# APPENDIX E

# MODELING REPORT FOR THE BOWIE POWER STATION

# Appendix E

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1) Modeling Report

# APPENDIX E

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# FOR THE
# BOWIE POWER STATION

**Prepared for:**

**Arizona Department of Environmental Quality**

**September 2013**

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# MODELING REPORT
# FOR THE
# BOWIE POWER STATION

**Prepared by:**
Wind River Environmental Group LLC
12081 West Alameda Parkway, #415
Lakewood, CO 80228

**Prepared for:**
Arizona Department of Environmental Quality
Air Quality Division
1110 West Washington Street
Phoenix, Arizona 85007

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# LIST OF ACRONYMS

| | |
|---|---|
| °F | Degrees Fahrenheit |
| $\mu g/m^3$ | Micrograms per cubic meter |
| AAAQS | Arizona Ambient Air Quality Standards |
| AAC | Arizona Administrative Code |
| AADT | Annual Average Daily Traffic |
| ADEQ | Arizona Department of Environmental Quality |
| AERMET | AERMOD Meteorological Preprocessor |
| AERMOD | AMS/EPA Regulatory Model |
| AMS | American Meteorological Society |
| AQRV | Air quality related value |
| AQS | Air Quality System |
| AZ | Arizona |
| Be | Beryllium |
| BPIP | Building Profile Input Program |
| CA | California |
| CAPCOA | California Air Pollution Control Officers Association |
| CFR | Code of Federal Regulations |
| CO | Carbon monoxide, Colorado |
| D | Distance |
| DAT | Deposition Analysis Thresholds |
| DC | Deposition concentration |
| DLN | Dry low $NO_x$ |
| EAB | Environmental Appeals Board |
| EC | Elemental carbon |
| EPA | United States Environmental Protection Agency |
| EPNG | El Paso Natural Gas |
| FLAG | Federal Land Managers' Air Quality Related Values Workgroup |
| FLM | Federal Land Manager |
| ft | Feet |
| GE | General Electric |
| GEP | Good Engineering Practice |
| HAP | Hazardous air pollutant |
| HAPRACT | Hazardous air pollutant reasonable available control technology |

# LIST OF ACRONYMS (CONTINUED)

| | |
|---|---|
| $HNO_3$ | Nitric acid |
| hp | Horsepower |
| HRSG | Heat recovery steam generator |
| IMPROVE | Interagency Monitoring of Protected Visual Environments |
| ISA | Integrated Science Assessment |
| IWAQM | Interagency Workgroup on Air Quality Modeling |
| K | Kelvin |
| Kg/ha/yr | Kilogram per hectare per year |
| km | Kilometers |
| lb/hr | Pound per hour |
| LCC | Lambert conformal coordinates |
| LMP | Limited Maintenance Plan |
| m | Meter |
| mi | Mile |
| $mi^2$ | Square mile |
| MM | Mesocale modeled |
| MMBtu/hr | Million British thermal units per hour |
| MRPO | Midwest regional Planning Organization |
| m/s | Meters per second |
| msl | Mean sea level |
| MW | Megawatt |
| NA | Not applicable |
| NAAQS | National Ambient Air Quality Standards |
| NACAA | National Association of Clean Air Agencies |
| NAD83 | North American Datum 1983 |
| NCDC | National Climate Data Center |
| NED | National Elevation Dataset |
| NHS | National Historic Site |
| NLCD | National Land Cover Dataset |
| NM | National Monument, New Mexico |
| NMED | New Mexico Environmental Department |
| $NO_x$ | Oxides of nitrogen |
| $NO_2$ | Nitrogen dioxide |

# LIST OF ACRONYMS (CONTINUED)

| | |
|---|---|
| $NO_3$ | Nitrate |
| NP | National Park |
| NPS | National Park Service |
| NSR | New Source Review |
| NWS | National Weather Service |
| OC | Organic carbon |
| PDEQ | Pima County Department of Environmental Quality |
| $PM_{2.5}$ | Particulate matter less than 2.5 micrometers |
| $PM_{10}$ | Particulate matter less than 10 micrometers |
| PMC | Coarse particulate matter |
| PMF | Fine particulate matter |
| ppb | Parts per billion |
| ppm | Parts per million |
| ppmw | Parts per million by weight |
| PSD | Prevention of Significant Deterioration |
| PTE | Potential to emit |
| PVMRM | Plume Volume Molar Ratio Method |
| Q | Emissions |
| SCR | Selective catalytic reduction |
| SIL | Significant impact level |
| SLAMS | State and Local Air Monitoring Station |
| SOA | Secondary organic aerosol |
| $SO_2$ | Sulfur dioxide |
| $SO_4$ | Sulfate |
| SMC | Significant monitoring concentration |
| SWPG | SouthWestern Power Group II, LLC |
| TC | Tissue concentration |
| TDS | Total dissolved solids |
| tpy | Tons per year |
| TSS | Technical Support System |
| USDA | United States Department of Agriculture |
| USGS | United States Geological Survey |
| VOC | Volatile organic compound |

# LIST OF ACRONYMS (CONTINUED)

| | |
|---|---|
| WA | Wilderness Area |
| WRAP | Western Regional Air Partnership |
| WREG | Wind River Environmental Group LLC |
| WY | Wyoming |

# E1.0 INTRODUCTION AND PROJECT BACKGROUND

SouthWestern Power Group II, LLC (SWPG), plans to build a 1,000 megawatt (MW; 1,050 with duct firing) natural gas-fired, combined-cycle power plant. The facility, called the Bowie Power Station, will be built in phases. Phase one will be 525 MW and is addressed in this modeling report. This phase will consist of two General Electric (GE) natural gas-fired 7FA, Model 4 combustion turbine generators, two heat recovery steam generators with supplemental firing, a steam turbine generator, and a nine cell mechanical draft cooling tower. Auxiliary equipment includes a natural gas-fired boiler and a diesel-fired emergency fire pump. The plant will be owned and operated by Bowie Power Station, LLC (Bowie). Bowie Power Station, LLC is wholly owned by SWPG.

The plant will be located approximately 2 miles (mi) north of the unincorporated community of Bowie in Cochise County in southeastern Arizona, approximately 80 mi east of Tucson. The area is attainment for all pollutants.

The project property consists of approximately 2.5 square miles ($mi^2$) of agricultural land. The power plant site, switchyards, and evaporation impoundment will encompass approximately 150 acres. A project vicinity map is shown as Figure E1-1.

