INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
We Protect Hoosiers and Our Environment.

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Governor

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April 26, 2012

Ms. Susan Hedman
Regional Administrator
U.S. Environmental Protection Agency
Region V
77 West Jackson Boulevard, R-19J
Chicago, IL 60604-3950

Dear Ms. Hedman:

Re: Technical Addendum to Provide Updated Recommendations Concerning Air Quality Designations for the 2010 1-Hour National Ambient Air Quality Standard for Sulfur Dioxide (SO_2)

The Indiana Department of Environmental Management (IDEM) has prepared this technical addendum to provide updated designation recommendations concerning the 2010 1-Hour National Ambient Air Quality Standards (NAAQS) for sulfur dioxide (SO_2).

Indiana's initial designation recommendations for the 2010 revised 1-Hour SO_2 NAAQS were sent to the United States Environmental Protection Agency (U.S. EPA) on May 11, 2011. A technical addendum with updated recommendations was sent to U.S. EPA on January 6, 2012. Since that time, 2011 1-hour SO_2 monitoring data for the State of Indiana has been quality assured. Based on the 2009 through 2011 1-hour SO_2 monitoring data, Indiana wishes to update its nonattainment recommendations. Specifically, Indiana is now recommending Fulton Township in Fountain County, Eugene Township in Vermillion County and Montgomery Township in Gibson County as unclassifiable. See Enclosure 2 for a summary table of the changes to Indiana's designation recommendations.

The following enclosures are included with this letter:

- Enclosure 1: 2000 through 2011 Indiana 1-hour SO_2 Monitoring Data
- Enclosure 2: Changes to Indiana's Designation Recommendations
- Enclosure 3: Map of Indiana SO_2 Designation Recommendations
- Enclosure 4: Fountain County SO_2 Missing Data Analysis

As outlined in Enclosure 4, the 2009 through 2011 monitoring design value for the Fountain County, Indiana monitor is incomplete. Indiana has completed an analysis regarding the missing data for the first quarter of 2011. The analysis shows that the Fountain County monitor value should be deemed well below the 1-hour SO_2 standard.

Indiana reserves the right to supplement and/or revise the recommendations contained herein as additional monitoring and modeling information become available. I appreciate the opportunity to provide updated designation recommendations to U.S. EPA concerning the SO_2 NAAQS. Likewise, I look forward to working with your staff as U.S. EPA moves forward with the designation process. If you have questions regarding Indiana's recommendations, please feel free to contact me at (317) 232-8611 or Keith Baugues, Assistant Commissioner, Office of Air Quality, at (317) 232-8222.

Sincerely

Thomas W. Easterly
Commissioner

TWE/sad/skr
Enclosures

Enclosure 1: 2000 through 2011 Indiana 1-hour SO_2 Monitoring Data
Enclosure 2: Changes to Indiana's Designation Recommendations
Enclosure 3: Map of Indiana SO_2 Designation Recommendations
Enclosure 4: Fountain County SO_2 Missing Data Analysis

cc: George Czerniak, U.S. EPA Region V
John Mooney, U.S. EPA Region V
John Summerhays, U.S. EPA Region V
Keith Baugues, IDEM-OAQ
Scott Deloney, IDEM-OAQ
Christine Pedersen, IDEM-OAQ
Sarah Raymond, IDEM-OAQ

Enclosure 1

Indiana 1-Hour SO_2 Monitoring Data Summary

(January 1, 2000 through December 31, 2011)

NOTE: U.S. EPA established a new 1-hour primary SO_2 standard on June 2, 2010. The new 1-hour standard is 75 parts per billion (ppb). Attainment is determined by evaluating the three-year average of the 99th percentile (4th high) values of the daily maximum 1-hour average at each monitor within an area, which must not exceed 75 ppb. Starting with the 2008-2010 design values, any three-year design value over the new 1-hour SO_2 standard has been highlighted. Data prior to this was compared to the Annual and 24-hour SO_2 standards and the 99th percentile values and 3-year design values from 2000 to 2007 are included for reference purposes only.

