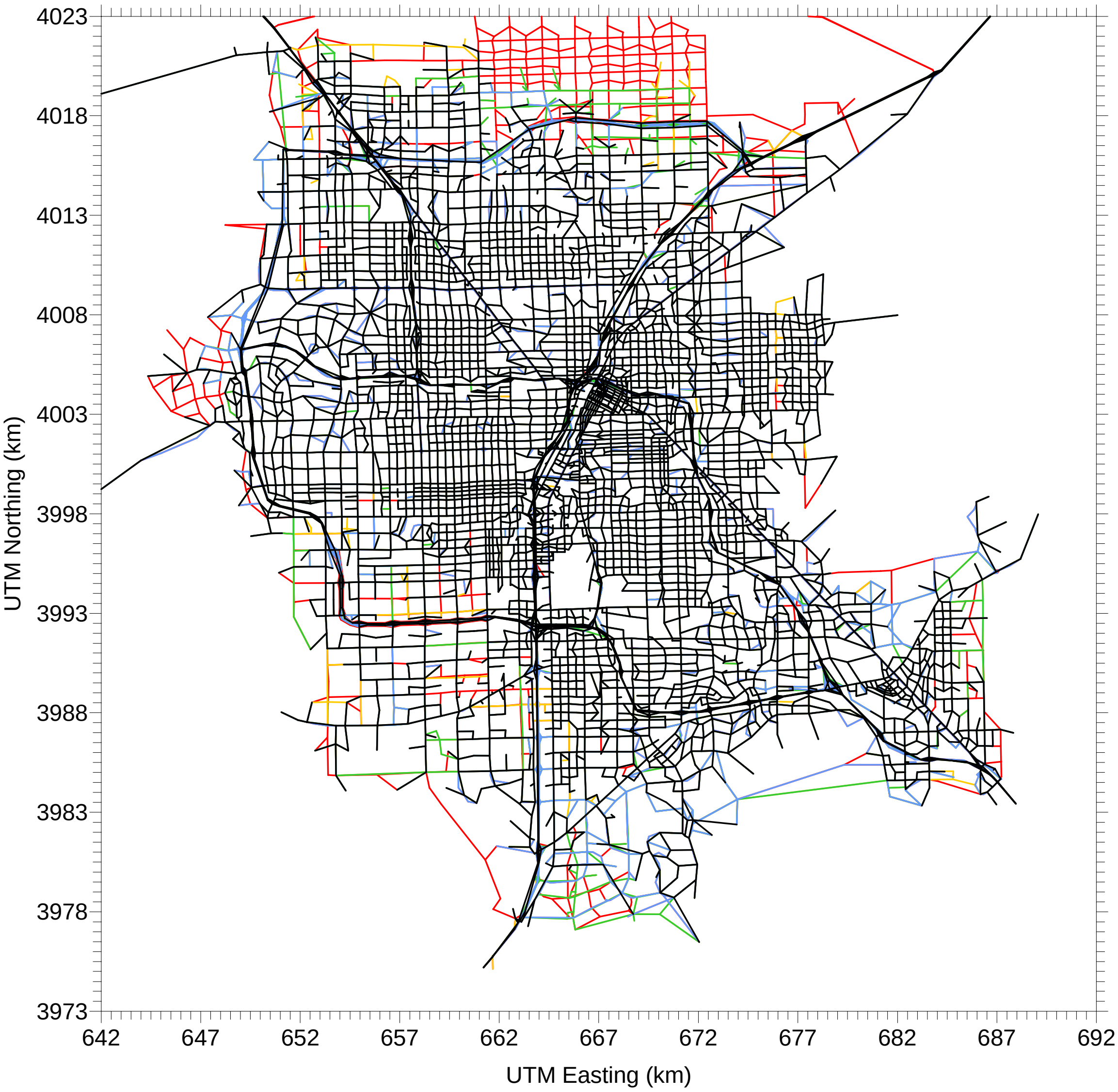


Figure 2-9. Evolution of the TransCAD link network on the UAM modeling grid for future years 2006 (black), 2010 (blue), 2015 (green), 2020 (yellow) and 2030 (red).

2.3.5 Future Year Intrazonal Activity

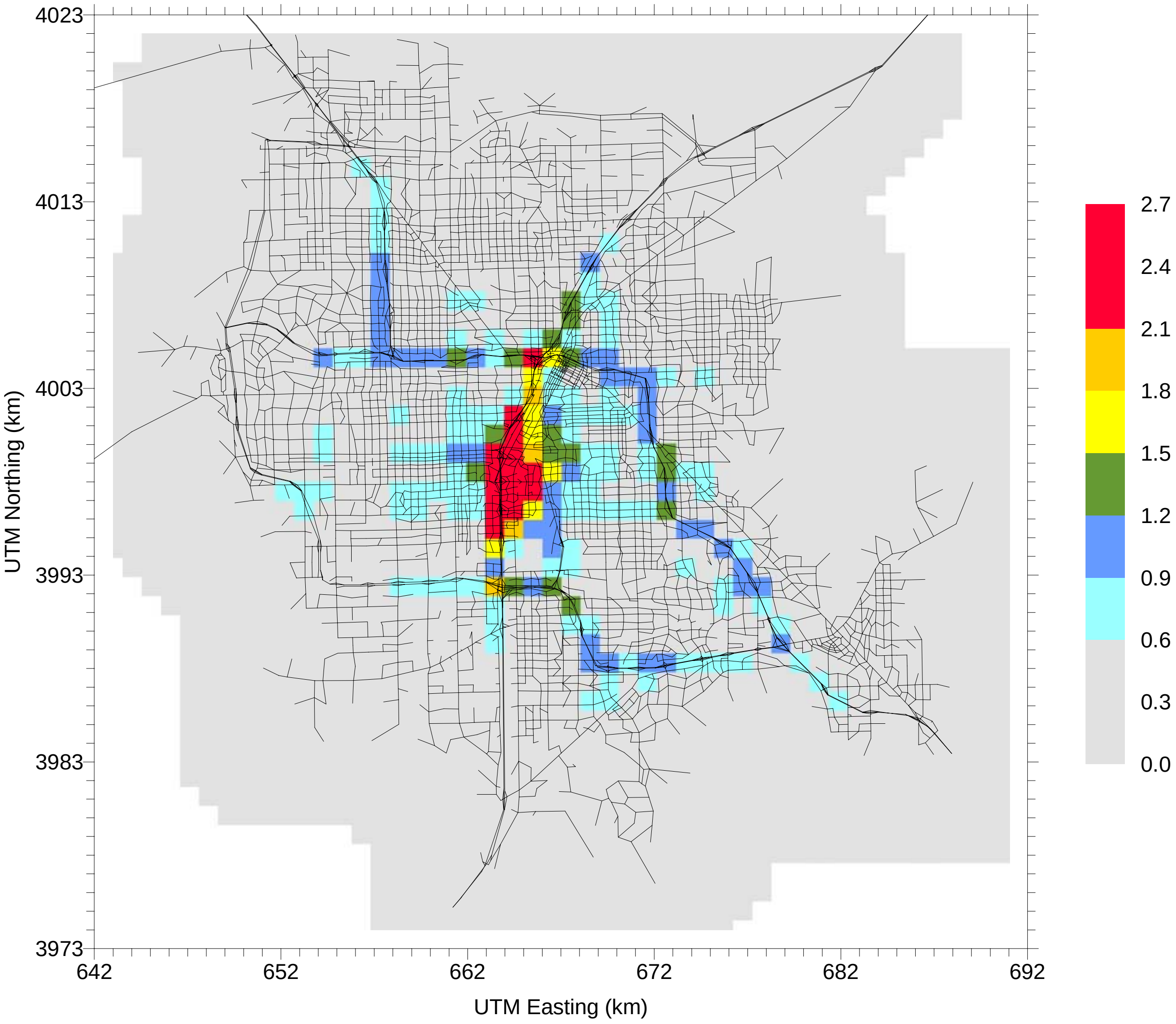
The intrazonal VMT was calculated assuming a default length of 1 mile for each intrazonal trip (as is described in the 2004-2005 Regional Transportation Plan documentation [FY 2004-2025 RTP and FY 2004-2006 TIP, Chapter 5, page 5-16]).

2.3.6 Future Year Total Emissions

Table 2-15 lists the component and total on-road mobile source emissions for all future years. Figures 2-10 through 2-14 present the future year spatial distribution of the total on-road mobile source emissions for December 9, 1996.

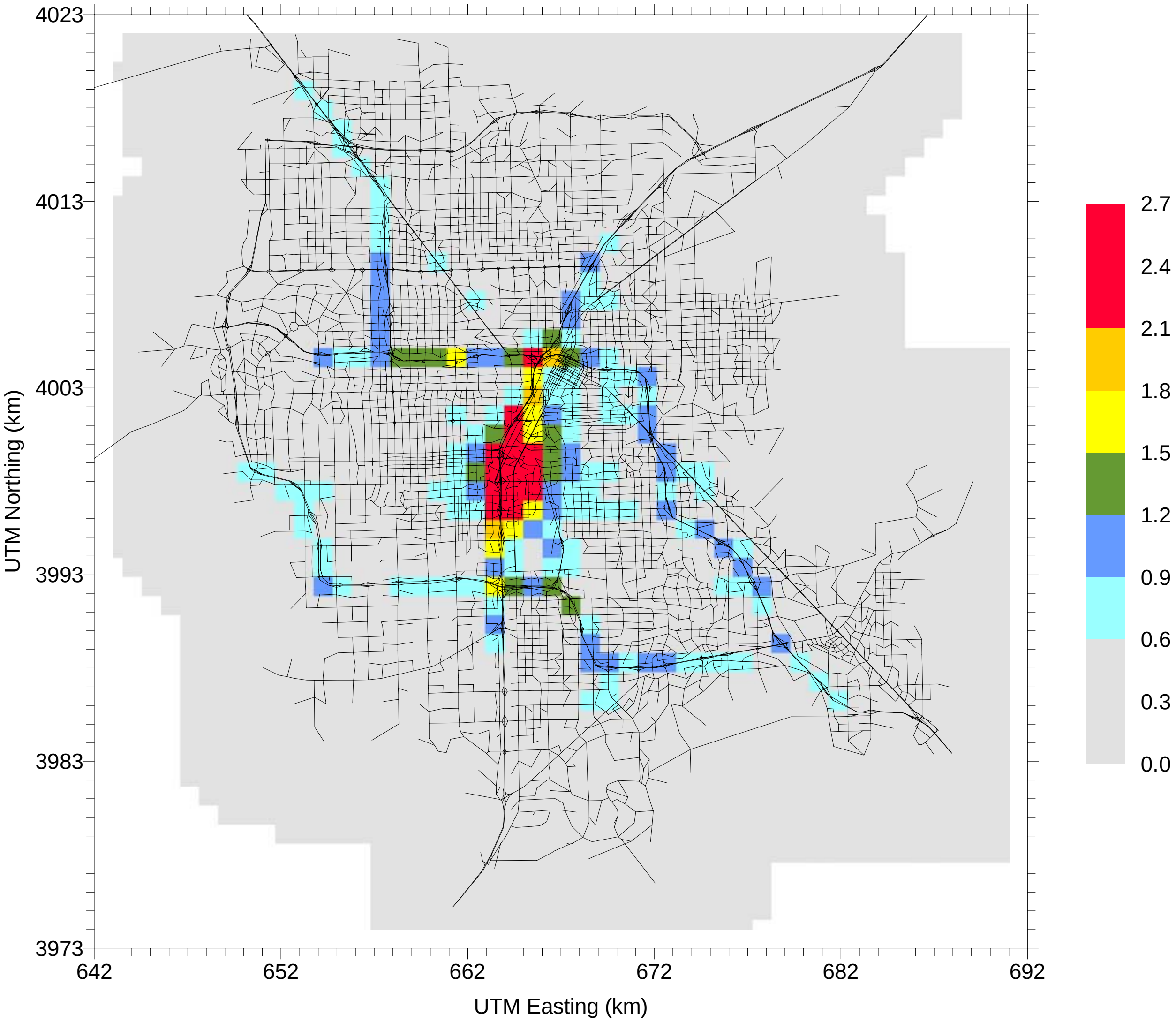
Table 2-15. Component and total on-road mobile source CO emissions (TPD) for all future years.

	2006	**2010**	**2015**	**2020**	**2030**
Sunday 12/8/2005					
Links - Running	149.64	150.26	137.32	133.15	142.66
Starts	125.10	135.93	138.46	139.23	152.54
Intrazonals	0.57	0.82	0.66	0.71	0.70
Total	**275.30**	**287.01**	**276.44**	**273.09**	**295.90**
Monday 12/9/2005					
Links - Running	204.62	205.29	187.70	182.00	194.67
Starts	235.73	257.33	262.53	264.10	289.81
Intrazonals	0.88	1.33	1.07	1.14	1.13
Total	**441.23**	**463.95**	**451.30**	**447.24**	**485.61**



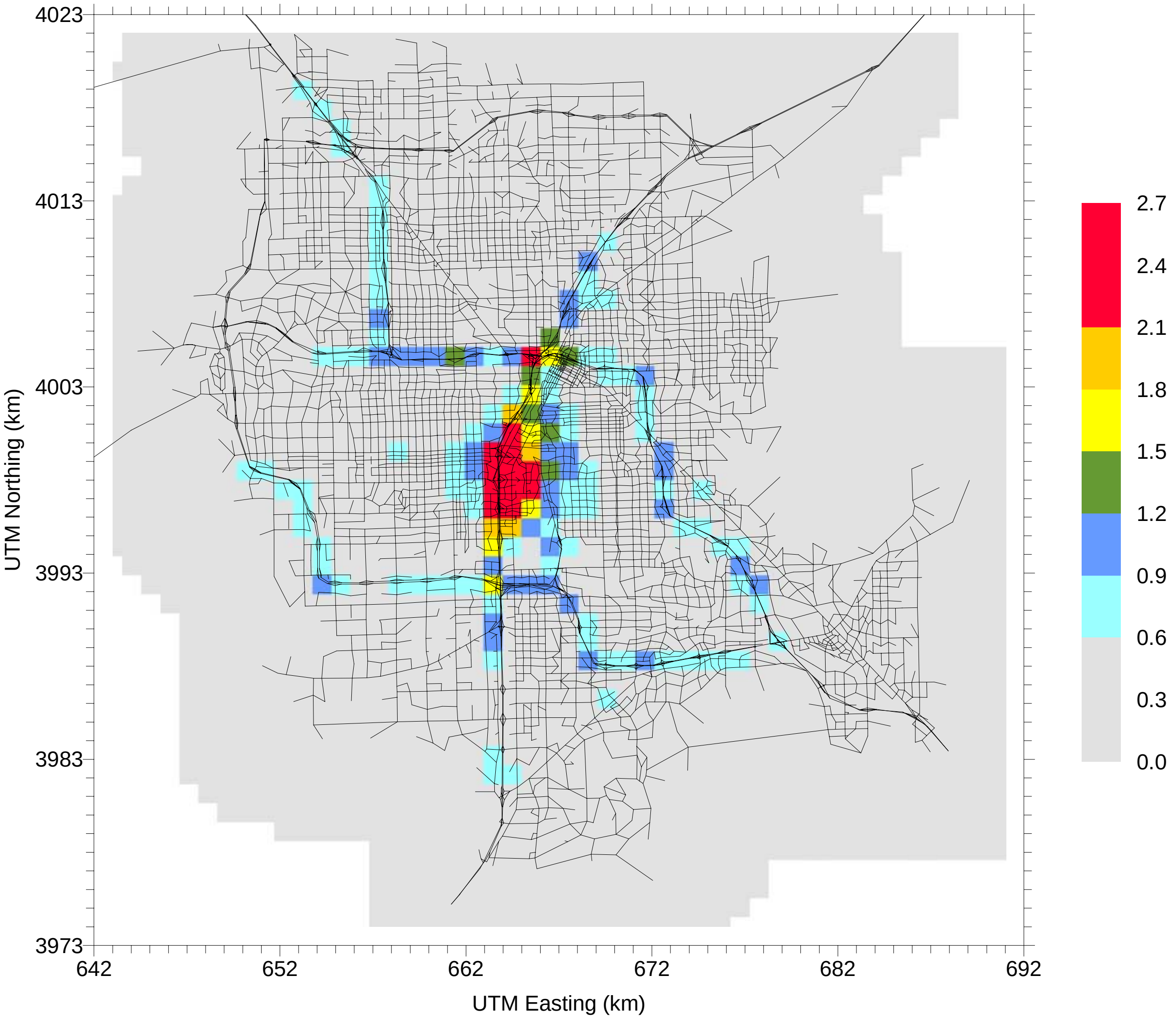
ONROAD Emissions
Future Year - Dec 9, 2006
CO (tons per day)

Figure 2-10. Spatial distribution of total on-road mobile source CO emissions for the 2006 future year.



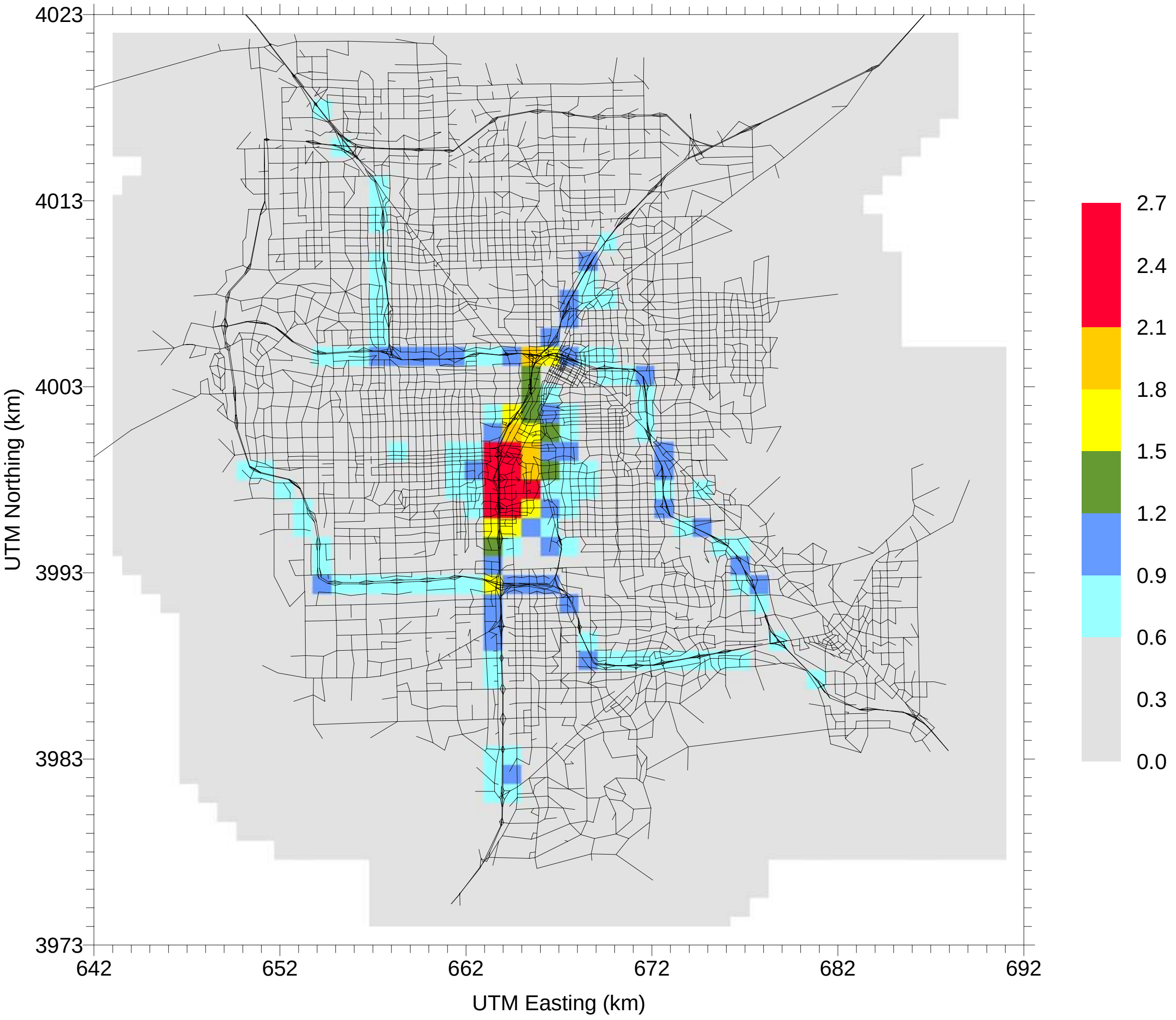
ONROAD Emissions
Future Year - Dec 9, 2010
CO (tons per day)

Figure 2-11. Spatial distribution of total on-road mobile source CO emissions for the 2010 future year.



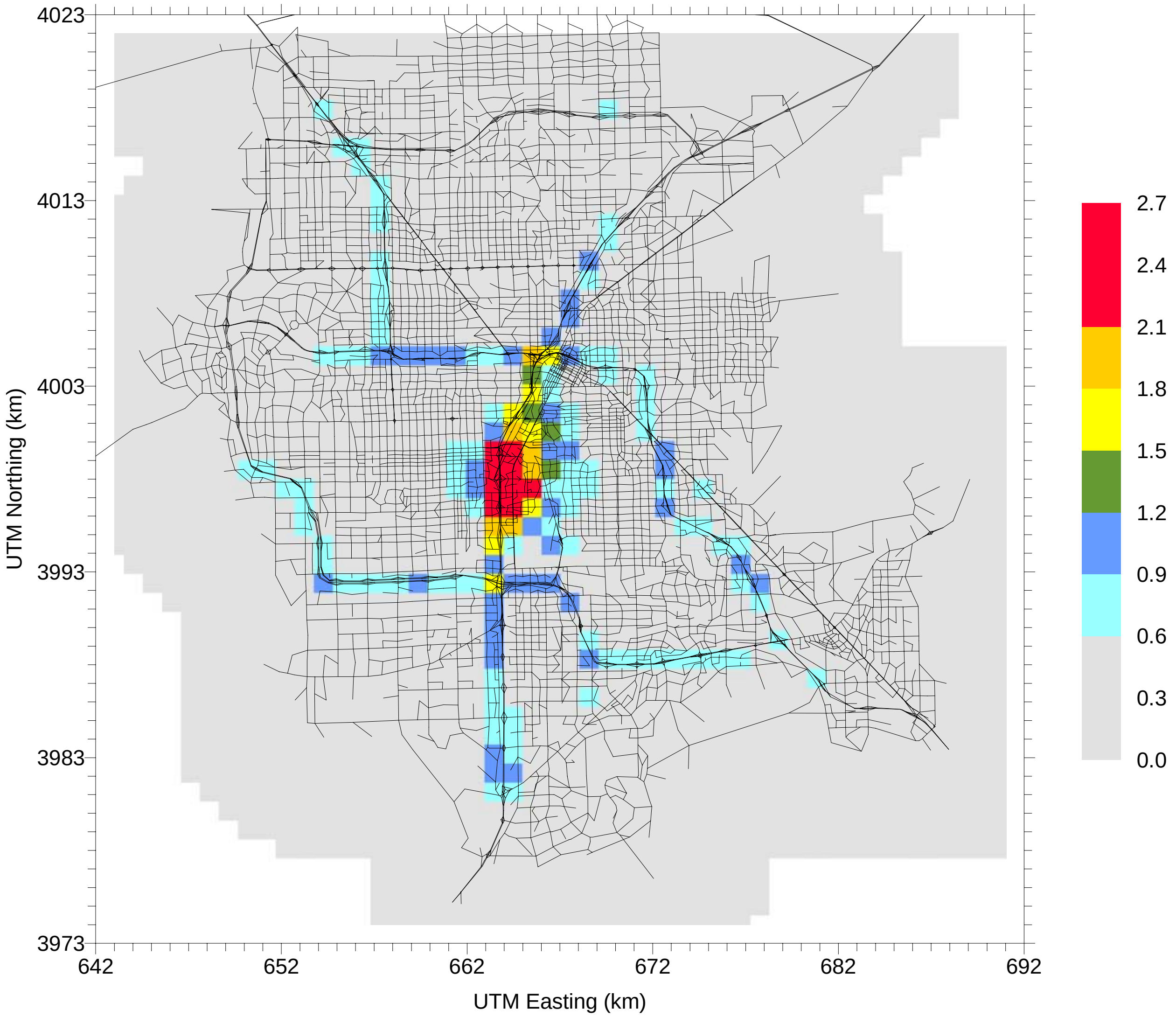
ONROAD Emissions
Future Year - Dec 9, 2015
CO (tons per day)

Figure 2-12. Spatial distribution of total on-road mobile source CO emissions for the 2015 future year.



ONROAD Emissions
Future Year - Dec 9, 2020
CO (tons per day)

Figure 2-13. Spatial distribution of total on-road mobile source CO emissions for the 2020 future year.



ONROAD Emissions
Future Year - Dec 9, 2030
CO (tons per day)

Figure 2-14. Spatial distribution of total on-road mobile source CO emissions for the 2030 future year.

3. OTHER EMISSION CATEGORIES

3.1 NON-ROAD CATEGORIES

3.1.1 Airports

In 1999, Clark County and their contractor Ricondo and Associates developed a detailed emissions inventory at the three county civil airports (McCarran, North Las Vegas, and Henderson), and performed dispersion modeling using the Federal Aviation Administration's (FAA) EDMS model. At the time, EDMS had MOBILE5a embedded as the source of on-road mobile emissions generation, and used PAL2 and CALINE3 for dispersion calculations. EDMS was run for the 1996 base year, along with the future years of 2000, 2010, and 2020. UAM results were used to provide the larger scale "background" CO levels. The combination of UAM-predicted grid cell concentrations from the 2000 SIP submittal, plus EMDS-predicted receptor concentrations, were used for the airport microscale analyses. The UAM+EDMS results showed no 8-hour CO exceedances at any EDMS receptor (Ricondo, 1999).

In 2003, Clark County sponsored an updated EDMS project for the three county airports. The latest version of EDMS was used, which introduced the AERMOD dispersion model. On-road mobile sources were estimated using Clark County runs of MOBILE6.2. EDMS was run for 2000, 2005, 2010, 2015 and 2020 (the 1996 base year was skipped). UAM results were not added to the EDMS receptor results. The revised modeling resulted in predictions above the 8-hour CO standard at several receptors in all years (Ricondo, 2003); however, these were located in "non-public access" areas (primarily aircraft docking areas, apron, etc.), as documented by Ricondo (2005). EPA has indicated that it will accept the removal of receptors in non-public access areas from consideration.

To properly account for the contributions of airports toward the valley-wide distribution of CO during the December 8-9 episode, UAM needs to include the updated EDMS airport emissions within the gridded inventory. Airport emissions for 1996 were taken from the Ricondo (1999) estimates, while emissions for the 2010, 2015, and 2020 future years were taken from the updated Ricondo (2003) estimates. Emission estimates for 2006 were derived by linearly interpolating total airport emissions from 2005 and 2010, while emission estimates for 2030 were derived by linearly extrapolating total airport emissions from 2015 and 2020. Annual airport emissions are shown in Table 3-1. Note that original 2000 SIP emission estimates for Nellis AFB were retained in the UAM modeling.

3.1.1.1 Temporal and Spatial Allocation

The EDMS CO emission estimates are reported as tons per year. Therefore it was necessary to disaggregate these estimates to December, Sunday and Monday, and to each hour of the day. Clark County provided activity data for these airports on which to base the disaggregation from annual to hourly emission rates.

Table 3-1. Annual airport CO emission estimates (tons per year) reported by Ricondo (1999) for the 1996 base year, and by Ricondo (2003) for future years 2010, 2015, and 2020 (2006 and 2030 estimated as described in the text).

Year	McCarran	Henderson	North Las Vegas
1996	10,022	536	2,727
2006	11,600	646	1,848
2010	13,494	762	1,880
2015	15,482	949	1,924
2020	17,553	1,220	1,971
2030	21,695	1,762	2,063

Factors to translate from annual to December emissions are provided in Table 3-2. The same day-of-week activity factors were given for Henderson and North Las Vegas airports to translate from monthly estimates to specific days: 3.2% for Sunday, and 2.5% for Monday. No day-specific factors were given for McCarran airport, so a constant day-of-week profile was applied. Figure 3-1 shows the hourly distribution applied to McCarran airport, while Figure 3-2 shows the hourly distribution applied for both Henderson and North Las Vegas airports.

Table 3-2. Monthly factors used to disaggregate annual airport CO emissions to monthly totals. The factors for December were used in this study.

Month	McCarran	Henderson	North Las Vegas
January	7.75%	8.46%	6.25%
February	7.61%	9.13%	7.27%
March	8.86%	10.26%	7.20%
April	8.47%	9.00%	7.13%
May	8.70%	10.16%	9.35%
June	8.40%	8.37%	7.82%
July	8.43%	7.11%	8.32%
August	8.67%	7.18%	8.53%
September	8.47%	7.84%	9.49%
October	9.01%	8.71%	10.40%
November	8.10%	7.38%	9.76%
December	**7.54%**	**6.40%**	**8.48%**

Airport emissions were placed evenly across the grid cells in which the airports reside. Note that in this project we expanded the definition of McCarran airport from two cells (as treated in the 2000 SIP modeling) to twelve cells, based on grid overlays upon aerial photographs of the airport layout (Figure 3-3). The single host cell for North Las Vegas airport was shifted one cell east to better locate that property relative to the nearby roadways. The location of Henderson was not changed from the original location.

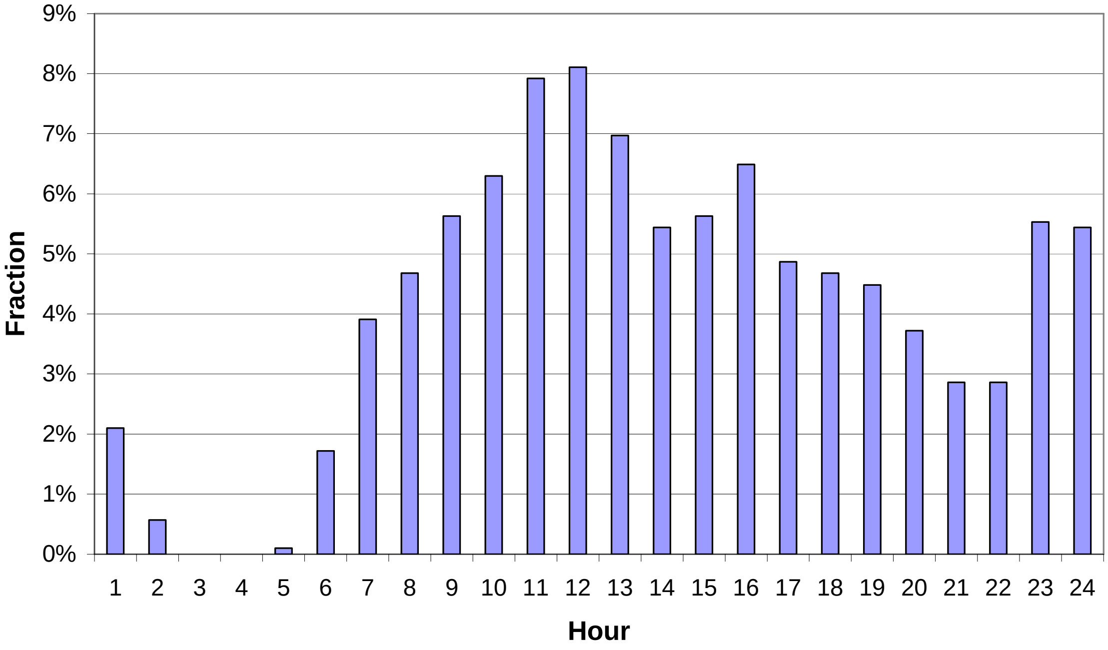


Figure 3-1. Hourly activity at McCarran airport used to temporally allocate daily emissions for all years modeled.

