EXPERT REPORT OF DAVID KEEN, QEP

IN THE MATTER OF PORT ARTHUR STEAM ENERGY, L.P. V.
OXBOW CALCINING LLC

September 10, 2019

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1.0 QUALIFICATIONS

My name is David Keen. I received a Master's degree in Environmental Management from Duke University in 1987. In 1999, I received certification from the Institute of Professional Environmental Practice as a Qualified Environmental Professional (QEP). I am currently a Senior Project Manager with RTP Environmental Associates, Inc., working from the company's office in Raleigh, North Carolina. My primary area of expertise is air quality with an emphasis on atmospheric dispersion modeling, industrial air permitting and compliance. I have 31 years of experience providing dispersion modeling, regulatory compliance planning and permitting services to a wide range of industrial sources located throughout the country. I have provided testimony and reviewed modeling evaluations in support of contested permit applications. I have performed dispersion modeling analyses using EPA-approved procedures and models as well as other proprietary modeling packages. My complete CV is attached to this report as Exhibit 1. Information regarding my trial testimony is listed in Exhibit 2. My employer is being paid an hourly rate of $325 for work in preparing and providing testimony in this case. Compensation for my services is not contingent upon the findings and conclusions identified herein.

2.0 PURPOSE

In March of 2017, I was engaged by Dunn & Neal, LLP on behalf of the plaintiff to conduct an ambient air dispersion modeling analysis of emissions of sulfur dioxide (SO_2) from the Oxbow Calcining (Oxbow) facility located near Port Arthur, Texas.

Specifically, I was asked to provide my opinion on three issues:

1. Whether the operation of the Oxbow facility in either the "hot" stack mode or "cold" stack mode would lead to ground-level concentrations in excess of the 75 parts per billion (196 μg/m^3) National 1-hour (hr) National Ambient Air Quality Standard (NAAQS) for SO_2;

2. Whether the Texas Commission on Environmental Quality's (TCEQ) ambient SO_2 monitor was located in an area that would capture the highest ambient concentrations near the Oxbow facility under either the "hot" stack mode or "cold" stack mode of operation; and,

3. Whether the addition of SO_2 controls and/or stack height modifications would allow the facility to comply with the 1-hr SO_2 NAAQS.

My conclusions are based upon my experience performing atmospheric dispersion modeling analyses my general knowledge of available models and modeling techniques, current and historic EPA modeling guidance and regulations, and the models that I developed for the site.

3.0 SUMMARY OF KEY FINDINGS AND OPINIONS

Based on the results of the modeling I conducted for the Oxbow facility, I conclude the following:

- Operation in "hot" stack mode will result in ground ground-level concentrations in excess of the 75 parts per billion (196 μg/m^3) NAAQS for SO_2.

- Operation in "cold" stack mode will result in ground ground-level concentrations in excess of the 75 parts per billion (196 μg/m^3) NAAQS for SO_2.

- The TCEQ ambient SO_2 monitor is located in an area that would be expected to capture the highest ambient concentrations near the Oxbow facility when operating in "cold" stack mode.

- The TCEQ ambient SO_2 monitor should be located to the south of the facility to capture the highest ambient concentrations near the Oxbow facility when operating in "hot" stack mode.

- The Oxbow facility would be compliant with the 1-hr SO_2 NAAQS if the permitted, potential SO_2 emissions from Kiln Nos. 3 and 5 were controlled by 95% and the stack on Kiln No. 2 were increased from 125 to 213 feet. No modifications to the "hot" stack on Kiln No. 4 would be required. Alternatively, the facility would comply if the SO_2 permitted emissions from Kiln Nos. 2, 3, and 5 were controlled by 95% without any modifications to the Kiln No. 4 "hot" stack. The facility would also comply if the potential emissions from Kiln Nos. 3, 4 and 5 were controlled by 95% and the stack on Kiln No. 2 were increased from 125 to 150 feet.

4.0 DOCUMENTS RELIED ON IN FORMING OPINIONS

1. Texas Commission of Environmental Quality, 2017 EIQ Report, Oxbow Calcining LLC.
2. Texas Commission of Environmental Quality, AIR/New Source Review Permit for Kiln No. 4 Stack Replacement, September 20, 2018.
3. Texas Commission of Environmental Quality, 2016 Annual Monitoring Network Plan, Oxbow Calcining Monitor Placement Evaluation, June 29, 2016.

4. Texas Commission of Environmental Quality, Enforcement Matter – Case No. 57022, Oxbow Calcining LLC, Failure to Comply with the National Primary One-hour Ambient Air Quality Standard for Sulfur Dioxide, October 30, 2018.
5. Texas Commission of Environmental Quality, Emission Sources – Maximum Allowable Emission Rates – Permit Number 45622, February 28, 2019.
6. Air Dispersion Modeling Report, Oxbow Calcining LLC, Port Arthur, Texas, AECOM, July 2010.
7. U.S. Environmental Protection Agency, Report on the Environment, Sulfur Dioxide Concentrations, 2017.
8. Email from Ron Thomas, TCEQ, to David Keen, RTP Environmental, Port Arthur SO_2 Monitor Siting, August 13, 2018.
9. Modeling files from Oxbow's 1st Production Related to AERMOD (Bates Nos OXBOW-0021340-1369).
10. SO_2 Scrubbing System for the Port Arthur Plant, Fives Solios Proposal No 16022F-R00, October 21, 2016 (Bates No. OXBOW-0019982-0020015).

5.0 BACKGROUND

Oxbow owns and operates a petroleum coke (petcoke) calcining plant. The primary sources of SO_2 emissions are from the four calcining kiln stacks. The exhaust from three of the kilns (Kiln Nos. 3, 4 and 5) can operate in a "hot" or "cold" stack mode. The hot and cold modes refer to the exhaust gas temperature. In "cold" stack mode, the kiln exhaust gas is routed to waste heat boilers. These boilers use the waste heat to generate steam which is either sold to an adjacent refinery or use to run a steam turbine to generate electricity. In "hot" stack mode, the exhaust gas is vented directly to the atmosphere, absent any heat recovery.

On June 2, 2010, the EPA established the primary, health-based 1-hr SO_2 NAAQS. The NAAQS was established at a level of 75 ppb. On August 10, 2015, EPA finalized the Data Requirements Rule (DRR) for the 1-hr SO_2 NAAQS. The DRR required air agencies to provide data to characterize air quality around sources that emit 2,000 tons per year (tpy) or more of SO_2 that are located in areas designated as attainment. The DRR also provided deadlines for source-oriented monitoring and/or modeling to characterize ambient air quality impacts from the identified SO_2 sources. Air agencies had the option to characterize air quality by modeling the impacts of actual source emissions or by using ambient air quality monitors. The monitors were to be located in areas surrounding the identified SO_2 sources where maximum 1-hr SO_2 concentrations were expected. Dispersion modeling was to be conducted to inform monitor placement.

TCEQ determined that the Oxbow facility is subject to the requirements of the DRR because actual SO_2 emissions from the facility exceed 2,000 tpy.[1] As a result, in 2016, the TCEQ conducted a modeling analysis of the facility in order to locate an SO_2 ambient monitor where the maximum 1-hr SO_2 concentrations were expected.

I obtained from TCEQ the modeling input data used to locate the SO_2 monitor.[2] The input data show that the TCEQ modeled the facility assuming the facility would operate in the "cold" stack mode. The TCEQ modeled the "cold" stack mode of operation and the model calculated that maximum SO_2 concentrations would occur north of the facility, within approximately 500m of the facility fenceline. Consistent with these modeling results TCEQ placed an ambient SO_2 monitor north of the facility, in close proximity to the modeled maxima.

6.0 AMBIENT AIR DISPERSION MODELING OF THE OXBOW FACILITY

I employed ambient air dispersion models in forming my opinions. I used the latest EPA-approved dispersion model as well as meteorological data and source inputs and emissions obtained from the TCEQ. Each of these are described in more detail in Sections 6.1 through 6.3 below.

6.1 Model

I used the AMS/EPA Regulatory Model, AERMOD (Version 18081) to conduct the dispersion analysis of SO_2 emissions from the Oxbow site. AERMOD has been EPA's preferred model for estimating the impact of new or existing sources of pollution on ambient air quality levels at source-receptor distances of less than 50 km since 2006.[3] AERMOD is a Gaussian plume dispersion model that is based on planetary boundary layer principles for characterizing atmospheric stability. The AERMOD modeling system has three components: AERMAP is the terrain preprocessor program, AERMET is the meteorological data preprocessor and AERMOD includes the dispersion modeling algorithms.