			99th Percentile Values (4th High) (ppb)												Three-Year Design Value (ppb)									
County	Site ID	Site Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	00-02	01-03	02-04	03-05	04-06	05-07	06-08	07-09	08-10	09-11
Daviess	180270002	West off of SR 57	120	119	119	107	131	91	135	112	122	138	115	100	119	115	119	110	119	113	123	124	125	118
Dearborn	180290004	Lawrenceburg - Tate St	179	164	245	181	237	166	102	61	Monitor Discontinued				196	197	221	195	168	110	82	61	Monitor Discontinued	
Floyd	180430004	0.2 mile North of Bald Knob Rd at Wlky Tower	130	98	115	151	152	159	123	139	117	87	72	36	114	121	139	154	145	140	126	114	92	65
Floyd	180430007	New Albany - Falling Run	170	120	68	67	74	157	158	164	192	68	75	Monitor Discontinued	119	85	70	99	130	160	171	141	112	Monitor Discontinued
Floyd	180431004	New Albany - Green Valley Elementary Sch	163	151	119	173	174	158	177	194	138	125	123	38	144	148	155	168	170	176	170	152	129	95
Fountain	180450001	N of SR 234, E of Wabash River	104	118	114	127	125	180	169	200	236	38	26	29	112	120	122	144	158	183	202	158	100	31
Gibson	180510001	E - SE of Plant	103	106	86	82	135	122	101	103	56	44	45	Monitor Discontinued	98	91	101	113	119	109	87	66	48	Monitor Discontinued
Gibson	180510002	Gibson Coal Rd	279	203	194	266	226	154	265	136	90	65	74	68	225	221	229	215	215	185	164	97	76	69
Hendricks	180630001	CR 800 N and CR 275 E	Monitor began operation in 2004				43	30	18	4	Monitor Discontinued				Monitor began operation in 2004		43	37	30	17	Monitor Discontinued			
Hendricks	180630002	Pittsboro - N Meridian St	Monitor began operation in 2004				49	40	37	46	32	34	Monitor Discontinued		Monitor began operation in 2004		49	45	42	41	38	37	33	Monitor Discontinued
Hendricks	180630003	Lizton - Pittsboro High Sch	Monitor began operation in 2004				48	33	30	46	Monitor Discontinued				Monitor began operation in 2004		16	27	37	36	38	46	Monitor Discontinued	
Jasper	180730002	Wheatfield - Center St	74	60	44	66	44	58	64	49	61	88	39	32	59	57	51	56	55	57	58	66	63	53
Jasper	180730003	Asphaltum Substation	31	47	44	Monitor Discontinued									41	46	44	Monitor Discontinued						
Jefferson	180770004	Wilson Ave	68	64	95	62	81	90	Monitor Discontinued						76	74	79	78	86	90	Monitor Discontinued			
Lake	180890022	Gary - IITRI	79	87	80	75	111	115	78	66	67	59	57	58	82	81	89	100	101	86	70	64	61	58
Lake	180892008	Hammond - 141st St	105	115	53	72	39	42	36	50	37	37	34	40	91	80	55	51	39	43	41	41	36	37
LaPorte	180910005	Michigan City - 341 W 4th St	32	37	33	31	31	29	27	26	29	23	30	19	34	34	32	30	29	27	27	26	27	24
LaPorte	180910007	Michigan City - Cool Spring Substation	45	29	28	Monitor Discontinued									34	29	28	Monitor Discontinued						
Marion	180970042	Indianapolis - Mann Rd	67	72	61	89	71	117	92	68	Monitor Discontinued				67	74	74	92	93	92	80	68	Monitor Discontinued	
Marion	180970057	Indianapolis - S Harding	89	98	111	122	116	103	127	122	79	75	103	63	99	110	116	114	115	117	109	92	86	80
Marion	180970073	Indianapolis - E 16th St	66	73	82	78	92	79	69	51	29	61	48	60	74	78	84	83	80	66	50	47	46	56
Marion	180970078	Indianapolis - Washington Park										Monitor began operation in 2010	20	60							Monitor began operation in 2010		20	40
Morgan	181091001	Martinsville - High Street	Monitor began operation in 2004				130	141	108	140	91	98	105	96	Monitor began operation in 2004		130	136	126	130	113	110	98	100
Perry	181230006	Tell City - Old Brushy Fork Rd	124	201	157	147	147	Monitor Discontinued							161	168	150	147	147	Monitor discontinued				
Perry	181230007	Tell City - Waupaca Foundry	125	178	148	179	123	Monitor Discontinued							150	168	150	151	123	Monitor discontinued				
Pike	181250005	E Arda Lane	107	155	130	183	151	119	161	172	205	194	211	119	131	156	155	151	144	151	179	190	203	175
Porter	181270011	Dune Acres Substation	62	53	57	53	59	74	55	62	82	51	62	44	57	54	56	62	63	64	66	65	65	52
Spencer	181470002	Highway 245	86	78	Monitor Discontinued										82	78	Monitor Discontinued							
Spencer	181470010	Honeycreek	Monitor began operation in 2002		72	62	84	69	65	46	Monitor Discontinued				73	67	73	72	73	60	56	46	Monitor Discontinued	
Sullivan	181530004	SR 154	52	47	52	54	60	54	45	Monitor Discontinued					50	51	55	56	53	50	45	Monitor Discontinued		
Vanderburgh	181630012/21	Evansville - Buena Vista	97	82	64	85	72	66	67	69	41	17 [1]	19	19	81	77	74	74	68	67	59	43 [2]	26 [3]	18 [4]
Vanderburgh	181631002	Roth Rd	33	33	33	45	79	60	21	27	43	14	18	14	33	37	52	61	53	36	30	28	25	15
Vigo	181670018	Terre Haute - Lafayette Ave	99	104	69	83	130	100	99	90	120	115	61	95	91	85	94	104	110	96	103	108	99	91
Vigo	181671014	Terre Haute - Ft Harrison Rd	143	204	129	143	134	138	104	133	137	142	169	139	159	159	135	138	125	125	125	137	149	150
Warrick	181730002	200 Yards S of S 650 & 1/4 Mile E of W 400	253	233	202	217	238	143	199	103	111	38	18	Monitor Discontinued	229	217	219	199	193	148	138	84	56	Monitor Discontinued
Wayne	181770006	Richmond - S 9th St	101	107	109	96	101	126	95	100	109	70	109	82	106	104	102	108	107	107	101	93	96	87
Wayne	181770007	Richmond - Boston Pike	101	102	94	113	96	91	67	96	104	Monitor Discontinued			99	103	101	100	85	85	89	Monitor Discontinued		