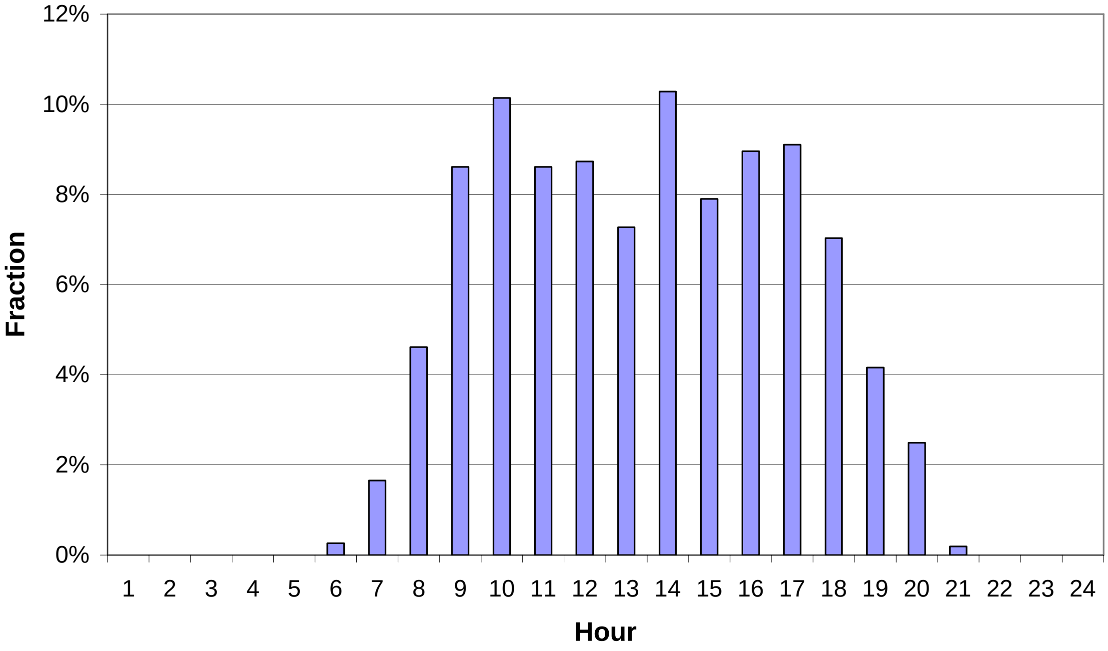


Figure 3-2. Hourly activity at Henderson and North Las Vegas airports used to temporally allocate daily emissions for all years modeled.

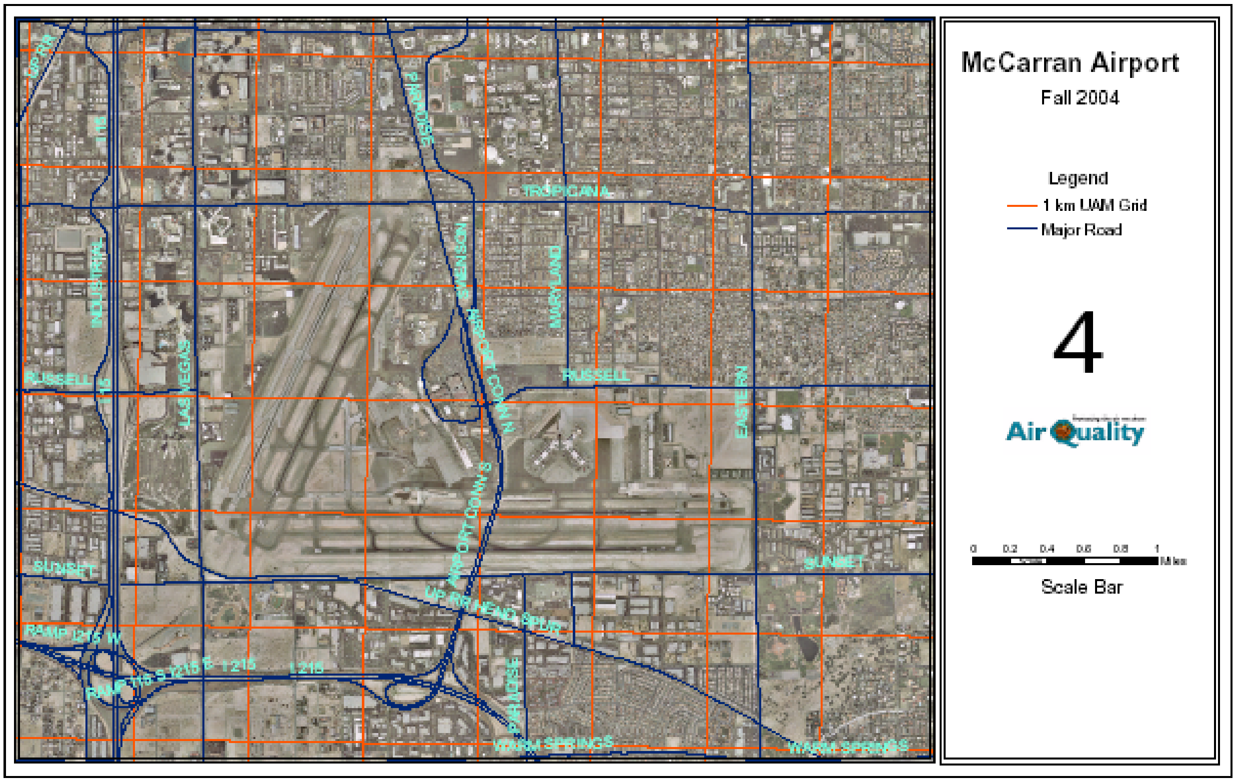


Figure 3-3. Arial photograph of McCarran airport with UAM grid cells overlaid.

Airport grid cells are defined as follows:

McCarran (i,j)	(24,21) (24,22) (24,23),(24,24) (25,21) (25,22) (25,23),(25,24) (26,21) (26,22) (27,21) (27,22)
North Las Vegas (i,j)	(21,36)
Henderson (i,j)	(27,10)

3.1.2 Locomotives

Clark County has updated railroad emissions for 2001 based on a Mactec non-road study (Mactec, 2003). These updated emission estimates were incorporated into this work. The base year emissions estimates were taken from Table 3-33 of the Mactec report. Locomotive emissions from the Mactec report include both line haul and switching. For switching, emissions are placed at the same two facilities as modeled previously. The grid cells for these facilities are:

Civic Center Yard (i,j)	(24,29) (24,30) (25,30) (25,31) (25,32)
Boulder Junction Wye (i,j)	(21,20)(21,21)(21,22)(21,23)

These locations are modeled as zero length link sources. For the line haul, the locomotive emissions were put into grid cells using coordinates defined from the rail map provided by Clark County. Each segment is defined by two node endpoints with the emissions of each segment distributed equally along the line between each node.

3.1.2.1 Locomotive Projections

Projecting locomotive emissions requires two estimates: activity growth and effects of emissions control through fleet turnover with EPA engines. Only Union Pacific operates locomotives in Clark County, so Union Pacific may have more accurate figures of historic usage for the specific rail segments in Clark County. However, conducting a survey of this historic usage was beyond the scope of this project.

The locomotive activity unit most useful for emission evaluation is fuel consumption. Projected fuel consumption from locomotive use is difficult to estimate especially for a given track segment such as through Clark County. The fuel consumption depends on factors not exclusively restricted to the number of trains, tons of freight, or business indicators because of efficiency improvements to the trains or operations.

To project the locomotive activity increases due to the growth in business, a time series plot of the available fuel consumption data was used. Three sources of fuel consumption data were available: online data purchased from the American Association of Railroads (AAR) for the years 1999 and 2002 (AAR, 2004), the AAR ten years trends report for 1990 through 1999 (AAR, 2000), and estimates from the Energy Information Administration (EIA) of the Department of Energy that track fuels consumption by end use (EIA, 2005). As shown in Figure 3-4, the EIA data does not match at all the AAR figures so these were ignored. The AAR online data provides fuel consumption estimates for individual railroads and has a total of the largest railroads called Class 1 railroads, of which Union Pacific is the largest. The most recent trend between 1999 and 2001 for Union Pacific indicates a 1.9% per year increase in fuel consumption. While basing a growth estimate with only two years of data is suspect, the 1.9% per year growth rate mirrors the US total growth rate of 2.0% for 1990 through 1999 and 1.5% for the period of 1990 through 2002.

The emissions were projected using the EPA's estimates of the effect of fleet turnover. Table 3-3 shows the percent reduction in emissions for Class 1 line-haul and switching engines due to the Federal standard (EPA, 1997). Combining the projected growth from fuel consumption estimates with the expected emission reductions from engine controls, the emissions relative to 1996 were calculated and shown in Table 3-4.

The 1996 railroad maintenance emissions were estimated with EPA's NONROAD Model, which is discussed in detail in the following subsection. These estimates were processed and reported separately. The 1996 base case railroad maintenance emissions were projected based on the locomotive projections presented in Table 3-4.

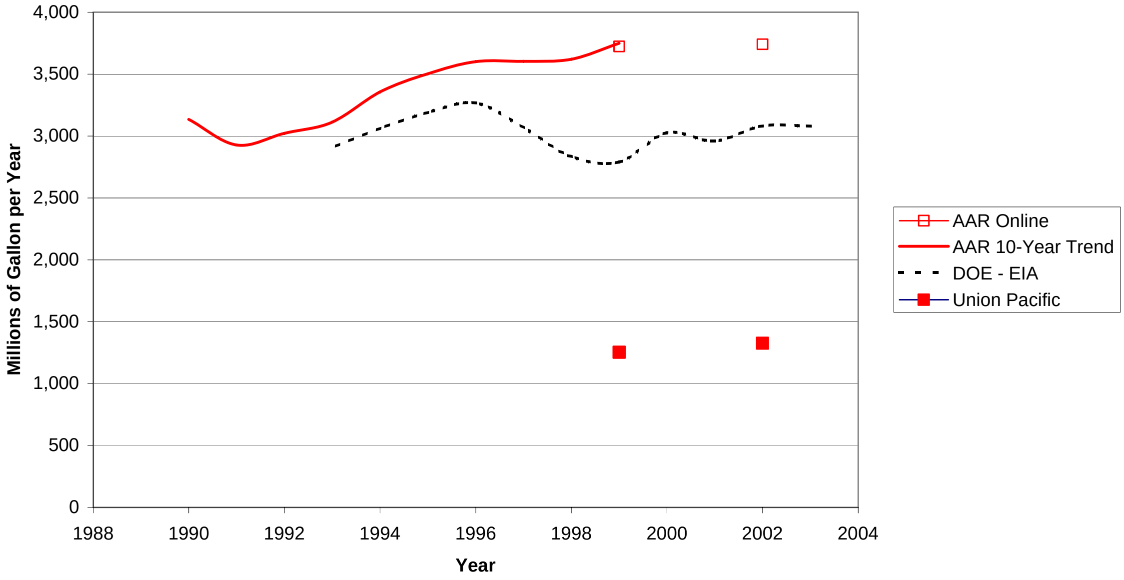


Figure 3-4. Available locomotive fuel consumption trends.

Table 3-3. Locomotive emission reductions due to EPA regulations (EPA, 1997).

Year	HC	CO	NOx	PM
Class 1 Line-Haul				
1996	0.0%	0.0%	0.0%	0.0%
2002	0.1%	0.0%	11.8%	0.0%
2006	7.5%	0.0%	37.6%	7.7%
2010	17.8%	0.0%	46.1%	18.7%
2015	24.1%	0.0%	49.7%	25.4%
2020	30.0%	0.0%	53.1%	31.8%
2025	35.4%	0.0%	56.2%	37.6%
Switching Engines				
1996	0.0%	0.0%	0.0%	0.0%
2002	0.0%	0.0%	1.7%	0.0%
2006	1.1%	0.0%	8.9%	1.3%
2010	3.6%	0.0%	16.7%	4.2%
2015	7.3%	0.0%	27.1%	8.3%
2020	11.4%	0.0%	33.3%	13.1%
2025	16.2%	0.0%	38.1%	18.5%

Table 3-4. Locomotive emissions relative to 1996.

Year	HC	CO	NOx	PM
Class 1 Line-Haul				
1996	1	1	1	1
2002	1.12	1.12	0.99	1.12
2006	1.12	1.21	0.75	1.12
2010	1.07	1.30	0.70	1.06
2015	1.09	1.43	0.72	1.07
2020	1.10	1.57	0.74	1.07
2025	1.12	1.73	0.76	1.08
Switching Engines				
1996	1	1	1	1
2002	1.12	1.12	1.10	1.12
2006	1.19	1.21	1.10	1.19
2010	1.26	1.30	1.08	1.25
2015	1.33	1.43	1.04	1.31
2020	1.39	1.57	1.05	1.37
2025	1.45	1.73	1.07	1.41

3.1.3 Other Non-Road Categories

3.1.3.1 NONROAD Model Equipment Estimates

Weekday and weekend emissions were estimated using EPA's NONROAD Model (Core Model Ver. 2.3c, Apr 2004). For the Clark County base year inventory, the period type was set to Winter Season, and emissions were reported as tons per day.

Table 3-5 summarizes the input parameters specified for the 1996 Clark County base year NONROAD Model runs. The temperatures used for the NONROAD modeling were the same as the modeling temperatures used for the previous Clark County SIP modeling work. Gasoline fuel RVP, oxygen weight %, gasoline sulfur level, and CNG/LPG sulfur levels were those used in 1996 modeling for Clark County in work performed by ENVIRON for the Western Regional Air Partnership (Pollack et al., 2004). From discussions with Clark County, the non-road diesel sulfur level for 1996 was set at 250 ppm for this modeling. In addition, it was agreed that Clark County would be modeled as a "Southwest" region instead of the EPA default "Central West" region and the NONROAD model seasonality file (containing temporal adjustment data), SEASON.DAT, was modified to reflect this decision.

Similar NONROAD Model (Core Model Ver. 2.3c, Apr 2004) weekday and weekend runs were performed for the five future years (2006, 2010, 2015, 2020, 2030) for Clark County. Table 3-6 summarizes the NONROAD Model input parameters for each future year. Temperature and CNG/LPG sulfur level inputs were not changed from the base year. From discussions with Clark County, the oxygen weight % was set to 3.5% for all the future years based on local regulations. The gasoline sulfur level was set to 30 ppm for all future years and the non-road diesel sulfur level was set to 250 ppm for 2006 and 15 ppm for subsequent future years, per federal regulation. Similar to the base year, Clark County was modeled as a "Southwest" region instead of the default "Central West" region.

Table 3-5. Summary of inputs used for NONROAD modeling for 1996.

	1996	
	Weekday (tons/day)	**Weekend (tons/day)**
Period Type	Seasonal	Seasonal
Summation Type	Typical Day	Typical Day
Year of Episode	1996	1996
Season of Year	Winter	Winter
Weekend or Weekday	Weekday	Weekend
Fuel RVP for gas	9	9
Oxygen Weight %	3.31	3.31
Gas sulfur %	0.009	0.009
Diesel sulfur %	0.025	0.025
CNG/LPG sulfur %	0.003	0.003
Minimum temper. (F)	42	42
Maximum temper. (F)	66	66
Average temper. (F)	51.875	51.875
Altitude of region	low	Low

Table 3-6. Summary of inputs used for NONROAD modeling future years.

	2006		2010		2015		2020		2030	
	Weekday (tpd)	**Weekend (tpd)**	**Weekday (tpd)**	**Weekend (tpd)**	**Weekday (tpd)**	**Weekend (tpd)**	**Weekday (tpd)**	**Weekend (tpd)**	**Weekday (tpd)**	**Weekend (tpd)**
Period Type	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly
Summation Type	Typical Day	Typical Day	Typical Day	Typical Day	Typical Day	Typical Day	Typical Day	Typical Day	Typical Day	Typical Day
Year of Episode	2006	2006	2010	2010	2015	2015	2020	2020	2030	2030
Month of Year	Dec.	Dec.	Dec.	Dec.	Dec.	Dec.	Dec.	Dec.	Dec.	Dec.
Weekend or weekday	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Fuel RVP for gas	9	9	9	9	9	9	9	9	9	9
Oxygen Weight %	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Gas sulfur %	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Diesel sulfur %	0.025	0.025	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
CNG/LPG sulfur %	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Minimum temper. (F)	42	42	42	42	42	42	42	42	42	42
Maximum temper. (F)	66	66	66	66	66	66	66	66	66	66
Average temper. (F)	51.9	51.9	51.9	51.9	51.9	51.9	51.9	51.9	51.9	51.9
Altitude of region	low	low	low	low	low	low	low	low	low	low

Airport ground support equipment (GSE) was removed from the NONROAD emissions estimates because they were handled separately, as described above in Section 3.1.1. Recreational marine estimates were also removed since the major water areas in Clark County lie outside of the modeling domain. Railroad maintenance emissions for the 1996 base case were extracted from the non-road output and processed with locomotive emissions.

Table 3-7 presents a summary of NONROAD model CO emissions estimates for the base year and all future years evaluated in this modeling. The NONROAD model estimates emissions for the entirety of Clark County; the emissions shown in Table 3-7 are those for the modeling domain only. The gridding approach is described in the next subsection.

Table 3-7. Clark County CO NONROAD gridded emission estimates (TPD).

	Base	2006	2010	2015	2020	2030
Sunday 12/8/2005						
Recreational	2.47	2.40	2.44	2.52	2.58	2.72
Construction and Mining	17.47	1.28	0.99	0.80	0.68	0.59
Industrial	1.80	1.34	0.95	0.41	0.25	0.24
Lawn & Garden	33.56	32.61	36.28	39.97	43.58	50.70
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	10.82	12.91	14.86	16.98	19.12	23.23
Total	**66.13**	**50.53**	**55.52**	**60.68**	**66.22**	**77.48**
Monday 12/9/2005						
Recreational	1.24	1.20	1.22	1.26	1.29	1.36
Construction and Mining	34.94	2.56	1.98	1.60	1.36	1.18
Industrial	3.36	2.54	1.74	0.69	0.46	0.43
Lawn & Garden	42.22	42.24	46.32	51.03	55.66	64.78
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00
Commercial	21.64	25.82	29.72	33.97	38.24	46.45
Total	**103.40**	**74.36**	**80.98**	**88.55**	**97.02**	**114.20**

3.1.3.2 Base Year Gridding Surrogates

Base year emission estimates were allocated to the modeling grid cells using spatial surrogates developed from land use acreage obtained from the Clark County RTC. These surrogate data were the same that were used in the 2000 SIP submittal. However, since the NONROAD Model generates more source categories than were originally used in the 2000 SIP, additional surrogates were developed for this base inventory. Tables 3-8 and 3-9 indicate the categories provided by Clark County and the surrogate category mapping used for the base inventory.

The original Clark County land use data set covers the UAM modeling domain for the Las Vegas urban growth area while the NONROAD emissions estimates are county totals. Therefore, an additional set of county-wide landuse data provided by RTC was used to estimate the fraction of each category that was allocated to the modeling grid. Table 3-10 lists the surrogates that were used to spatially allocate each of the NONROAD source categories to the UAM grid, and the fraction of county surrogate within the modeling domain.

3.1.3.3 Future Year Gridding Surrogates

Future-year emissions estimates were allocated to the modeling grid cells using a different set of spatial surrogates that were developed from an updated land use database obtained from the Clark County RTC. The updated land use data were developed for the year 2003 and characterized the land use in the entire county based on the descriptions given in Table 3-11. Figure 3-5 displays a subset of these data for the Las Vegas area as aggregated land use categories for clarity.

Table 3-8. Base year non-road surrogate categories.

Category	Description
Rural	1-2 units per acre
Low Density	3-5 units per acre
Medium	6-8 units per acre
Medium High	9-18 u/ac, single level apts., some trailer, multi-family low
High Density	7-18 u/ac, multi-level apartments, some trailer parks
Neighborhood Retail	grocery, convenience, restaurants, service station, etc.
Community Retail	large shopping centers
Regional Retail	small shopping malls, factory outlet
Resort Casino	casinos with table gaming
Office	office complexes, government, medical, banking, etc.
Light Industrial	small manufacturing, repair, warehousing, etc.
Heavy Industrial	cement plants, steel, BMI complex, larger manufacturing
Government	non-office building government (fire, police, bus yard)
Education	schools and attached parks
Hospitals	hospitals only
Parks and Golf Courses	free standing parks (incl. buildings)
Public Facilities	limited trip generators (landfill, utility facilities)
Open Space	drainages and other un-developable land
Mining	gravel pits, excavation projects
Religion	churches, etc.
Special Generators	UNLV, McCarran Airport, Nellis AFB, etc.
Vacant	land that can be developed
Agriculture	farming

Table 3-9. Land use category to surrogate code mapping.

Surrogate Code	Surrogate Description	Based on 1995 LULC categories
1	Housing	rural + low density + medium + medium high + high density
2	Industrial	light industrial + heavy industrial
3	Commercial	neighborhood retail + community retail + regional retail
4	Buildings	above Housing + above Commercial + above Industrial + casinos + office + government + education + hospitals + public facilities + religion
5	Land area	land area
6	Casinos	resort and casinos
7	Recreational Space	open space + mining + vacant
8	Commercial Lawn & Garden	neighborhood retail + community retail + regional retail + parks and golf courses
9	Golf Courses	parks and golf courses
10	Agriculture	agriculture
11	Vacant Land	vacant land
12	Population	density weighted housing

Table 3-10. Source category cross references to gridded surrogates for NONROAD sources with county-to-modeling grid adjustment factors.

Surrogate Code	SCC	Adjustment Factor	Description	Surrogate Description
1	22xx004xxx	0.950	Lawn & Garden Equipment	Housing
2	22xx003xxx	0.786	Industrial Equipment	Industrial
3	22xx006xxx	0.786	Light Commercial	Commercial
7	22xx001xxx	0.244	Recreational Vehicles	Recreational Space
8	22xx004yyy	0.802	Lawn and Garden Equipment (Commercial)	Commercial Lawn & Garden
9	22xx001050	0.802	Recreational Vehicles, Golf Carts	Golf Courses
10	22xx005xxx	0.113	Farm Equipment	Agriculture
11	22xx002xxx	0.958	Construction Equipment	Vacant Land

Table 3-11. Land use categories available in the Clark County GIS data coverages for 2003.

#	LU_TDFM	NOTE	DENSITY	AVG
1	**RRes**	Residential - Rural	< 2	2.0
2	**LDRes**	Residential - Low Density	>= 2, < 6	5.0
3	**MDRes**	Residential - Mid Density	>= 6, < 8	6.0
4	**MHDRes**	Residential - Mid-High Density	>= 8, < 13.5	12.0
5	**HDRes**	Residential - High Density	>= 13.5	16.0
6	**Hotel_R**	Hotel&Resort		
7	**Hotel_H**	Hotel		
8	**Casino**	Casino		
9	**RRet**	Retail - Regional		
10	**CRet**	Retail - Community		
11	**NRet**	Retail - Neighborhood		
12	**CarSale**	Retail - Auto Dealership		
13	**ORet**	Retail - Race Track, etc		
14	**Office**	Office		
15	**Hospital**	Hospital and Medical Center		
16	**School**	School		
17	**Religiou**	Religious		
18	**P_F**	Police and Fire Station		
19	**Trans_1**	Transportation - Terminal, Depot, etc		
20	**Warehous**	Warehouse		
21	**REC_O**	Recreational - out door (golf course, race track)		
22	**REC_I**	Recreational - indoor		
23	**REC_RP**	Recreational - RV Park		
24	**Parking**	Parking lot, garage		
25	**OS**	Open Space		
26	**LInd**	Light Industrial		
27	**HInd**	Heavy Industrial		
28	**AgMining**	Agriculture, Ranching, Mining		
29	**ROW**	Right-Of-Way		
30	**PHeld**	Public Land Management Area\Public Held		
31	**NAFB**	Nellis AFB		
32	**MIA**	MaCarran Int'l Airport		
33	**UNLV**	UNLV		
34	**Vac**	Vacant		

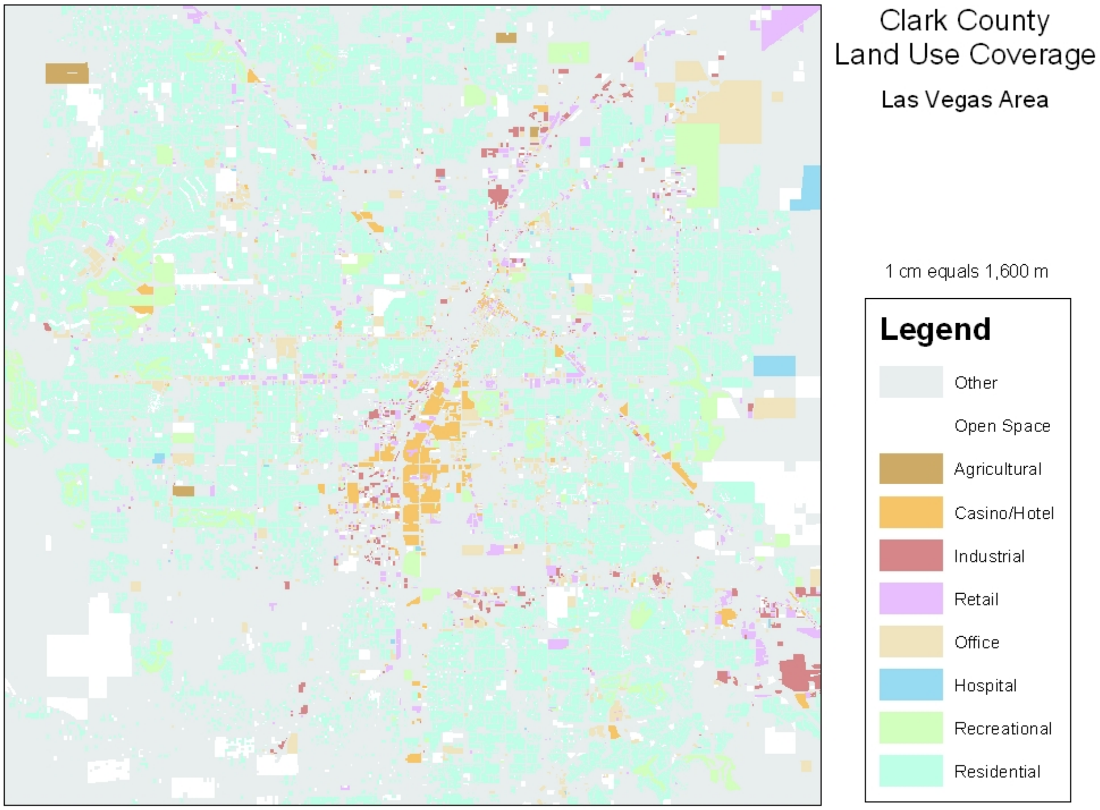


Figure 3-5. 2003 land use data for the Las Vegas area of Clark County.

For future-year land use, Clark County provided GIS databases that specify which vacant land parcels in the 2003 dataset are to be developed for each of the planning years 2005, 2010, 2015, 2020, 2025 and 2030, as well as the planned land use for that parcel. The land use planning databases included separate GIS coverages for Las Vegas, North Las Vegas, Henderson and the rest of Clark County. Land use coverages for each of the future years modeled were developed by replacing those vacant land parcels in the land use base-year datasets with the future year planned land use category. Each of the future year GIS databases was developed incrementally from the previous planning year starting from the 2003 land use base year database.

The Arc/INFO GIS was used to generate the required spatial surrogate ratios for the development of gridding surrogates. Within the GIS, each future year land use coverage was overlayed with the modeling grid and the fraction of each land use type in each grid cell was calculated. Because the land use categories available in the databases (Table 3-11) are more detailed than required for spatial allocation of emission estimates, they were aggregated prior to the development of the surrogate ratios. Table 3-12 presents the aggregation scheme used for the project.

Table 3-13 provides a comparison of the domain-wide percentage of primary land use categories used for allocation of non-road mobile source emissions for each of the future years modeled.

Table 3-12. Landuse category aggregation used for developing spatial allocation surrogates for non-road categories.

Surrogate Code	Surrogate Description	Based on 1995 LULC categories
1	Housing	residential: rural + low + mid + mid-high + high density + single family + multi family
2	Industrial	light industrial + heavy industrial + industrial
3	Commercial	neighborhood retail + community retail + regional retail + racetrack retail + car sale retail
4	Buildings	above Housing + above Industrial + above Commercial + hotels + casinos + office + government + education + hospitals + public facilities + religion
5	Land area	land area
6	Casinos	hotels + hotels&resort + casinos
7	Recreational Space	recreational outdoor + open space + vacant land
8	Commercial Lawn & Garden	neighborhood retail + community retail + regional retail + recreational_outdoor + hotel&resort + school + hospital
9	Golf Courses	Recreational – outdoor
10	Agriculture	Agriculture, Ranching and Mining
11	Vacant Land	vacant land

Table 3-13. Comparison of domain-wide land use percentages for future year spatial allocation.

% of county total within modeling domain											
Year	Housing	Industrial	Commercial	Buildings	Land Area	Casinos	Rec Space	Comm L&G	GolfCrses	Agriculture	Vacant
2005	0.812	0.611	0.741	0.775	0.120	0.845	0.091	0.793	0.794	0.140	0.086
2010	0.886	0.672	0.772	0.844	0.120	0.857	0.075	0.816	0.794	0.140	0.069
2015	0.895	0.702	0.788	0.853	0.120	0.870	0.071	0.826	0.794	0.140	0.064
2020	0.898	0.726	0.801	0.860	0.120	0.877	0.068	0.833	0.794	0.140	0.061
2025	0.901	0.736	0.806	0.864	0.120	0.881	0.066	0.837	0.794	0.140	0.059
2030	0.903	0.748	0.811	0.867	0.120	0.885	0.065	0.840	0.794	0.140	0.058

3.1.3.4 Temporal Allocation

Figure 3-6 shows the hourly distribution used to temporally allocate non-road sources.

3.2 POINT SOURCES

The 1996 base year point source inventory from the original 2000 SIP modeling was used for this update. Clark County provided an updated point source emission inventory for future years that included updated stack parameters and emissions based on “Potential To Emit” (PTE) levels for seven specific facilities. The UAM future year inventories included PTE levels plus a 70 ton/year buffer for these sources. All future year modeling used the same future year point source data. Table 3-14 indicates the future year tons per year estimates by facility provided by Clark County. Table 3-15 shows a breakdown by elevated and low-level point sources.

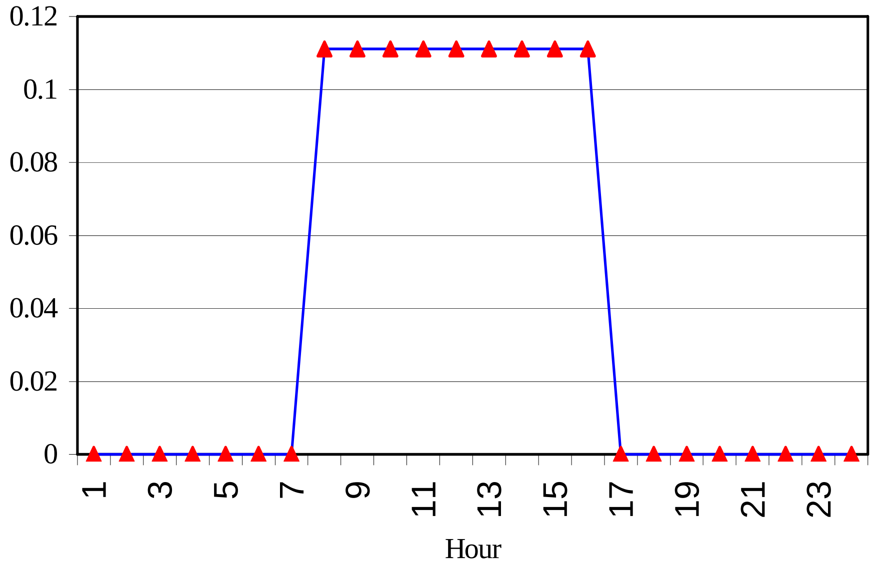


Figure 3-6. Hourly activity profile used to temporally allocate non-road emissions.