The proposed project will be a new major source as defined in the Arizona Administrative Code (AAC), Title 18, Chapter 2, Article 4, Section R18-2-401 and is required to obtain a Class I (Title V) permit and demonstrate compliance with the provisions in Article 3. This modeling report addresses impact analyses that were performed as part of an application for a Class I Prevention of Significant Deterioration (PSD)/Title V permit. The analyses were prepared in accordance with the Modeling Protocol prepared for this project (Wind River Environmental Group LLC [WREG] 2013) and subsequently approved by the Arizona Department of Environmental Quality (ADEQ), Air Quality Division.

## E1.1 Project Description

The project will include the following emission units:

- Two combined-cycle, natural gas-fired, GE Frame 7FA combustion turbines;
- Two heat recovery steam generators (HRSGs), each equipped with a 420 million British thermal unit per hour [MMBtu/hr] heat input) duct burner;
- Nine-cell cooling tower;
- Evaporation pond (not modeled);
- Natural gas-fired auxiliary boiler (50 MMBtu/hr heat input); and
- Diesel-fired emergency fire pump (260 horsepower).

The project plans to use GE Frame 7FA, Model 4 (7FA.04) combustion turbines with a “fast start” configuration.

Oxides of nitrogen ($NO_x$) emissions from the turbines and duct burners will be controlled using selective catalytic reduction (SCR) systems. Carbon monoxide (CO), volatile organic compound (VOC), and organic hazardous air pollutant (HAP) emissions from the turbines and duct burners will be controlled using oxidation catalysts.

**Figure E1-1. Bowie Power Station Location**

The project will be a major PSD source, with potential emissions of $NO_x$ and CO greater than 100 tons per year (tpy). Pollutants for which PSD review is required include not only $NO_x$ and CO, but also particulate matter less than 10 micrometers ($PM_{10}$) and particulate matter less than 2.5 micrometers ($PM_{2.5}$). The project is less than significant for sulfur dioxide ($SO_2$), VOCs, and lead; however, $SO_2$ has been modeled for comparison with ambient standards in accordance with ADEQ policy. The project is a minor source of HAPs.

## E1.2 Site Description

The project site and surrounding areas are primarily agricultural. This area lies within the San Simon Valley, defined by the Pinaleno, Dos Cabezas, and Chiricahua Mountain ranges to the west of the site, and the Peloncillo Mountain range to the east. The San Simon Valley has a general northwest-to-southeast orientation, with a gentle slope upward from the northeast to the southwest. The nearest elevated terrain to the project site occurs in the Fisher Hills, located within the valley to the northwest. The leading edge of these hills is within 7 kilometers (km) of the site. The highest terrain feature within a radius of 30 km of the site is Government Peak (7,580 feet above mean sea level [ft msl]), located within the Dos Cabezas Mountain range. The site will be graded to a base elevation of approximately 3,737 ft msl (1,139 meters). The location of the site within the valley is shown in Figure E1-1. The proposed location is in Township 12S, Range 28E, Section 28.

Figure E1-2 shows the site layout; Figure E1-3 shows a more detailed plot plan.

## E1.3 Regional Climatology

The climate in the Bowie area can be characterized as mild and dry. Seasonal temperatures and precipitation totals observed in Safford, Arizona (approximately 53 km to the north) for the period 1951-1980 are shown in Table E1-1 (Gale 1985). The annual average temperature for the Safford area is 62.5 degrees Fahrenheit (ºF).

**Table E1-1. Seasonal Temperatures and Precipitation**

| Season | Temperature (ºF) | | | Total Average Precipitation (inches) |
|---|---|---|---|---|
| | Maximum | Minimum | Average | |
| Spring | 78.7 | 42.6 | 60.7 | 0.9 |
| Summer | 97.0 | 64.1 | 80.6 | 3.6 |
| Autumn | 80.7 | 46.5 | 63.7 | 2.3 |
| Winter | 61.3 | 29.0 | 45.1 | 1.9 |

Notes:

°F = Degrees Fahrenheit
Maximum = Mean daily maximum
Minimum = Mean daily minimum