One Year of Data Two Years of Data Incomplete Data Design Value greater than or equal to 76 ppb

[1] The 99th percentile value for 2009 was found by using the first 6 months of data from West Mill Rd (163-0012) and the last 6 months of data from Buena Vista (163-0021)

[2] The (07-09) 3-yr design value was calculated by using West Mill Rd (163-0012) for 2007, 2008 and West Mill Rd (163-0012) and Buena Vista (163-0021) for 2009

[3] The (08-10) 3-yr design value was calculated by using West Mill Rd (163-0012) for 2008, West Mill Rd (163-0012) and Buena Vista (163-0021) for 2009 and Buena Vista (163-0021) for all of 2010.

[4] The (09-11) 3-yr design value was calculated by using West Mill Rd (163-0012) and Buena Vista (163-0021) for 2009 and Buena Vista (163-0021) for all of 2010 and 2011.

Enclosure 2
Changes to Indiana's Designation Recommendations

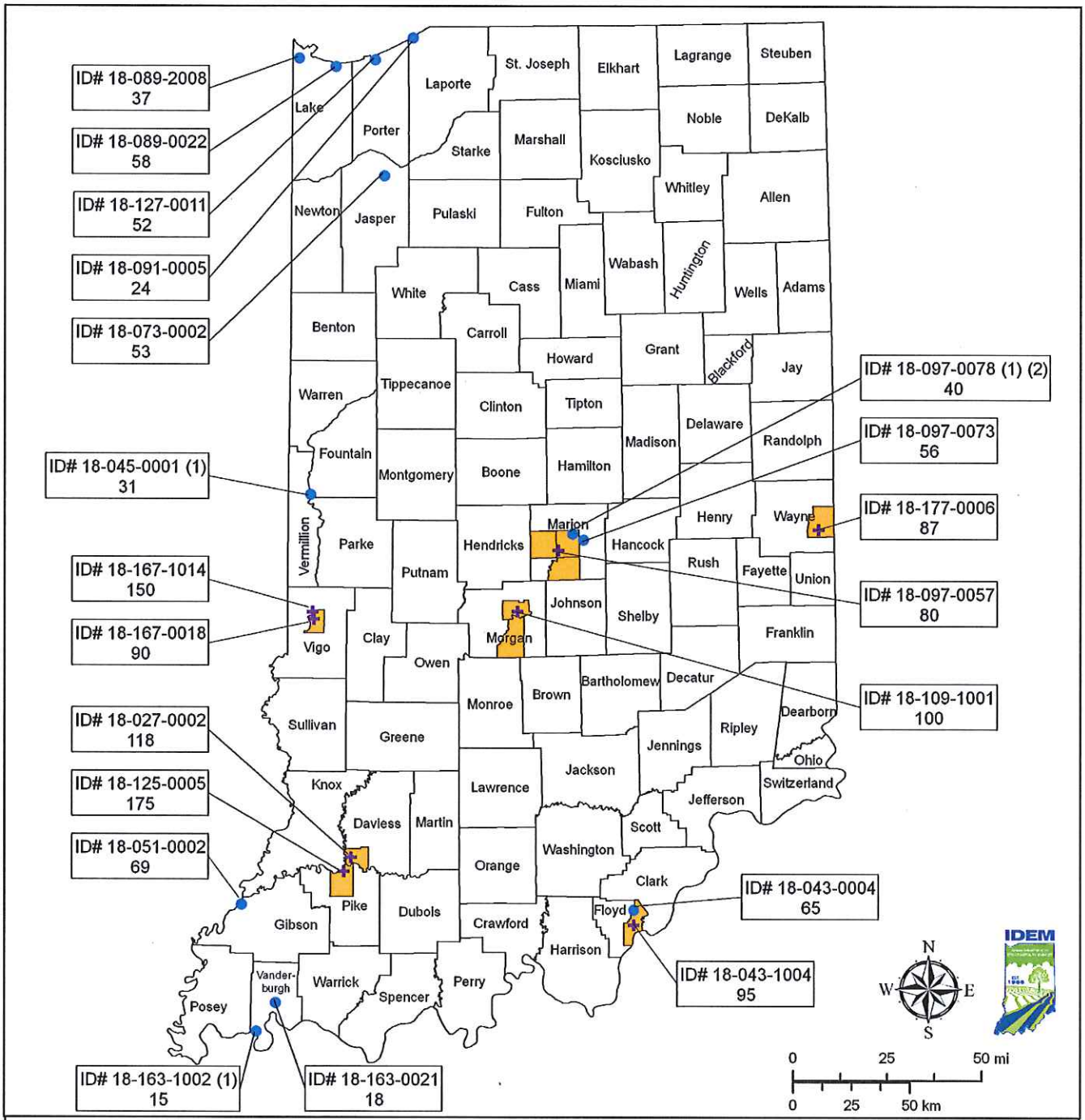
County (Monitor ID)	2009-2011 Design Value (ppm)	Indiana's Updated Designation Recommendations for 1-hour SO_2 NAAQS
Fountain (180450001)	31	Entire County Unclassifiable
Gibson (180510002)	69	Entire County Unclassifiable
Vermillion		Entire County Unclassifiable

Incomplete Data

Note: There is no SO_2 monitor in Vermillion County.

Enclosure 3

Map of Indiana 1-Hour SO2 Designation Recommendations



This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Mapped By: S. Raymond, Office of Air Quality
Date: 3/1/2012

Non Orthophotography Data - Obtained from the State of Indiana Geographical Information Office Library and OAQ