Table 3-14. Clark County CO future year Potential To Emit (PTE) estimates + 70 TPY by facility.

Facility Name	PTE + 70 (tons/Year)
Nevada Power- Clark Station (NDEP)	620.9
Nevada Power- Clark Station (DAQM)	2106.9
Nevada Power - Sunrise Station (NDEP)	392.9
Nevada Power - Sunrise Station (DAQM)	463.5
Titanium Metals	1707.8
USAF - 99 CES/CEV	295.7
James Hardie Gypsum/BPB Gypsum, Inc	184.4
Total	**5772.1**

Table 3-15. Modeling CO point source emission estimates (TPD).

	Base	Future Years
Elevated	2.07	15.53
Low Level	1.06	0.28
Total	**3.13**	**15.82**

3.3 AREA SOURCES

The 1996 base year area source estimates were taken from the 2000 SIP modeling with no changes. The base year emissions were projected by the factors shown in Table 3-16 to the future modeling years. These factors were developed by the Clark County Department of Air Quality and Environmental Management. Values were interpolated for those modeling years in between reported years.

Table 3-16. Future year growth/projection factors for area sources.

Category Description	Adjustment Factors Applied to Base Year				
	2006	**2010**	**2015**	**2020**	**2030**
Electric Utility Generation	1.2312	1.3154	1.4101	1.5048	1.6942
Small Stationary	1.2632	1.3623	1.4738	1.5853	1.8083
Boiler Emissions	1.2632	1.3623	1.4738	1.5853	1.8083
Industrial Natural Gas	1.2636	1.3627	1.4743	1.5858	1.8089
Commercial Natural Gas	1.2291	1.3429	1.4331	1.5233	1.7037
Residential Natural Gas	1.1686	1.2329	1.2917	1.3504	1.4679
Fireplaces	1.5022	1.7254	2.0221	2.3187	2.9121
Railroad Equipment	0.9479	0.9341	0.9186	0.9031	0.8722
Brush Fires	1.5022	1.7254	2.0221	2.3187	2.9121
Cigarette Smoking	1.5022	1.7254	2.0221	2.3187	2.9121
Structural Fires	1.5022	1.7254	2.0221	2.3187	2.9121
Vehicular Fires	1.5022	1.7254	2.0221	2.3187	2.9121

3.3.1 Area Source Gridding Surrogates

The 1996 base year area source emissions were spatially allocated to the modeling domain using the same gridding surrogates that were developed for the 2000 SIP. The future year gridding surrogates were based upon those developed for the non-road emission categories, as described in Section 3.1.3.3. The only change needed for area source categories was to normalize them relative to the modeling domain (instead of county total), since the original area source emission estimates were wholly contained within the UAM domain.

A summary of area source emissions by category is provided in Table 3-17 for each future year.

3.4 SUMMARY OF TOTAL EMISSIONS

Table 3-18 presents a summary of total daily CO emissions by source category, including on-road emissions, for 1996 base and all future years. Figures 3-7 through 3-9 show the spatial distribution of component and total CO emissions for the 1996 base case. Figures 3-10 through 3-14 show the spatial distribution of total CO emissions for all future years.

Table 3-17. Clark County CO area source gridded emission estimates (TPD) after season, and day-of-week adjustments.

Source Category	Base	2006	2010	2015	2020	2030
Sunday 12/8						
Electric Utility Generation	0.558	0.687	0.734	0.787	0.840	0.946
Small Stationary	2.701	3.412	3.680	3.981	4.283	4.885
Boiler Emissions	0.385	0.486	0.524	0.567	0.610	0.696
Industrial Natural Gas	0.148	0.186	0.201	0.218	0.234	0.267
Commercial Natural Gas	0.041	0.051	0.055	0.059	0.063	0.070
Residential Natural Gas	0.308	0.360	0.380	0.398	0.416	0.452
Fireplaces	3.033	4.556	5.233	6.133	7.033	8.832
Brush Fires	1.262	1.896	2.178	2.552	2.927	3.675
Cigarette Smoking	0.044	0.066	0.076	0.089	0.102	0.128
Structural Fires	0.646	0.971	1.115	1.307	1.499	1.882
Vehicular Fires	0.054	0.081	0.093	0.110	0.126	0.158
Total	**9.181**	**12.753**	**14.270**	**16.200**	**18.131**	**21.991**
Monday 12/9						
Electric Utility Generation	0.558	0.687	0.734	0.787	0.840	0.946
Small Stationary	2.701	3.412	3.680	3.981	4.283	4.885
Boiler Emissions	0.385	0.486	0.524	0.567	0.610	0.696
Industrial Natural Gas	0.369	0.466	0.503	0.544	0.585	0.667
Commercial Natural Gas	0.103	0.127	0.138	0.148	0.157	0.176
Residential Natural Gas	0.308	0.360	0.380	0.398	0.416	0.452
Fireplaces	3.033	4.556	5.233	6.133	7.033	8.832
Brush Fires	1.262	1.896	2.178	2.552	2.927	3.675
Cigarette Smoking	0.044	0.066	0.076	0.089	0.102	0.128
Structural Fires	0.646	0.971	1.115	1.307	1.499	1.882
Vehicular Fires	0.054	0.081	0.093	0.110	0.126	0.158
Total	**9.464**	**13.109**	**14.654**	**16.615**	**18.576**	**22.497**

Table 3-18. Summary of total daily CO emissions (TPD) in the UAM CO SIP revision.

	Base	2006	2010	2015	2020	2030
Sunday 12/8						
On-Road Running (Links)	202.75	149.40	150.18	137.31	133.18	142.80
On-Road Starts	126.42	125.10	135.93	138.46	139.23	152.54
On-Road Intrazonals	0.78	0.57	0.82	0.66	0.71	0.70
Henderson Airport	1.12	1.35	1.59	1.99	2.55	3.69
McCarran Airport	24.69	28.57	33.24	38.14	43.24	53.44
Nellis AFB	2.86	2.86	2.86	2.86	2.86	2.86
North LV Airport	7.58	5.13	5.22	5.35	5.48	5.73
Area Sources	9.18	12.75	14.27	16.20	18.13	21.99
Non-road - NONROAD	66.13	50.49	55.50	60.66	66.21	77.44
Point Sources	3.13	15.82	15.82	15.82	15.82	15.82
Railway - Line Haul	0.14	0.17	0.19	0.20	0.22	0.27
Railway - Maintenance	0.03	0.04	0.04	0.04	0.05	0.06
Total	**444.81**	**392.49**	**415.73**	**417.71**	**427.65**	**477.19**
Monday 12/9						
On-Road Running (Links)	269.31	204.62	205.29	187.70	182.00	194.67
On-Road Starts	241.09	235.73	257.33	262.53	264.10	289.81
On-Road Intrazonals	1.03	0.88	1.33	1.07	1.14	1.13
Henderson Airport	0.88	1.07	1.26	1.57	2.01	2.91
McCarran Airport	24.69	28.57	33.24	38.14	43.24	53.44
Nellis AFB	2.86	2.86	2.86	2.86	2.86	2.86
North LV Airport	5.98	4.05	4.12	4.22	4.32	4.52
Area Sources	9.46	13.11	14.65	16.62	18.58	22.50
Non-road - NONROAD	103.40	74.30	80.94	88.52	96.99	114.17
Point Sources	3.13	15.82	15.82	15.82	15.82	15.82
Railway - Line Haul	0.14	0.17	0.19	0.20	0.22	0.27
Railway - Maintenance	0.11	0.14	0.15	0.16	0.18	0.21
Total	**662.08**	**581.31**	**617.17**	**619.41**	**631.46**	**702.31**

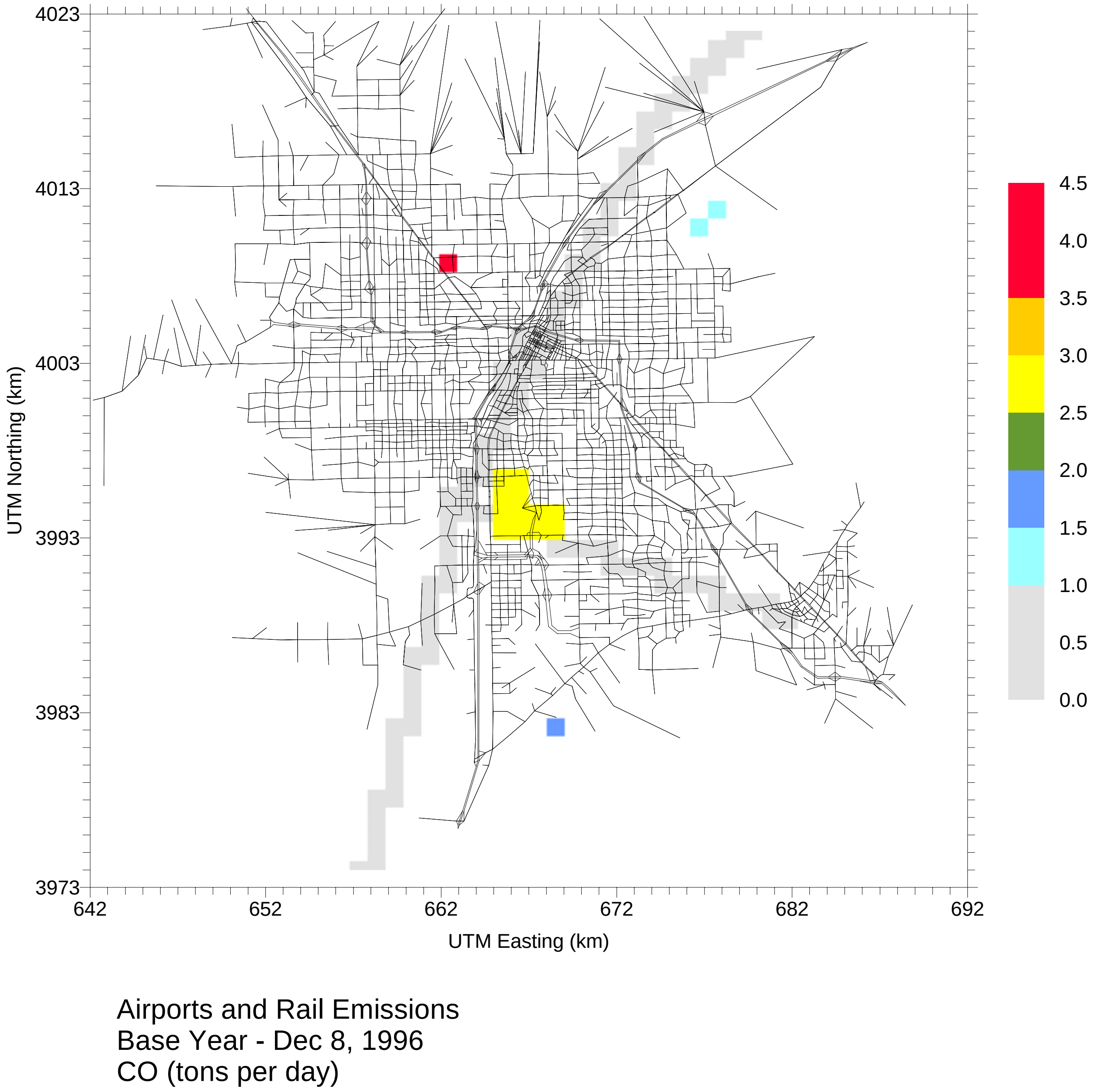
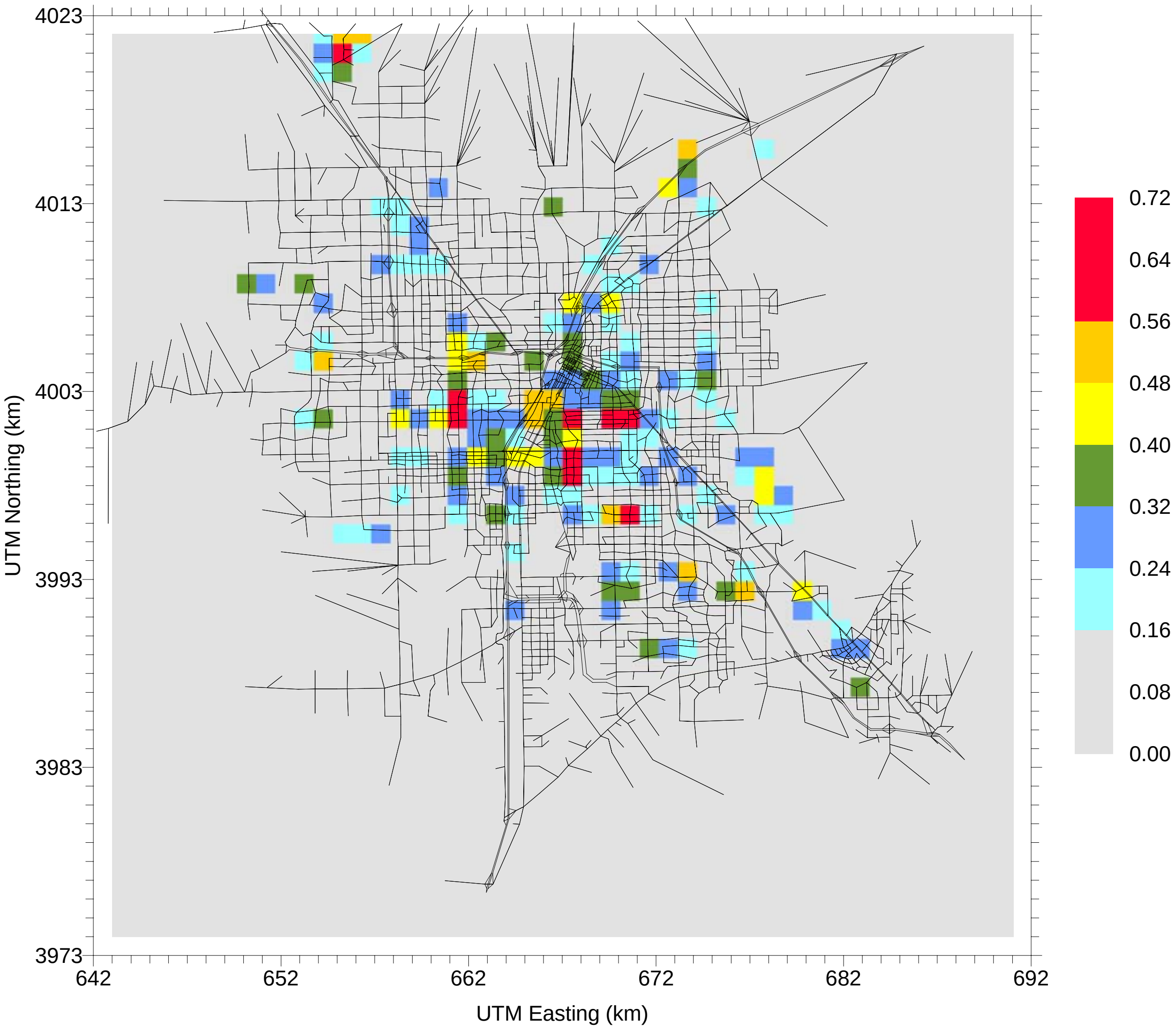
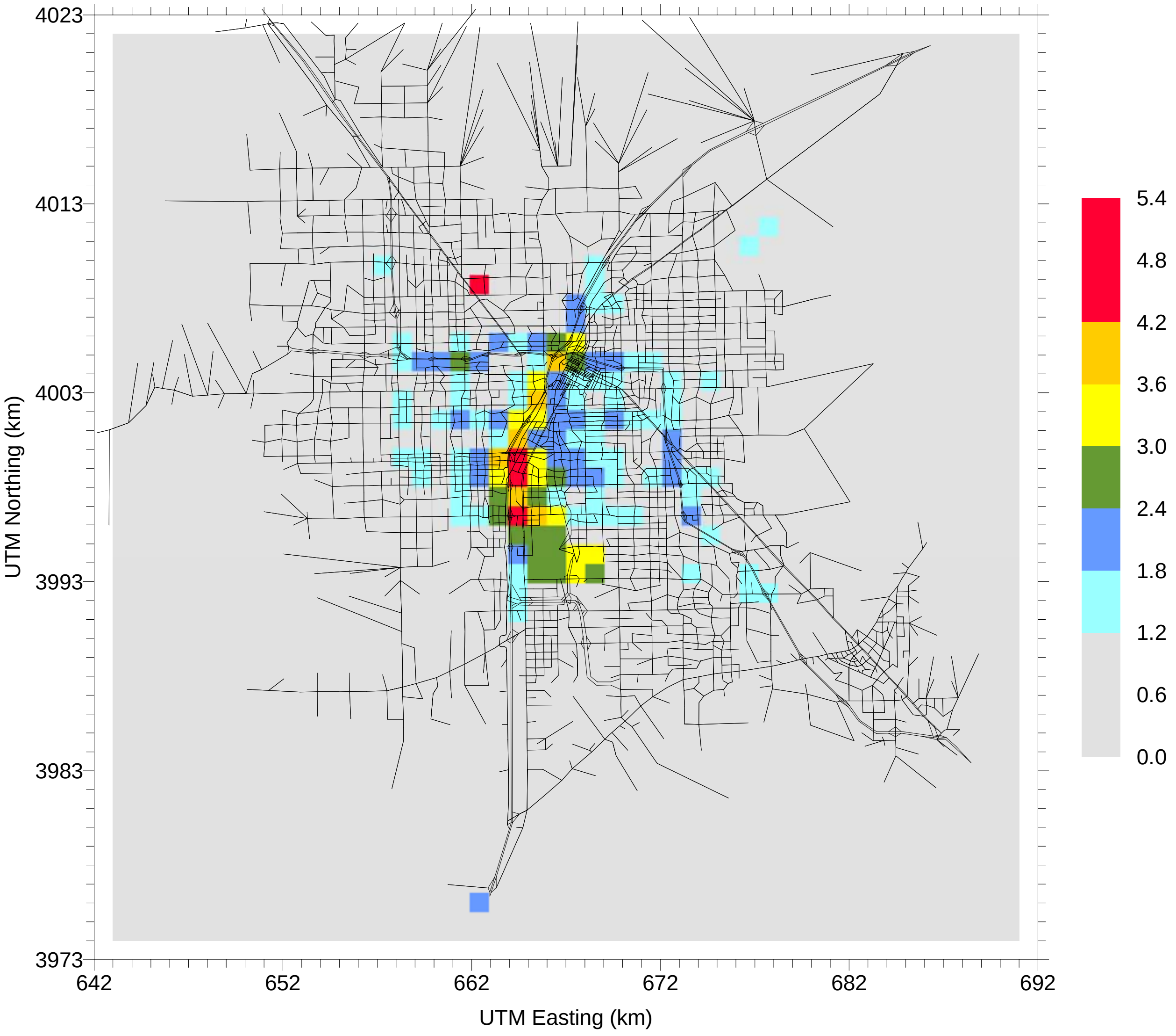


Figure 3-7. Spatial distribution of airport and locomotive CO emissions for the 1996 Base Case.



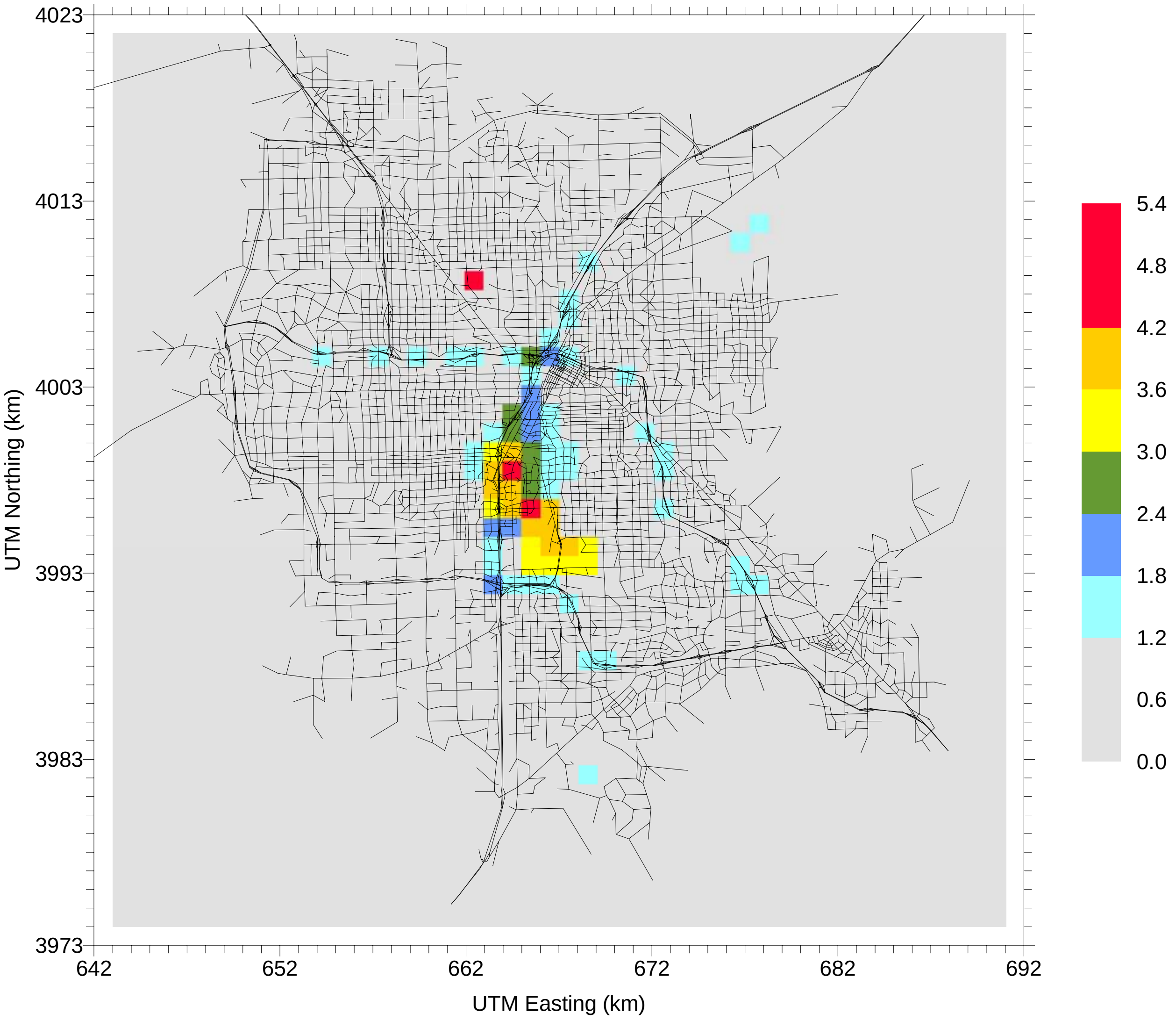
Area and NONROAD Emissions
Base Year - Dec 9, 1996
CO (tons per day)

Figure 3-8. Spatial distribution of non-road and area source CO emissions for the 1996 Base Case.



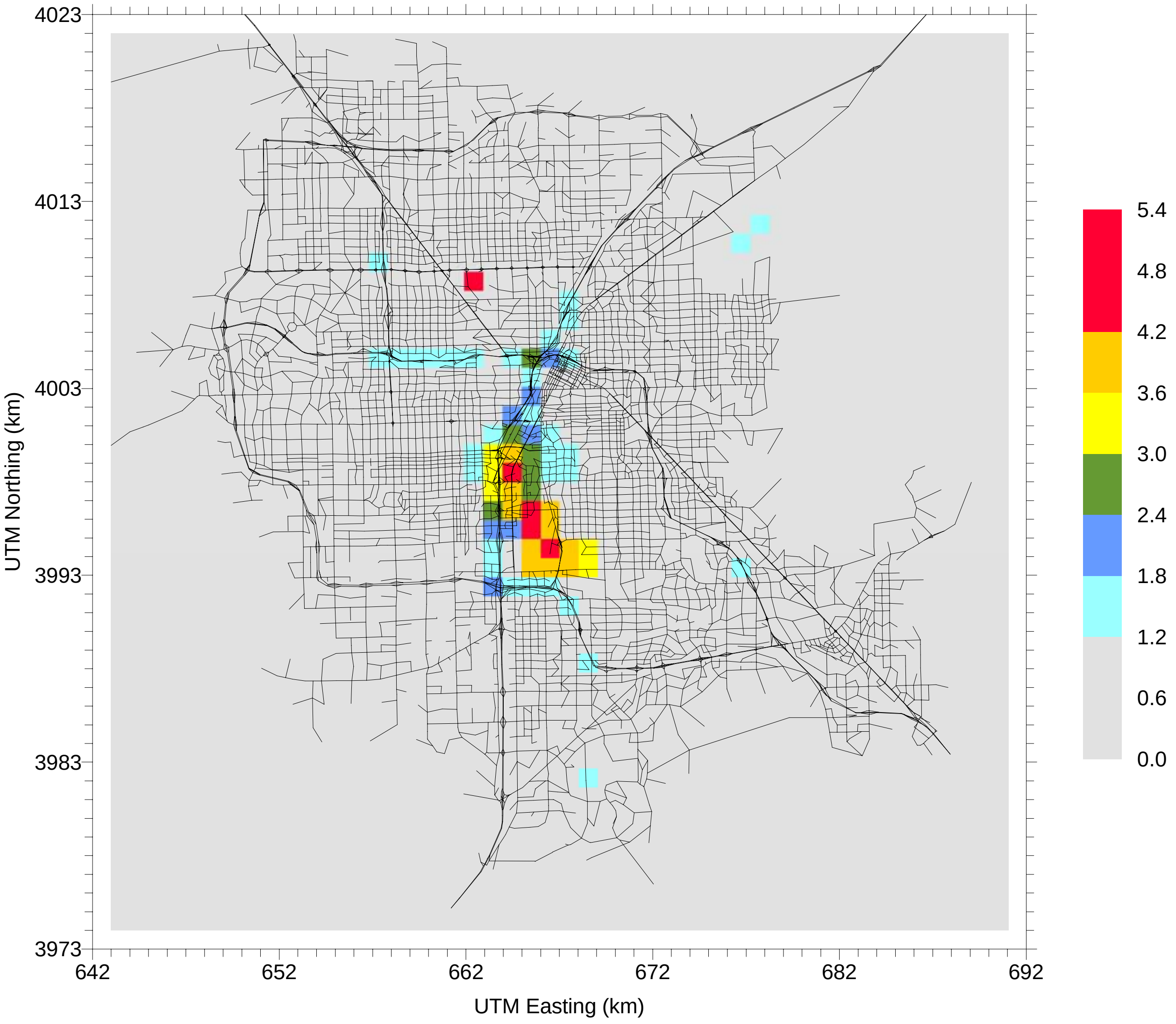
Total Surface Emissions
Base Year - Dec 9, 1996
CO (tons per day)

Figure 3-9. Spatial distribution of total surface gridded CO emissions for the 1996 Base Case.



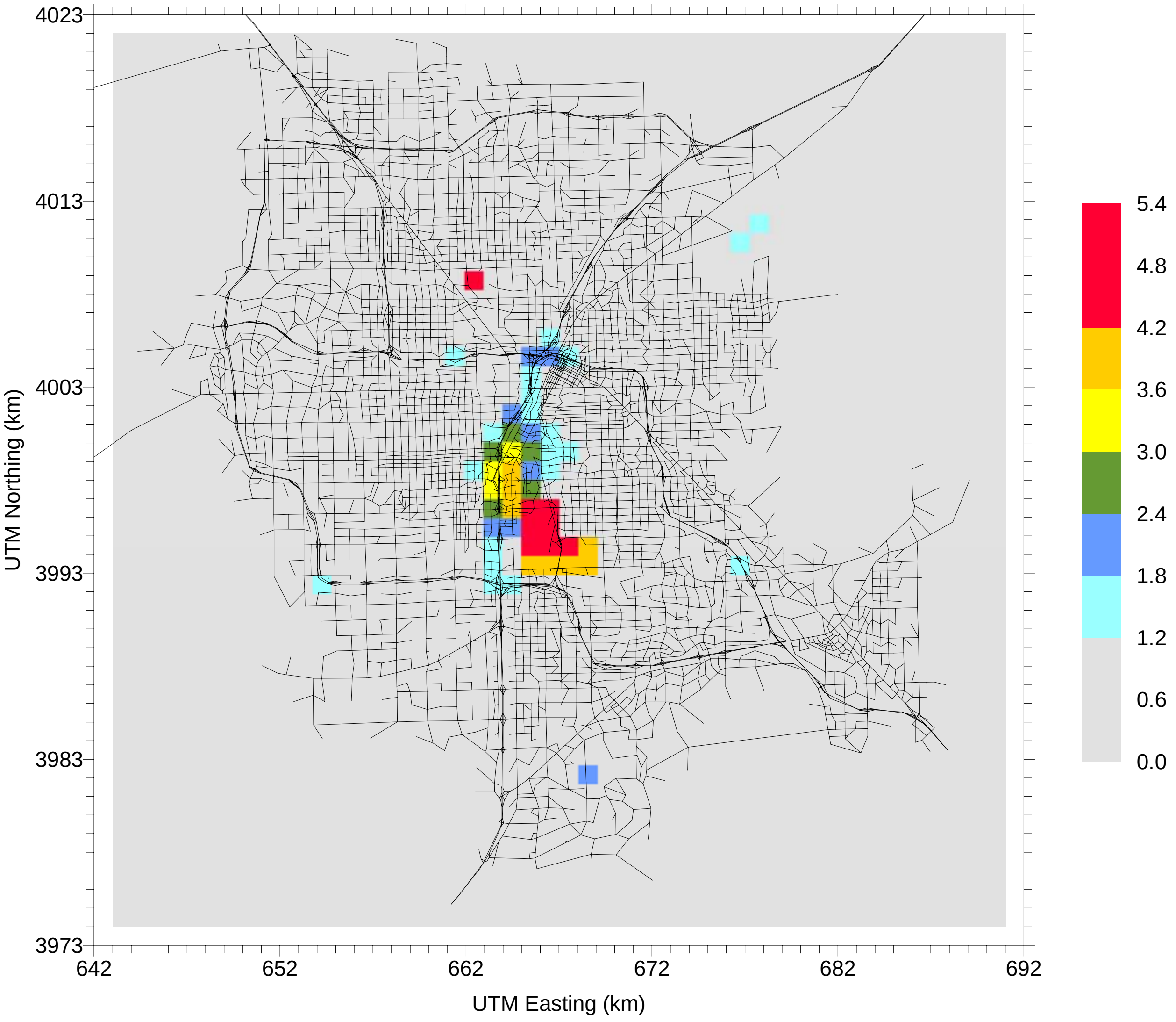
Total Surface Emissions
Future Year - Dec 9, 2006
CO (tons per day)

Figure 3-10. Spatial distribution of total surface gridded CO emissions for the 2006 future year.