AERMOD is the most appropriate model for calculating ambient concentrations near the Oxbow facility based on the model's ability to incorporate multiple sources. The model can also account for convective updrafts and downdrafts and meteorological data throughout the plume depth. The model also has the ability to incorporate building wake effects which can affect plume dispersion near industrial facilities.

[1] Oxbow reported approximately 11,500 tons of SO_2 emissions in 2017.
[2] Email from Ron Thomas, TCEQ, to David Keen, RTP Environmental, Port Arthur SO2 Monitor Siting, August 13, 2018.
3. 40 CFR Part 51, Appendix W, Guideline on Air Quality Dispersion Models, November 2005.

6.2 Meteorology

I used Meteorological (MET) data that was obtained from the TCEQ website.[4] The data were for the period 2011-2015 and are recommended by the TCEQ for modeling facilities in Jefferson County. Surface measurements were made at Jefferson County airport in Port Arthur. Upper air data were from Lake Charles, LA. The TCEQ has processed the MET data using AERMET (Version 16216). The TCEQ provides three MET datasets. One was developed with low surface roughness length, one with medium surface roughness length, and one with high surface roughness length. The surface roughness length is related to the height of obstacles to the wind flow and is, in principle, the height at which the mean horizontal wind speed is zero-based on a logarithmic profile. Generally, in AERMOD, lower the surface roughness lengths lead to lower turbulence and higher ground-level concentrations. Based on the surface characteristics as calculated near the site using EPA's AERSURFACE program, I determined that the lower surface roughness meteorological dataset should be used. However, AECOM, the contractor Oxbow used to perform modeling submitted to the TCEQ in July of 2010, demonstrated to the TCEQ that the medium surface roughness length data were more appropriate based on more current land use data.[5] I, therefore, elected to use the medium surface roughness length meteorological dataset. Had I employed the meteorological dataset with the lower surface roughness, in my opinion the model would have calculated higher ground level concentrations and my conclusions would not have been affected.

6.3 Source Inputs and Emissions

The modeled source input data (e.g. stack height, stack diameter, gas exit temperatures, and gas flow rates) were obtained from the TCEQ's modeling files. These modeling files were developed by Oxbow's consultant AECOM and submitted to the TCEQ in July of 2010 to support amendments to Oxbow's air permits Nos. 5421 and 45622.[6]

I used the stack release data (i.e., stack height, diameter, gas exit temperature, and velocity) from the TCEQ's modeling files. Oxbow recently replaced the hot stack on Kiln No. 4. I obtained the information for this new stack from the permit application Oxbow submitted to the TCEQ in September of 2018.[7] In October of 2016, Fives Solios Corp, provided Oxbow with a cost and design estimate for a scrubber on Kiln Nos. 3 and 5.[8] This scrubber was included in this modeling analysis to assess the potential affects of

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[4] www.tceq.texas.gov/permitting/air/modeling/aermod-datasets.html.
[5] Air Dispersion Modeling Report, Oxbow Calcining LLC, Port Arthur, Texas, AECOM, July 2010.
[6] IBID.
[7] Texas Commission of Environmental Quality, AIR/New Source Review Permit for Kiln 4 Stack Replacement, September 20, 2018.
[8] SO_2 Scrubbing System for the Port Arthur Plant, Fives Solios Proposal No 16022F-R00, October 21, 2016 (Bates No. OXBOW-0019982-0020015).

control on the facility's ability to comply with the 1-hr SO_2 standard. The physical characteristics of the scrubber stack and its location were obtained from the Fives proposal. All other stack and all building location data, including the building profile inputs, were obtained from modeling Oxbox conducted in November of 2017 as obtained by PASE.[9] The Oxbow location data were used as the location data in the TCEQ modeling files were based upon a North American Datum (NAD) projection from 1927. The Oxbow locations were based upon the more current NAD projection of 1983. I did not employ the stack release data from the Oxbow 2017 model as the 2017 stack data were not consistent the data represented by Oxbow in the July 2010 model submittal or in Oxbow's annual emission inventory reports.[10] I ran a model to compare the results of the Oxbow 2017 and the 2010 inputs. I found that the 2017 inputs resulted in concentrations that are approximately 25% higher than the concentrations calculated using the 2010 inputs. As a result, use of the 2010 inputs provides a conservative, under estimate of concentrations.

The model layout is shown in Figure 1 below. A three-dimensional rendering of the facility is shown in Figure 2.

As noted below, I ran the model using actual emissions from Oxbow's 2017 Annual Emissions Inventory submitted by Oxbow to the TCEQ for the ozone season.[11] I also ran the model using the facility's permitted maximum allowable emission rates "allowable rate."[12] I obtained the allowable rates from Oxbow's air Permit No. 45622.

I modeled four current operational scenarios:

- The "hot" stack mode with actual emissions.
- The "hot" stack mode with permitted maximum allowable emissions
- The "cold" stack mode with actual emissions, and
- The "cold" stack mode with permitted maximum allowable emissions.

In addition to the four current operational scenarios, I also ran three "controlled" scenarios. The first controlled scenario employed the scrubber designed by Fives Solios Corp for Oxbow to reduce emissions from Kiln Nos. 3 and 5 by 95%.[13] In this scenario, Kiln Nos. 2 and 4 were assumed to operate in "hot" stack mode and the height of the stack of Kiln No. 2 was increased from 125 to 213 feet. The "hot" stack on Kiln No. 4 was not modified. The second controlled scenario employed a 95% efficient SO_2 scrubber on Kiln Nos. 2, 3 and 5. Kiln No. 4 was assumed to operate in "hot" stack mode without modification to its height. In the third controlled scenario, a 95% efficient

[9] Modeling files from Oxbow's 1st Production Related to AERMOD (Bates Nos OXBOW-0021340-1369).
[10] Texas Commission of Environmental Quality, 2017 EIQ Report, Oxbow Calcining LLC.
[11] IBID.
[12] The maximum allowable rate is referred to in TCEQ air permits as the Maximum Allowable Emission Rate (MAERT).
[13] SO_2 Scrubbing System for the Port Arthur Plant, Fives Solios Proposal No 16022F-R00, October 21, 2016 (Bates No. OXBOW-0019982-0020015).

scrubber was assumed installed on Kilns 3, 4 and 5. The Kiln No. 2 stack height was increased from 125 to 150 feet. The modeled source input data are shown in Table 1.

6.4 Receptors

The receptors are the locations surrounding the facility where the model calculates concentrations. The modeled receptor grid consisted of a dense network of cartesian receptors near the facility. The receptors in this portion of the grid were spaced at 100m intervals and the grid extended to 3km from the facility. Additional receptors spaced at 250m were placed between 3 and 5km. A third cartesian grid was employed that extended from 5 to 10km. The receptors in this grid were spaced at 500m intervals. Approximately 8,200 receptors were employed. The maximum facility impacts were captured within the dense 100 by 100m grid. Receptor elevations and hill height scale factors, as well as stack and structure base elevations, were calculated using the EPA AERMAP (Version 18081) terrain processor. The near field receptor set is shown in Figure 3.

6.5 Model Results

Model results were compared to the 1-hr SO_2 National Ambient Air Quality Standard (NAAQS). The model results are shown in Table 2. As shown, the four current operational scenarios result in exceedances of the 1-hr SO_2 NAAQS. The three controlled scenario result in concentrations that are compliant with the 1-hr SO_2 NAAQS.

Figures 4 and 5 show the receptors with modeled concentrations in excess of the SO_2 1-hr NAAQS for the four current operational scenarios. Figure 4 shows the actual emissions scenario for both “hot” and “cold” stack mode. While Figure 5 shows the permitted allowable emissions scenario for both “hot” and “cold” stack mode. These figures also show the location of the TCEQ SO_2 monitor as well as the locations of the maximum modeled concentrations from “hot” and “cold” stack operation. As can be seen in Figure 4, when actual emissions are modeled from the Oxbow facility, the locations of concentrations in excess of the 1-hr SO_2 NAAQS under “hot” mode operation occur in areas (indicated by the red stars), to the north, the south and west of the facility. The areas where the 1-hr SO_2 NAAQS is calculated to be exceeded in “hot” mode does not extend to the location of the SO_2 monitor. This demonstrates that that when Oxbow operates in “hot” stack mode, the monitor would not be expected to measure the elevated concentrations attributable to Oxbow.

The area where the standard is exceeded in “cold” stack mode is much more widespread, as indicated by the blue stars in Figure 4. The monitor is therefore much more likely to measure exceedances under “cold” stack operation. The figure also shows the locations of the maximum SO_2 concentration under both “hot” and “cold” stack operation. As shown, the “cold” stack maximum is calculated to occur north of the facility. This is consistent with the TCEQ monitor placement study which also showed the “cold” stack maximum in the same general location.