Orthophotography- Obtained from Indiana Map Framework Data (www.indianamap.org)

Map Projection: UTM Zone 16 N Map Datum: NAD83

Legend

- SO_2 Monitor with Design Value Less Than 76 ppb.
- SO_2 Monitor with Design Value Greater Than Or Equal To 76 ppb.
- Proposed Nonattainment Area
- Unclassifiable Area

Notes:
- Values posted are in units of ppb.
- SO_2 Design Value Based on 2009 - 2011 Data.
(1) Based on incomplete data.
(2) Based on two years of data.

Enclosure 4

Missing Data Analysis for Cayuga monitor #18-045-0001, Fountain County Indiana

Estimation of Missing SO2 Monitor Values

Problem: The 1st quarter of 2011 SO_2 hourly ambient monitoring data from the Cayuga monitor, (ID# 18-045-0001) located in Fountain County, did not meet the 75% completeness requirements to calculate a valid design value for the 3-year, 1-hour primary standard for SO_2.

Goal:

Estimate missing daily 1-hour max SO_2 values at the Cayuga monitor (#18-045-0001) from 1/12/2011 to 3/3/2011, and calculate the three year design value for the 1-hour SO_2 NAAQS.

Methods:

Two separate analyses were performed to evaluate the potential of the Cayuga 1-hour SO_2 monitor having an exceedance of the 1-hour standard during a time period where the monitor was not functioning. One method followed U.S. EPA's recommendations as outlined in the Primary National Ambient Air Quality Standard for Sulfur Dioxide. The other was a multiple linear regression using continuous emissions monitoring information and meteorological data.