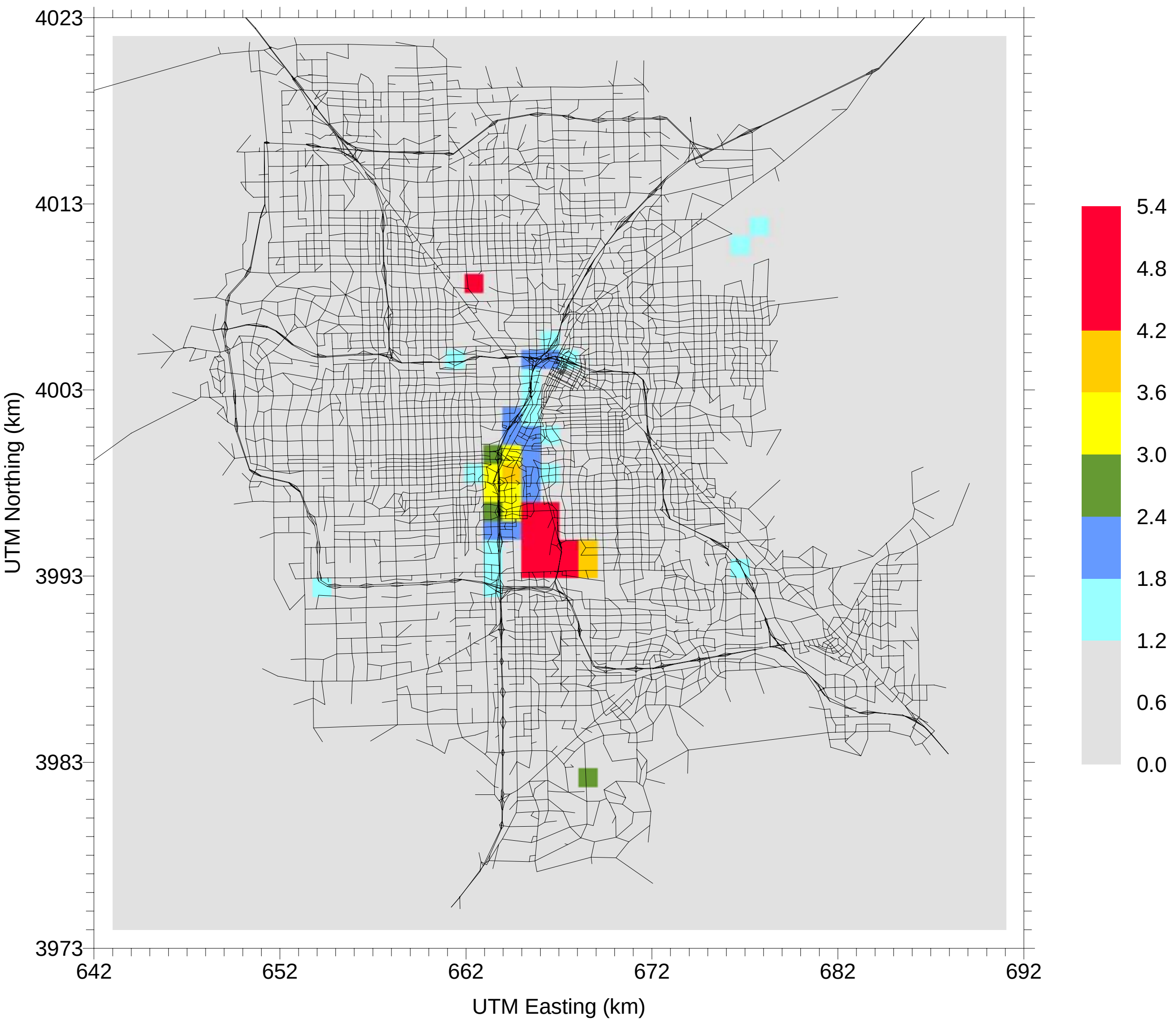
Total Surface Emissions
Future Year - Dec 9, 2010
CO (tons per day)

Figure 3-11. Spatial distribution of total surface gridded CO emissions for the 2010 future year.



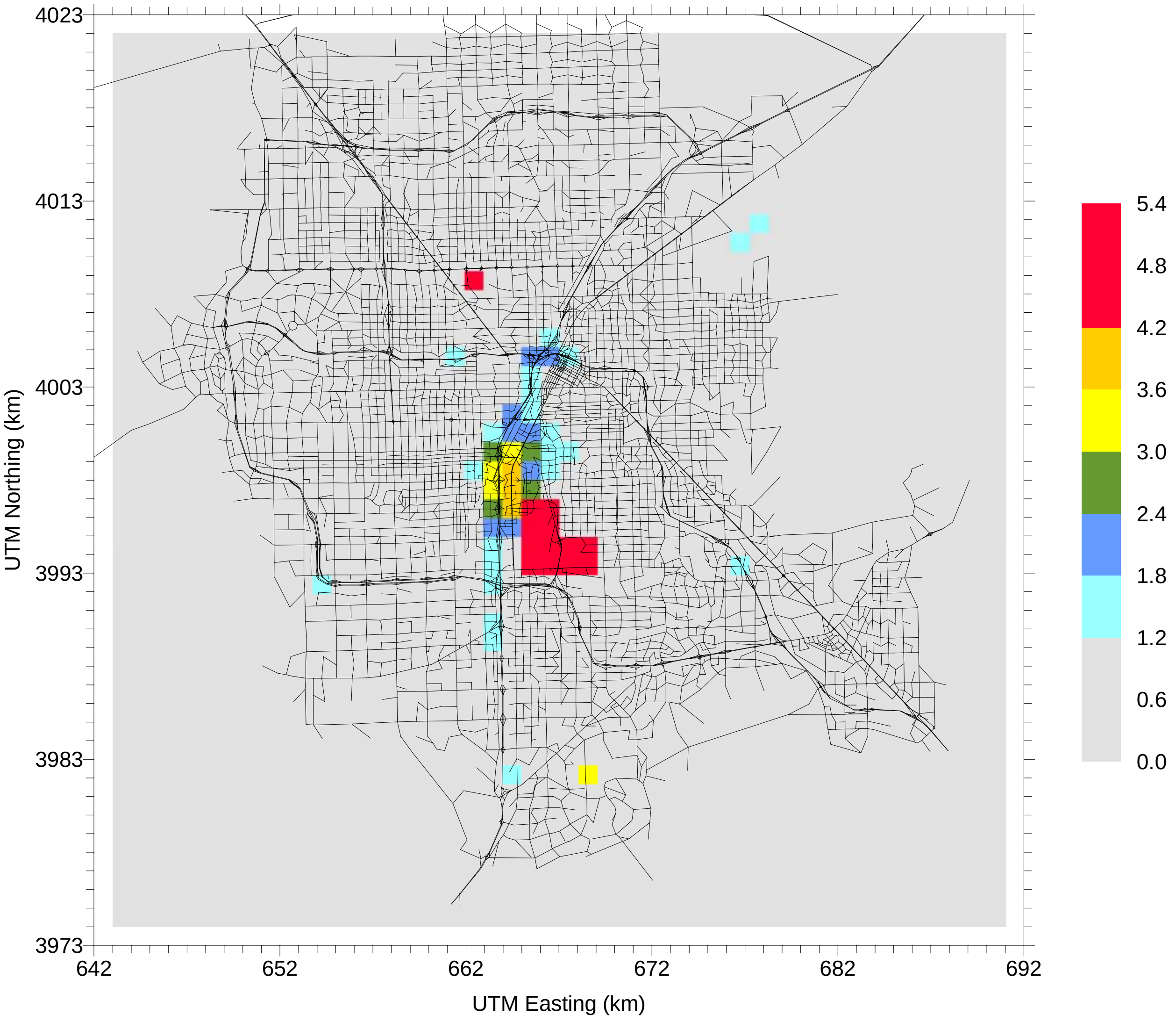
Total Surface Emissions
Future Year - Dec 9, 2015
CO (tons per day)

Figure 3-12. Spatial distribution of total surface gridded CO emissions for the 2015 future year.



Total Surface Emissions
Future Year - Dec 9, 2020
CO (tons per day)

Figure 3-13. Spatial distribution of total surface gridded CO emissions for the 2020 future year.



Total Surface Emissions
Future Year - Dec 9, 2030
CO (tons per day)

Figure 3-14. Spatial distribution of total surface gridded CO emissions for the 2030 future year.

4. URBAN AIRSHED MODELING

The Urban Airshed Model (UAM) was provided with the updated emission inventories for on-road mobile, non-road mobile, point and area sources, and run for the December 8-9, 1996 historical CO event. All other environmental parameters were taken from the original modeling as documented in the 2000 CO SIP. A base-year CO model performance evaluation was similarly conducted. The UAM was then used with the updated future year inventories for 2006, 2010, 2015, 2020 and 2030 to determine peak 8-hour CO levels in the basin for the same December 8-9, 1996 conditions.

For the future year assessments, we addressed UAM valley-wide CO distributions, intersection “hot spot” modeling with CAL3QHC, and the updated EDMS micro-scale results reported by Ricondo (2003). With regard to the airports, it was necessary to run UAM twice using two different inventories per future year:

1. Valley-wide CO and micro-scale intersection modeling – including updated EDMS emissions in the UAM;
2. Micro-scale airport CO modeling – removing EDMS airport emissions from the UAM inventory in order to avoid double-counting.

EDMS results from the Ricondo (2003) analyses were combined with the revised UAM model predictions for the future years of 2006, 2010, 2015, 2020 to estimate 8-hour CO concentrations for the duration of the episode on and around the airport properties. This was not done for the 1996 base case since the EDMS dispersion results for that year are considered out-dated. Note that the 2005 EDMS results were added to the 2006 UAM results, and that 2030 was disregarded since it was not considered in the EDMS analysis.

For hotspot modeling, the CAL3QHC model was used to model three intersections: Charleston/Eastern, Charleston/Fremont and Eastern/Fremont, which are referred to collectively as the “Five Points” area. EPA (1992, 1995) guidance for screening level modeling of these three intersections was followed. The ambient temperature for each hour of the episode (needed to estimate emissions with the MOBILE6 model), and the wind direction and speed (needed for the CAL3QHC dispersion estimates) were taken from the original UAM/CAL3QHC modeling documented in the 2000 SIP. The same MOBILE6 inputs documented for the on-road emissions calculations in Section 2 were used to estimate emission inputs for CAL3QHC. The CAL3QHC model output was added to the background UAM levels to estimate 8-hour CO concentrations for the duration of the episode.

Following the micro-scale analyses, additional ancillary simulations were run with UAM to develop on-road mobile emission budgets, both for the entire modeling domain and just the central urban portion, that demonstrate compliance with the 8-hour CO standard.

4.1 BASE CASE SIMULATION

The UAM was used to simulate the emissions and transport of carbon monoxide throughout the Las Vegas Valley during the night of December 8-9, 1996 (Sunday-Monday). Specifically, the UAM was run from 1500 LST December 8 to 1100 LST December 9 to cover the most cold, stagnant and stable portion of the episode during which CO was observed to build up. Two base case simulations were run:

A. With revised on-road emission estimates, keeping all point, area, and non-road emissions the same as the 2000 SIP modeling (see Section 4.1.1);

B. With both revised on-road and non-road emission estimates, keeping all point and area emission the same as the 2000 SIP modeling (see Section 4.1.2).

In both cases, revised 1996 airport emissions from Ricondo (1999) were included in the emissions inventory. Model performance was evaluated graphically and statistically relative to the observational data that were available during this period. EPA (1992) provides the following criteria that must be met in order to consider UAM performance acceptable for CO attainment demonstrations:

1. The unpaired peak prediction accuracy (UPPA; a comparison between the peak measurement and the peak prediction anywhere in the domain at any time) must be within ±30-35%;

2. The average gross error among all paired measured and predicted peaks (matched in space and time) above 5 ppm must be within 20-25%;

3. The average gross error in the timing of the predicted peaks among all sites above 5 ppm must be within 2 hours.

4.1.1 UAM Results From Revised On-Road Emissions

Figure 4-1 shows the UAM predicted episode-maximum 8-hour CO concentrations (ppm) from the base case simulation using the revised on-road emissions documented in Section 2. Two distinct areas of CO maxima occur in the simulation: (1) near the “elbow” of U.S. 95 in northeast Las Vegas, and (2) along the Las Vegas Boulevard “strip” near the intersection with Spring Mountain Road. The peak in the domain is 10.7 ppm along Las Vegas Boulevard. The secondary maximum reaches above 9 ppm along U.S. 95, and this occurs during the morning commute hours on Monday, December 9. Overall, the spatial pattern of predicted 8-hour maximum CO agrees with the previous modeling performed for the 2000 CO SIP, and with the distribution of observed CO for this period.

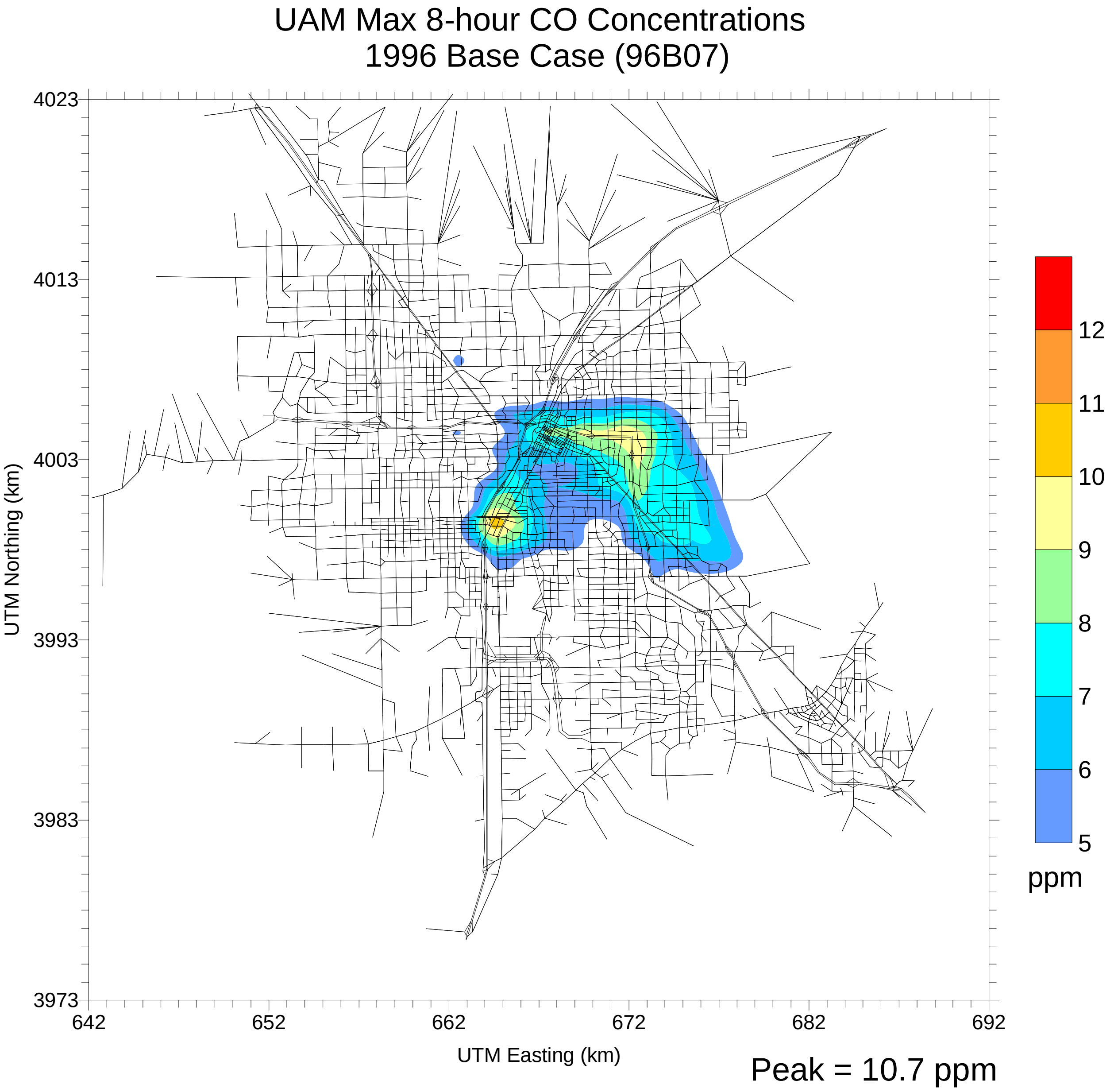


Figure 4-1. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 Base Case with updated on-road mobile emissions.

Standard and EPA criteria model performance statistics are shown in Table 4-1 for this simulation. These statistics are based upon pairings of 8-hour CO predictions and observations across all available monitoring sites for the period, which include standard EPA-method monitoring conducted by Clark County, as well as special saturation monitoring performed for the Las Vegas Phase II field monitoring study (Egami et al., 1998; Emery et al., 1998). Figure 4-2 shows the locations of all monitoring sites operating during the Phase II field study, while Table 4-2 lists the site names with their coordinates. Based upon these statistics, UAM performance is quite good and should be considered acceptable.

Table 4-1. Summary performance statistics for the December 8-9, 1996 Base Case, with updated on-road mobile source emissions. Bold/colored metrics denote EPA criteria statistics; green (red) indicates within (outside) acceptance criteria.

Peak 8-hour Observation	9.6 ppm, Marnell Field
Unpaired Peak	10.7 ppm
Paired Peak	8.1 ppm
Statistical Measures	
Unpaired Peak Accuracy	**12 %**
Paired Peak Accuracy	-15 %
Peak Timing Error	1 hr
Average Peak Bias > 5 ppm	-5 %
Average Peak Error > 5 ppm	**12 %**
Average Peak Timing Bias > 5 ppm	1 hr
Average Peak Timing Error > 5 ppm	**2 hr**
Overall Bias > 5 ppm	-7 %
Overall Error > 5 ppm	14 %

Figure 4-3 presents hourly time series of observed and predicted CO concentrations at each of these monitoring sites. The dots represent the observations at each site, while the solid line shows the UAM prediction at that location. The gray shaded area delineates the minimum to maximum predicted CO concentrations within the surrounding nine grid cells around each site to indicate the extent of predicted spatial gradients. Overall, the trends are reproduced adequately. Some notable exceptions include City Center, Shadow Lane, Winterwood, MGM, and Eastern and Owens. The MGM site was new in 1995 and measured micro-scale influences near the busiest intersections on Las Vegas Boulevard. The general under prediction there is likely due to the inability of UAM to resolve the small scale conditions. The Eastern and Owens special study site is located about 2.5 km north of U.S. 95 in northeastern Las Vegas; according to Egami et al. (1998), this site is situated in a local depression, and a pooling of locally-derived CO may be occurring there. The other identified sites are located within or very near high emission density grid cells (freeways) and over predictions at these sites might be the result from a “smearing” of high CO emissions over the entire 1 km grid cells. In most cases the range of predicted CO within one grid cell of each site is sufficient to contain the observed CO each hour.

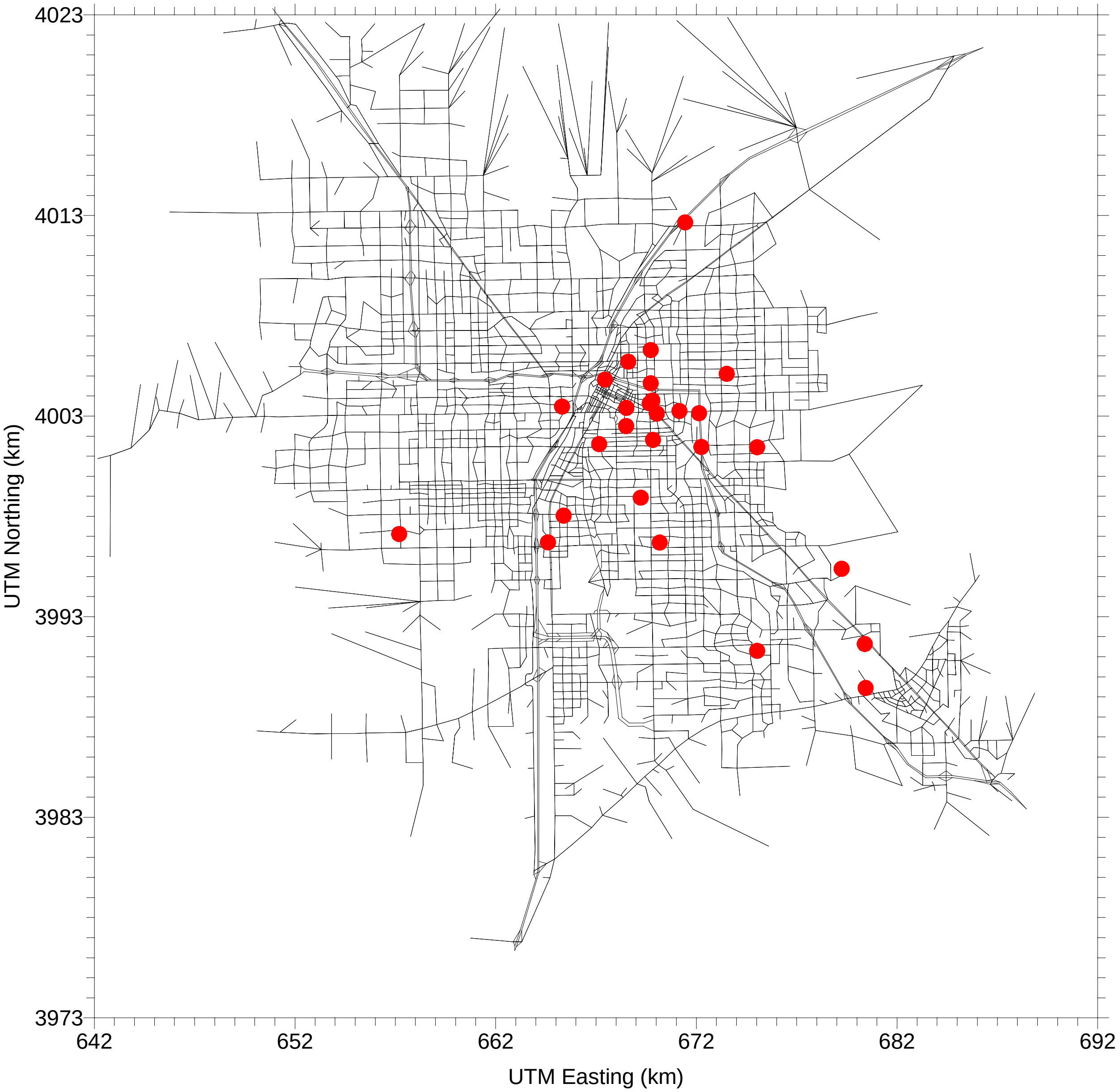


Figure 4-2. Locations of all Phase II monitoring sites operating during the Phase II field study over the winter of 1996/97 (Emery et al., 1998).

Table 4-2. Names and coordinates of all monitoring sites operating during the Phase II field study over the winter of 1996/97 (Egami et al., 1998). The first 14 sites are the standard Clark County sites.

Symbol	Site Name	UTM Easting (km)	UTM Northing (km)
BS	Craig Road/Bemis	671.439	4012.654
CC	City Center	667.440	4004.817
CW	Crestwood	668.500	4002.500
EC	East Charleston	670.028	4003.124
FL	East Flamingo	665.386	3998.034
GV	Green Valley	675.025	3991.294
MC	Maycliff	672.246	4001.458
MG	MGM	664.600	3996.700
PL	Powerline	680.431	3989.445
PM	Paul Meyer	657.191	3997.118
PT	Pittman	680.390	3991.640
SA	Sunrise Acres	669.675	4003.630
SL	Shadow Lane	665.304	4003.473
WW	Winterwood	675.025	4001.446
ECB	East Charleston DRI	670.028	4003.124
MAF	Marnel Field	669.804	4003.776
EAB	Eastern & Bonanza	669.720	4004.636
EAO	Eastern and Owens	669.722	4006.290
BAG	Bruce and Grayson	668.604	4005.709
CAR	Carson and 17th	668.510	4003.407
EAT	Eastern and Tioga	669.226	3998.931
SLA	St. Louis & Atlantic	669.836	4001.811
CAP	Charleston and Pecos	671.152	4003.252
CAS	Charleston & Sacrame	672.130	4003.142
PVP	Paradise Valley Park	670.171	3996.693
DRS	Del Robison School	673.511	4005.104
SIL	Silver Bowl	679.238	3995.384
ALC	Alhambra & Cordova	667.151	4001.601

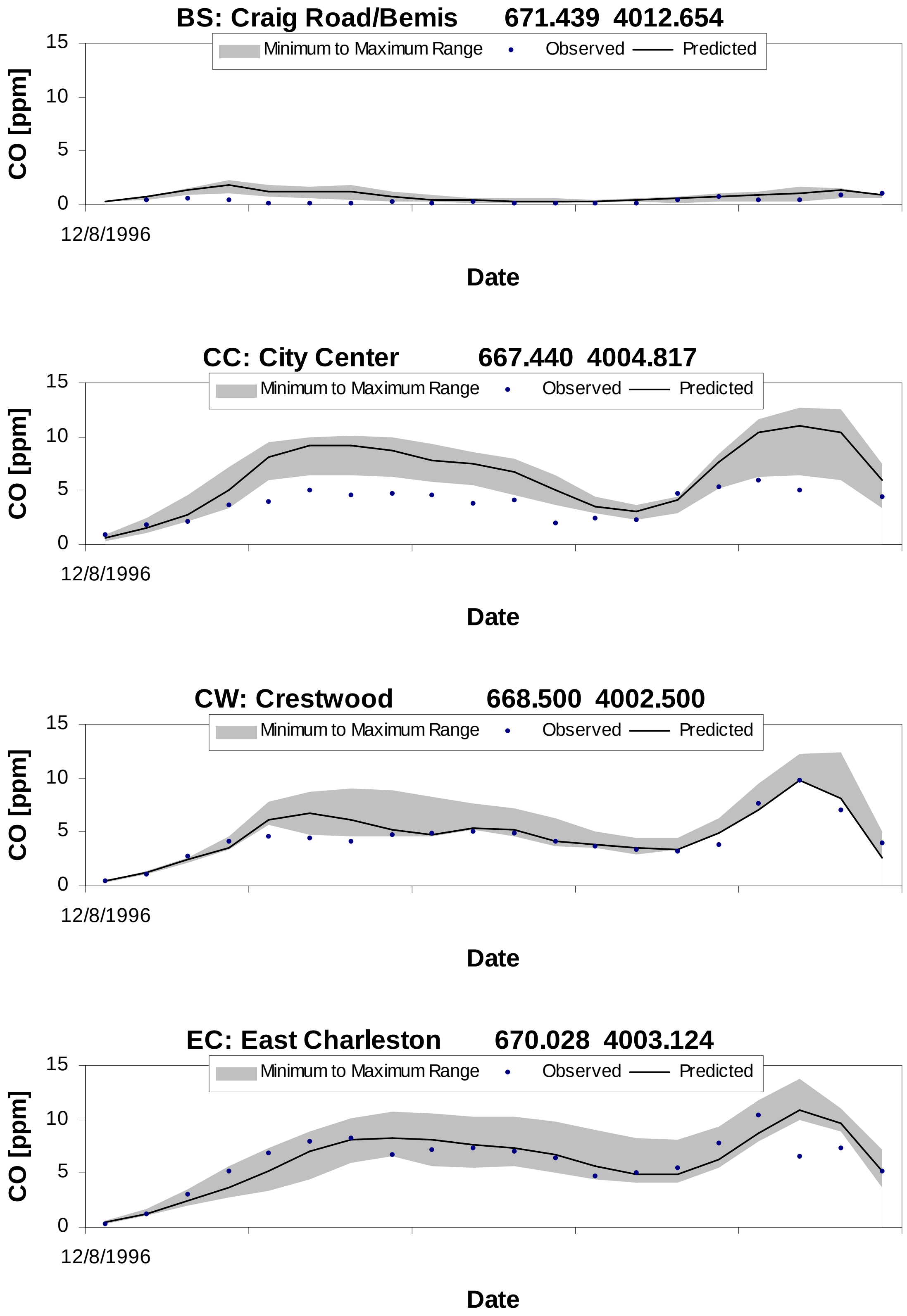
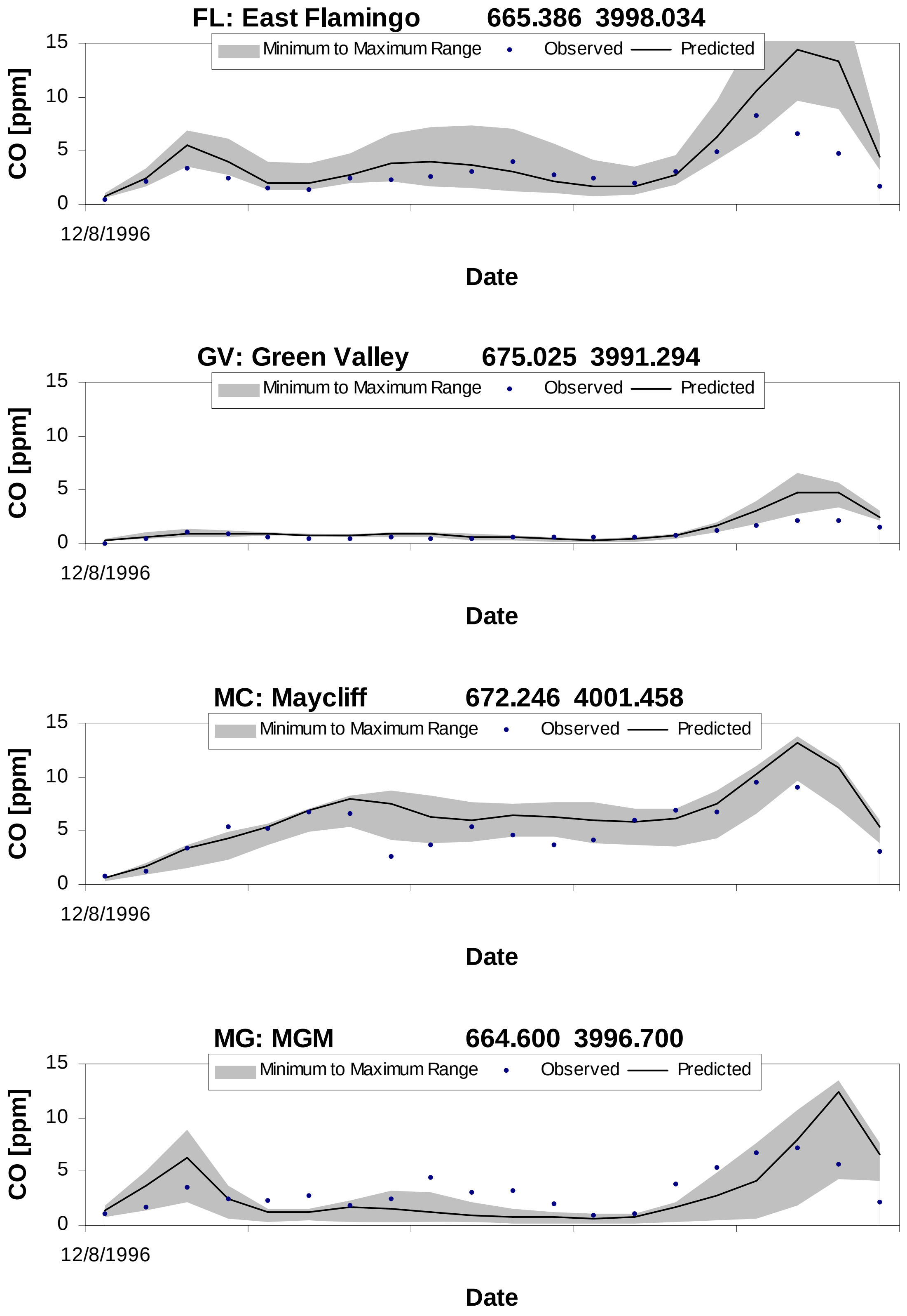


Figure 4-3. Time series of hourly CO measurements (dots) and UAM predictions (line) at Phase II field study monitoring sites. Plots cover the period 1500 LST December 8 to 1100 LST December 9, 1996. Gray shading indicates the range of minimum to maximum predicted CO concentrations in the nine cells surrounding each site.