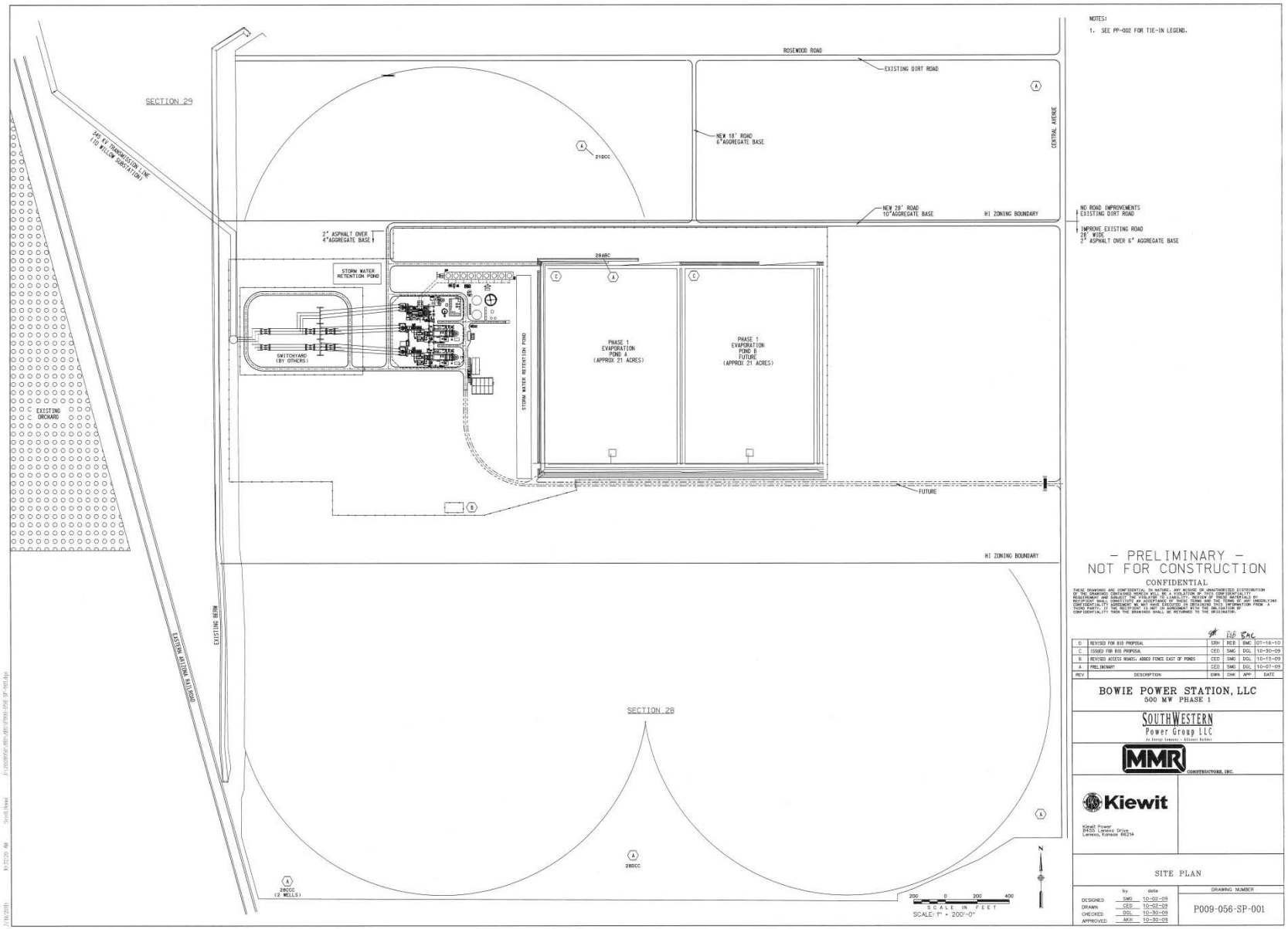



**Figure E1-2. Bowie Power Station Site Plan**

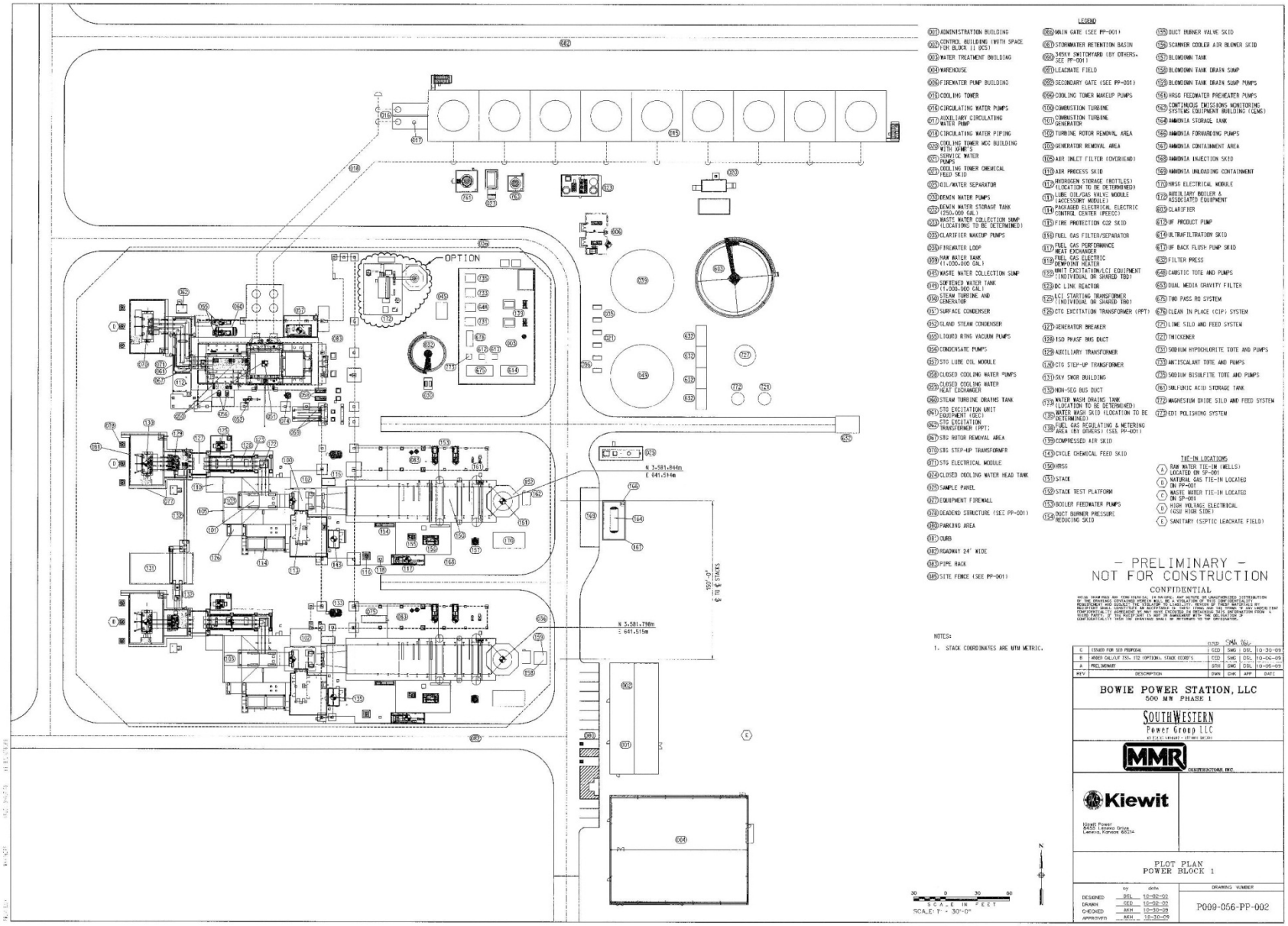



**Figure E1-3. Bowie Power Station Plot Plan**

# E2.0 REGULATORY STATUS

The Bowie Power Station will be located in Cochise County, Arizona. The air permitting authority is the ADEQ, Air Quality Division.

## E2.1 Source Designation

The proposed project will require a Class I permit. The project has the potential to emit more than 100 tpy of $NO_x$ and CO. In addition, the project has the potential to emit more than 15 tpy of $PM_{10}$ and 10 tpy of $PM_{2.5}$ ($NO_x$ is also considered a precursor to both $PM_{10}$ and $PM_{2.5}$). An air quality impact analysis is required for these pollutants. The analysis included the following components:

- Dispersion modeling to determine whether ambient impacts due to the proposed project would exceed modeling significant impact levels (SILs);
- For 1-hour nitrogen dioxide ($NO_2$), a refined dispersion analysis to assess the effect of the proposed project and other sources on ambient air quality (compliance with national and Arizona ambient air quality standards [NAAQS/AAAQS]);
- An assessment of the proposed project's impacts to soils and vegetation;
- An assessment of the project's impacts to visibility;
- An assessment of regional population growth and associated emissions that may be caused by the proposed project; and
- An assessment of the proposed project's potential to affect increments, visibility, or other air quality related values (AQRVs) in nearby Class I areas.