SO_2 Design Value Substitution Method for 2009-2011 data years at the Cayuga Monitor (ID# 18-045-0001), located in Fountain County, Indiana

Substitution Method

As per the "test design value" method described in Appendix T of the 2010 Primary National Ambient Air Quality Standard for Sulfur Dioxide (75 Federal Register 35596), in the case where a design value is calculated using data which does not meet the 75% completeness requirements, the U.S. EPA allows the use of a substitution test to validate the design value. If the design value (calculated using data from a quarter with less than 75% data capture) is less than or equal to the 75 ppb SO_2 primary NAAQS standard, the substitution test requires use of the highest reported daily maximum 1-hour value from the same site for the same quarter (in this case, the 1st quarter) within the three year span under consideration as a substitute for missing data values. This substitution method was considered valid at this site because there were at least 200

days with valid monitoring data across the three quarters under consideration (1st quarter for years 2009, 2010 and 2011), which met the 75% completeness requirements. The table below summarizes the number of days with valid monitoring data from 1st Quarter, 2009-2011 for Monitor ID#18-045-0001.

Table 1. Monitor ID#18-045-0001: number of 1st quarter days from 2009-2011 with valid monitoring data (must be >200).

2009	2010	2011	**Total Days**
90	90	39	**219**

After ranking all of the 1st quarter daily maximum values for 2009-2011 (including days with less than 75% data capture) from highest to lowest, it was determined that the highest daily maximum reported concentration was 51 ppb. There were 51 reported missing days in the 1st quarter of 2011 at the Cayuga monitor (from 1/12/2011 to 3/3/2011), for which 51 ppb was substituted.

The U.S. EPA method for calculating the 3-year, 1-hour primary standard design value was then applied using the substituted data (75 FR 35597). Table 2 shows the procedure for determining which value to use as the 99th percentile value. For all three years under consideration, the 4th highest value was determined to be the 99th percentile value for that year.

Table 2. Determination of 99th percentile value rank.

Year	Annual number of days with valid data (>75% hours in day)
2009	365, $P_{0.99}$ = 4th highest value
2010	365, $P_{0.99}$ = 4th highest value
2011	306, $P_{0.99}$ = 4th highest value

Design Values: Table 3 shows the values used to calculate the test design value. This was calculated by taking the mean of the 4th highest value for each year from 2009-2011 after ranking all daily maximum values from highest to lowest. The calculated test design value using the substituted data for the 1st quarter of 2011 was 38.3 ppb. Note that the 2011 data uses the substituted 51 ppb value.

The test design value of 38.3 ppb is below the 3-year, 1-hour primary standard for SO_2, thus the data has passed the diagnostic test and is deemed valid. A valid 3-year design value was then calculated using the data actually reported for the period. The results of this analysis are presented in Table 4.

Table 3. Monitor ID#18-045-0001: 3-year Test Design Value for 2009-2011.

Year	Date	Max Daily Value of Hourly SO2 (ppb)
2009	2/5/2009	49
	1/12/2009	43
	12/16/2009	41
	2/6/2009	**38 ($P_{0.99}$)**
2010	2/1/2010	32
	1/13/2010	28
	12/10/2010	28
	3/30/2010	**26 ($P_{0.99}$)**
2011	3/20/2011	51*
	3/20/2011	51*
	3/20/2011	51*
	3/20/2011	**51* ($P_{0.99}$)**
2009-2011 Test Design Value		**38.3**

Table 4. Monitor ID#18-045-0001: 3-year Design Value for 2009-2011.

Year	Date	Max Daily Value of Hourly SO2 (ppb)
2009	2/5/2009	49
	1/12/2009	43
	12/16/2009	41
	2/6/2009	**38 ($P_{0.99}$)**
2010	2/1/2010	32
	1/13/2010	28
	12/10/2010	28
	3/30/2010	**26 ($P_{0.99}$)**
2011	3/20/2011	51
	12/12/2011	37
	11/18/2011	30
	12/11/2011	**29 ($P_{0.99}$)**
2009-2011 Design Value		**31**

*substituted highest reported daily maximum value across 1st Quarter from 2009-2011

Utilizing the U.S. EPA's method for substitution of missing 1-hour SO_2 ambient monitoring data, it was determined that a valid 3-year design value could be calculated for the Cayuga monitor (ID# 18-045-0001) for data years 2009-2011. The calculated design value of 31 ppb demonstrates that the Cayuga site is below the 75 ppb NAAQS 1-hour primary standard for SO_2.