However, the monitor is not in a location that would enable it to measure SO_2 exceedances when Oxbow operates in “hot” stack mode for two reasons. First, the location of calculated maximum SO_2 concentration under “hot” stack mode is due south of the facility – the opposite direction of where the monitor is located. Second, the exceedance locations in “hot” stack mode do not extend to the location of the monitor.

Figure 5 presents similar information as Figure 4. However, Figure 5 shows the results of the model using the permitted maximum allowable SO_2 emission rates. This figure shows a similar pattern of 1-hr SO_2 exceedances. The exceedances, however, cover a much larger area surrounding the facility.

Typically, a background concentration is added to the model results to account for the contribution from sources not included in the model. In order to provide a conservative result – a result that would be expected to underestimate total SO_2 concentrations – I did not add a background concentration to the Oxbow model results. The average 1-hour SO_2 concentration across the 20 SO_2 monitoring sites in EPA Region 6, including Texas, was approximately 25 ppb in 2017.[14] If this background value were added to the modeling results, the actual 1-hr concentrations near the Oxbow site would be approximately 10% higher than the lowest modeled concentration from the facility.

To the best of my knowledge, the information presented herein is accurate. I reserve the right to supplement this report if additional relevant information or documents are identified in this matter.

David Keen, QEP

[14] U.S. Environmental Protection Agency, Report on the Environment, Sulfur Dioxide Concentrations, 2017.

Table 1. Oxbow Model Input Data

Source ID	Source Description	Easting (UTM, m)	Northing (UTM, m)	Base Elevation (ft)	Stack Height (ft)	Temp. (°F)	Exit Velocity (ft/sec)	Stack Diameter (ft)	SO_2 Allowable Rates (lb/hr)	2017 Actual SO_2 (lb/hr)
Current Operation Scenarios										
KS2_H	Kiln Stack 2 - Hot	406928.34	3300868.01	9.0	125.0	2000.0	68.7	10.5	727.0	481.7
KS3_C	Kiln Stack 3 - Cold	406975.10	3300908.09	11.7	185.0	350.0	92.1	6.8	1131.0	793.0
KS4_C	Kiln Stack 4 - Cold	406914.40	3300993.50	11.9	185.0	350.0	92.1	6.8	1131.0	817.8
KS5_C	Kiln Stack 5 - Cold	406964.30	3300829.74	8.5	185.0	350.0	78.6	7.8	1170.0	810.1
KS3_H	Kiln Stack 3 - Hot	406947.89	3300889.83	10.2	150.0	2000.0	66.5	13.5	1131.0	793.0
KS4_H	Kiln Stack 4 - Hot	406966.22	3300971.37	13.7	170.0	2000.0	66.5	10.58	1131.0	817.8
KS5_H	Kiln Stack 5 - Hot	406917.88	3300852.15	8.1	175.0	2000.0	50.0	16.5	1170.0	810.1
Control Scenario 1										
K3&5SRCB	Kilns 3&5 Scrubber - PTE	406971.41	3300858.94	9.61	185.0	220.00	17.95	11.00	115.05	NA
KS2_H_P	Kiln Stack 2 - Hot - PTE	406928.34	3300868.01	8.96	213.0	2000.00	68.70	10.50	727.00	NA
KS4_H_P	Kiln Stack 4 - Hot - PTE	406966.22	3300971.37	13.75	170.0	2000.00	66.50	10.58	1131.00	NA
Control Scenario 2										
K235SCRB	Kilns 2,3&5 Scrubber - PTE	406971.41	3300858.94	9.61	185.0	220.00	17.95	11.00	151.40	NA
KS4_H_P	Kiln Stack 4 - Hot - PTE	406966.22	3300971.37	13.75	170.0	2000.00	66.50	10.58	1131.00	NA
Control Scenario 3										
K345SCRB	Kilns 3,4&5 Scrubber - PTE	406971.41	3300858.94	9.61	185.0	220.00	17.95	11.00	173.55	NA
KS2_H_P	Kiln Stack 2 - Hot - PTE	406928.34	3300868.01	8.96	150.0	2000.00	68.70	10.50	727.00	NA

NA- Not applicable. Actual emissions not modeled for the controlled scenario.

Table 2. Oxbow 1-hr SO_2 Model Results

Stack Gas Release Scenario	Emission Scenario	Maximum Modeled Concentration (ppb)	1-hr SO_2 Standard (ppb)	Percent Standard
Hot	Actual	110.5	75.0	147%
	Allowable	158.7		212%
Cold	Actual	185.8		248%
	Allowable	265.6		354%
Controlled Scenario 1	Allowable	74.5		99%
Controlled Scenario 2	Allowable	60.6		81%
Controlled Scenario 3	Allowable	52.4		70%