At ADEQ's request, an air quality impact analysis was also performed to show compliance with $SO_2$ NAAQS/AAAQS.

Refined dispersion analyses were not performed to assess the effect of the proposed project and other sources on Class II increments of allowable deterioration in air quality (increment consumption) because only 1-hour $NO_2$ impacts exceeded a SIL and no increment has been promulgated for 1-hour $NO_2$.

The Bowie Power Station will be a minor source of HAPs, with total HAP emissions less than 25 tpy and emissions of each individual HAP less than 10 tpy. The Bowie Power Station does not belong to one of the source categories listed in Table 2 of the Arizona Administrative Code, Title 18, Chapter 2, Article 17 (R18-2-1702) and therefore the Arizona State Hazardous Air Pollutant Program does not apply to the project. As such, neither the imposition of HAP Reasonably Available Control Technology (HAPRACT) nor the demonstration of a lack of adverse effects using a Risk Management Analysis is required for the project. Modeling of HAPs and other noncriteria pollutants were not performed except as needed to evaluate additional impacts to soils and vegetation in the project vicinity.

## E2.2 Area Classifications

The proposed project location is attainment/unclassified for the NAAQS/AAAQS for all pollutants regulated under the PSD program. PSD review is required for any pollutant regulated under the program that will be emitted in significant amounts.

The proposed project is located within 50 mi of the Arizona-New Mexico border, which makes New Mexico an affected state. Tribal lands within 50 mi of the project's impact area are also generally treated as affected states and informed of the project so that they may provide comments. The nearest tribal land to the project area is the San Carlos Indian Reservation located approximately 75 km (47 mi) to

the north and northwest. Other tribal lands in southern Arizona and New Mexico, including Tohono O'odham and Pascua Yaqui, both located in Pima County, Arizona, and Mescalero in Otero County, New Mexico, are located further from the proposed project site.

## E2.3 Baseline Dates and Area

For a given pollutant, a PSD increment is the maximum increase in concentration allowed above an established baseline concentration. The baseline concentration represents the actual ambient concentration existing at the initiation of the PSD program in a given area.

Two types of baseline dates have been established: major source baseline dates and minor source baseline dates. The major source baseline date identifies the point in time after which major sources affect available increment, while the minor source baseline date identifies the point in time after which actual emission changes from all sources (both major and minor) affect available increment. The amount of PSD increment that has been consumed within an area is determined from the actual emission increases and decreases that have occurred since the applicable baseline date.

The major source baseline dates are as follows:

- January 6, 1975, for $SO_2$ and $PM_{10}$;
- February 8, 1988, for$NO_2$; and
- October 20, 2010, for $PM_{2.5}$.

The trigger dates are the dates after which a minor source baseline can be established for an area. The trigger dates are as follows:

- August 7, 1977, for $SO_2$ and $PM_{10}$;
- February 8, 1988, for $NO_2$; and
- October 20, 2011 for $PM_{2.5}$.

The minor source baseline date in the Southeast Arizona Intrastate Air Quality Control Region for $NO_x$, $SO_2$, and $PM_{10}$ is April 5, 2002. The baseline area for the project encompasses the counties of Cochise, Graham, Greenlee, and Santa Cruz. The applicable $PM_{2.5}$ minor source baseline date has not yet been set.

# E3.0 AMBIENT DATA REQUIREMENTS

Preconstruction and post-construction monitoring requirements are discussed below.

## E3.1 Representative Data Satisfying the Preconstruction Air Quality Monitoring Requirements

A PSD permit applicant can satisfy the preconstruction monitoring requirements associated with the PSD permitting process by using data from existing monitors that are determined by ADEQ to be representative of background conditions in the affected area. On January 22, 2013, the US Court of Appeals for the DC Circuit issued an opinion granting the US Environmental Protection Agency's (EPA's) request to voluntarily remand the portion of a regulation establishing SILs for $PM_{2.5}$ and invalidating the portion of the regulation establishing the significant monitoring concentration (SMC) for $PM_{2.5}$.; the decision contained no holdings, and thus has no effect with respect to the SILs or SMCs for any other pollutant. Subsequently, on March 4, 2013, the EPA issued *Draft Guidance for $PM_{2.5}$ Permit Modeling* in light of the Court's decision. The draft guidance and all associated guidance relate exclusively to $PM_{2.5}$, and do not alter, impact, or otherwise change the ability of ADEQ to use and rely upon the SILs or SMCs for other pollutants. Also, neither the Court opinion nor the draft guidance have altered ADEQ's discretion to use representative data to satisfy the preconstruction monitoring requirements of PSD permitting. See *Draft Guidance for $PM_{2.5}$ Permit Modeling*, p. 11 (EPA 2013): "[T]he EPA believes PSD permit applicants may continue to meet the preconstruction monitoring requirements in these regulations by using data from existing monitors that are determined by the applicable permitting authority to be representative of background conditions in the affected area," citing to *In re: Northern Michigan University Ripley Heating Plant, PSD Appeal* No. 08-02, slip op. at 58 (Feb. 18, 2009): "EPA has long implemented the PSD program pursuant to the understanding that representative data may be substituted where circumstances warrant."

ADEQ has the discretion and authority to use representative data to satisfy the preconstruction monitoring requirements associated with the PSD permitting process and such authority was not impacted or altered by the recent DC Circuit opinion. Therefore, this section contains an expanded analysis of the representativeness of nearby existing monitoring data that was used in connection with the modeling.

The *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA 1987) discuss the concept of "representative" air quality data. Use of the *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* has been upheld as appropriate by the EPA's Environmental Appeals Board (EAB), as has the use of representative data to satisfy the preconstruction monitoring requirements of PSD permitting. See, for example, *In re Knauf Fiber Glass, GmbH*, 8 E.A.D. 121, 145-48 (EAB 1999); *In re Haw. Elec. Light Co*., 8 E.A.D. 66, 97-105 (EAB 1998); *In re Hibbing Taconite Co., 2 E.A.D.* 838, 850-51 (Adm'r 1989), all cited to and relied upon by *In re: Northern Michigan University Ripley Heating Plant, PSD Appeal* No. 08-02, slip op. at 58 (Feb. 18, 2009) for the proposition that representative data may be used to satisfy the preconstruction monitoring requirements.