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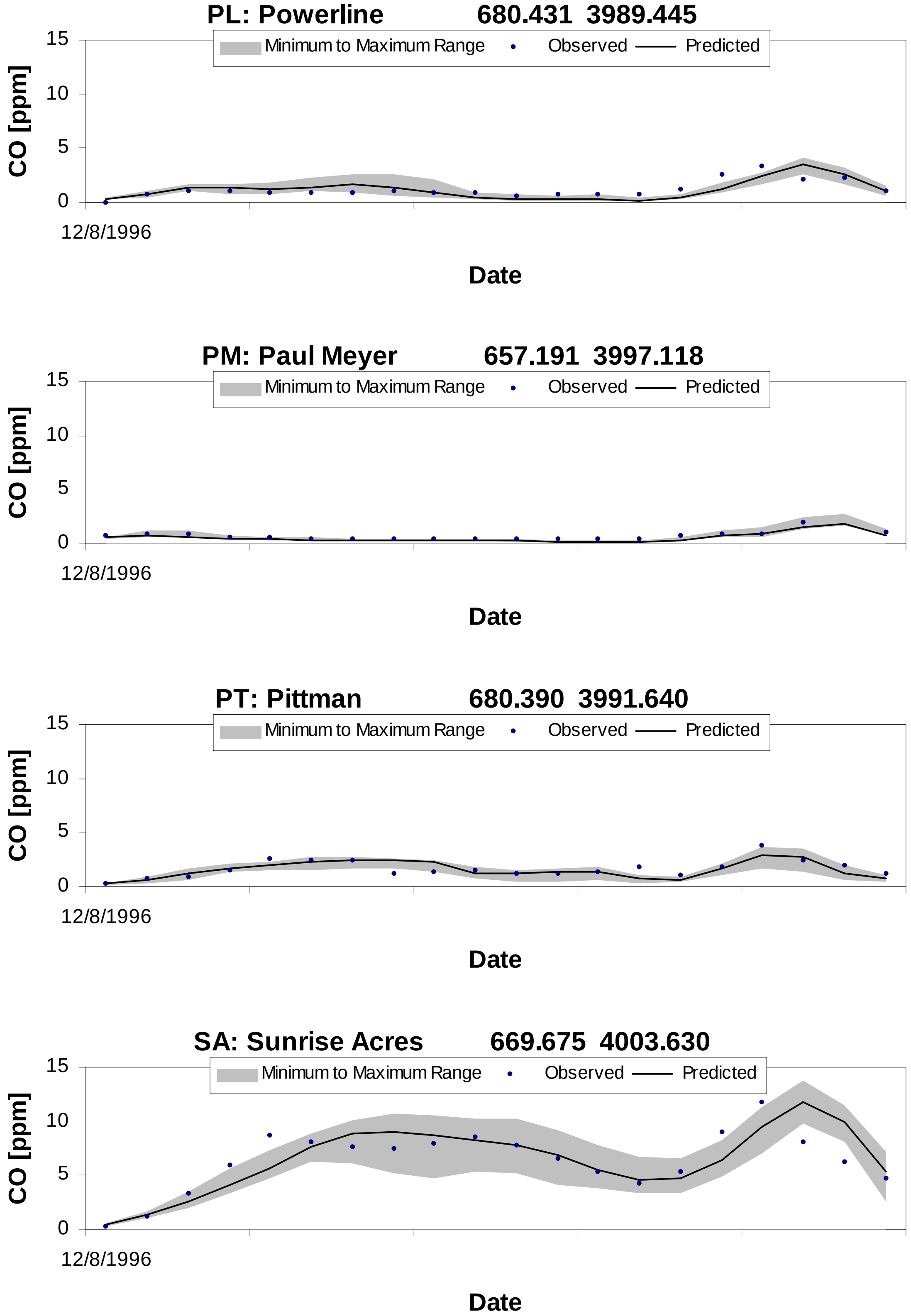

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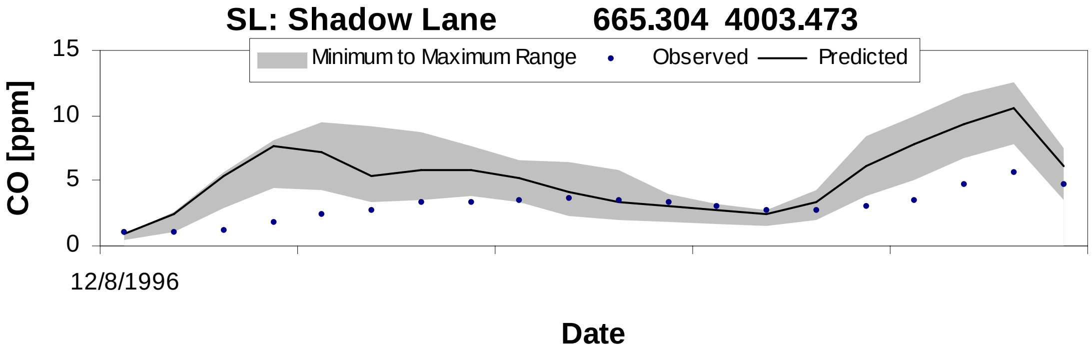

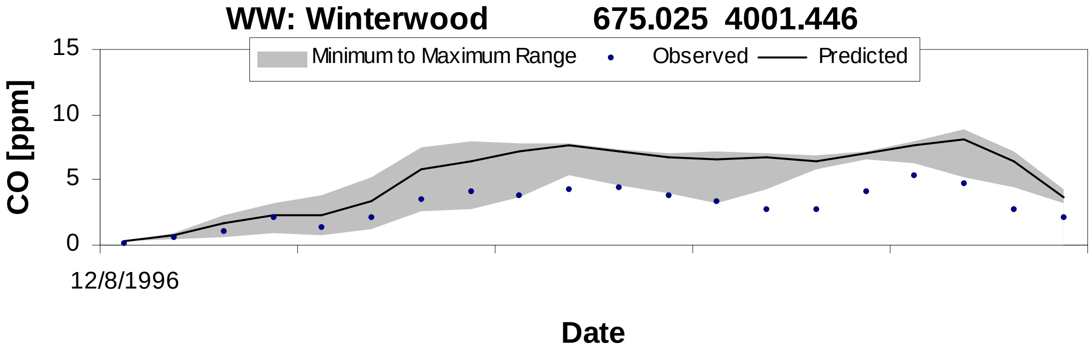

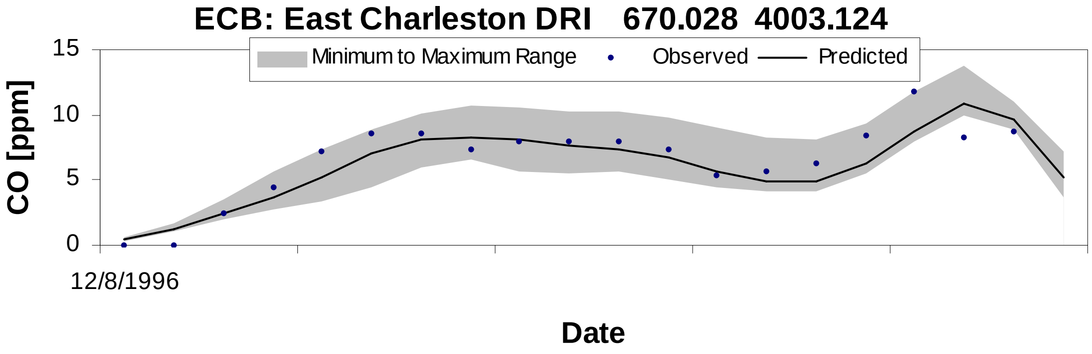

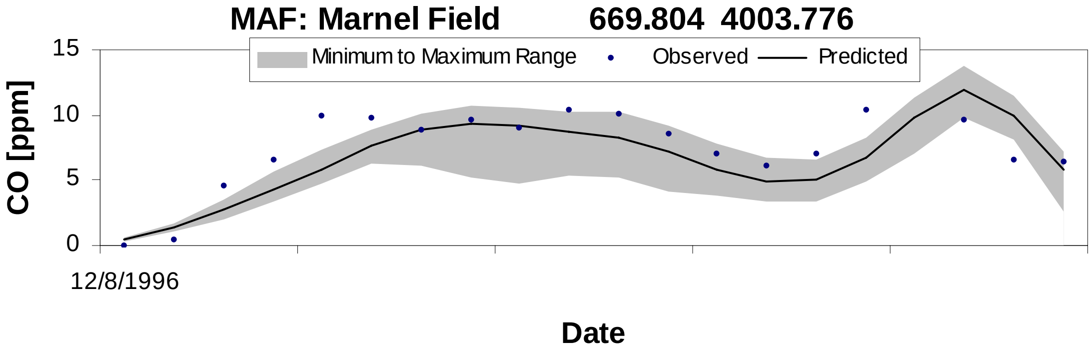

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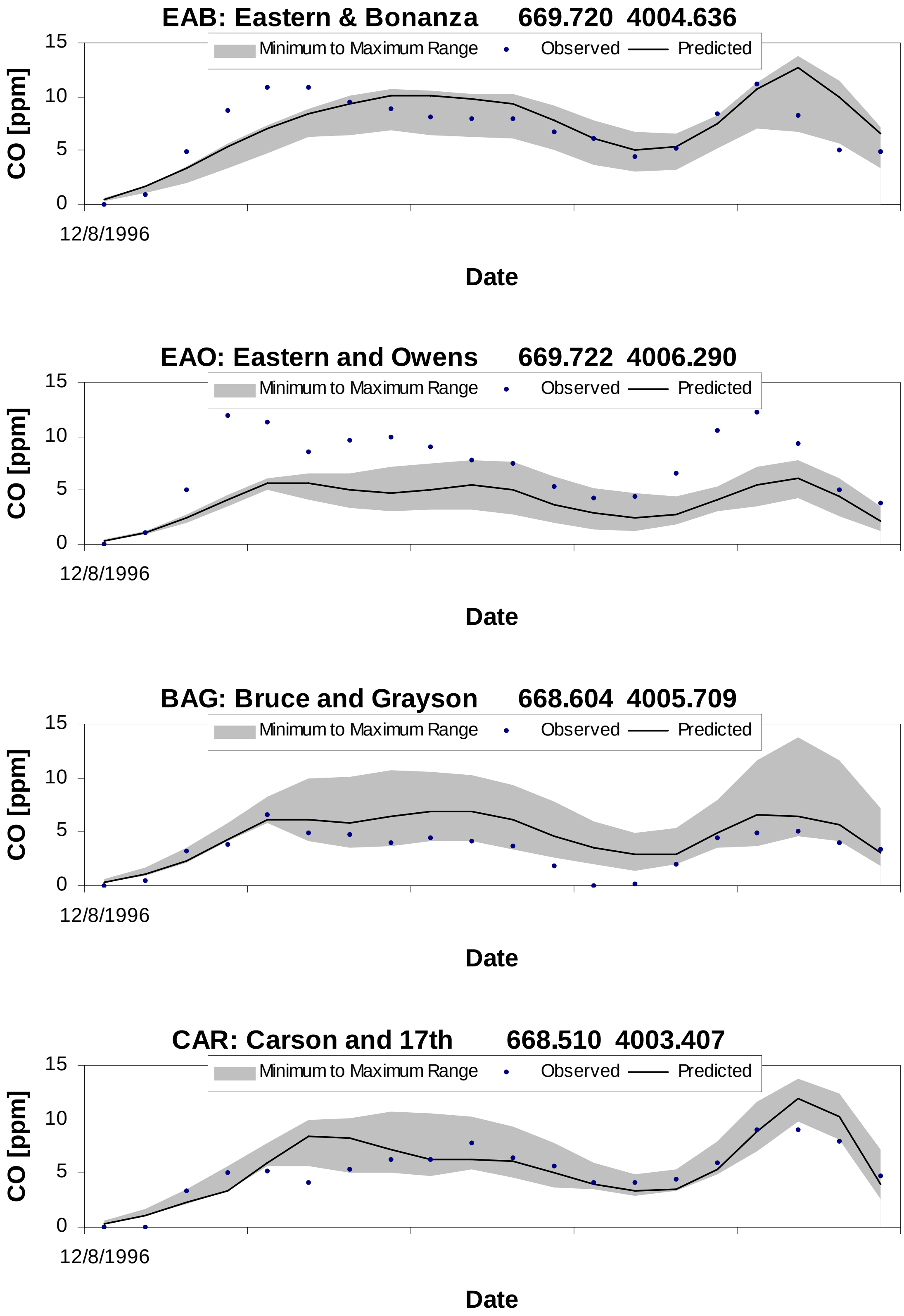

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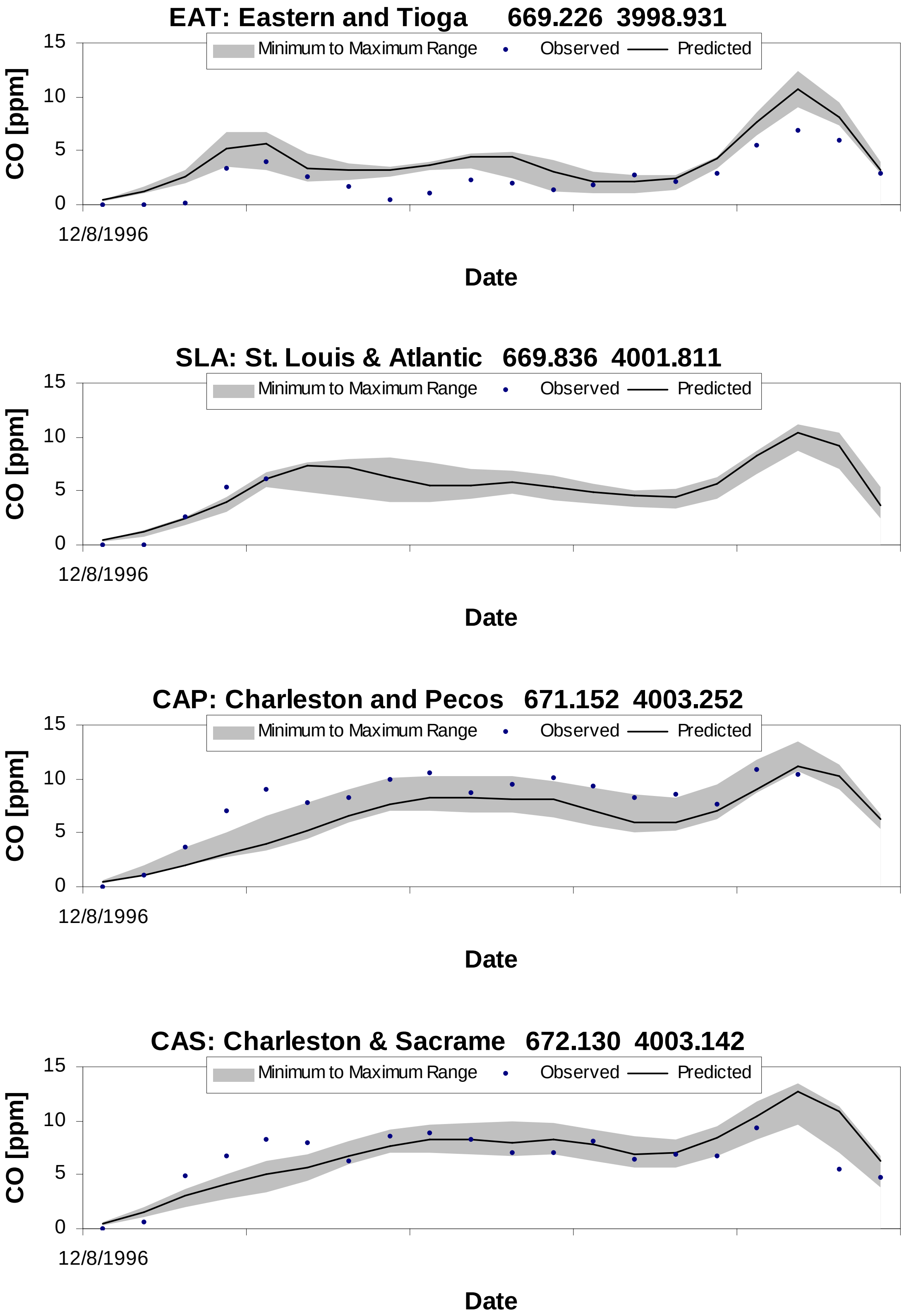
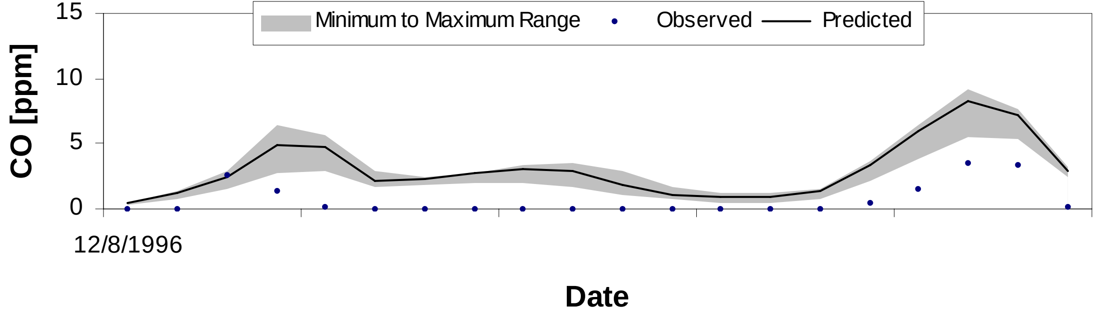
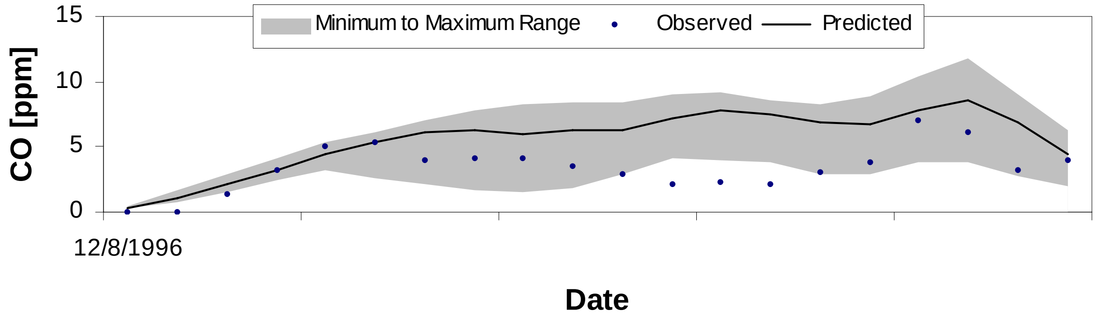


Figure 4-3. (continued).

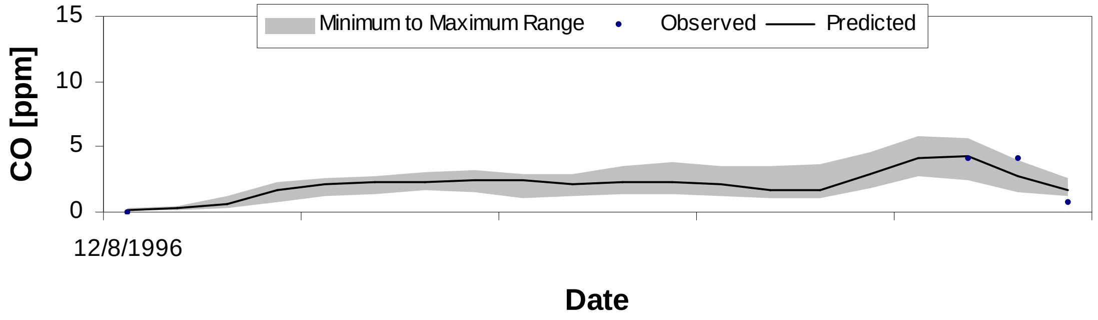
PVP: Paradise Valley Park 670.171 3996.693



DRS: Del Robison School 673.511 4005.104



SIL: Silver Bowl 679.238 3995.384



ALC: Alhambra & Cordova 667.151 4001.601

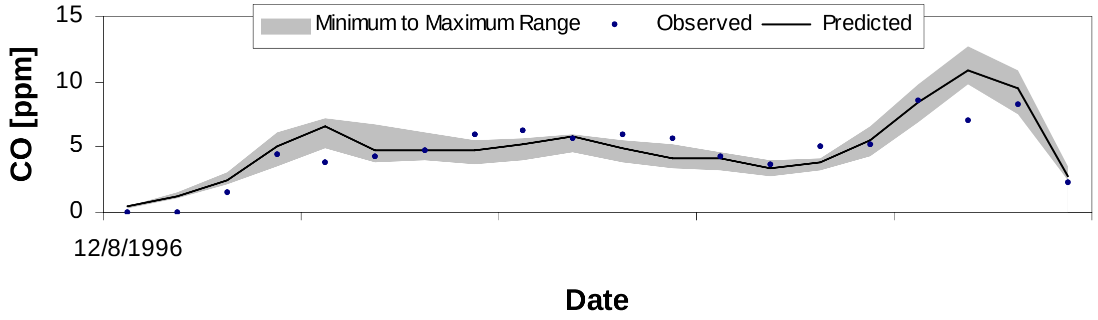


Figure 4-3. (concluded).

A scatter diagram of all observations and predictions combined from all monitoring sites is provided in Figure 4-4. The slope of the regression line is near 1:1, which indicates that the UAM develops only a minor negative bias tendency towards increasing CO concentrations. Model performance in this regard is quite good and encouraging. The R^2 value (fraction of variation explained) provides a quantitative measure that indicates a large degree of scatter (as seen in the spread of the observation-prediction pairings). At first glance an R^2 value of 0.62 would appear to be low; however this is a common trait of dispersion modeling and so UAM performance in this regard is not particularly problematic when considered in that context.

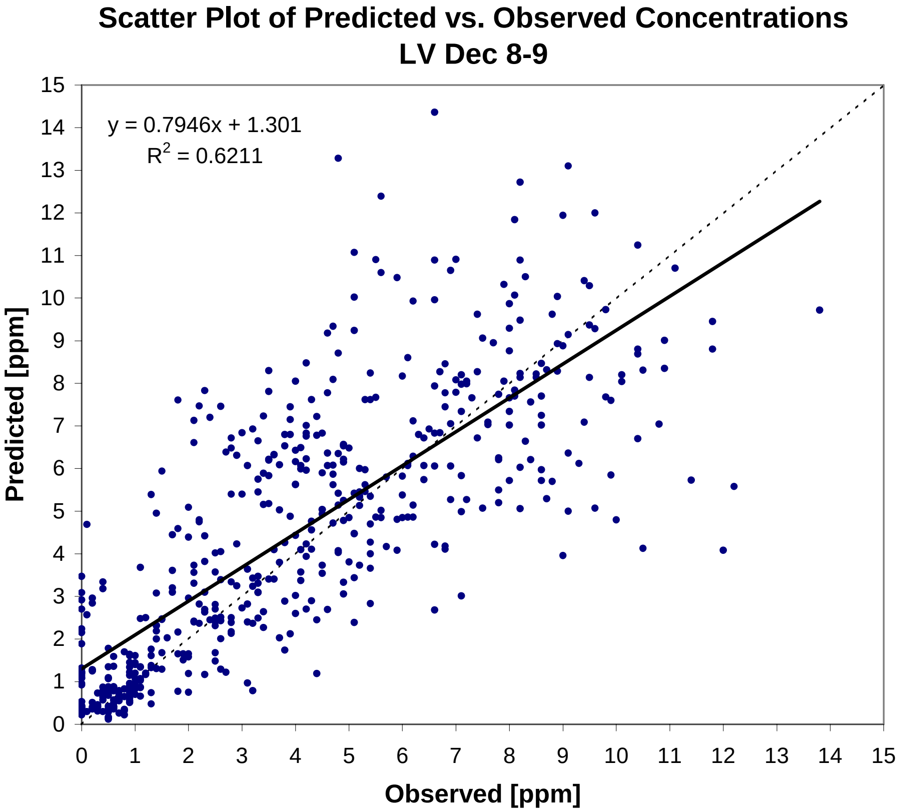


Figure 4-4. Scatter diagram of UAM predictions vs. observations for the 1996 Base Case. The linear regression equation is given as the bold line.

4.1.2 UAM Results From Revised On-Road and Non-Road Emissions

Figure 4-5 shows the UAM predicted episode-maximum 8-hour CO concentrations (ppm) from the base case simulation using the revised on-road and non-road emissions documented in Sections 2 and 3. Overall the pattern is quite similar to the results described in Section 4.1.1, with a slight increase in CO of a few tenths of a ppm. The peak in the domain is 11.4 ppm along Las Vegas Boulevard.

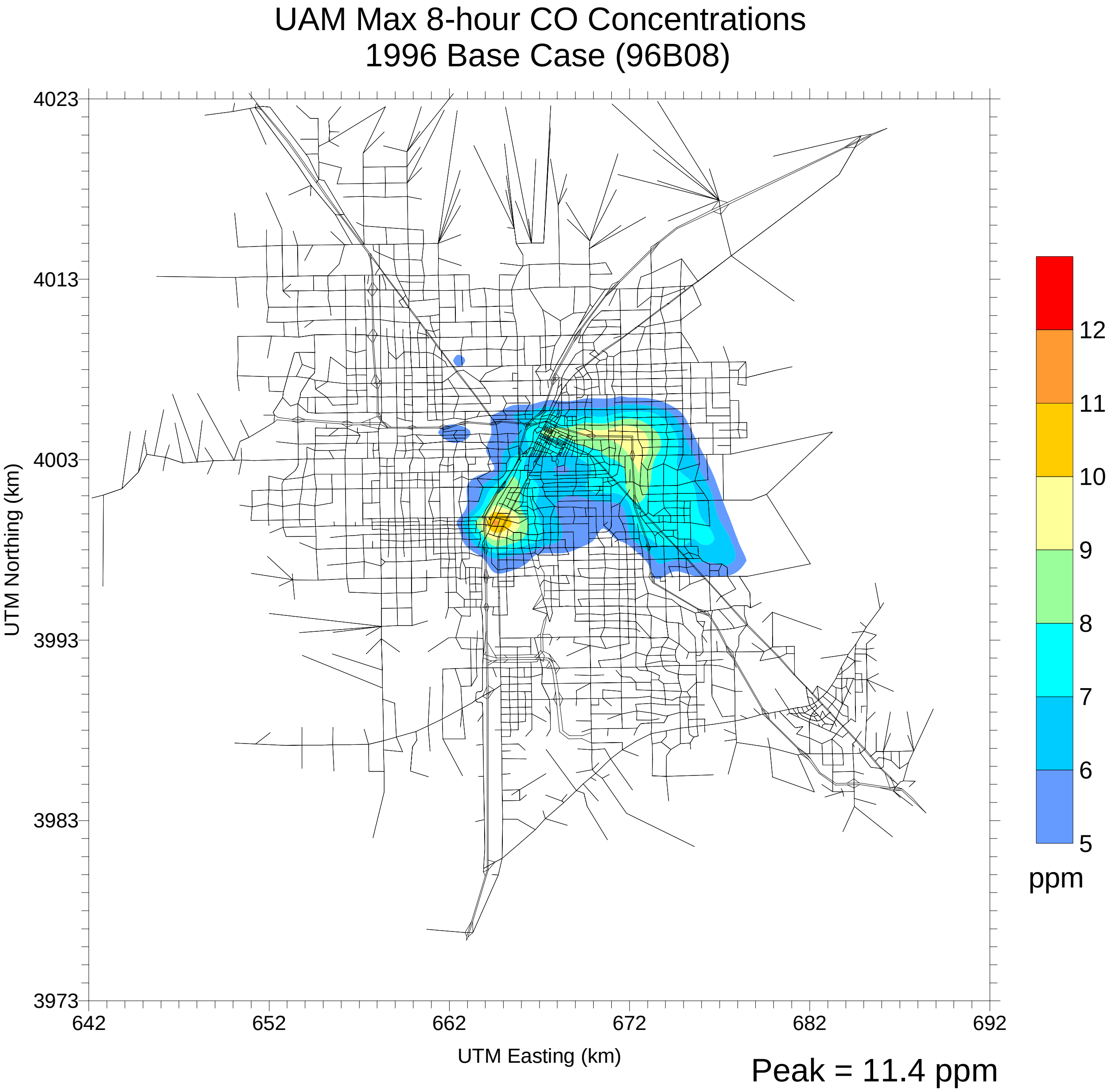


Figure 4-5. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 Base Case with updated on-road and non-road mobile emissions.

Standard and EPA criteria model performance statistics are shown in Table 4-3 for this simulation. UAM performance is quite similar to the previous run, and should be considered acceptable.

Figure 4-6 presents hourly time series of observed and predicted CO concentrations at each of the monitoring sites. The dots represent the observations at each site, while the black solid line shows the UAM predictions from Section 4.1.1, and the red solid line shows the UAM predictions with the addition of updated non-road emissions. Differences in the model predictions only appear in the morning hours, when non-road emissions begin to build up. However, these differences are insignificant as they are certainly within model uncertainty, and they do not overtly impact model performance.

Table 4-3. Summary performance statistics for the December 8-9, 1996 Base Case with updated on-road and non-road mobile source emissions. Bold/colored metrics denote EPA criteria statistics; green (red) indicates within (outside) acceptance criteria.

Peak 8-hour Observation	9.6 ppm, Marnell Field
Unpaired Peak	11.4 ppm
Paired Peak	8.1 ppm
Statistical Measures	
Unpaired Peak Accuracy	**19 %**
Paired Peak Accuracy	-15 %
Peak Timing Error	1 hr
Average Peak Bias > 5 ppm	-3 %
Average Peak Error > 5 ppm	**13 %**
Average Peak Timing Bias > 5 ppm	2 hr
Average Peak Timing Error > 5 ppm	**2 hr**
Overall Bias > 5 ppm	-6 %
Overall Error > 5 ppm	15 %

4.2 FUTURE YEAR SIMULATIONS

Figures 4-7 through 4-11 display predicted 8-hour maximum CO concentrations in the modeling domain for the years 2006, 2010, 2015, 2020, and 2030, respectively. UAM predictions show that the 8-hour CO standard of 9 ppm will not be violated anywhere within the domain. Peak 8-hour CO decreases in each year to 2015, then begins to increase out to 2030:

Year	Peak 8-hour CO
2006	7.4
2010	7.2
2015	6.5
2020	6.7
2030	8.0

Note that the contribution of McCarran airport to local CO concentrations in that area steadily increases over this period. This is due to the projected growth in airport activities as reported by Ricondo (2003). In each successive year through 2020, however, the contribution from on-road mobile sources diminishes, while the peak moves from the U.S. 95 “elbow” in northeast Las Vegas to the northern boundary of McCarran airport along Tropicana Boulevard. Like the 1996 Base Case, a lower secondary peak occurs in the Las Vegas Boulevard area near Spring

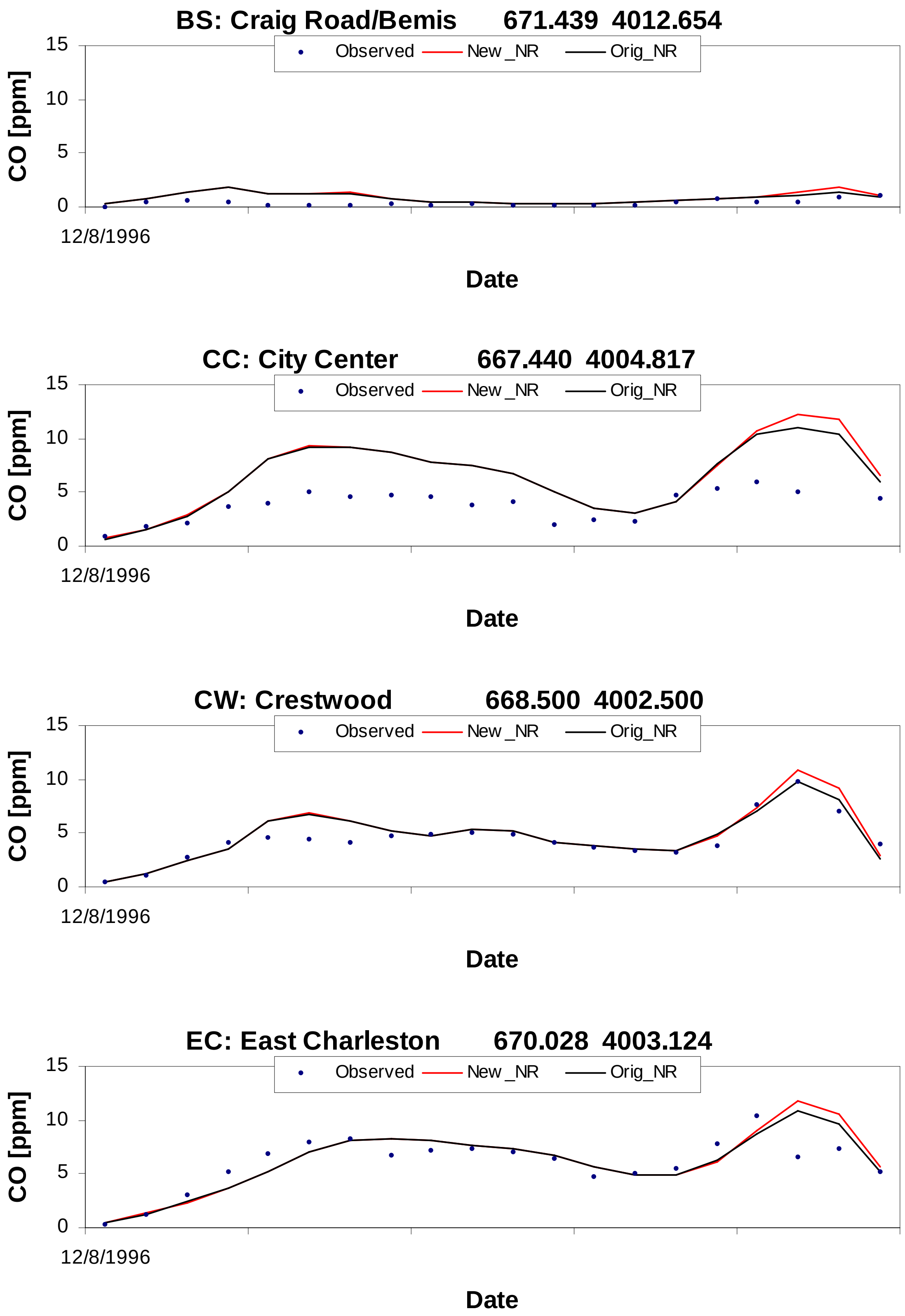


Figure 4-6. Time series of hourly CO measurements (dots) and UAM predictions (black line = revised on-road emissions, red line = revised on-road and non-road emissions) at Phase II field study monitoring sites. Plots cover the period 1500 LST December 8 to 1100 LST December 9, 1996.