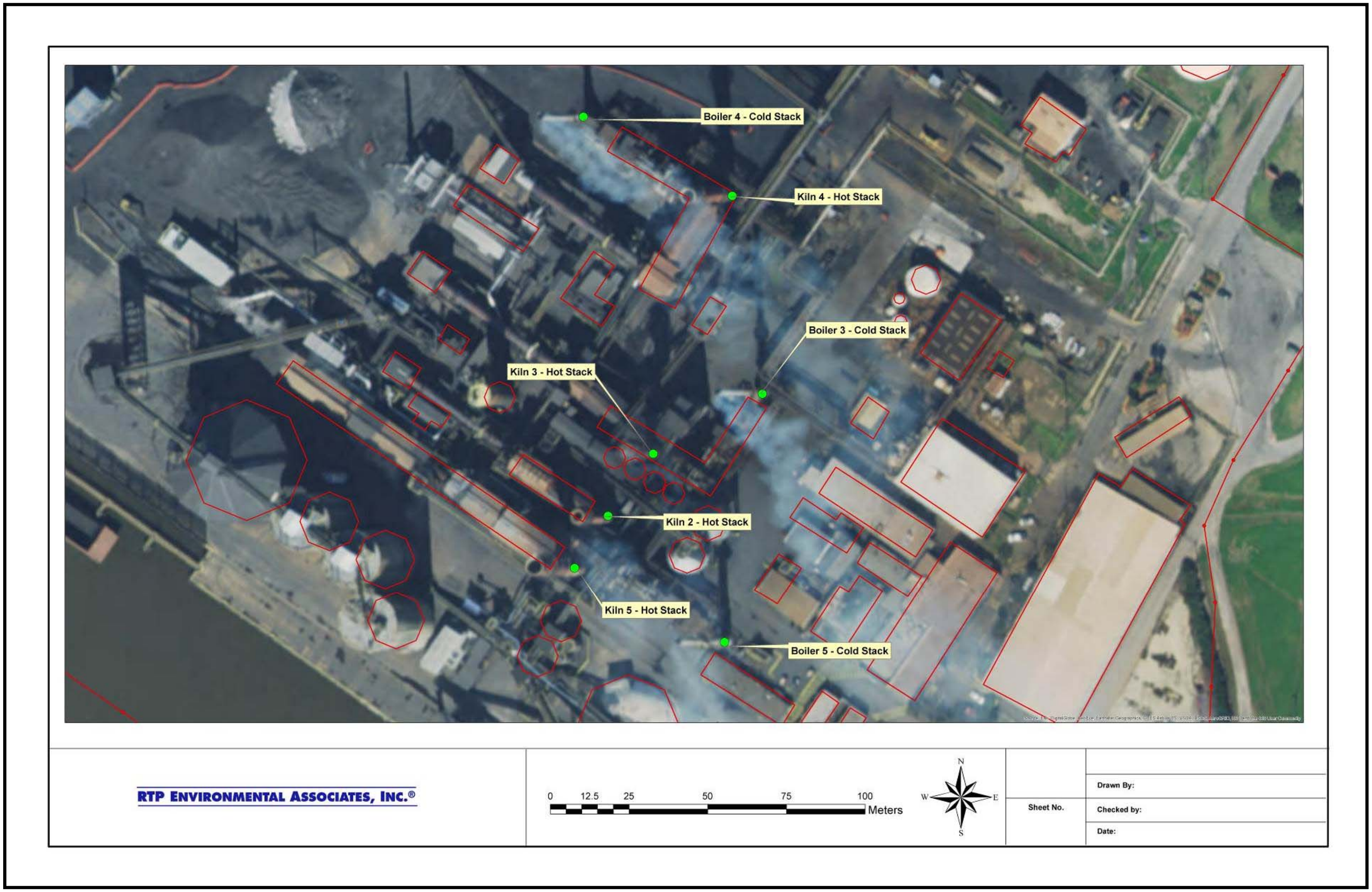

Figure 1. Oxbow Plot Plan Showing Modeled SO2 Sources

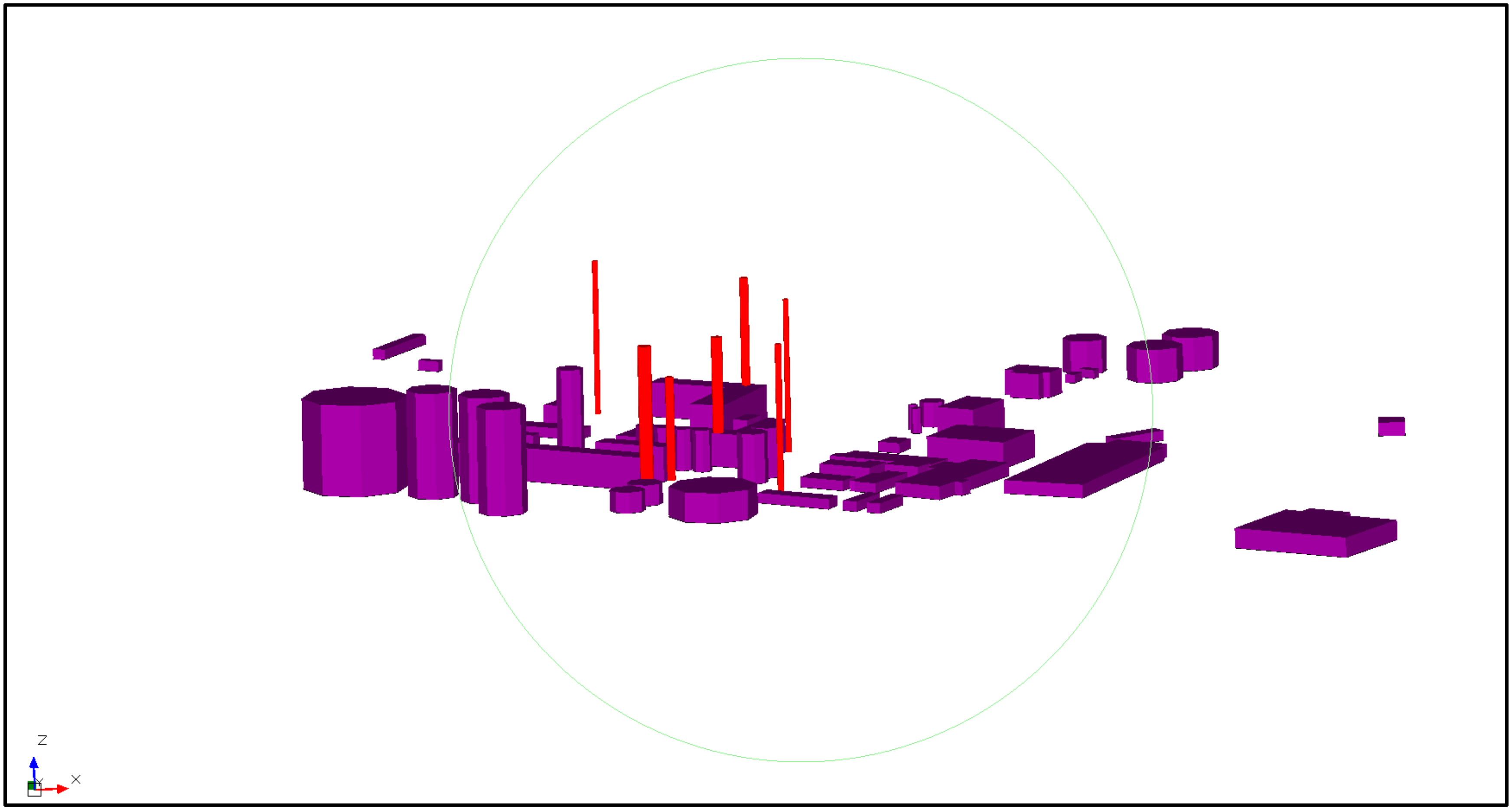

Figure 2. Three-Dimensional Rendering of the Oxbow Facility (View from SE)