Multiple Linear Regression

The multiple linear regression used continuous emissions monitoring (CEMs) data from the primary source of SO_2 and compared the concentrations to the ambient monitor (EGU located 2.72 miles south-southwest of the monitor) as well as factored in meteorological data (from a monitor located in Carroll County). This method statistically fills in the missing data by performing a multi variable correlation analyses from the CEMs data during the time the ambient air monitor was not operational.

Below is a table of variables used in the regression. All data are the available daily values between January 1, 2009 and May 31, 2011 (n=643).

Variable	Description	Type
monitor	Maximum 1-hour SO2 value (ppb)	Continuous
maxemit	Maximum one hour emissions (lbs)	Continuous
meanemit	Mean 24-hour SO2 emissions (lbs)	Continuous
maxdirection	Resultant 1-hour wind direction corresponding to the maximum 1-hour monitor value for the day—binary variable using a 90 degree wedge in reference to the source and its likely impact on the monitor	Indicator
meandirection	Resultant 24-hour wind direction—binary variable using a 90 degree wedge in reference to the source and its likely impact on the monitor	Indicator
maxtemp	Maximum 1-hour temperature (°F)	Continuous
meantemp	Mean 24-hour temperature (°F)	Continuous
maxhumid	Maximum 1-hour relative humidity (%)	Continuous
meanhumid	Mean 24-hour relative humidity (%)	Continuous

Model:

The following model was used for the regression,

$$monitor_t = monitor_{t-1} + monitor_{t-5} + (maxdirection_t \times maxemit_t) + (maxdirection_t \times \sqrt{maxemit_t}) + (maxdirection_t \times \log(maxemit_t)) + (maxdirection_t \times e^{-maxemit_t}) + (meandirection_t \times e^{-meanemit_t}) + maxhumid_t + \sqrt{maxhumid_t} + \log(maxhumid_t) + \sqrt{meanhumid_t} + maxtemp_t + \sqrt{maxtemp_t} + \log(maxtemp_t) + meantemp_t$$

where $monitor_{t-1}$ is the monitor value from the previous day, and $monitor_{t-5}$ is the monitor value from the fifth previous day.

Regression Statistic	Value
Adjusted Correlation Coefficient (r)	0.4839
Adjusted Coefficient of Determination (r^2)	0.2342
Standard Error (SE)	5.209
P-value	0.000

Results:

The three year design value for the monitor for years 2009, 2010, and 2011 was calculated to be 33.9 ppb.

Instead of creating a confidence interval using an arbitrary confidence level, an upper confidence estimate was created by comparing the fitted values from the model to the actual model results for every day from 1/12/2010 to 3/3/2010 (the same time period being estimated in 2011). The largest absolute error between the modeled fitted values and the observed monitor values was found (26.19 ppb). One-step-ahead prediction was performed for the missing monitor days, and 26.19 ppb was added to every predicted value. These upper confidence limit estimates were then combined with the valid monitor values from 2011 and the 99th percentile was found (37.72 ppb).

The r^2 for the model is not particularly high, and the mean absolute percentage error for prediction (calculated for the last 10 days of May, 2011) was also not particularly good (63%). There are several possible reasons for the low r^2 value. This may be because local meteorological data was not available. There may also be another unidentified local source of SO_2 that is impacting the monitor. Also, the regional background could fluctuate appreciably, adding a significant amount of noise to the data. The r^2 could possibly still be improved by finding another set of meteorological data that is a better representation of the local conditions at this monitor. It might also be improved by using emissions data from other local sources, and/or including estimations of the regional SO_2 background concentration.

The inclusion of so many different transformations on a single variable (specifically, the maxemit variable is included as $\sqrt{\text{maxemit}}$, $\log(maxemit)$, and $\exp(-maxemit)$) indicates that the model may be finding small variations in the data that are not from the signal (i.e., it's describing patterns in the noise). This would cause problems for prediction. However, these terms were added because they each, individually, have a high correlation with the response variable, when compared to all of the other explanatory variables considered for the model. It may be desirable to remove some of the transformed versions of the same variable to obtain a more parsimonious model, but this would result in a lower r^2 for the model.

Conclusion:

Both evaluation methods derived design values that were well below the regulatory standard. Both evaluations applied conservative factors to the analyses to give a "high end' value. Even with this level of conservatism included in the analyses, the design value was just over half the regulatory limit. The independent evaluations of the missing data also derived values that were close to each other which adds to the weight of evidence that the methods are accurate. These two analyses demonstrate that it is extremely unlikely that SO_2 concentrations during the time of the missing ambient air monitoring data would have been at levels to cause a violation of the standard.