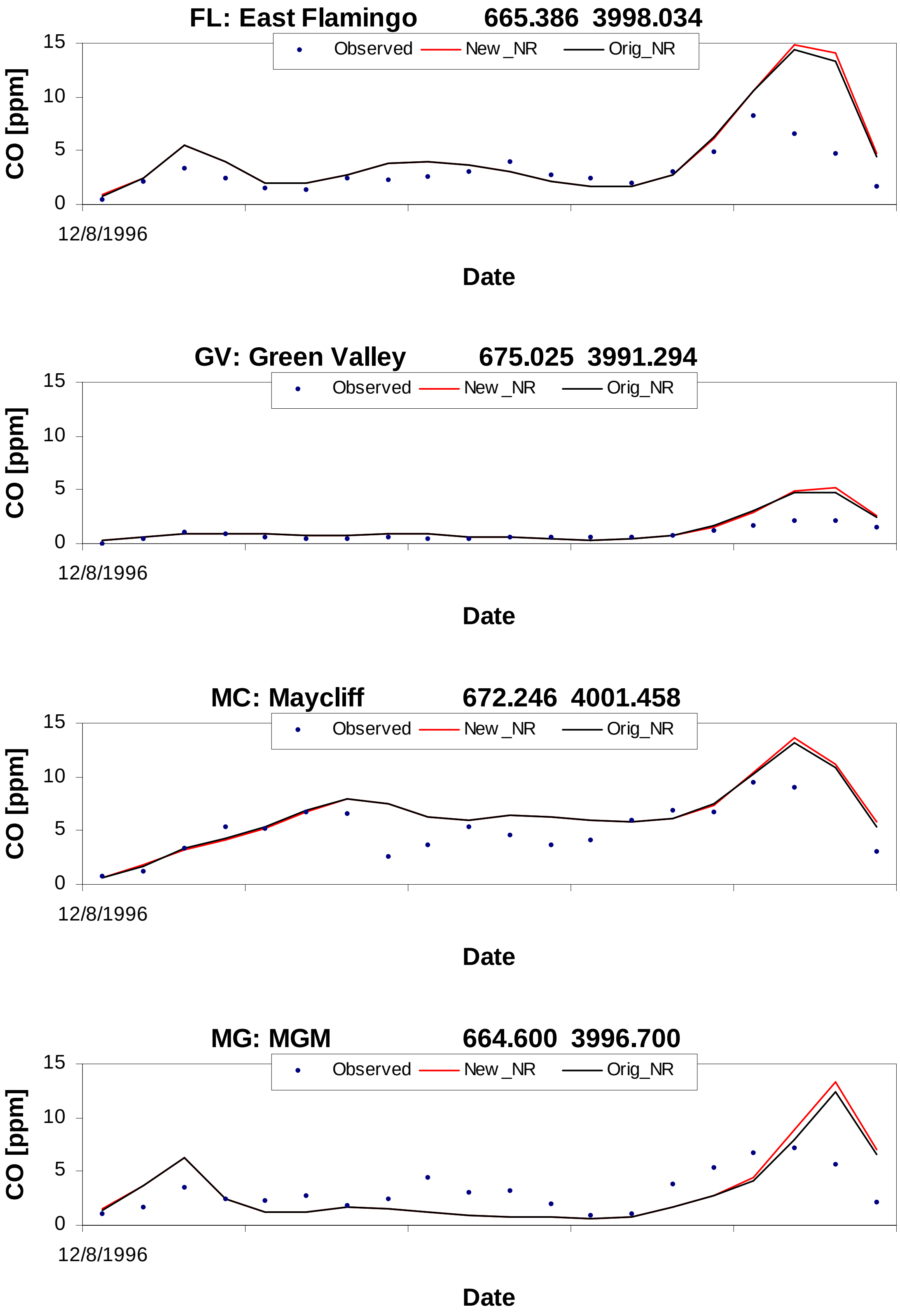


Figure 4-6. (continued).

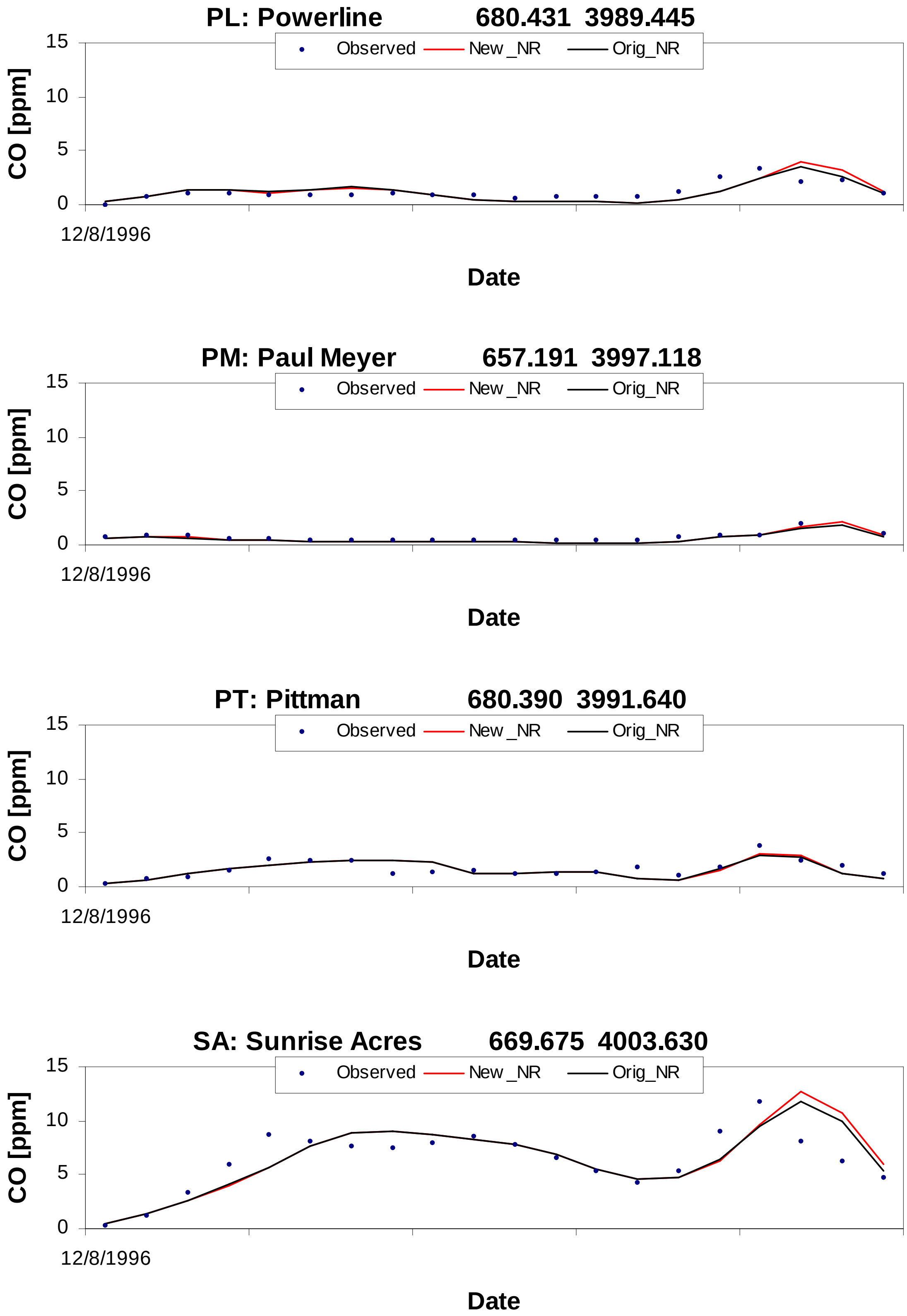


Figure 4-6. (continued).

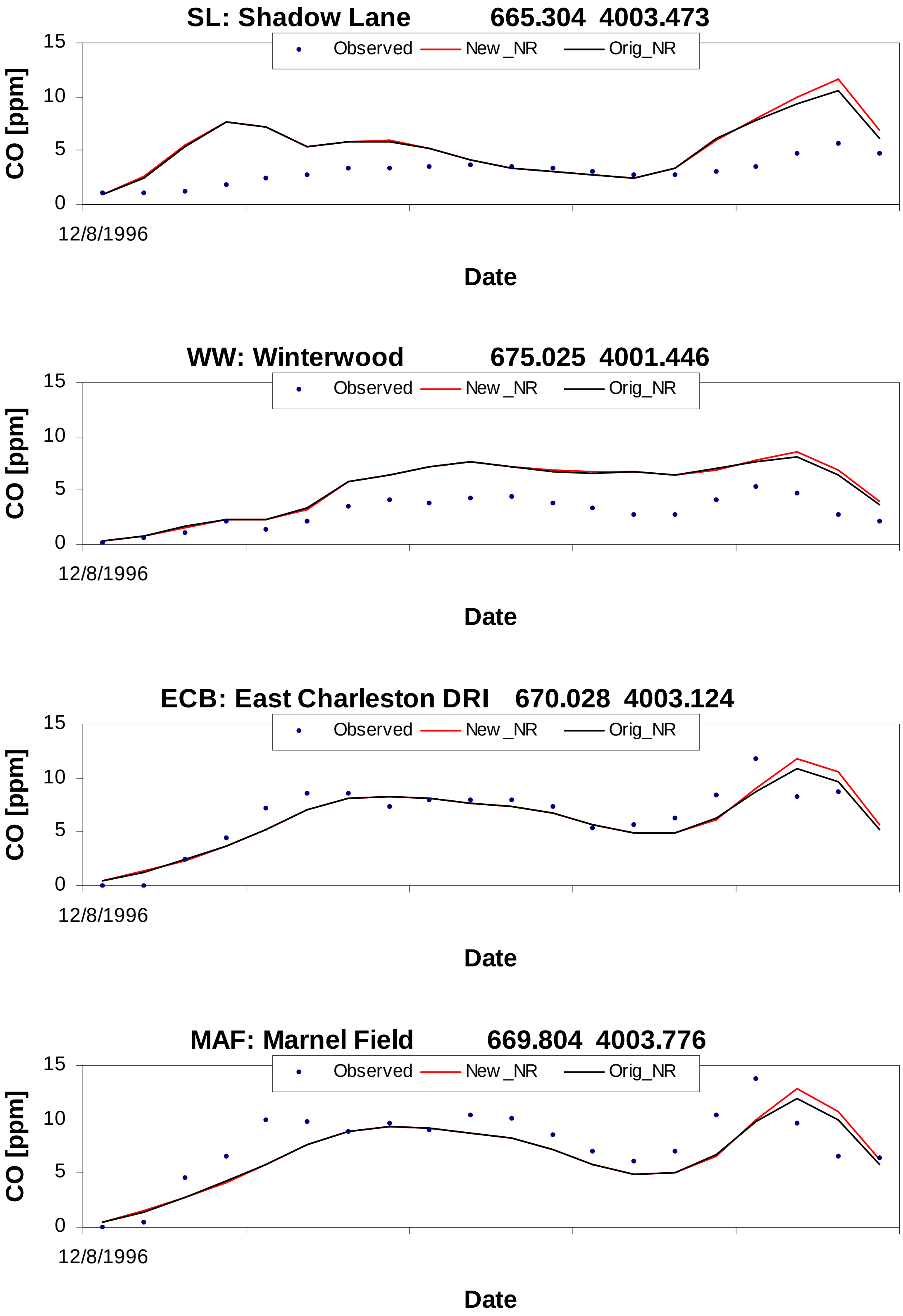


Figure 4-6. (continued).

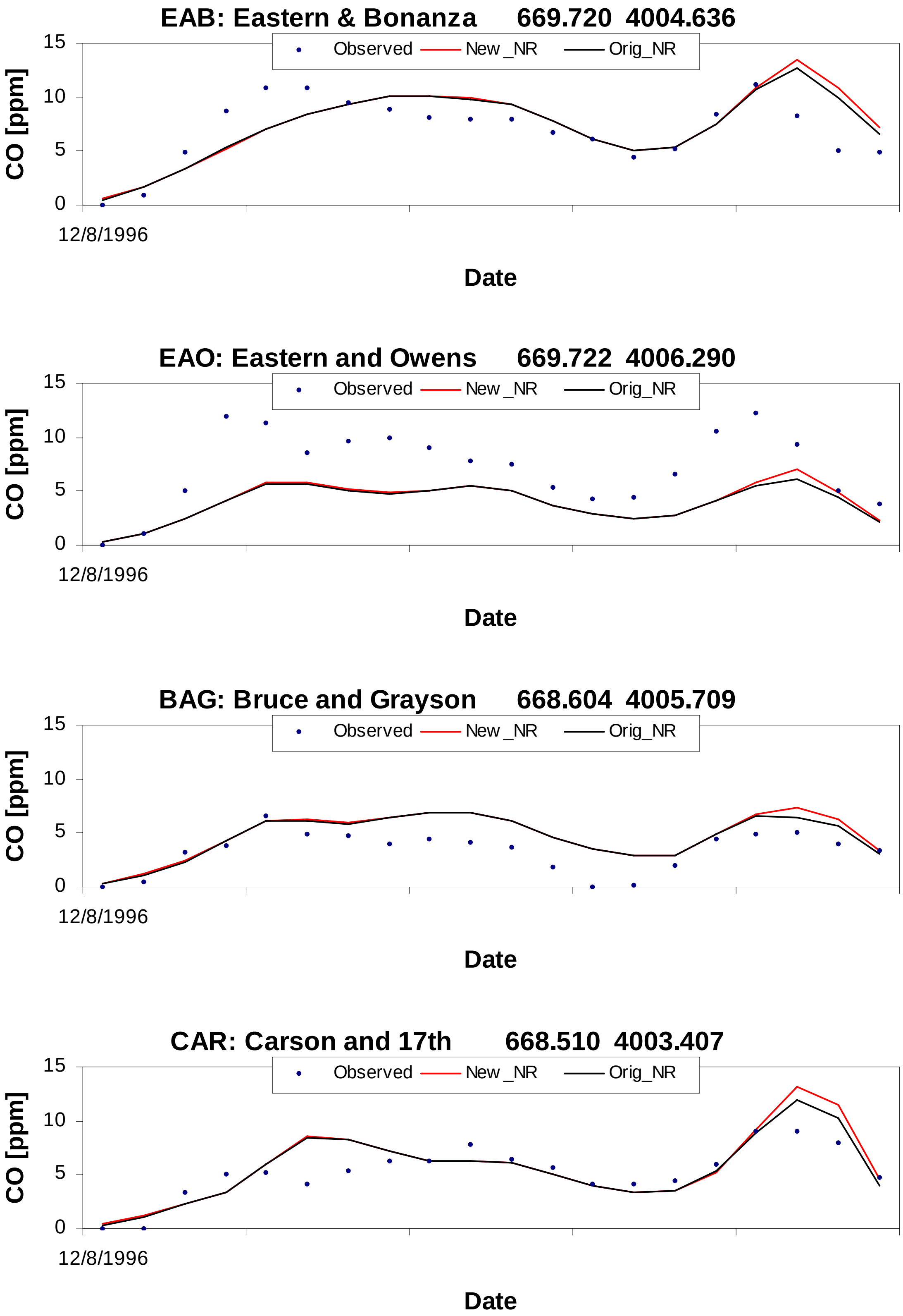
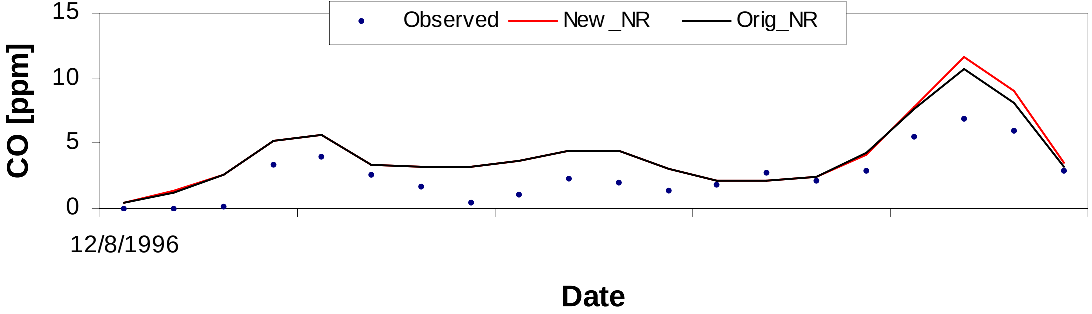
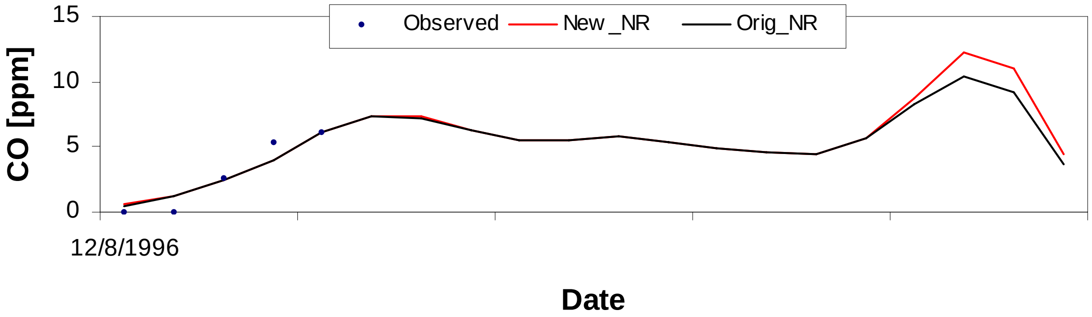


Figure 4-6. (continued).

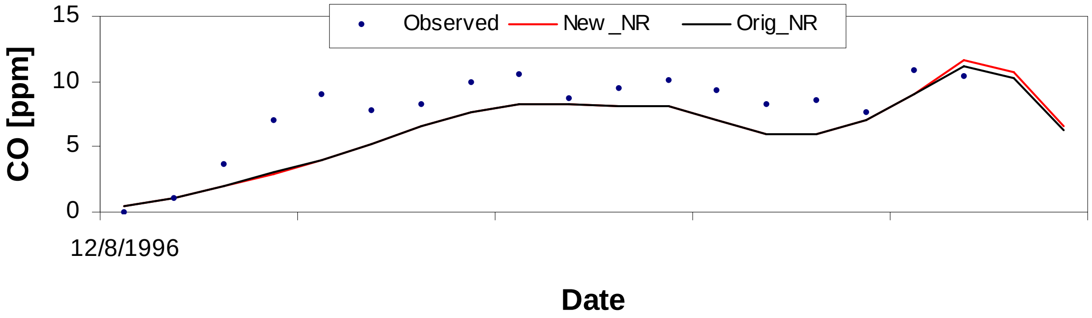
EAT: Eastern and Tioga 669.226 3998.931



SLA: St. Louis & Atlantic 669.836 4001.811



CAP: Charleston and Pecos 671.152 4003.252



CAS: Charleston & Sacrame 672.130 4003.142

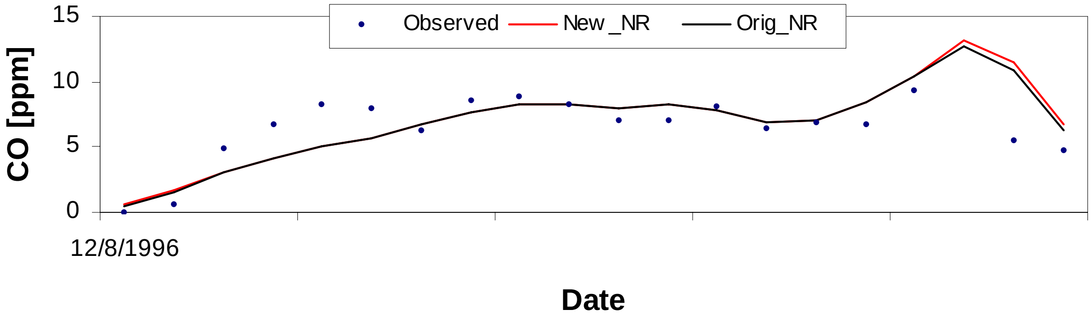


Figure 4-6. (continued).

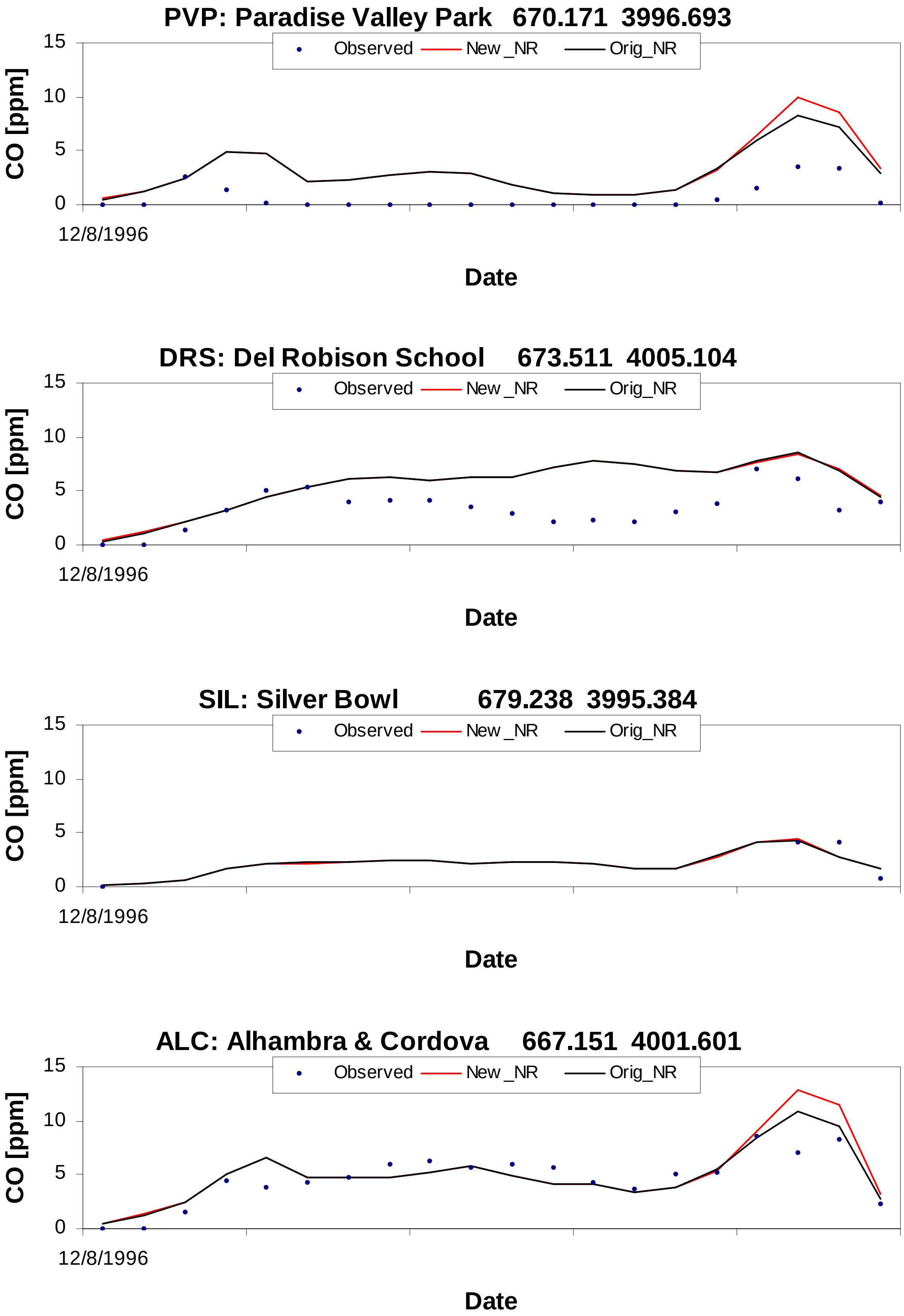


Figure 4-6. (concluded).

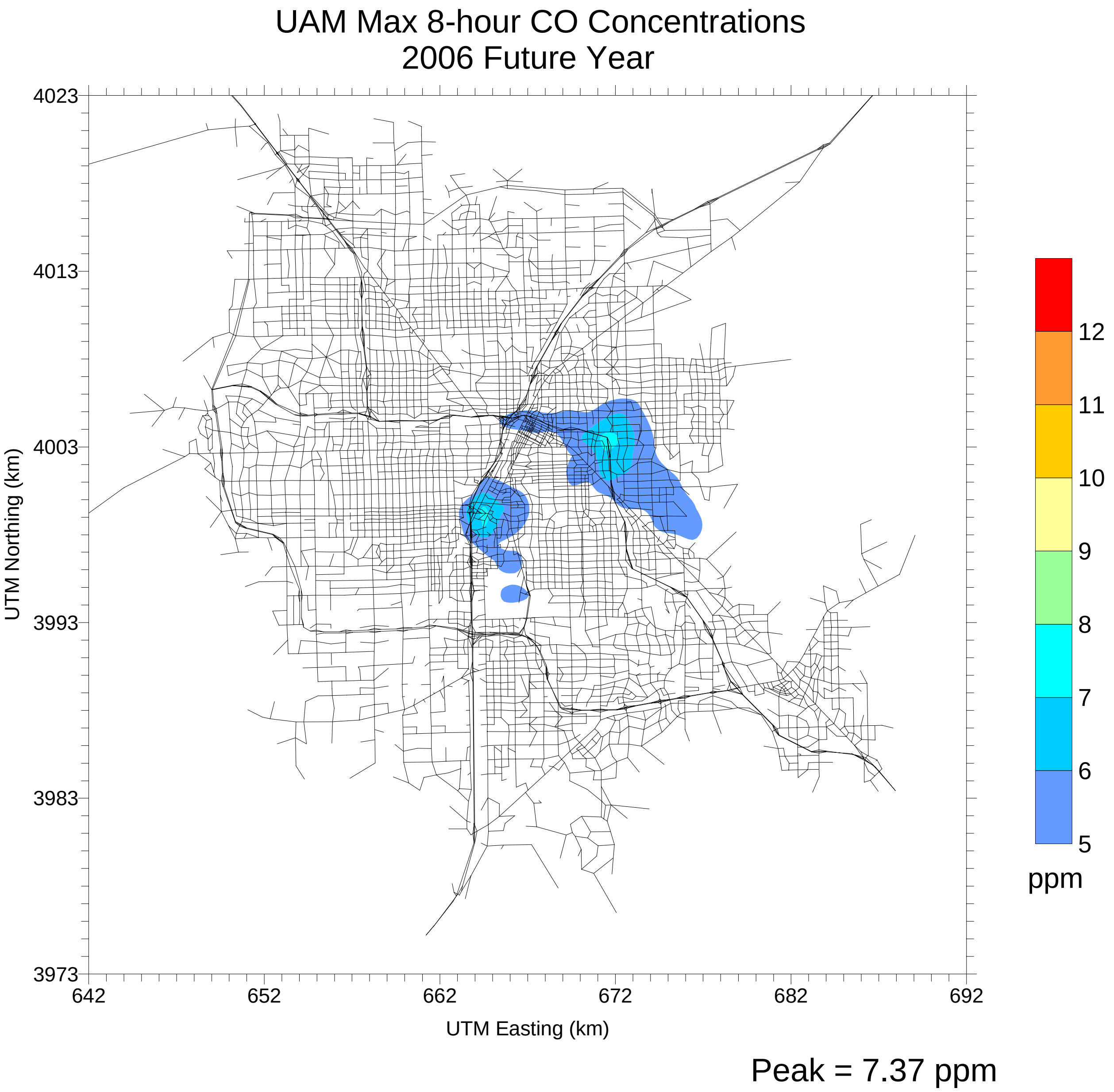


Figure 4-7. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2006.