The *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA 1987) provide that, with respect to location, the existing monitoring data should be representative of three types of areas: 1) the location(s) of maximum concentration increase from the proposed source or modification, 2) the location(s) of the maximum air pollutant concentration from existing sources, and 3) the location(s) of the maximum impact area (i.e., where the maximum pollutant concentration would hypothetically occur based on the combined effect of the existing sources and the proposed new source). The Guidelines go on to state that if the proposed source will be constructed in an area that is generally free from the impact of other point sources and area sources associated with human activities, then monitoring data from a "regional" site may be used as representative data. Such a site could be out of the maximum

impact area but must be similar in nature to the impact area. The Bowie Power Station will be located in an area with low population. Moreover, the Bowie Power Station location is not adjacent to other point sources and is situated such that it is not considered to be in a "multisource" area. As with much of rural southern Arizona, the surrounding land use is a mixture of undisturbed desert and agriculture.

In 2011, the National Association of Clean Air Agencies (NACAA) published a report from the NACAA $PM_{2.5}$ Modeling Implementation Workshop, titled *$PM_{2.5}$ Modeling Implementation for Projects Subject to National Ambient Air Quality Demonstration Requirements Pursuant to New Source Review* (NACAA 2011). A discussion from the Representative Background Concentrations Subgroup expands on the factors to be considered in determining whether a monitoring site is representative of the maximum impact area for a proposed source:

- Proximity to the source(s) modeled. In general, the nearest monitoring site is preferable. A monitoring site that is far from the source(s) modeled may be affected by the secondary formation of $PM_{2.5}$ precursors that are emitted under much different circumstances.
- Similarity of the surrounding source(s). Sources in the vicinity of the monitor should be similar to those near the source(s) modeled. The background concentration should not be affected by major point sources that would not affect receptors in the vicinity of the source being permitted. But, the concentrations at a monitoring site that is impacted by suburban or industrial sources might be representative of the background in an area that has similar sources.
- Conservativeness of the background concentrations. The intent of any analysis is to ensure that it is "conservative" (i.e., ambient concentrations are overestimated). Thus, an effort should be made to select a background monitoring site where the measured concentrations are equal to or greater than those that would be measured were a monitor to be located in the vicinity of the source(s) to be modeled.

Although this guidance relates to modeling for $PM_{2.5}$, it is consistent with EPA's guidance and EAB decisions discussing the factors used in establishing whether particular data are "representative" generally with respect to any pollutant. ADEQ's *Draft Revised Modeling Guidelines* (August 2013; p. 34) further support the use of conservative data as background data. Thus, the NACAA guidance is referenced and used as support for the position that the data relied upon for each pollutant is "representative" such that is satisfies the preconstruction monitoring requirements of PSD permitting.

### E3.1.1 Ozone

Ambient ozone monitoring data from the nearby Chiricahua National Monument (NM) has been proposed and accepted by ADEQ as representative ozone data that meets the PSD preconstruction monitoring requirement. The Chiricahua NM monitor is located approximately 41 km to the south-southeast of the project. The ozone monitor is located at an elevation of 5,151 feet (the Bowie Power Station will be located at 3,737 feet elevation). It is the nearest location to the project where ozone is monitored and the only ozone monitoring location in Cochise County. Because ozone is a regional pollutant, the Chiricahua NM data are expected to be representative of the project site. Both the Bowie project and the Chiricahua NM are located in rural areas, far from major areas of ozone precursor emissions (i.e., Tucson, Phoenix, etc.). On April 30, 2012, EPA designated Cochise County attainment/unclassifiable with respect to the 2008 ozone NAAQS based on data from this monitor, along with an analysis of population density, emissions, and commuting patterns. ADEQ has concluded that Cochise County does not contribute to ambient air quality that does not meet the 8-hour ozone standard (ADEQ 2009).

### E3.1.2 Particulate Matter

Particulate matter ($PM_{2.5}$ and $PM_{10}$) data are also collected at the Chiricahua NM through the Interagency Monitoring of Protected Visual Environments (IMPROVE) program, monitored on a 1-in-3 day schedule. These data were proposed as representative data for $PM_{2.5}$ and $PM_{10}$ in the Modeling Protocol prepared for this project (WREG 2013) and subsequently approved by ADEQ.

Local and regional emissions from upwind urban areas and rural sources can account for 50%-75% of total observed particulate matter concentrations. Generally, $PM_{10}$ consists of 40%-60% $PM_{2.5}$, and the remainder is primarily locally generated, crustal/geological and biological material. In contrast, most of the observed $PM_{2.5}$ mass usually originates as precursor gases and, through various physiochemical processes, is transferred to the condensed phase as secondary particulate matter. (NARSTO 2004)

Particulate matter is composed of multiple chemicals, largely sulfate, organic carbon, and nitrate, in combinations that differ by geographic region. Non-coastal rural areas are dominated by sulfate, organic carbon, and black carbon, while nitrate-containing particles are important in parts of the west. Almost all sulfate originates from $SO_2$ oxidation mediated by ammonia. While 95% of $SO_2$ sources are anthropogenic, from fossil fuel combustion, the majority of ammonia sources are related to agricultural activities. Essentially all particle nitrate is derived from atmospheric oxidation of $NO_x$. The major anthropogenic source of $NO_x$ is fossil fuel combustion. Organic carbon may be primary and/or secondary, of biogenic (vegetative material, biogenic gases, spontaneous forest fires) and anthropogenic (fossil fuel combustion, prescribed fires, cooking) origin. Black carbon originates as ultrafine or fine particles from primary sources during incomplete combustion of carbon-based fuels. (NARSTO 2004)

$PM_{2.5}$ concentrations tend to be highest in the central portions of urban areas, diminishing to background levels at the urban fringe. The typically smaller spatial variations of $PM_{2.5}$ compared to $PM_{10}$ are consistent with the long atmospheric residence time of fine particles, which permits transport over distances of 10 to 1,000 km and leads to more uniform mass concentrations. $PM_{10}$ concentrations are not spatially distributed smoothly because each monitoring site is strongly influenced by the degree of localized emissions of coarse particles. (NARSTO 2004; ADEQ 2009)

The Chiricahua NM monitoring location is the closest site at which $PM_{2.5}$ and $PM_{10}$ data are recorded (41 km). Both the Chiricahua NM site and the proposed Bowie Power Station location are rural areas without significant nearby population. The surrounding land use in each case includes a mixture of desert and agriculture, both of which are sources of directly emitted $PM_{2.5}$ and $PM_{10}$. Other southeastern Arizona locations where $PM_{2.5}$ and/or $PM_{10}$ are monitored (Douglas, Arizona; Saguaro National Park [NP] East; and several locations in the Tucson metropolitan area) are located over twice as far from Bowie and the surrounding land uses are different (Tucson and Douglas have larger populations; Douglas is also impacted by nearby particulate matter sources in Agua Prieta, Mexico; and Saguaro NP East is located in an undisturbed desert environment at the eastern edge of the Tucson metropolitan area).