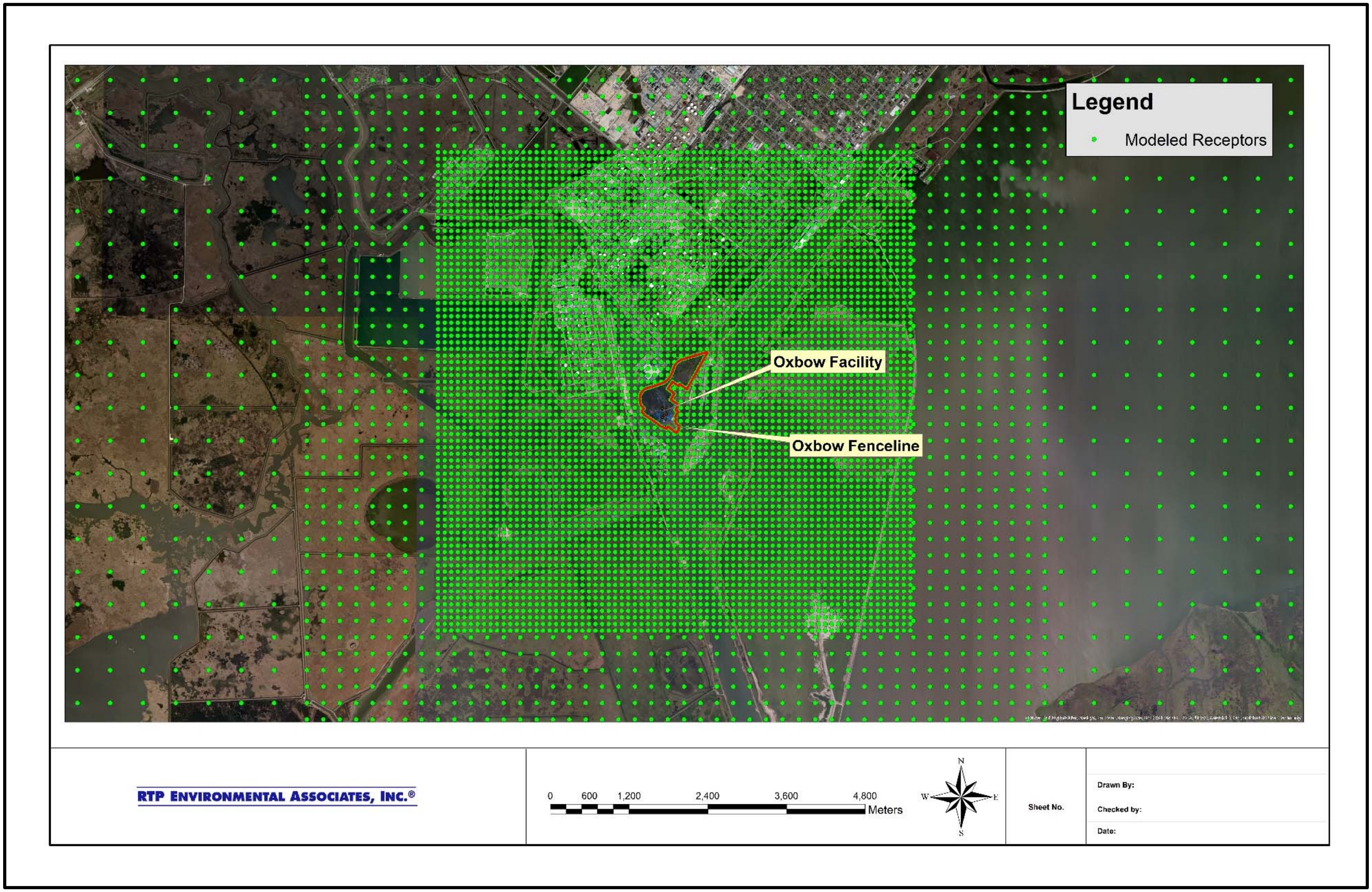

Figure 3. Near Field Receptor Grid

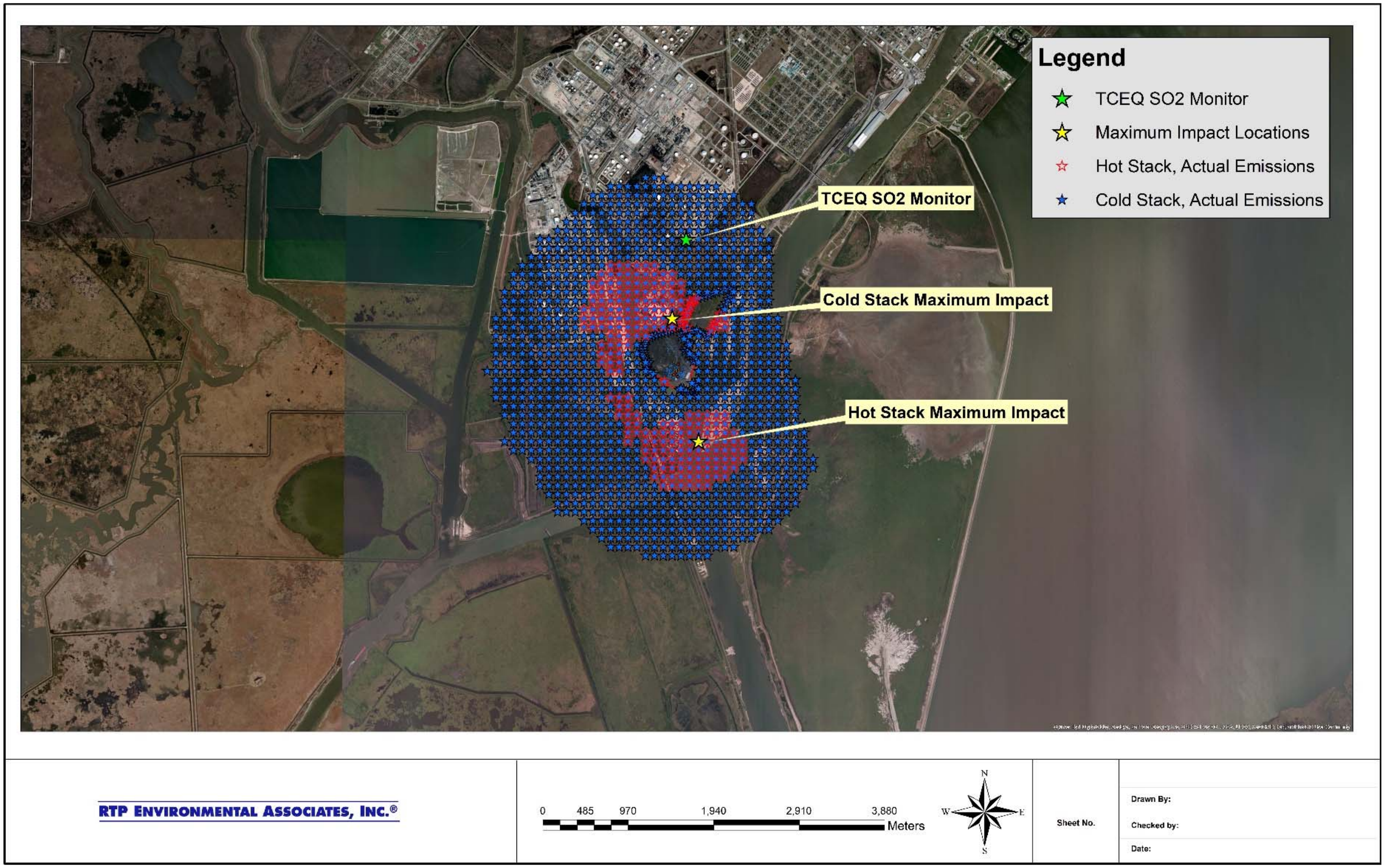

Figure 4. Locations of Modeled 1-hr SO_2 NAAQS Exceedances with Actual Emissions

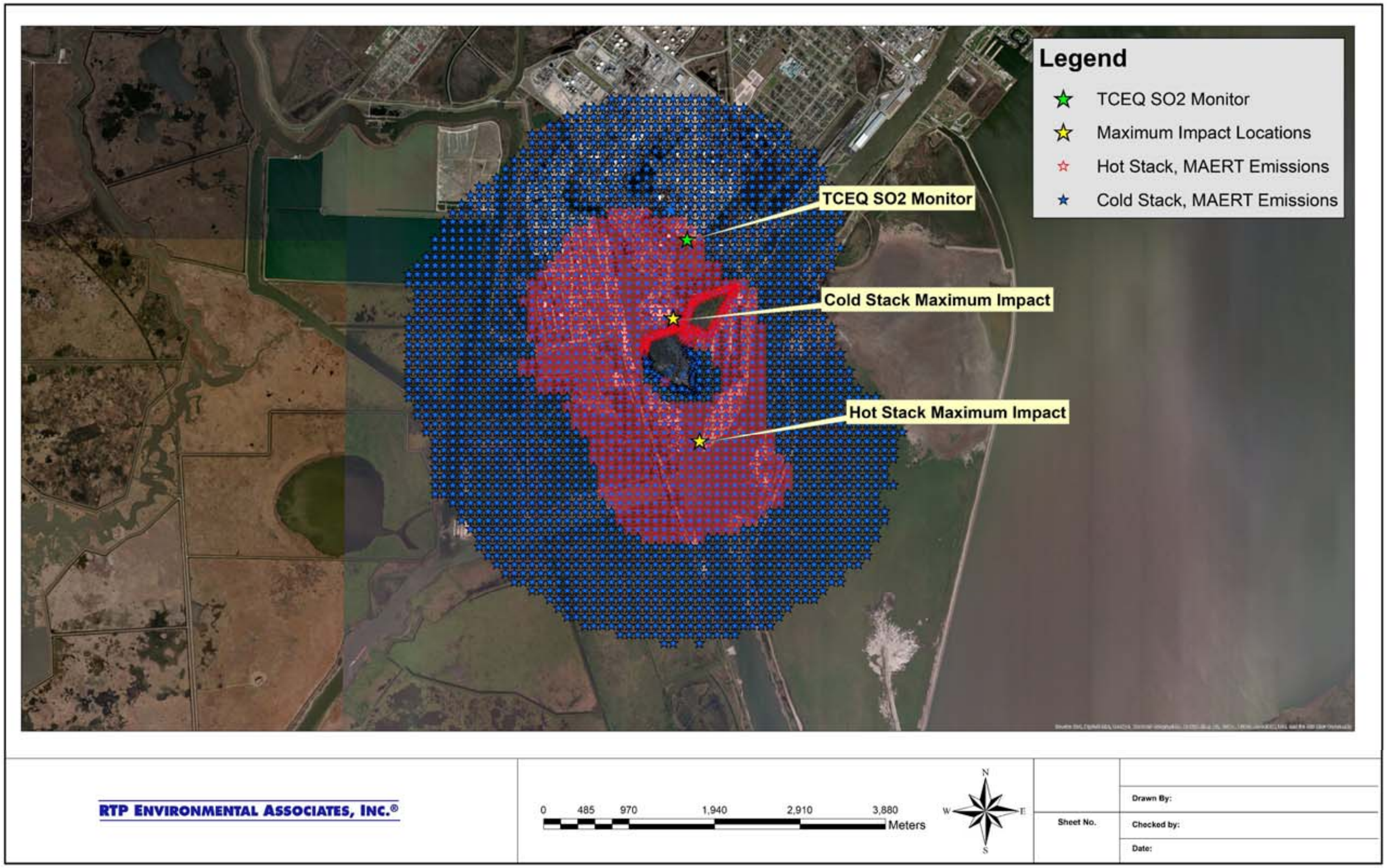

Figure 5. Locations of Modeled 1-hr SO_2 NAAQS Exceedances with Permitted Emissions

EXHIBIT 1

RTP ENVIRONMENTAL ASSOCIATES, INC.®

DAVID E. KEEN, QEP

Senior Project Manager

Education

- M.E.M., 1987, Environmental Management, Duke University, Durham, NC.
- B.S., 1984, Biology, Presbyterian College, Clinton, SC.

Chronological Work Experience

- Senior Project Manager, RTP Environmental Associates, Raleigh, North Carolina, 1999- Present.
- Project Manager, Senior Scientist, Group Leader, Radian International, LLC, Research Triangle Park, North Carolina, 1988-1999.

General Work Experience

Mr. Keen is a Senior Project Manager in RTP Environmental's Raleigh, North Carolina office. His primary area of expertise is in air quality with an emphasis in the areas of atmospheric dispersion modeling, industrial air permitting and compliance. Mr. Keen has over 30 years of experience providing dispersion modeling, regulatory compliance planning and permitting services to a wide range of industrial sources located throughout the country.