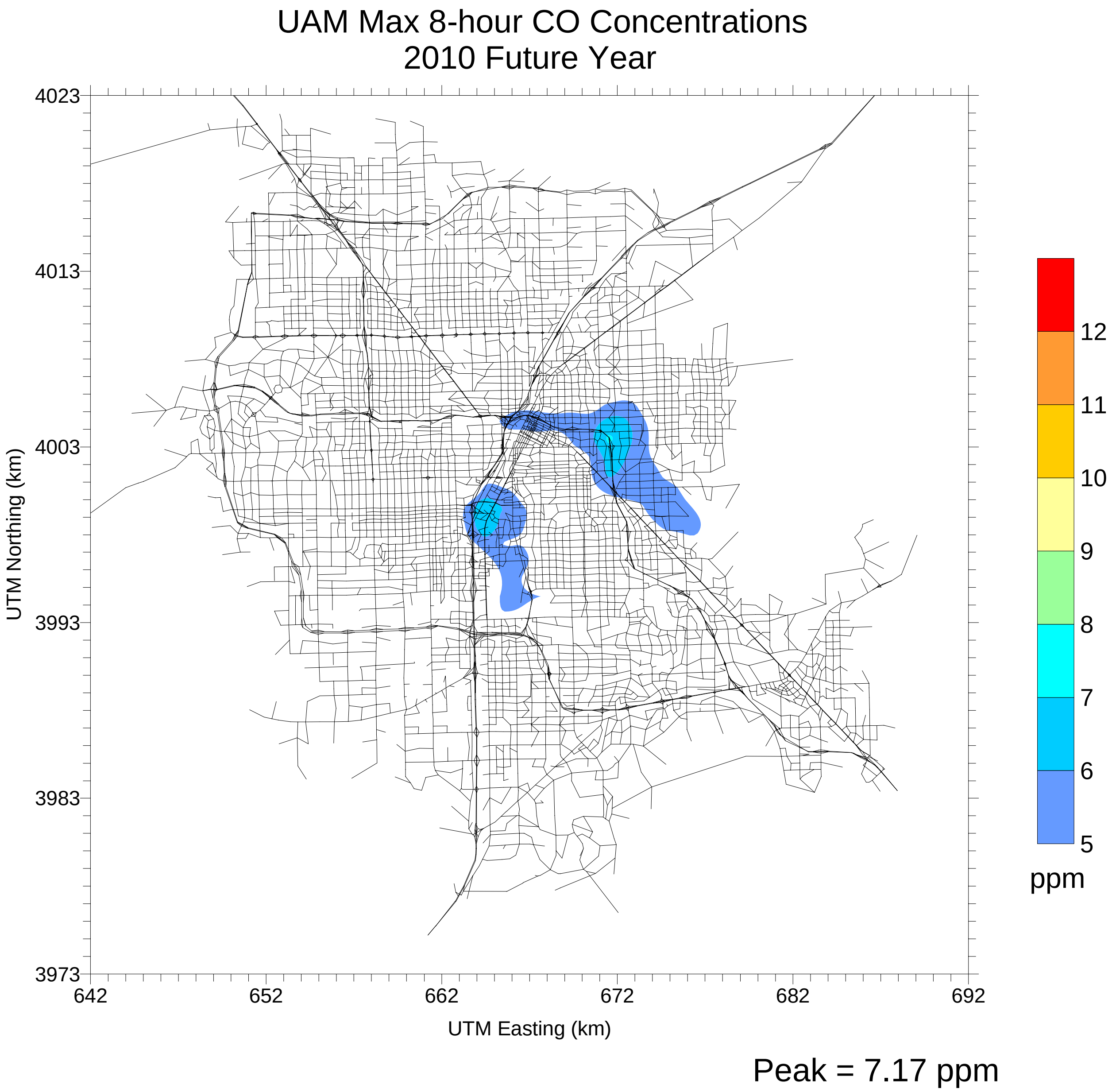


Figure 4-8. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2010.

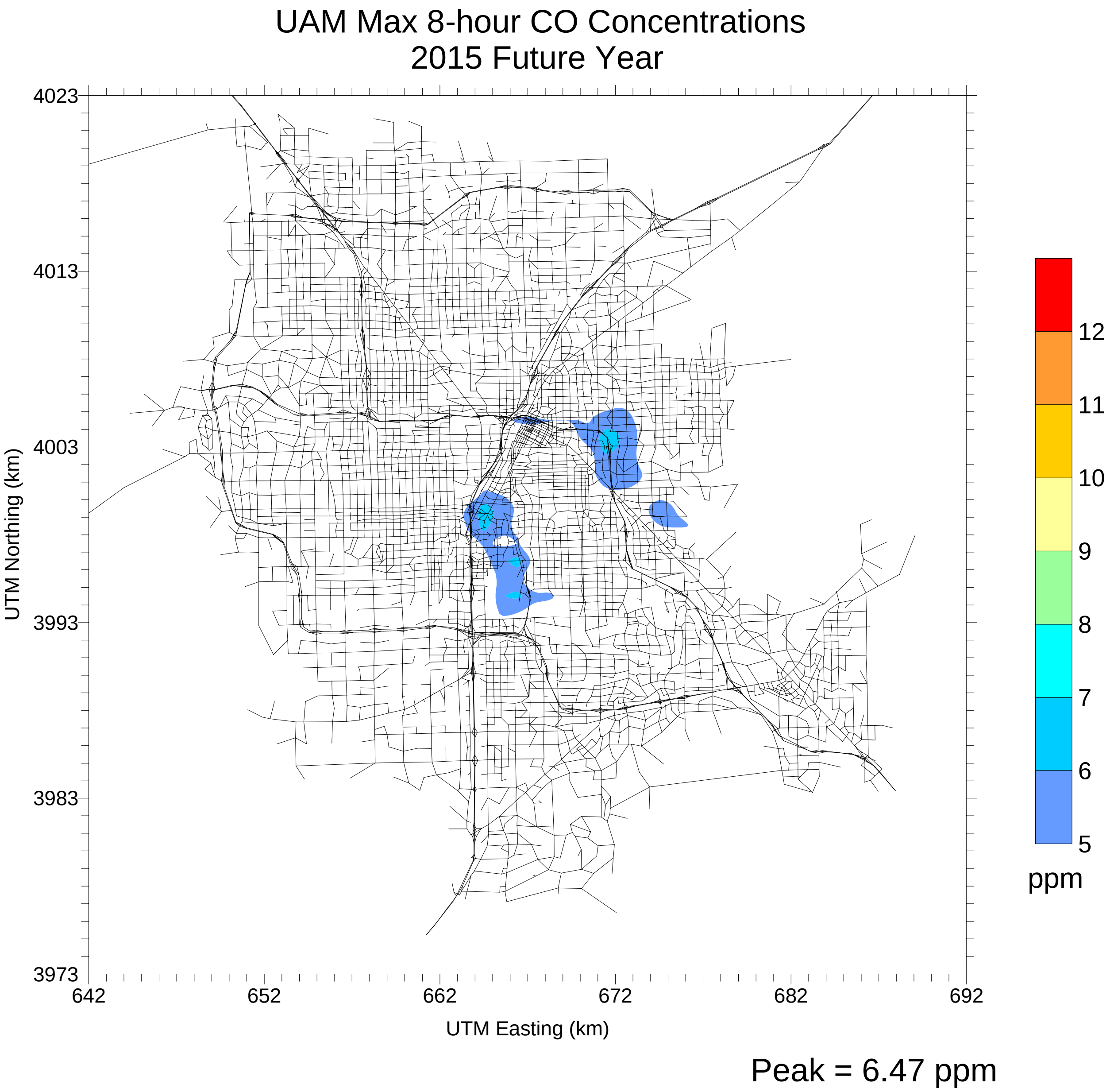


Figure 4-9. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2015.

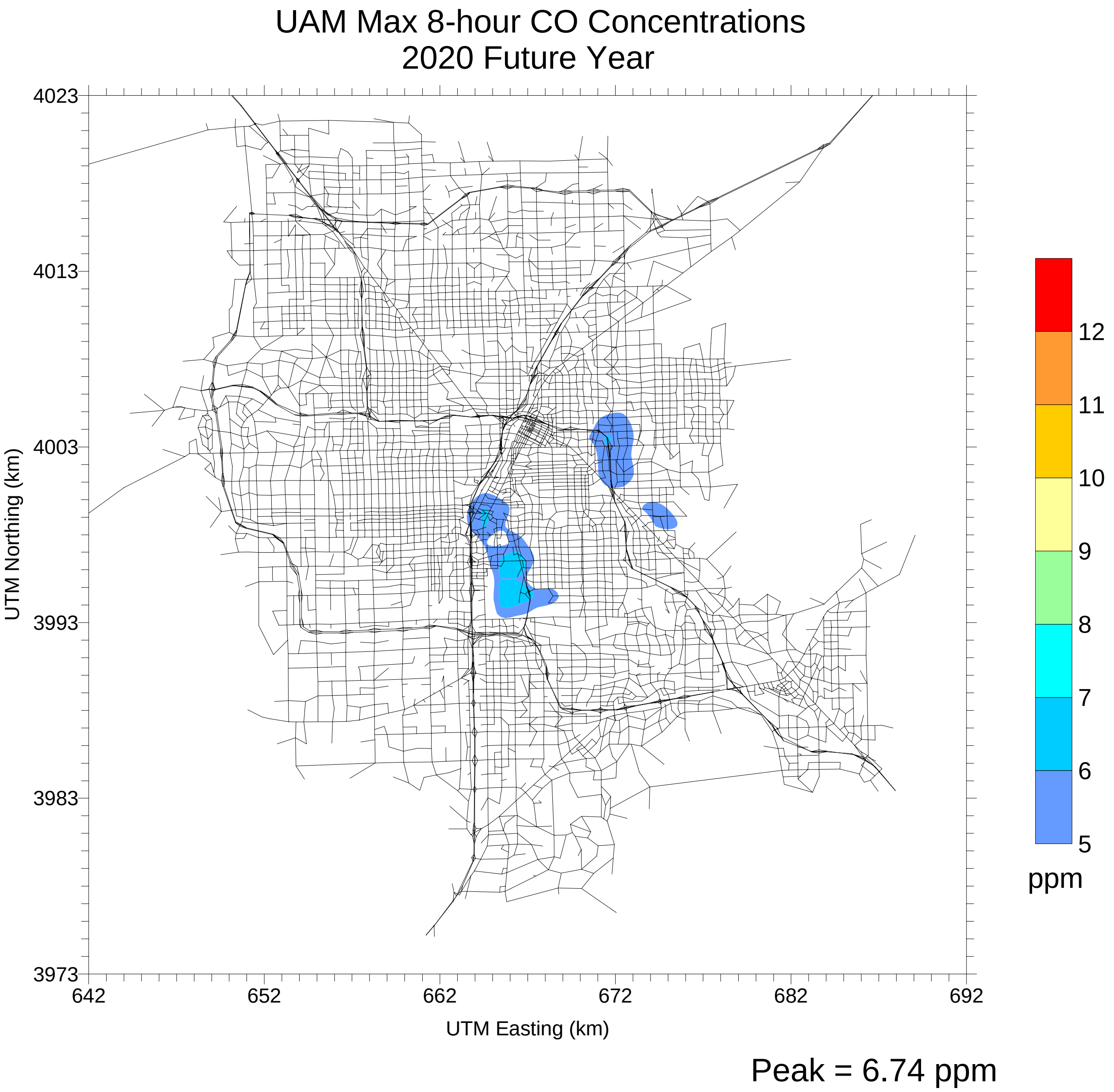


Figure 4-10. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2020.

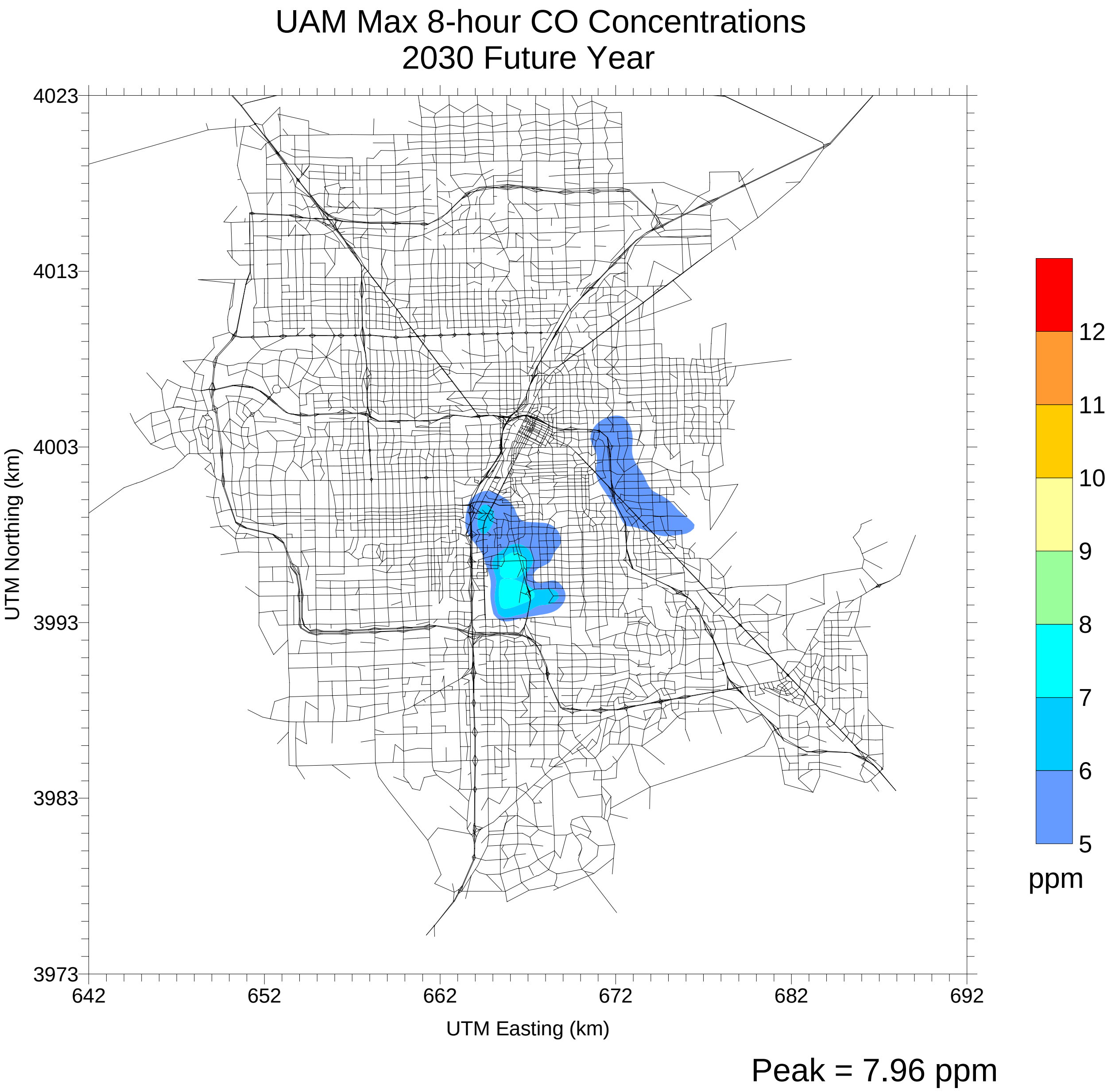


Figure 4-11. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2030.

Mountain Road. The Las Vegas Boulevard – Spring Mountain road area possesses a high concentration of parking structures, which leads to a local maximum in trip starts in the RTC TransCAD transportation demand model, and therefore a local maximum in vehicle "start" emissions in the modeling emission inventory. This poses a potential for an actual local emissions "hot spot" in this area. However, Clark County recently undertook a saturation study in 2002 (T&B Systems and Parsons Engineering Science, 2002[1]) to address this possibility. Although the TransCAD, EPS, and UAM modeling show a potential emissions hot spot at Spring Mountain Road and Las Vegas Boulevard, the 2002 saturation study showed no hot spot at all in that location.

4.3 MICROSCALE MODELING

Future year UAM simulation results were used to provide estimates of background ambient CO levels for micro-scale modeling performed for the "Five Points" hot spot intersection and for the three civil airports in the modeling domain (McCarran, Henderson Executive, and North Las Vegas). UAM concentrations from the appropriate grid cells were simply added to the concentrations predicted at each micro-scale receptor to obtain a total (background + micro-scale) CO concentration. Procedures for running CAL3QHC and combining with UAM predictions followed the same methodology as described in the 2000 CO SIP. Results are presented in the following sub-sections.

4.3.1 CAL3QHC Intersection Modeling

Table 4-4 presents the individual peak 8-hour average CO concentrations predicted by UAM, CAL3QHC, and their combination, in each of the future years and for each of the three intersections in the "Five Points" area. Note that the peak 8-hour periods among the UAM, CAL3QHC, and UAM+CAL3QHC results occur at different times. All values are well below the 9 ppm standard.

Table 4-4. Peak 8-hour average CO concentrations (ppm) predicted by UAM, CAL3QHC, and UAM+CAL3QHC for each future year and for each of the Five Points intersections. Note that peaks reported for each of the models and their combined effect occur over different 8-hour periods.

Year	UAM	Eastern/Charleston		Eastern/Fremont		Fremont/Charleston	
		CAL3QHC	CAL3QCH+UAM	CAL3QHC	CAL3QHC+UAM	CAL3QHC	CAL3QHC+UAM
2006	4.89	1.64	6.14	1.28	5.66	0.71	5.09
2010	4.62	1.33	5.61	1.14	5.32	0.69	4.81
2015	4.19	1.16	4.97	0.96	4.76	0.51	4.31
2020	3.97	1.05	4.67	0.88	4.48	0.49	4.07
2030	4.07	1.03	4.83	0.84	4.58	0.50	4.20

4.3.2 EDMS Airport Modeling

In consideration of micro-scale airport modeling, the UAM was run for all future years with exactly the same inputs as described in Section 4.2; however, airport emissions for the three civil

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[1] Information regarding the 2002 Las Vegas Boulevard Saturation Study can be found at http://www.co.clark.nv.us/air_quality/Studies/COSat1-7.pdf.

airports in the domain were removed from the UAM inventory to avoid double counting. Clark County provided EDMS simulations for 2005, 2010, 2015 and 2020, based on the work of Ricondo (2003). In each of these years, several receptors at McCarran airport reported total 8-hour CO concentrations (sum of EDMS and UAM components) above the 8-hour CO standard of 9 ppm. Note, however, that all receptors above the 9 ppm standard in all future years evaluated occur within areas that are not publicly accessible, as defined by Ricondo (2005). Disregarding any receptors in publicly restricted areas removes all exceedance estimates.

Table 4-5 presents the peak total 8-hour CO concentration at all three airports for each future year evaluated. Values for McCarran are taken from the peak publicly accessible receptor. All peak CO concentrations are below the 9 ppm standard in all years.

Table 4-5. Peak total UAM + EDMS 8-hour CO concentrations (ppm) at all three airports and for all future years evaluated. Values shown for McCarran airport occur at the peak publicly accessible receptor.

Airport	2005	2010	2015	2020
McCarran	7.47	7.14	7.60	8.45
Henderson Executive	1.12	1.36	1.99	3.05
North Las Vegas	5.01	5.04	4.46	4.19

4.4 ESTIMATING ON-ROAD EMISSION BUDGETS

The UAM was used to undertake several sensitivity tests to refine the estimation of future year on-road mobile CO emission budgets for the central, most urbanized portion of the modeling domain. The definition of the central urban sub-domain is given in Table 4-6 and shown in Figure 4-12. The first analysis tested the assertion that the emissions inventory outside of the central urban sub-domain has no significant impact on CO concentrations downtown, along the Las Vegas Boulevard “strip”, and in traditional “hot spot” areas. Emissions in the outer grid area were doubled for each future year, and the UAM was run to show the incremental impact on the peak CO concentration.

In the second analysis, on-road mobile source emissions were scaled up over the entire domain to the point at which the peak 8-hour CO concentration reached 8.9 ppm in each of the future years. Hence, the resulting daily on-road emission totals for December 9 can be used to establish future-year emission budgets for both the entire domain and the central urban sub-domain.

Table 4-6. Grid definition of the central urban sub-domain.

	Column	Row	UTM East	UTM North
Low-left	11	19	652.000	3991.000
Upper-Right	36	45	678.000	4018.000

4.4.1 Impacts of Emissions from the Outer Domain

The total CO emissions inventory in the outer area of the modeling domain was doubled to investigate the sensitivity of peak predicted CO in central Las Vegas to outlying emission sources. As shown in Table 4-7, peak 8-hour CO concentrations changed by a maximum of only 0.07 ppm. There was no change in the location of the predicted peak.

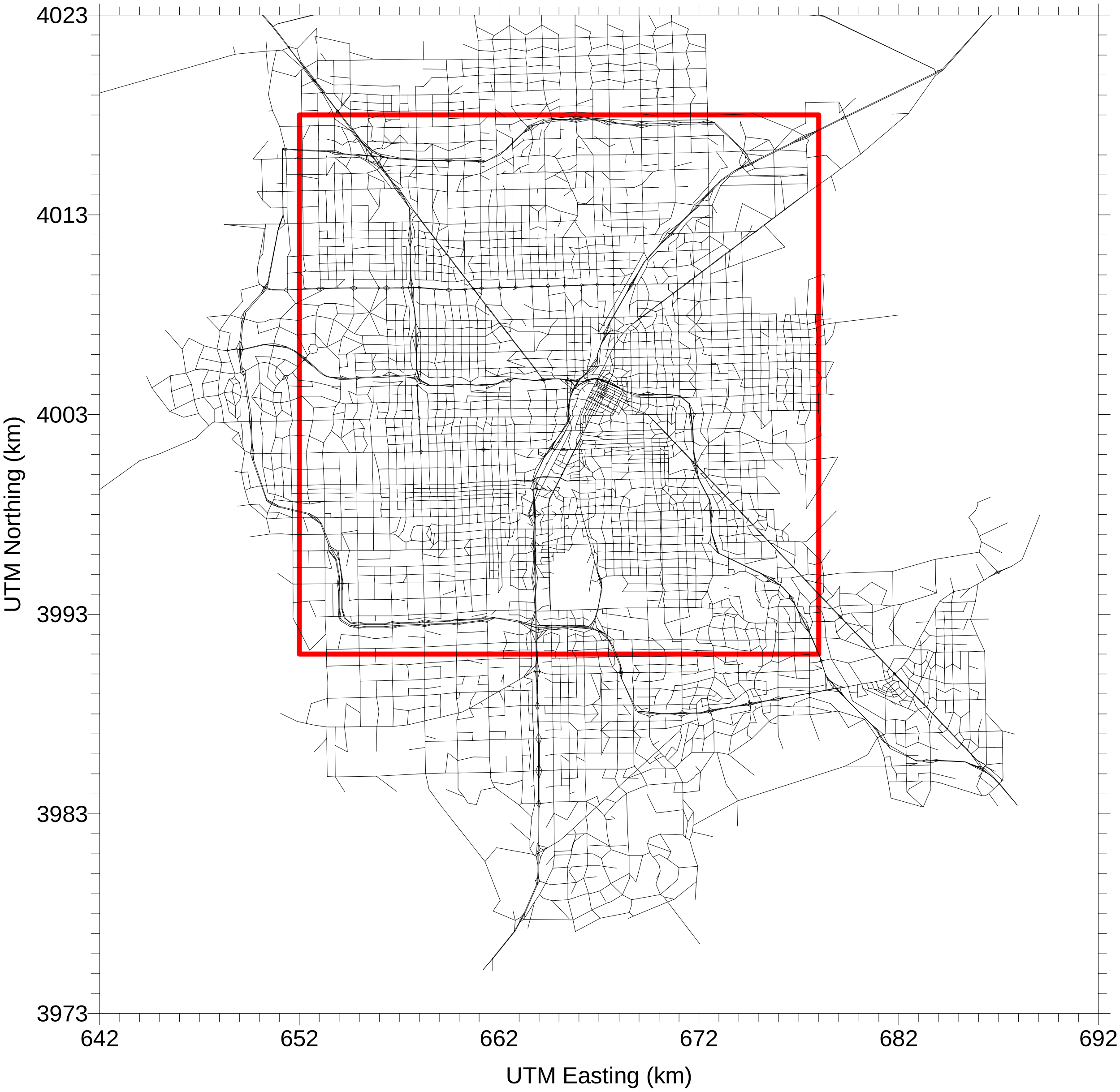

Figure 4-12. Location of the central urban sub-domain used in the UAM sensitivity tests (heavy red line). Link network shown is from the 2030 TransCAD.

Table 4-7. Change in peak 8-hour CO from doubling the total CO emissions inventory outside of the central urban sub-domain.

Year	Peak 8-hour CO (ppm)	
	From Section 4.2	**Doubled Outer Emissions**
2006	7.37	7.41
2010	7.17	7.24
2015	6.47	6.54
2020	6.74	6.80
2030	7.96	8.03

This demonstrates that the model-predicted peak CO is driven by local emission sources in the central urban sub-domain, and is therefore insensitive to large changes in emissions in outer areas.

4.4.2 Emission Budgets from Scaling On-Road Emissions

Future year on-road mobile source emissions were scaled up across the entire modeling domain to the point at which the peak 8-hour CO concentration reached 8.9 ppm. Additionally, the on-road mobile source emissions outside the central urban sub-domain were increased by an additional 70% in each year to reach a maximum peak 8-hour CO concentration of just under 9.0 ppm. This additional 70% increase to the projected emissions budgets is intended to capture the large expected growth in vehicular activity in the outer areas of the domain. Results from this analysis are presented in Table 4-8. Plots of daily maximum CO concentrations for each future year are shown in Figures 4-13 through 4-17. There was no change in the location of the predicted peak. No additional hot spots were generated anywhere in the domain by increasing the on-road mobile source emissions in the outer portion of the domain by 70%.

Table 4-8. Weekday domain-wide on-road emission increase, net on-road emission increase that includes an additional 70% increase outside the central urban sub-domain, resulting UAM predicted peak CO, and resulting total and sub-domain on-road emission budgets for each future year.

Year	Domain-Wide On-Road Emissions Increase	Net On-Road Emissions Increase	Peak 8-hr CO (ppm)	Total Domain On-Road Emissions (TPD)	Sub-Domain On-Road Emissions (TPD)
2006	23%	41%	8.96	623	427
2010	26.5%	49%	8.98	690	438
2015	41.5%	70%	8.98	768	453
2020	50%	83%	8.97	817	463
2030	46%	81%	8.97	881	464

Future year CAL3QHC intersection results were similarly scaled up by the domain-wide on-road emission increases shown in the second column of Table 4-8. Table 4-9 presents the individual peak 8-hour average CO concentrations predicted by UAM, CAL3QHC, and their combination, in each of the future year sensitivity runs shown in Table 4-8 and for each of the three intersections in the “Five Points” area. Note that the peak 8-hour periods among the UAM, CAL3QHC, and UAM+CAL3QHC results occur at different times. All values remain well below the 9 ppm standard.

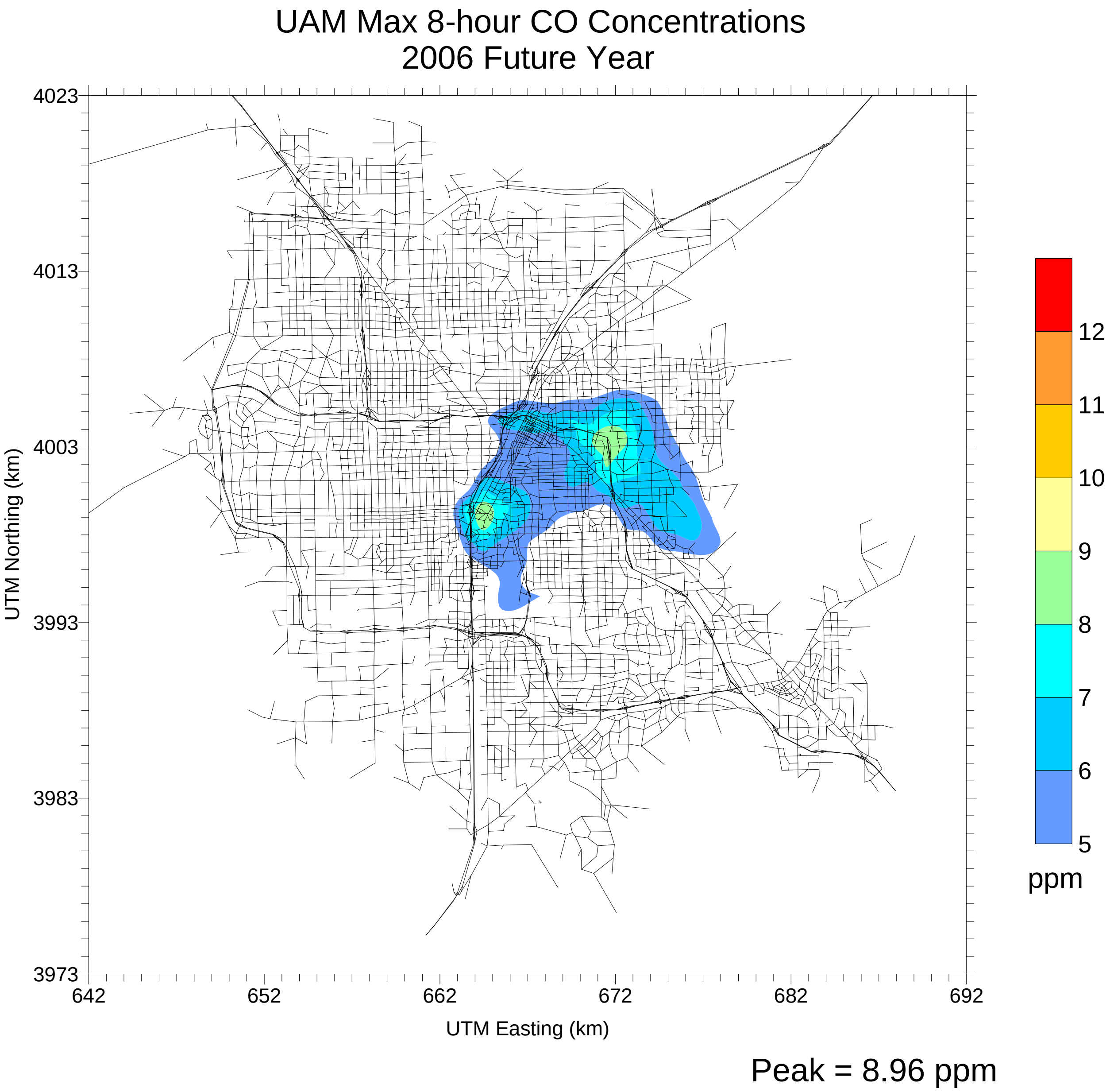

Figure 4-13. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2006 with increased on-road mobile source emissions to reach peak CO just under 9.0 ppm.

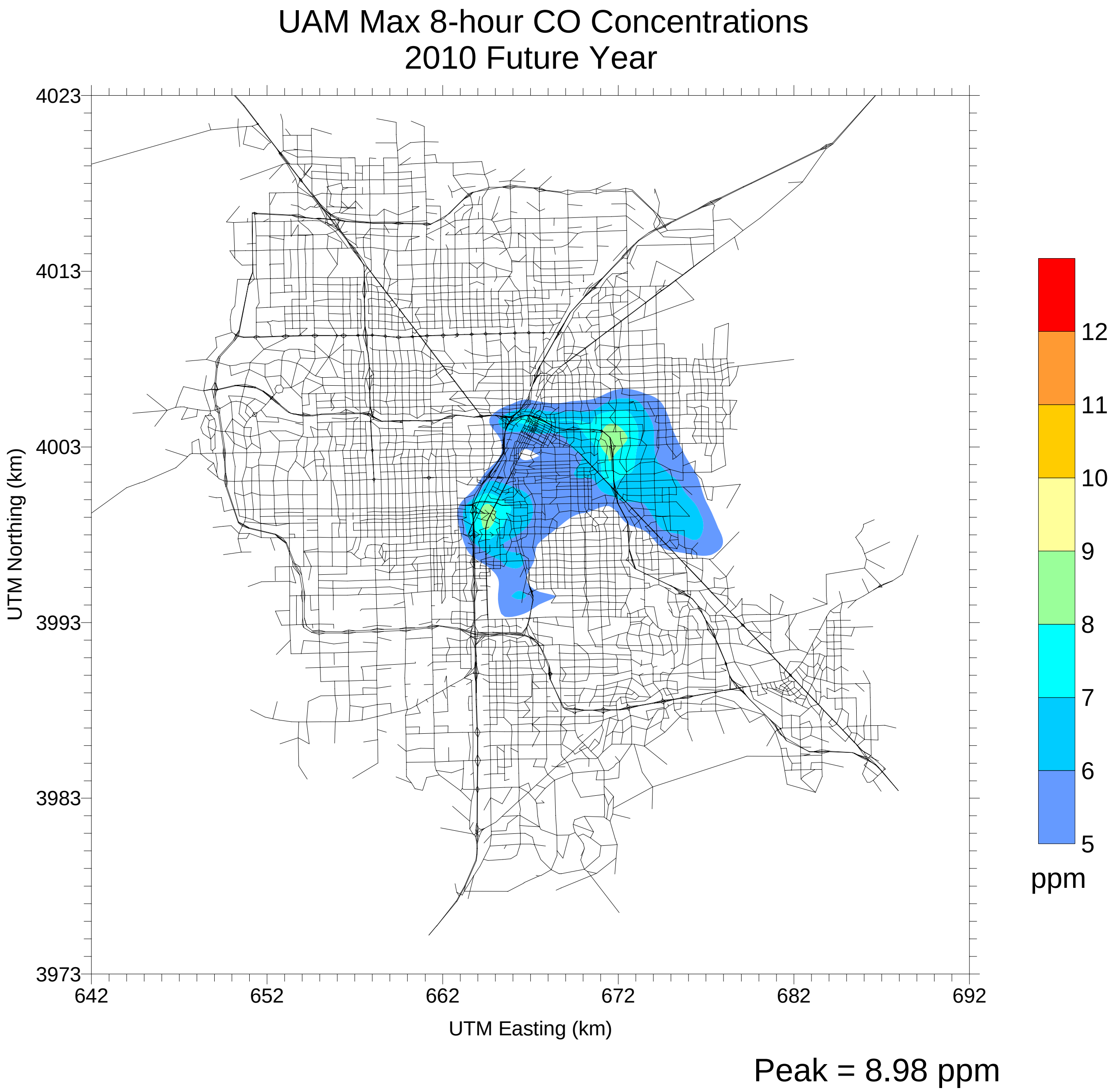

Figure 4-14. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2010 with increased on-road mobile source emissions to reach peak CO just under 9.0 ppm.