Both the Chiricahua NM and the Bowie Power Station site are potentially impacted by a number of point sources of directly emitted $PM_{2.5}$ and $PM_{10}$, as well as $PM_{2.5}$ precursor emissions ($NO_x$ and $SO_2$). ADEQ supplied a listing of permitted sources within approximately 50 km of each location. Table E3-1 lists the nearby point sources of directly emitted $PM_{2.5}$ and $PM_{10}$, as well as $PM_{2.5}$ precursor emissions, that may impact the Chiricahua monitor location and the Bowie Power Station. Figures E3-1 and E3-2 portray this information graphically. $PM_{10}$ is plotted in Figure E3-1 ($PM_{2.5}$ emissions are identical for most sources), while Figure E3-3 compares the cumulative point source emissions with distance from the Bowie Power Station and the Chiricahua NM monitoring site.

## Table 3-1. $PM_{10}/PM_{2.5}$ and $PM_{2.5}$ Precursor Emissions near Bowie Power Station and Chiricahua NM Monitor

| Source | Distance From Bowie (km) | Distance from Chiricahua Monitor (km) | $PM_{10}/PM_{2.5}$ Potential to Emit (tpy) | $PM_{2.5}$ Precursors Potential to Emit (tpy) |
|---|---|---|---|---|
| Pistachio Corporation of America | 7.6 | 33.1 | 1.3/1.3 | 17.0 |
| Level 3 Communications | 16.9 | 31.8 | 0.25/0.25 | 3.7 |
| EPNG-Bowie Compressor Station | 18.9 | 44.3 | 1.8/1.8 | 316.9 |
| EPNG-Cimarron Compressor Station | 28.0 | 51.0 | 5.2/5.2 | 51.8 |
| Biad Chili San Simon | 32.4 | 33.9 | 1.3/1.3 | 30.3 |
| EPNG-Willcox Compressor Station | 32.4 | 28.1 | 4.8/4.8 | 489.5 |
| Maid Rite Feeds | 34.0 | 49.5 | 4.5/0.35 | 0.00 |
| Westlawn Chapel & Mortuary | 34.4 | 50.2 | 0.04/0.03 | 0.13 |
| Willcox Greenhouse #1 | 40.1 | 65.0 | 1.2/1.2 | 16.1 |
| Kansas Settlement Gin | 41.8 | 35.9 | 64/64 | 7.2 |
| EPNG-San Simon Compressor Station | 42.2 | 36.6 | 1.6/1.6 | 306.4 |
| Sunizona Greenhouses | 43.8 | 26.6 | 7.9/7.9 | 15.3 |
| Eurofresh Farms | 44.3 | 73.4 | 10.2/7.7 | 145.4 |
| Federal Bureau of Prisons-FCI Safford | 44.7 | 84.7 | 0.39/0.39 | 16.9 |
| Faria Dairy | 44.9 | 34.9 | 0.13/0.13 | 5.7 |
| Apache Generating Station | 50.1 | 48.0 | 476.6/476.6 | 27,576 |
| Boral Materials - Apache | 50.4 | 48.0 | 0.14/0.14 | 0.00 |

Notes:

| | | | | | |
|---|---|---|---|---|---|
| hp | = | Horsepower | km | = | Kilometer |
| MMBtu/hr | = | Million British thermal units per hour | MW | = | Megawatt |
| $NO_x$ | = | Oxides of nitrogen | NM | = | National Monument |
| tpy | = | Tons per year | | | |