Mr. Keen has provided expert testimony and reviewed modeling evaluations in support of contested permit applications. He has performed dispersion modeling analyses using EPA-approved procedures and models as well as other proprietary modeling packages. He has helped develop modeling tools designed to improve modeling efficiency. These tools include programs for calculating cavity concentrations at complex facilities and post-processing routines for simplifying modeling for large sources. Mr. Keen also develop a modeling post-processing routine to determine modeled concentrations consistent in both time and space to assess the potential for a facility to "cause or contribute" to existing modeled exceedences. In addition, Mr. Keen coordinated a study performed in a wind tunnel which was designed to more accurately define the aerodynamic influence of structures on plume behavior near a chemical plant. The study was recently approved by the EPA and saved the chemical plant nearly two million dollars in costly air pollution control equipment.

Mr. Keen's experience also includes configuring and implementing emissions data management systems at large industrial complexes and military installations. Mr. Keen has implemented Radian's Emissions Data Management System (R-EDMS™) at military installations as well as Essential Technologies Air Emissions Management

System (AEMS™) and PlantWare™ at chemical manufacturing facilities. Mr. Keen has also led efforts to develop customized Access database programs to help several military installations comply with air quality requirements. Implementation of these systems has greatly reduced the record keeping and reporting burdens at these facilities. These data management systems also offer the facilities a central repository for environmental data.

Project Assignments

Recent Assignments

- David prepared the modeling evaluations for PSD permitting of two off-shore oil and LNG export terminals. The modeling involved petitioning the US EPA for use of an alternative model and evaluation of prognostic meteorological data for use in lieu of observational buoy data.

- David conducted the dispersion modeling for a PSD application prepared for a brown-field iron production facility in Ohio. David was able to develop a compliant model despite the new facility's location in a highly industrialized area.

- David prepared the air quality modeling analyses for three surface mining operations in Idaho. Several phases of the mining operation at each site were evaluated based upon the mine progression. Mining operations included stripping, blasting, and hauling.

- David conducted dispersion modeling for a carbon calcining operation to assess compliance with the SO_2 Data Requirements Rule. David then provided expert testimony in the District Court of Jefferson County, Texas regarding the validity of the modeled results.

- David reviewed the model, model inputs and methodology employed in the air dispersion modeling analysis of a zinc smelter. David also conducted an independent modeling evaluation of the smelter. David then prepared and expert report and provided expert witness testimony in the United States District Court, Northern District of Oklahoma regarding his opinions.

- David conducting the dispersion modeling for a new nitrogen based fertilizer facility in North Dakota. In addition to evaluating the air quality impacts of criteria pollutants as required under Prevention of Significant Deterioration (PSD) review, David evaluated the impacts of thermal and visible plumes on a nearby airport as is required by the Federal Aviation Administration. David employed The Air Pollution Model (TAPM) and CALPUFF models in this evaluation.

- David conducted the modeling and provided testimony for a proposed new nitrogen based fertilizer complex in Idaho. The analysis involved a comprehensive evaluation of the air quality impacts including NAAQS, PSD increments, and visibility.

- David conducted the dispersion modeling for a PSD construction permit application prepared for an ethanol production facility in Illinois.

- David has conducted dispersion modeling for nearly 25 rock quarry operations located in the south eastern US. The modeling has involved compliance with the NAAQS as well as state air toxic regulations. The models addresses emissions from all aspects of the mining operations.

- David conducted the dispersion modeling analysis for a PSD permit application submitted for a major petroleum refiner that plans to construct a brownfield ethylene cracking facility in Pennsylvania. Modeling required a detailed assessment of the impacts of the new facility on existing modeled violations.

- David conducted the dispersion modeling and provided testimony for a proposed new petroleum refinery in South Dakota. This modeling effort helped secure one of the first PSD permits for a new refinery since the 1970s.

- David prepared the air dispersion modeling analyses in support of PSD permit application for a greenfield ammonium nitrate production facility in Tennessee. This application was one of the first submitted in the country which included a detailed assessment of compliance with the 1-hr NO_2 NAAQS.

- David reviewed the modeling assessment for a proposed new power generation facility in Montana and provided technical support in the deposition of the plaintiffs in opposition to the permit.

- David has prepared Best Available Retrofit (BART) evaluations, including the long-range transport modeling, for five facilities.

- David successfully obtained PSD permits for several Portland cement manufacturers. David negotiated favorable BACT limitations and completed the air dispersion modeling demonstrations.

- David obtained minor source construction permits for three fiber glass manufactures. The applications involved modeling compliance for toxic and criteria pollutants and negotiation of favorable permit terms.

- David wrote a PSD compliance manual for the cement industry. The manual addresses PSD issues and policy as it pertains to the manufacture of portland cement.

- David completed a "mock" Section 114 data request and historical evaluation of the applicability of the PSD regulations for two cement plants. The project included the review of nearly 200 requests for capital expenditures to determine whether the PSD permitting requirements could potentially apply. NSR policies and interpretive guidance was used to argue against a determination of PSD applicability for the vast majority of projects encountered.

- David has helped several facilities respond to EPA Section 114 requests. David has helped assemble 114 responses, evaluated potential NSR liability and developed response packages for EPA.

- David also prepared a NSR Workshop for the American Portland Cement Alliance. The Workshop was designed to overview current NSR issues facing the cement industry.

- David prepared a permit application for a Portland cement plant to enable the plant to burn whole tires. David developed a unique permitting approach that involved a more favorable emissions test to enable the facility to avoid PSD review.

- David prepared Prevention of Significant Deterioration permit applications for an electric utility in Texas and a corn processing plant in Illinois. The applications included air compliance modeling demonstrations for and Best Available Control Technology Analyses for emissions of PM_{10}.

- David also recently prepared an air permit application for a chemical facility's expansion. David prepared all aspects of the application including the emissions estimates, dispersion modeling analysis, and regulatory compliance analysis. David also is in the process of negotiating favorable permit terms and conditions with the NC state regulators.

<u>Contract Manager</u>

- Contract Manager- Southern Division of the Navy (Air Compliance Services/Pollution Prevention Services) - Mr. Keen was Radian's contract manager for all air compliance and pollution prevention activities conducted for the Southern Division of the Navy. Under these contracts, Radian provided air consulting and pollution prevention services to approximately 30 military installations throughout the United States. Radian services provided under these contracts included: air emissions inventories, permitting, dispersion modeling, development of ozone depleting substance transition plans, CAA Section 112(r) compliance assessments, EPCRA inventories, EPCRA reports, and pollution prevention and hazardous waste management plans, and identification of hazardous waste streams. Radian has also designed and implemented software to help the installations manage environmental compliance data. Mr. Keen's responsibility on these contracts was to ensure that the

Southern Division received the best possible service that Radian could offer. David mentored and developed staff to provide the work activities required by the contracts. David also coordinated with other air quality service providers so that the depth of Radian's corporate resources were available to SouthDiv.

Air Quality Permitting

- Title V Permit at Chemical Plant - Project manager for a Title V permit application for a chemical company. This Title V permit application required an innovative permit strategy because of the complexity of the plant and the plant's need to constantly change its production configuration. Mr. Keen directed the negotiation with the state to allow the site to permit groups of sources or common collection headers rather than individual sources. This greatly reduced the monitoring, recordkeeping, and reporting burden of the Title V operating permit by reducing the number of sources that had to be permitted. Because of this permitting strategy, the facility will be able to modify operations without the need to reopen its Title V operating permit. Operational flexibility is insured without delays due to permitting. In addition, this permit application was part of a regional effort for five plants within the company, and Mr. Keen helped direct the coordination of that effort among the five sites. An important component of the Title V permit at this company was the implementation of a comprehensive emission database. Mr. Keen directed the collection of the information to populate and configure the database. He worked with the software developers to assure that the software performed as the site needed it to perform. The database was used to calculate emissions from the facility and complete the forms for the air permit application. The client now has a complete and functional air emission inventory management tool, which will save the company time and money in future permitting and reporting.

- Title V Permit at a Vitamin Production Plant - Mr. Keen managed a "rush-order" Title V permit application for a Vitamin B and C plant on the coast of North Carolina. The facility went out for bids for the Title V work only 2 months before the application was due to the state agency. Mr. Keen assembled a team of engineers and regulatory experts who were able to characterize emissions, determine applicable requirements, develop a strategic minimal burden monitoring plan, and assemble the appropriate documentation in 6 weeks' time. An application was submitted, on-time and underbudget, which was subsequently accepted by the state agency. The client was so pleased with the team's efforts that follow-on work was awarded within weeks of Title V project completion.