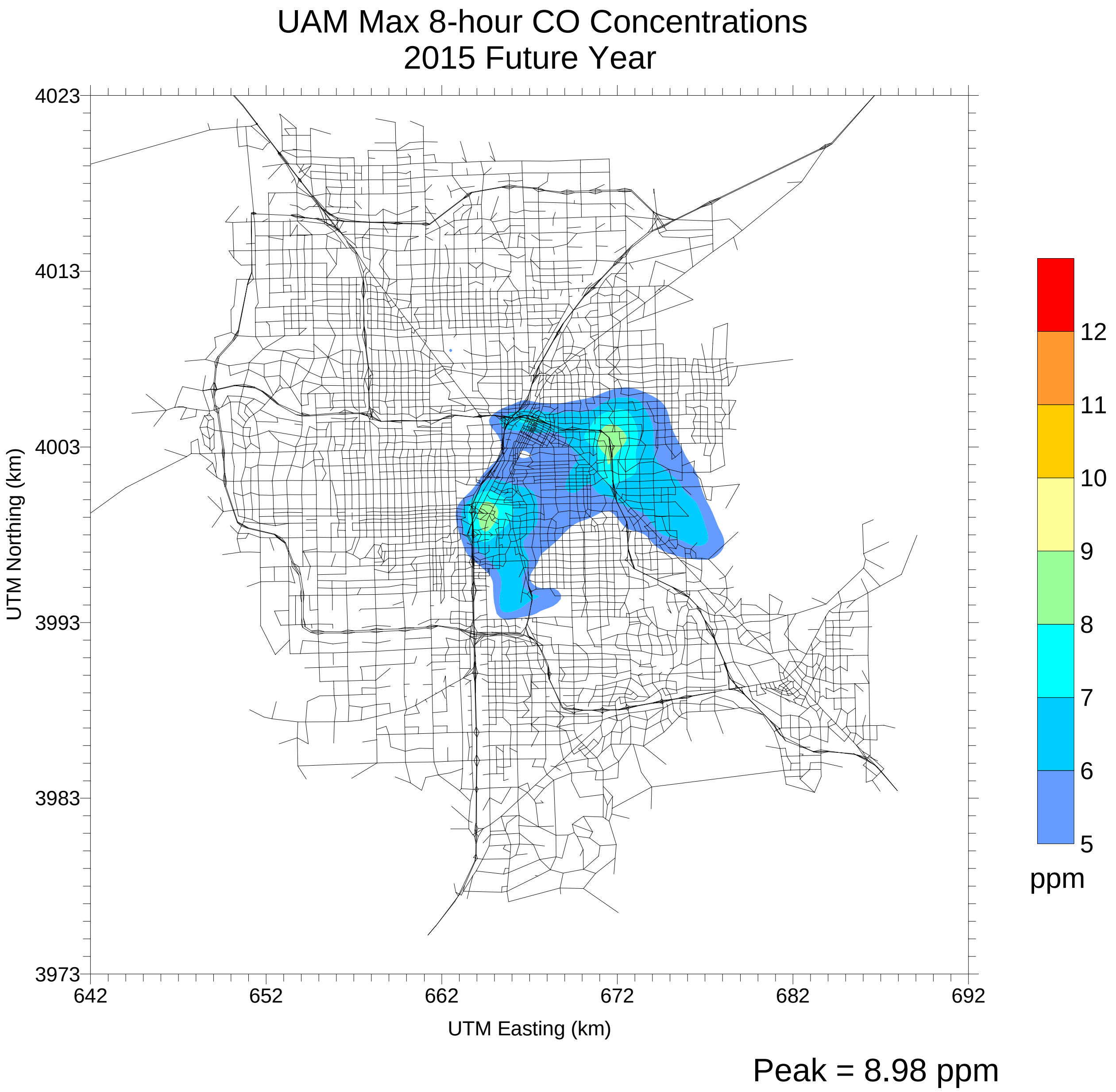

Figure 4-15. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2015 with increased on-road mobile source emissions to reach peak CO just under 9.0 ppm.

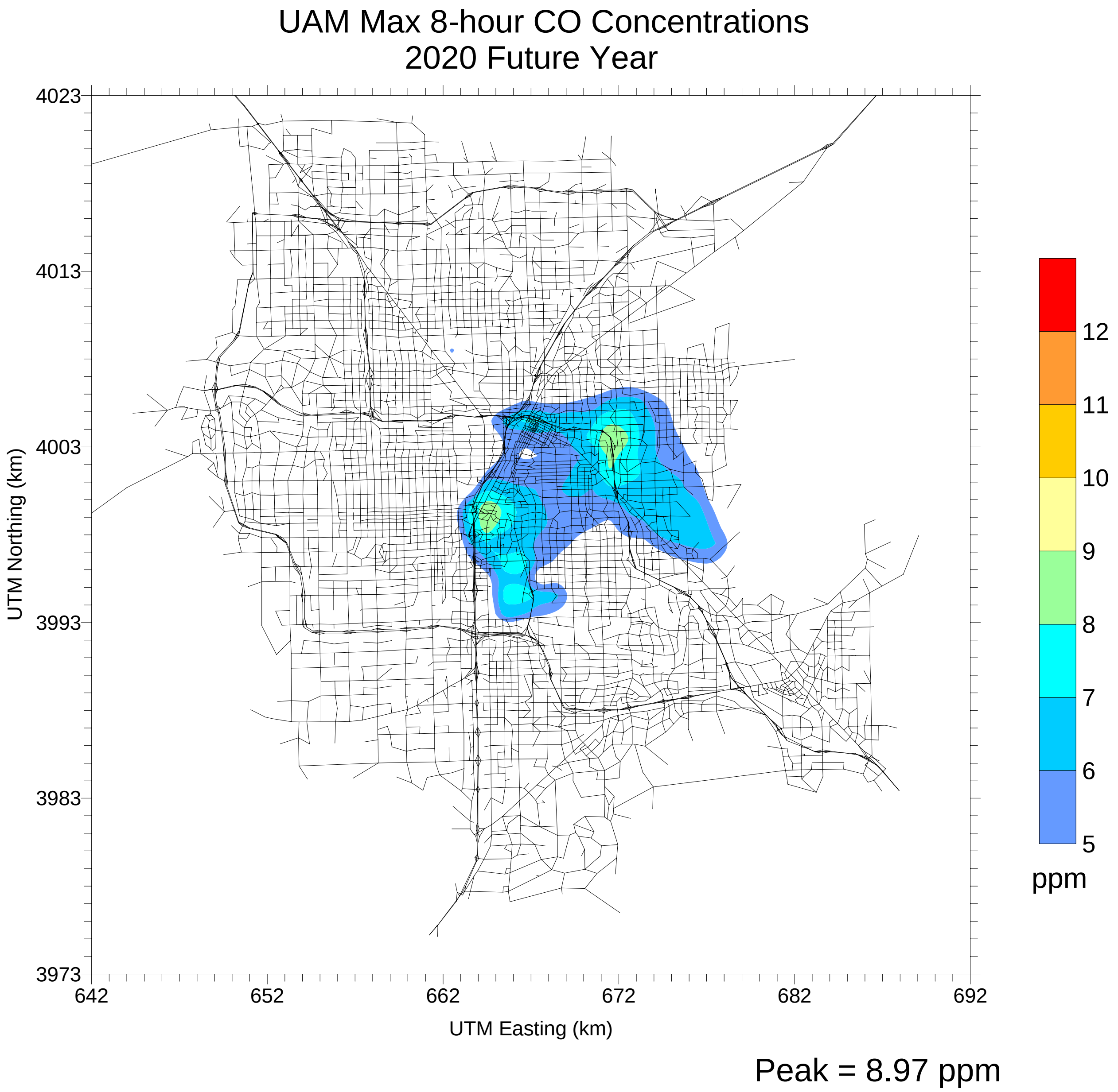

Figure 4-16. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2020 with increased on-road mobile source emissions to reach peak CO just under 9.0 ppm.

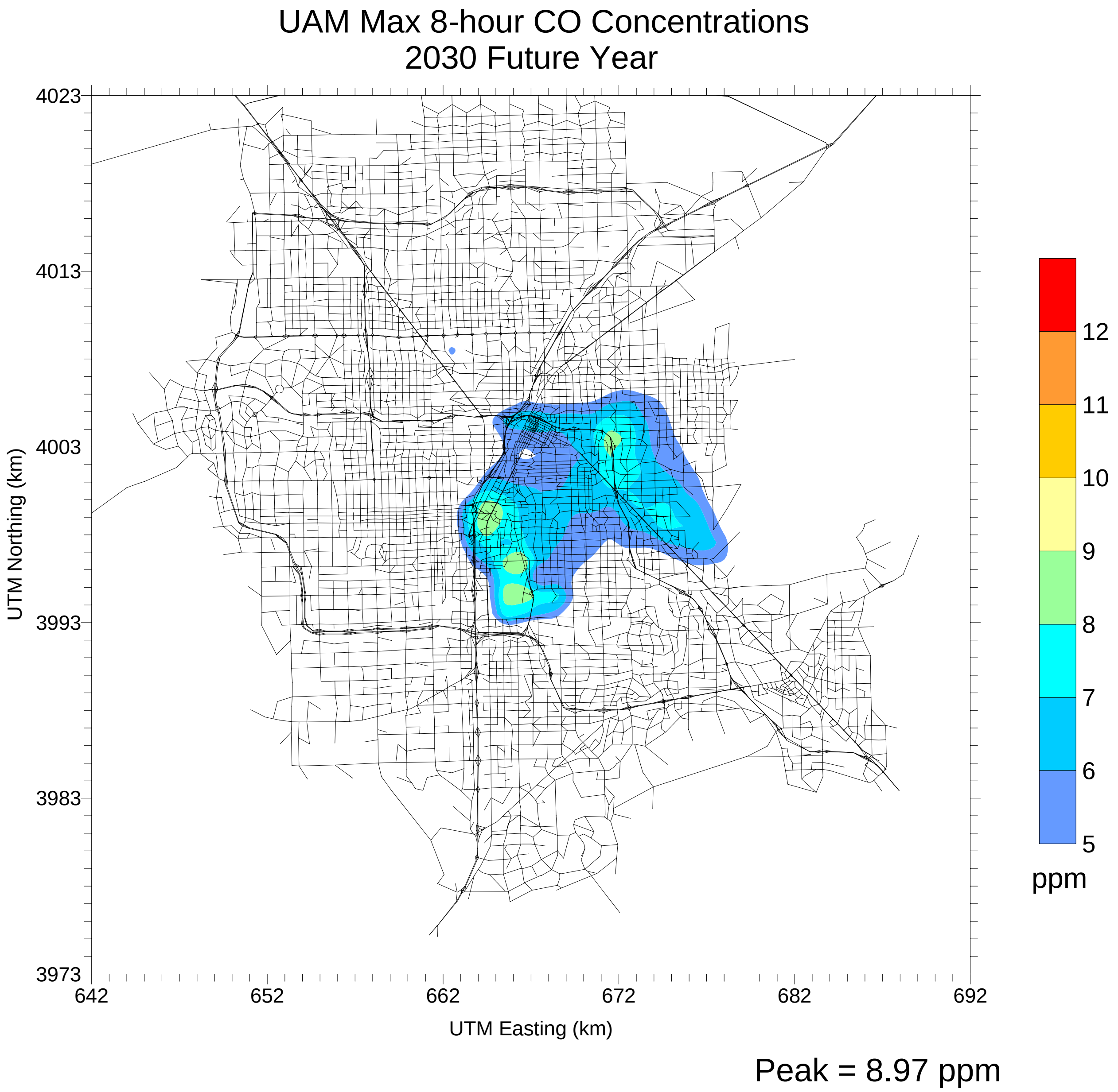

Figure 4-17. Spatial distribution of UAM predicted 8-hour maximum CO concentrations (ppm) for the December 8-9, 1996 episode using emission forecasts for 2030 with increased on-road mobile source emissions to reach peak CO just under 9.0 ppm.

Table 4-10 presents the peak total UAM + EDMS 8-hour CO concentration from the UAM sensitivity runs shown in Table 4-8 (without airports included) at all three airports for each future year evaluated. Note that EDMS results were not scaled up as on-road motor vehicle emissions consist of a fraction of the total EDMS inventory. Values for McCarran are taken from the peak publicly accessible receptor. All peak CO concentrations are below the 9 ppm standard in all years.

Table 4-9. Peak 8-hour average CO concentrations (ppm) predicted by UAM, CAL3QHC, and UAM+CAL3QHC for each future year, and for each of the Five Points intersections. UAM and CAL3QHC results are taken from the on-road sensitivity scaling tests. Note that peaks reported for each of the models and their combined effect occur over different 8-hour periods.

Year	UAM	Eastern/Charleston		Eastern/Fremont		Fremont/Charleston	
		CAL3QHC	CAL3QCH+UAM	CAL3QHC	CAL3QHC+UAM	CAL3QHC	CAL3QHC+UAM
2006	5.92	2.01	7.45	1.57	6.85	0.88	6.17
2010	5.75	1.68	6.97	1.44	6.61	0.87	5.99
2015	5.75	1.64	6.85	1.36	6.54	0.73	5.93
2020	5.73	1.58	6.78	1.31	6.48	0.73	5.88
2030	5.72	1.50	6.84	1.22	6.45	0.73	5.91

Table 4-10. Peak total UAM + EDMS 8-hour CO concentrations (ppm) at all three airports and for all future years evaluated. Values shown for McCarran airport occur at the peak publicly accessible receptor. UAM results are taken from the on-road sensitivity scaling tests.

Airport	2005	2010	2015	2020
McCarran	7.76	7.47	8.09	8.98
Henderson Executive	1.28	1.61	2.74	3.96
North Las Vegas	6.07	6.28	6.14	6.08

5. SUMMARY

The Clark County Department of Air Quality and Environmental Management has updated their UAM CO modeling and conformity analysis using the latest tools, data resources, and methodologies available to estimate CO emissions. From the revised modeling results, Clark County is submitting a revised CO SIP document. The revised modeling is based upon the previous UAM/CAL3QHC/EDMS modeling datasets developed for the December 8-9, 1996 episode and reported in the 2000 CO SIP for Clark County. Specific updates to the emission inventories include modifications to on-road mobile, non-road mobile, civil airports, railroads and point sources. Emission estimates for all remaining categories (mainly stationary area sources and Nellis Air Force Base) were taken from the previous modeling detailed in the 2000 CO SIP submittal, although new spatial distributions were developed for area sources from updated land use projections. The future years modeled in this update include: 2006, 2010, 2015, 2020, and 2030.

5.1 EMISSION UPDATES

The greatest effort in the CO modeling update has focused on the on-road mobile source inventory estimates. The original EPA vehicle emission factor model that was used in the previous SIP effort (MOBILE5b) was replaced by the latest version of the model, MOBILE6.2.03. However, the Air Improvement Resource (AIR) version of this model was used because it provides the capability to create a condensed database of composite emission factors. This is important for applications such as this one where many MOBILE6 scenarios must be run to generate lookup factors for link-level emissions estimates.

Since output data and formats for MOBILE6 are significantly different from its predecessor, the original utility that was used to estimate link-level CO emissions (DTIM) was replaced by two new programs. The first processes the link-based emissions, and the other processes the emissions based on traffic analysis zones (TAZ). Both of the new programs produce inputs for the Emission Processing System, version 3 (EPS3). The EPS3 is the latest version of the EPS program suite used in the original CO SIP modeling to generate gridded, time-resolved, UAM-ready CO emission input files.

For the 1996 base year, the RTC's original TRANPLAN transportation demand model (TDM) output was used to define link-based volume (vehicle miles traveled, or VMT) and other traffic volume-related parameters. However, no trip tables were available, which allow for the separate processing of start versus running emissions. Therefore, trip data from the newer 2000 TransCAD TDM was used as a means to spatially allocate the 1996 start emissions for each period available in the daily TransCAD output. All other original ancillary information, including vehicle fleet mix, seasonal/day-of-week adjustment factors, and hourly activity profiles remain the same as in the original modeling.

For all future years modeled in this update, the RTC provided output from their new TransCAD, which includes link volumes and trip tables for each year. For the link-based data, the same program written for the base year was used to produce the link-based emissions for EPS3. For the TAZ data, most of the same type of MOBILE6 output was used in the program developed for the base year; but start emissions were handled in a special way.

In this CO modeling update, the latest EDMS airport emission estimates developed in 2003 have been included into the UAM emissions inventory. The issue of double-counting airport emissions within the UAM and EDMS+UAM modeling results were carefully considered.

Clark County has updated their railroad emissions estimates for 2001 based on a recent non-road study, which include contributions from both line haul and switching. These have been incorporated into the updated UAM inventory.

The EPA's NONROAD model was used to generate emission inputs to EPS3 for each simulated future year. New spatial and temporal allocation factors were developed based on the latest land use projections from Clark County. Airport ground support equipment (GSE) were removed from the NONROAD estimates because they were included in the EDMS estimates; railroad maintenance emissions were left in since the Mactec emissions were estimated for locomotives only.

Clark County incorporated an updated point source emission inventory, which included revised stack parameters, and which defined Potential To Emit (PTE) levels for seven specific facilities. The UAM future year inventories included the PTE levels plus an additional 70 ton buffer (referred to as "PTE+70") for these sources. The original point source inventory was used, unchanged, for the 1996 base year simulation.

Table 5-1 presents a summary of total daily CO emissions by source category for 1996 base and all future years.

5.2 MODEL APPLICATION

UAM was provided the updated emission inventories for point, on-road mobile, and non-road mobile sources, and run for the December 8-9, 1996 historical CO event. All other environmental parameters were taken from the original modeling as documented in the 2000 CO SIP. A base-year model performance evaluation was conducted for two base cases: (1) using the original NEVES-based non-road emission estimates reported in the 2000 CO SIP; and (2) with revised non-road emission estimates developed using EPA's NONROAD model. The UAM was then used with the updated future year inventories for 2006, 2010, 2015, 2020 and 2030 to determine peak 8-hour CO levels in the basin for the same December 8-9, 1996 conditions. UAM results, without airport emissions included in the inventory, were added to EDMS receptor concentrations from the 2003 updated airport modeling.

For hotspot modeling, the CAL3QHC model was used to model three intersections: Charleston/Eastern, Charleston/Fremont and Eastern/Fremont. EPA (1992, 1995) guidance for screening level modeling of these three intersections was followed. The ambient temperature for each hour of the episode (needed to estimate emissions with the MOBILE6 model), and the wind direction and speed (needed for the CAL3QHC estimates) were taken from the original UAM/CAL3QHC modeling. The CAL3QHC model output was added to the background UAM levels to estimate 8-hour CO concentrations for the duration of the episode.

Table 5-1. Summary of total daily CO emissions (TPD) in the UAM CO SIP revision.

	Base	2006	2010	2015	2020	2030
Sunday 12/8/2005						
On-Road Mobile	329.95	275.30	287.01	276.44	273.09	295.90
Henderson Airport	1.12	1.35	1.59	1.99	2.55	3.69
McCarran Airport	24.69	28.57	33.24	38.14	43.24	53.44
Nellis AFB	2.86	2.86	2.86	2.86	2.86	2.86
North LV Airport	7.58	5.13	5.22	5.35	5.48	5.73
Area Sources	9.18	12.75	14.27	16.20	18.13	21.99
Non-road - NONROAD	66.13	50.49	55.50	60.66	66.21	77.44
Point Sources	3.13	15.82	15.82	15.82	15.82	15.82
Railway	0.17	0.21	0.23	0.24	0.27	0.33
Total	**447.81**	**395.81**	**419.81**	**422.51**	**433.24**	**484.39**
Monday 12/9/2005						
On-Road Mobile	511.43	441.23	463.95	451.30	447.24	485.61
Henderson Airport	0.88	1.07	1.26	1.57	2.01	2.91
McCarran Airport	24.69	28.57	33.24	38.14	43.24	53.44
Nellis AFB	2.86	2.86	2.86	2.86	2.86	2.86
North LV Airport	5.98	4.05	4.12	4.22	4.32	4.52
Area Sources	9.46	13.11	14.65	16.62	18.58	22.50
Non-road - NONROAD	103.40	74.30	80.94	88.52	96.99	114.17
Point Sources	3.13	15.82	15.82	15.82	15.82	15.82
Railway	0.25	0.31	0.34	0.36	0.40	0.48
Total	**669.15**	**591.60**	**627.67**	**630.36**	**643.13**	**715.87**

5.2.1 Base Case Simulations

The UAM base case results show two distinct areas of CO maxima occur in the simulation: (1) near the “elbow” of U.S. 95 in northeast Las Vegas, and (2) along the Las Vegas Boulevard “strip” near the intersection with Spring Mountain Road. Both base case simulations show a domain peak of 10.7 ppm and 11.4 ppm along Las Vegas Boulevard, respectively. This is primarily caused by a large contribution from automobile start emissions during the morning of December 9, which is in turn due to the large concentration of parking structures in that area, according to TransCAD. The secondary maximum reaches above 9 ppm along U.S. 95, and this occurs during the morning commute hours on Monday, December 9. Overall, the spatial pattern of predicted 8-hour maximum CO agrees with the previous modeling performed for the 2000 CO SIP, and with the distribution of observed CO for this period.

Performance statistics were calculated based upon pairings of 8-hour CO predictions and observations across all available monitoring sites for the period, which include standard EPA-method monitoring conducted by Clark County, as well as special saturation monitoring performed for the Las Vegas Phase II field monitoring study (Egami et al., 1998; Emery et al., 1998). Statistics were compared to EPA criteria for acceptable model performance, and all criteria were met. Based upon the statistics calculated for both base cases, UAM performance is quite good and should be considered acceptable. Analysis of time-series of predicted and observed hourly CO concentrations at each monitoring sites showed that the diurnal and neighborhood CO trends are reproduced adequately.

5.2.2 Future Year Simulations

UAM predictions show that the 8-hour CO standard of 9 ppm will not be violated anywhere within the domain. Peak 8-hour CO decreases in each year to 2015, then begins to increase out to 2030:

Year	Peak 8-hour CO
2006	7.4
2010	7.2
2015	6.5
2020	6.7
2030	8.0

In each successive year through 2020, the contribution from on-road mobile sources diminishes, while the peak moves from the U.S. 95 "elbow" in northeast Las Vegas to the northern boundary of McCarran airport along Tropicana Boulevard. Like the 1996 Base Case, a lower secondary peak occurs in the Las Vegas Boulevard area near Spring Mountain Road. Again, the Las Vegas Boulevard – Spring Mountain road area possesses a high concentration of parking structures, which leads to a local maximum in trip starts in TransCAD, and therefore a local maximum in vehicle "start" emissions in the modeling emission inventory. This poses a potential for an actual local emissions "hot spot" in this area. However, Clark County recently undertook a saturation study in 2002 (T&B Systems and Parsons Engineering Science, 2002) to address this possibility. Although the TransCAD, EPS, and UAM modeling show a potential emissions hot spot at Spring Mountain Road and Las Vegas Boulevard, the 2002 saturation study showed no hot spot at all in that location.

5.2.2.1 Micro-scale Modeling

Future year UAM simulation results were used to provide estimates of background ambient CO levels for micro-scale modeling performed for the "Five Points" hot spot intersection and for the three civil airports in the modeling domain (McCarran, Henderson Executive, and North Las Vegas). UAM concentrations from the appropriate grid cells were simply added to the concentrations predicted at each micro-scale receptor to obtain a total (background + micro-scale) CO concentration. Procedures for running CAL3QHC and combining with UAM predictions followed the same methodology as described in the 2000 CO SIP.

Table 5-2 presents the individual peak 8-hour average CO concentrations predicted by UAM, CAL3QHC, and their combination, in each of the future years and for each of the three intersections in the "Five Points" area. Note that the peak 8-hour periods among the UAM, CAL3QHC, and UAM+CAL3QHC results occur at different times. All values are well below the 9 ppm standard.

Table 5-2. Peak 8-hour average CO concentrations (ppm) predicted by UAM, CAL3QHC, and UAM+CAL3QHC for each future year and for each of the Five Points intersections. Note that peaks reported for each of the models and their combined effect occur over different 8-hour periods.

Year	UAM	Eastern/Charleston		Eastern/Fremont		Fremont/Charleston	
		CAL3QHC	CAL3QCH+UAM	CAL3QHC	CAL3QHC+UAM	CAL3QHC	CAL3QHC+UAM
2006	4.89	1.64	6.14	1.28	5.66	0.71	5.09
2010	4.62	1.33	5.61	1.14	5.32	0.69	4.81
2015	4.19	1.16	4.97	0.96	4.76	0.51	4.31
2020	3.97	1.05	4.67	0.88	4.48	0.49	4.07
2030	4.07	1.03	4.83	0.84	4.58	0.50	4.20

In consideration of micro-scale airport modeling, the UAM was re-run for all future years, but airport emissions for the three civil airports in the domain were removed from the UAM inventory to avoid double counting. Clark County provided EDMS simulations for 2005, 2010, 2015 and 2020, based on the work of Ricondo (2003). At McCarran airport, all receptors reporting peak 8-hour CO above the 9 ppm standard in all future years evaluated occur within areas that are not publicly accessible, as defined by Ricondo (2005). Disregarding any receptors in publicly restricted areas removes all exceedance estimates.

Table 5-3 presents the peak total 8-hour CO concentration at all three airports for each future year evaluated. Values for McCarran are taken from the peak publicly accessible receptor. All peak CO concentrations are below the 9 ppm standard in all years.

Table 5-3. Peak total UAM + EDMS 8-hour CO concentrations (ppm) at all three airports and for all three future years evaluated. Values shown for McCarran airport occur at the peak publicly accessible receptor.

Airport	2005	2010	2015	2020
McCarran	7.47	7.14	7.60	8.45
Henderson Executive	1.12	1.36	1.99	3.05
North Las Vegas	5.01	5.04	4.46	4.19

5.2.2.2 Estimating On-Road Emission Budgets

The UAM was used to undertake several sensitivity tests to refine the estimation of future year on-road mobile CO emission budgets for the central, most urbanized portion of the modeling domain. The first analysis tested the assertion that the emissions inventory outside of the central urban sub-domain has no significant impact on CO concentrations downtown, along the Las Vegas Boulevard “strip”, and in traditional “hot spot” areas. Emissions in the outer grid area were doubled for each future year, and the UAM was run to show the incremental impact on the peak CO concentration. As shown in Table 5-4, peak 8-hour CO concentrations changed by a maximum of only 0.07 ppm. There was no change in the location of the predicted peak. This demonstrates that the model-predicted peak CO is driven by local emission sources in the central urban sub-domain, and is therefore insensitive to large changes in emissions in outer areas

Table 5-4. Change in peak 8-hour CO from doubling the total CO emissions inventory outside of the central urban sub-domain.

Year	Peak 8-hour CO (ppm)	
	Future Year Peak	**Doubled Outer Emissions**
2006	7.37	7.41
2010	7.17	7.24
2015	6.47	6.54
2020	6.74	6.80
2030	7.96	8.03

In the second analysis, future year on-road mobile source emissions were scaled up across the entire modeling domain to the point at which the peak 8-hour CO concentration reached 8.9 ppm. Additionally, the on-road mobile source emissions outside the central urban sub-domain were increased by an additional 70% in each year to reach a maximum peak 8-hour CO concentration of just under 9.0 ppm. This additional 70% increase is intended to capture the large expected growth in vehicular activity in the outer areas of the domain. Hence, the resulting daily on-road emission totals for December 9 can be used to establish future-year emission budgets. Results from this analysis are presented in Table 5-5. There was no change in the location of the predicted peak. No additional hot spots were generated anywhere in the domain by increasing the on-road mobile source emissions in the outer portion of the domain by 70%.

Table 5-5. Weekday domain-wide on-road emission increase, net on-road emission increase that includes an additional 70% increase outside the central urban sub-domain, resulting UAM predicted peak CO, and resulting total and sub-domain on-road emission budgets for each future year.

Year	Domain-Wide On-Road Emissions Increase	Net On-Road Emissions Increase	Peak 8-hr CO (ppm)	Total Domain On-Road Emissions (TPD)	Sub-Domain On-Road Emissions (TPD)
2006	23%	41%	8.96	623	427
2010	26.5%	49%	8.98	690	438
2015	41.5%	70%	8.98	768	453
2020	50%	83%	8.97	817	463
2030	46%	81%	8.97	881	464

Future year CAL3QHC intersection results were similarly scaled up by the domain-wide on-road emission increases shown in the second column of Table 5-5. Table 5-6 presents the individual peak 8-hour average CO concentrations predicted by UAM, CAL3QHC, and their combination, in each of the future year sensitivity runs above and for each of the three intersections in the “Five Points” area. Note that the peak 8-hour periods among the UAM, CAL3QHC, and UAM+CAL3QHC results occur at different times. All values remain well below the 9 ppm standard.

Table 5-6. Peak 8-hour average CO concentrations (ppm) predicted by UAM, CAL3QHC, and UAM+CAL3QHC for each future year and for each of the Five Points intersections. UAM and CAL3QHC results are taken from the on-road sensitivity scaling tests. Note that peaks reported for each of the models and their combined effect occur over different 8-hour periods.

Year	UAM	Eastern/Charleston		Eastern/Fremont		Fremont/Charleston	
		CAL3QHC	CAL3QCH+UAM	CAL3QHC	CAL3QHC+UAM	CAL3QHC	CAL3QHC+UAM
2006	5.92	2.01	7.45	1.57	6.85	0.88	6.17
2010	5.75	1.68	6.97	1.44	6.61	0.87	5.99
2015	5.75	1.64	6.85	1.36	6.54	0.73	5.93
2020	5.73	1.58	6.78	1.31	6.48	0.73	5.88
2030	5.72	1.50	6.84	1.22	6.45	0.73	5.91

Table 5-7 presents the peak total UAM + EDMS 8-hour CO concentration from the UAM sensitivity runs (without airports included) at all three airports for each future year evaluated. Note that EDMS results were not scaled up as on-road motor vehicle emissions consist of a fraction of the total EDMS inventory. Values for McCarran are taken from the peak publicly accessible receptor. All peak CO concentrations are below the 9 ppm standard in all years.

Table 5-7. Peak total UAM + EDMS 8-hour CO concentrations (ppm) at all three airports and for all future years evaluated. Values shown for McCarran airport occur at the peak publicly accessible receptor. UAM results are taken from the on-road sensitivity scaling tests.

Airport	2005	2010	2015	2020
McCarran	7.76	7.47	8.09	8.98
Henderson Executive	1.28	1.61	2.74	3.96
North Las Vegas	6.07	6.28	6.14	6.08

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