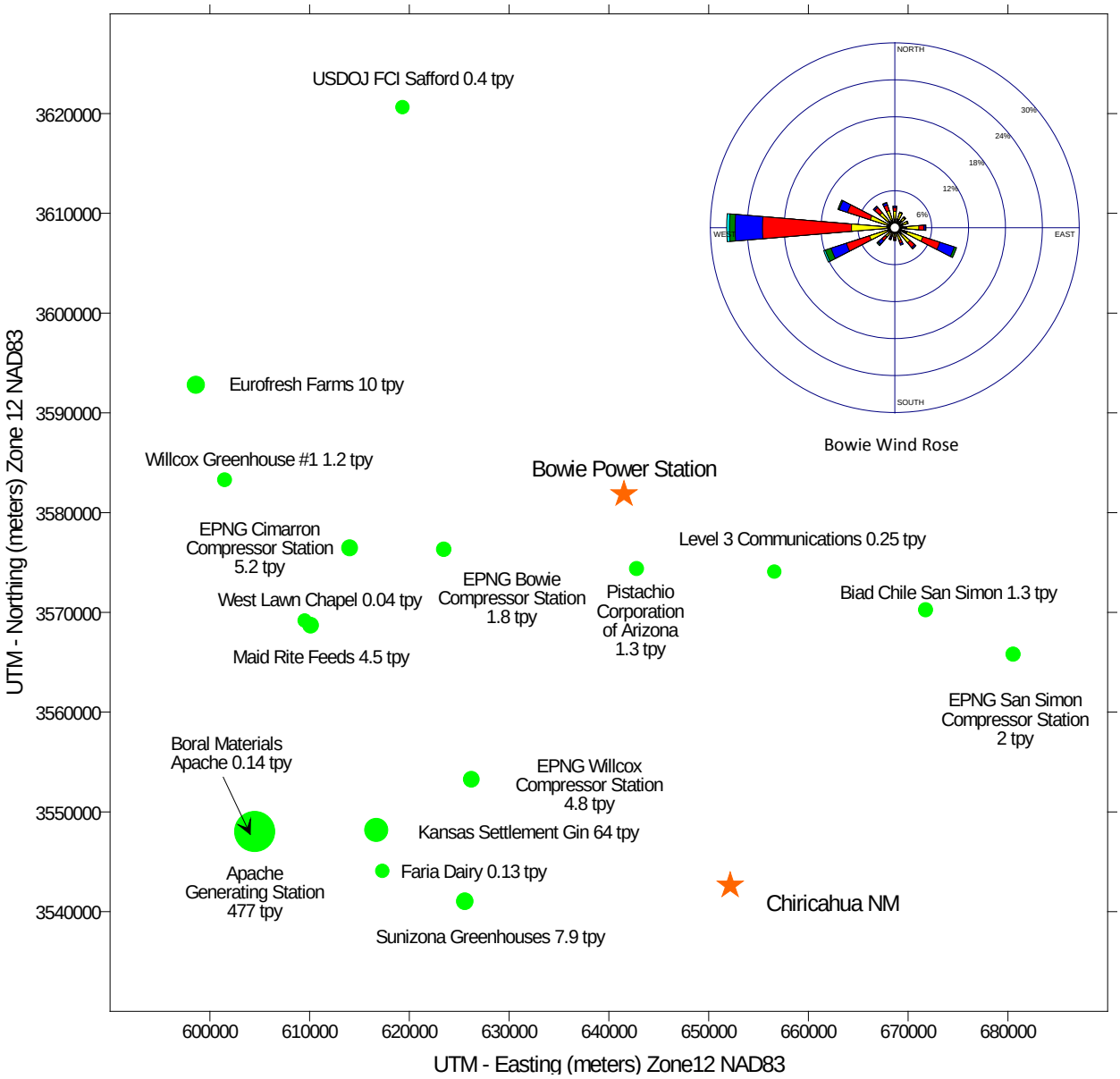



**Figure E3-1. $PM_{10}$ Emissions near Bowie Power Station and Chiricahua NM Monitor**

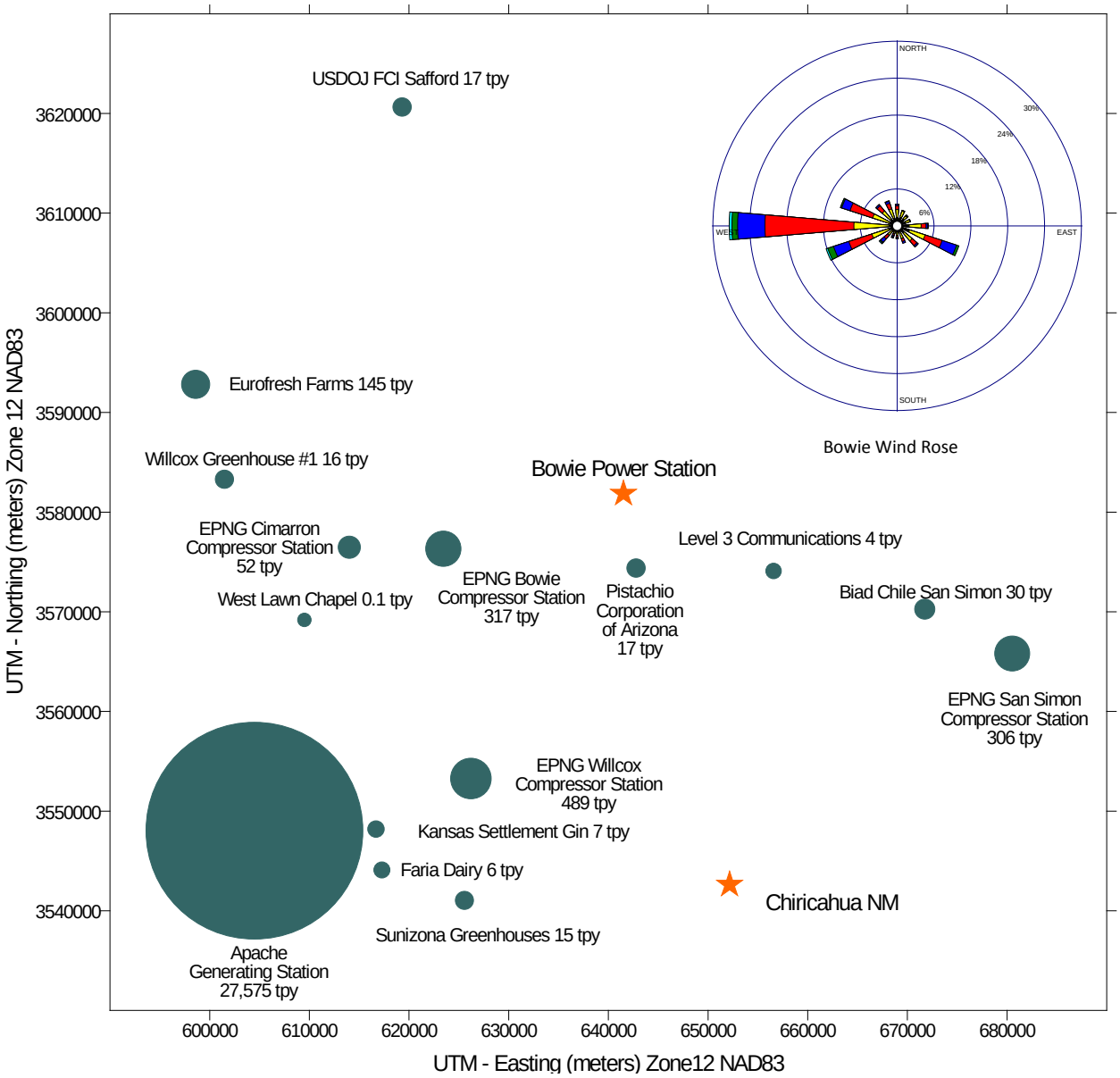
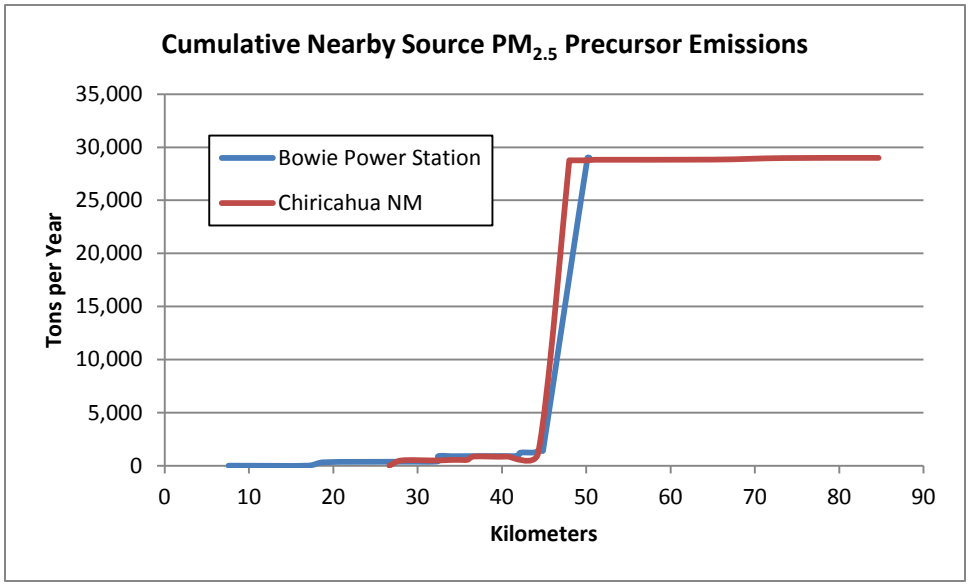