- Title V Permit at Military Base - Mr. Keen was the project manager for a Title V permit application for a large military base. The base has nearly 600 emission sources, spread over an area of nearly 50 square miles. The first issue in the Title V permitting process for such a large source was to focus the permit application on the emission sources that would be required to be permitted. The Title V rules have room for latitude in interpreting what can be considered exempt from permitting. Mr. Keen negotiated with the state to designate many sources at the base an insignificant and therefore exempt from permitting. Of the 600 sources at the base, only 50 sources ultimately required permitting. In this way, Mr. Keen effectively developed ways to demonstrate compliance with all applicable air regulations that did not involve permitting each individual source, thereby eliminating the compliance tracking and reporting burden to the facility. The second issue in the Title V permitting was the necessity of tracking and managing emission information for such a large facility. Mr. Keen directed entering all the emission information into Radian's R-EDMS (Environmental Data Management System) database so that each emission unit at the base could be tracked, and emissions calculated and reported electronically.

- BRAC Air Permit Application - Mr. Keen was the project manager for an air quality permit application for relocating Cecil Field to Cherry Point during Base Realignment and Closure (BRAC). The construction necessary for relocating the base would trigger review of the source under Prevention of Significant Deterioration (PSD). The construction schedule for the BRAC project did not allow the review time necessary for acquiring a PSD permit. Therefore, Mr. Keen developed a strategy to avoid triggering PSD review by creating an emissions cap for the activities to be relocated. Effectively, rather than specifying source by source emission limits, the base accepted a cap on overall base emissions below PSD significance levels. Within that cap, the base had flexibility to emit from any source. Mr. Keen developed a mathematical formula for demonstrating compliance with the overall base cap. The permitting process involved a detailed toxic air pollutant modeling effort for all sources of toxic emission at the base. Mr. Keen negotiated an innovative permit strategy with the state that involved merging emissions from many related sources and modeling them as volume sources to demonstrate compliance. The emission points at the base that were included in the toxic air pollutants toxic air pollutant modeling demonstration decreased from nearly 1000 to 100 using this strategy. This significantly decreased the modeling burden on the source while still assuring compliance with the regulations. Mr. Keen then directed the development of effective compliance alternatives for the numerous sources of toxic air pollutant emissions.

- Conditional Major Source Permit Application/Storm Water Permit - Mr. Keen helped develop a strategy for a paper machine roller repair plant to avoid having to obtain a Title V operating permit. Mr. Keen then implemented the strategy by obtaining a conditional major source permit.

Air Quality Modeling

- NAAQS Modeling and Wind Tunnel Study - Project manager on a project to evaluate alternate means of assessing compliance with National Ambient Air Quality Standards (NAAQS). Based on air dispersion modeling results conducted according to EPA policy, this plant would have been forced to make multimillion dollar modifications to the facility to comply with the NAAQS. Mr. Keen was able to propose to the EPA and the state an alternative way to model the facility that saved the client approximately $2 million in facility modification costs. The EPA and state policy requires that buildings be modeled as solid structures even if they are not solid. The structures at the facility were lattice structures and were not behaving like solid structures for the purposes of dispersion of pollutants in ambient air. Modeling these buildings as solid structures produced very high ground level pollutant concentrations. Mr. Keen contracted a wind tunnel consulting firm to construct a model of the facility and calculate the effective dimensions of the buildings if they were solid structures for the purposes of modeling. Mr. Keen negotiated with the EPA and the state to allow the facility to use these effective dimensions as the dimensions of the buildings for the NAAQS compliance modeling. Mr. Keen then directed a NAAQS modeling analysis of the facility and determined cost effective modifications (stack height increases) to allow the facility to model NAAQS compliance. Modeling in this way produced more accurate modeling results, with much lower ground level concentrations of air pollutants, and the facility was saved the costs of expensive modifications.

- Model Development - Mr. Keen was the project manager for two projects to determine air quality impacts for assessing the environmental costs of producing electrical power in the states of Wisconsin and Minnesota. A group of utilities were evaluating a number of planning scenarios involving different ways of producing power. Mr. Keen was responsible for determining the change in atmospheric concentrations of pollutants associated with the alternate power generation scenarios. There were no air dispersion models appropriate for such large areas (the states of Wisconsin and Minnesota) that would produce results sufficiently detailed for the study. The available regulatory models had to be adapted to obtain scientifically accurate results. The models were adjusted to allow results with integrity at the resolution required. These results were obtained by reprogramming, interpreting meteorological data, and extrapolating small-scale results to larger scales. In addition, no long-range transport models existed for mercury emissions. Mr. Keen consulted with mercury experts in Sweden and Germany and used the algorithms they developed to program models for mercury transport. The modeled Hg concentrations results correlated very well with observed mercury concentrations.

- Complex Hazardous Air Release Modeling - Project manager for a modeling analysis conducted at a chemical manufacturing facility. The modeling analysis evaluated emergency releases of toxic compounds in efforts to simplify emergency response planning. Mr. Keen developed simplistic look-up charts which allowed the facility to determine off-site impacts as they related to the mode and amount of chemical released. The look-up charts eliminated the facilities requirement to model hundreds of emergency release scenarios.

- Air Quality Modeling Study for Large Electric Producers - Mr. Keen was the project manager for two projects to determine air quality impacts for assessing the environmental costs of producing electrical power in the states of Wisconsin and Minnesota. A group of utilities were evaluating a number of planning scenarios involving different ways of producing power. Radian was responsible for determining the change in atmospheric concentrations of pollutants associated with the alternate power generation scenarios. There were no air dispersion models appropriate for such large areas (the states of Wisconsin and Minnesota) that would produce results sufficiently detailed for the study. The available regulatory models had to be adapted to obtain scientifically accurate results. The models were adjusted to allow results with integrity at the resolution required. These results were obtained by reprogramming, interpreting meteorological data, and extrapolating small-scale results to larger scales. In addition, no long-range transport models existed for mercury emissions. Mr. Keen consulted with mercury experts in Sweden and Germany and used the algorithms they developed to program models for mercury transport. The modeled Hg concentrations results correlated very well with observed mercury concentrations.

- Air Quality Monitoring Station - Mr. Keen was the project manager for two projects for a paper company: one for establishing a meteorological monitoring station and collecting the data and one for developing air pollution permitting strategies based on the monitoring data and subsequent air modeling results. Radian established a meteorological monitoring station, screened the meteorological data to verify integrity, and negotiated approval of the data for air permitting purposes with the Virginia Department of Air Pollution Control. Radian audited the meteorological sensors to assure data quality. Monthly reports of the data were provided to the Virginia Department of Air Pollution Control and to the client. The collected data were then formatted for use in a regulatory dispersion model. The modeling was conducted to help the company assess compliance with the National Ambient Air Quality Standards (NAAQS) and develop a strategy for achieving compliance. The ultimate permitting strategy involved different alternatives for compliance, including alternate boiler fuels, boiler stack height modifications, and modifications to the facility fence-line.

Air Quality Instruction

- Prepared PSD training manuals for cement industry.

- Conducted training on the New Source Review Reform rulemaking package for the cement industry.

- Air Enforcement Training – Prepared and presented 3-day course for air enforcement training.

- Prepared PSD training class for the US Navy and American Portland Cement Association.

- Air Program Managers Guide - Project manager for development of an Air Program Manager's Guide for the Atlantic Division of the Navy. The guide was developed to help air program managers at each of the 17 CINCLANTFLT installations comply with applicable air quality regulations. Mr. Keen's team was responsible for determining applicable regulatory requirements and summarizing the applicability of each regulation and the required control measures. The guide was used to train Air Program Managers at CINCLANTFTL installations on the procedures needed to comply with all applicable requirements of the Clean Air Act.

- Mr. Keen has conducted training seminars on air quality modeling for industrial clients. He has taught the role of meteorology and the use of models in demonstrating compliance with air quality goals. He has made presentations on the importance of meteorological phenomenon on dispersion, the role of screening and refined level models, and the role of modeling in permitting.

<u>Environmental Planning/Compliance Assessments</u>

- Air Compliance Audits – Mr. Keen has conducted environmental audits for numerous manufacturing facilities. The audits assessed facility compliance with the federal New Source Review permitting requirements, New Source Performance Standards, and state air toxics regulations.

- HON Applicability and Compliance Assessment - Mr. Keen managed a program to evaluate the applicability of the NESHAP for Hazardous Organic air pollutants (HON), for a large chemical company. This project required assessing which process units were affected by the HON, negotiating with the state to gain favorable interpretation of the rules, and applying the limitations in the HON to each affected source. The limitations were strategically applied to maintain facility operational flexibility while insuring compliance with all applicable limitations. The strategies for permitting developed in this analysis ultimately allowed the facility to avoid costly modifications they might otherwise been required to undertake.

- PET MACT Applicability and Compliance Assessment - Mr. Keen was project manager for several studies designed to evaluate the applicability of the Polyethylene Terephthalate (PET) MACT. These studies were conducted for three major PET manufacturing facilities. These projects included identifying the process units and affected sources, determining the group status of affected emission points, determining the compliance status of each point, and evaluating control options and options for demonstrating compliance. At one facility, emissions testing indicated that the polymerization emission vents would require control. The emissions testing, however, yielded unrealistically high emission rates due to flaws in the testing methodology. Mr. Keen's team effectively negotiated with the EPA to allow the use of alternate emission estimating techniques which lowered the calculated emission values and eliminated the need to control the emissions.

- STEP Analysis - Mr. Keen was the project manager for a Strategic and Tactical Environmental Plan (STEP) for a large chemical company. The STEP identified all the regulations that currently apply to the facility, all the regulations that will apply in the next 5-10 years, the alternatives for complying with these regulations. The STEP included an analysis of the costs of various compliance alternatives to plan the costs of compliance and to identify the most cost-effective compliance strategy. This plan is helping the facility avoid making business decisions that will involve unwanted environmental compliance costs. The plan is also helping to maintain plant flexibility by developing proactive plans for environmental management and by identifying opportunities to apply innovative technology.

- Aerospace NESHAP Compliance - Mr. Keen managed a program to provide a large military base with an evaluation of facility compliance with the Aerospace NESHAP. A program was also implemented to bring subjected sources into compliance with the regulation. A detailed report was prepared as part of the program. The report identified each regulated activity, the military or civilian unit responsible for the activity, the compliance status of the source, and compliance alternatives. Mr. Keen's team also configured Radian's Environmental Data Management System to provide facility-wide NESHAP compliance data management, recordkeeping, and reporting. Radian then provided the base with on-site training on R-EDMS and the Aerospace NESHAP.

Emissions Testing

- Mr. Keen was the project manager on a project to test leaks from gasoline dispensing operations at a large military base in order to assess compliance with Bulk Gasoline Plant regulations. Testing was done using the EPA reference methods. Compliance was demonstrated and state regulations met.

- Mr. Keen was also the project manager for emissions testing of two large coal-fired boilers. The test was conducted to verify criteria and toxic air pollutant emissions factors.

- Base Emission Inventory - Mr. Keen was the project manager on a project to develop detailed emission estimates for a large military base. For this inventory, the locations of emission units and control devices were pinpointed using a global positioning system (GPS), which gave much more accurate locations than were previously available. The inventory information was loaded into a database, and the database was used to calculate emissions. In addition, Mr. Keen directed a project to update the AutoCAD drawings of the base using the GPS derived source locations.

Information Technology

- R-EDMS™ - R-EDMS™ is Radian's Environmental Data Management System. Mr. Keen managed the configuration and population of the Air Emission Inventory module of R-EDMS™ and the configuration and population of the Waste Manifest and Resource Conservation and Recovery Act (RCRA) Module (for hazardous waste information) and the Subsurface Data Module (for groundwater monitoring). The waste manifest and RCRA module tracks waste data on the origin, destination, and movement of hazardous waste to store information necessary to support DoD and Resource Conservation and Recovery Act (RCRA) reporting. These data are also helpful for SARA 313 reporting and evaluating pollution prevention opportunities, treatment options, and cost saving measures. R-EDMS™ also produces the required annual DoD and RCRA reports. The Subsurface Module contains well sampling data: well characteristics, lithology, sampling schedules, sampling information, analytical methods, and results. This module is helpful for tracking and for producing required DoD, state, and federal reports. Using R-EDMS has reduced the cost to the client of producing required reports manually and provided a way for the client to track and manipulate environmental data for planning. For example, the database can be used to run what-if scenarios to estimate the environmental effect of a change in the base's operation or configuration.

- AEMS and PlantWare Databases - Mr. Keen directed the collection of the information to populate and configure a comprehensive emission database for two large chemical companies. He worked with the software developers to assure that the software performed as the site needed it to perform. The database was used to calculate emissions from the facility and to complete the application forms for the Title V operating permit application. The client now has a complete and functional air emission inventory management tool, which will save time and money in all future permitting activities and reporting.

Other Air Quality Compliance Services

- Mr. Keen has also directed additional impacts analyses required for PSD permitting. These analyses have involved interpreting air quality data and determining potential effects of pollutant impacts on soils, vegetation, and visibility. Mr. Keen has also conducted environmental impact analyses. These analyses have involved determining potential air quality impacts of air pollutants on vegetation, wildlife, and areas of public concern.

- Project director for an air toxics permitting analysis conducted for a bulk petroleum storage and transfer terminal. This project involved a complex mitigation modeling analysis to demonstrate air toxics compliance. The compliance analysis was one of the first and only for benzene emissions from a large petrochemical terminal in North

Carolina. The project included precedent-setting policy interpretations of the North Carolina air toxics regulations.

- Project director for permitting effort for a rotogravure printing operation. Permitting activities included lowest achievable emission rate determination as well as a facility-wide air toxics compliance demonstration.

- Project director of permitting effort for a transformer manufacturing facility which required the development of a facility-wide emissions inventory. Permits were successfully obtained from the Virginia Department of Air Pollution Control.

- Project director of a permit application for a small motor manufacturer in Iowa. The application included the development of a facility-wide emissions inventory. Emissions were then modeled to demonstrate compliance with the Iowa air toxics regulations.

- Project director for air quality permitting effort for a tire manufacturer. Permit effort included emissions characterization and modeling of criteria and toxic air pollutants.

- Project director for modeling analysis that evaluated ambient SO2 impacts of a large electric power plant. Impacts were calculated in complex and intermediate terrain locations.

- Project director of modeling analysis that evaluated toxic air pollutant emissions from a boat manufacturing plant.

- Project director for a modeling effort that analyzed odor complaints received by a furniture manufacturer.

- Task leader of modeling analysis for a large chemical manufacturer in New York. Analysis evaluated the ambient impacts of over 50 pollutants emitted from 30 sources.

- Task leader of an impacts analysis conducted for SO2 emissions from a chemical manufacturer. Ambient impacts were calculated in complex and intermediate terrain from over 30 sources.

- Task leader of air toxics modeling analysis for a chemical manufacturer in North Carolina. Compliance with the North Carolina air toxics regulations was successfully demonstrated for nearly a dozen pollutants emitted from approximately 70 sources.

- Task leader of an air toxics modeling analysis which evaluated the compliance of a pulp and paper manufacturer with the North Carolina air toxics regulations.

- Task leader of modeling analysis which evaluated the compliance of a major furniture manufacturer with the Virginia air toxics regulations.
- Task leader of air quality analyses in support of PSD permitting for 12 clients. These analyses have evaluated all criteria pollutant emissions as well as NESHAP and other air toxics.
- Conducted ambient impacts analysis of CO and NOx emissions from a petroleum refinery.
- Task leader of toxic air pollutant impact analyses in support of the North Carolina toxic air pollutant regulations for three major North Carolina furniture manufacturers.
- Provided technical and computer support in the development of a PM10 PSD increment.
- Performed dispersion modeling and generated reports from the New Source Review data base.
- Provided technical support in the manipulation of a large municipal landfill data base.
- Generated reports and performed various database calculations in support of industrial boiler litigation.
- Conducted statistical analyses of meteorological data using SAS.
- At Duke University, Mr. Keen was responsible for experimental design and supervision of data collection and analysis for a National Acidic Precipitation Assessment Program study that addressed the potential physiological effects of acidic precipitation and ozone on loblolly pine. His coursework included applied ecosystem ecology, applied ecological problem solving, natural resource ecology, environmental physiology, meteorology, and statistics.

Certifications
Qualified Environmental Professional, Institute of Professional Environmental Practice (#12990068)

Memberships
Air and Waste Management Association
Carolina Air Pollution Control Association

Other Training
Title V
Health & Safety
Kerzner Project Manager Training

Team Building

<u>Publications</u>
"Equivalent Building Dimensions for ISC2 Modeling Applications." Peterson, R.L., D.E. Keen, and R.N. Walton, Air and Waste Management Association 88th Annual Meeting, San Antonio, Texas, June, 1995.

EXHIBIT 2

I have provided testimony in the following recent cases:

1. In the Matter of Cyprus Amax Minerals Company V. TCI Pacific Communications, Inc. and CBS Operations, Inc. No. 11-CV-252-CVE-FHM.

2. In the Matter of Prevention of Significant Deterioration (PSD) Air Quality Permit Application of Hyperion Energy Center – Hyperion Refining, LLC , Permit #28.0701-PSD. Presented before the State of South Dakota, Department of Environment and Natural Resources, Board of Minerals and Environment.

3. Conagra Foods Lamb Weston, Inc. v. Idaho Department of Environmental Quality and Magnolia Nitrogen Idaho LLC, Case No. 0101-14-01.