**Figure E3-2. $PM_{2.5}$ Precursor Emissions near Bowie Power Station and Chiricahua NM Monitor**



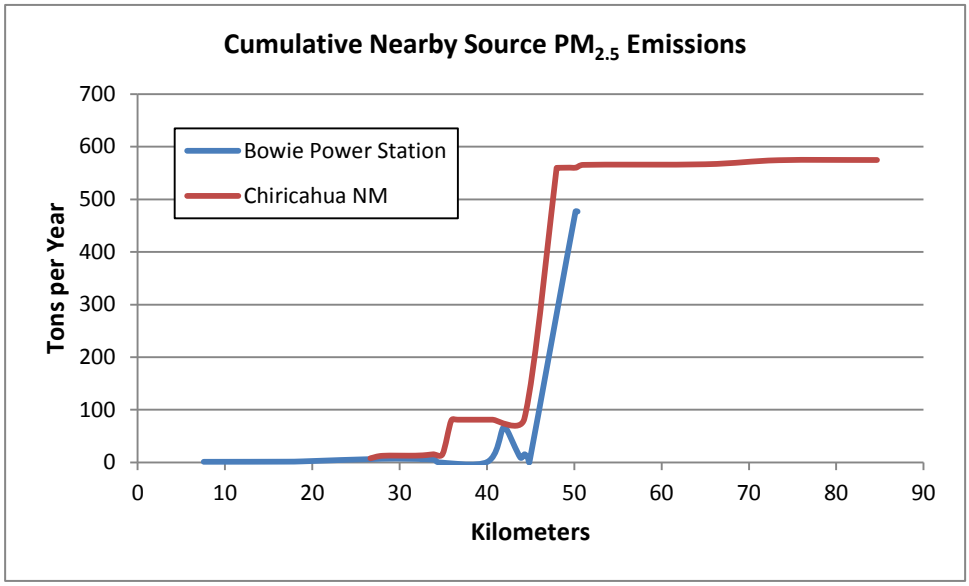




**Figure E3-3. Nearby Point Source Emission Profiles with Distance from the Bowie Power Station and Chiricahua NM Monitor Locations**

With respect to $PM_{2.5}$ precursors, the cumulative emissions profiles are almost identical and are dominated by emissions from the Apache Generating Station. For directly emitted $PM_{2.5}$ (and $PM_{10}$, which is not shown on the graphs because the profiles are virtually identical to those for $PM_{2.5}$), the Chiricahua NM monitoring site is slightly closer to the major particulate matter point sources in the region, rendering the monitoring data conservative relative to the Bowie Power Station location. As a result, the Chiricahua NM monitoring site may be considered representative of the Bowie Power Station impact area.

EPA has recently provided draft guidance on $PM_{2.5}$ modeling for New Source Review (EPA 2013). A secondary $PM_{2.5}$ analysis is required for the Bowie Power Station and the March 2013 draft guidance has been followed in preparing the analysis (see Section E5.4.1.4). This makes the Chiricahua NM IMPROVE data particularly valuable because the data are speciated and fractions of the major components of fine mass, including sulfate, nitrate, organic carbon etc., have provided useful reference information for a qualitative analysis of the Bowie Power Station's secondary $PM_{2.5}$ impacts.

### E3.1.3 Sulfur Dioxide

$SO_2$ emissions from the Bowie Power Station are below the significant emission rate for PSD and this pollutant is being modeled at the request of ADEQ, rather than as a required part of the PSD impact analyses. $SO_2$ is currently monitored at only a few locations in Arizona. Most locations were sited to capture maximum impacts from large $SO_2$ point sources, including smelters and coal-fired power plants. As such, these monitors would not be representative of expected $SO_2$ concentrations in the Bowie area, where the nearest major point source of $SO_2$ (Apache Generating Station) is located approximately 50 km away.

$SO_2$ is monitored at one location in the Tucson metropolitan area in Pima County, approximately 80 mi to the west of the Bowie location. Unlike most other $SO_2$ monitoring sites in Arizona, the Pima County monitor was not located to capture maximum impacts from a specific point or group of sources but instead represents general population exposures to this pollutant. According to the Pima County Department of Environmental Quality (PDEQ 2011), ambient concentrations of $SO_2$ in Tucson have historically remained well below all federal standards and in recent years have been extremely low. The only major stationary sources of $SO_2$ possibly affecting ambient concentrations in the Tucson air planning area are the coal burning generators at the Irvington Generating Station operated by Tucson Electric Power. $SO_2$ was monitored for a number of years at the 22nd and Craycroft location but that site was discontinued in December 2010, after an $SO_2$ trace monitor was added at the Children's Park NCore location. Although slightly older, three years of $SO_2$ data from the 22nd and Craycroft (2008-2010) site were proposed and accepted by ADEQ as representative monitoring data because of the shorter period of record from the Children's Park location. These data are expected to be conservative relative to the Bowie Power Station location because of possible influence from the Irvington Generating Station (156 MW capacity coal), located 5.4 km from the 22nd and Craycroft monitor site. While the Bowie site is potentially impacted by a larger coal fired power plant (Apache Generating Station, ~400 MW coal), it is further away (50 km).

### E3.1.4 Carbon Monoxide

CO is another pollutant that is only monitored at a few sites in Arizona. The closest CO monitoring locations are in Pima County (Tucson metropolitan area). PDEQ monitors CO at five locations. Motor vehicles are the primary source of CO nationally as well as in the Tucson area. In spite of increased vehicular traffic, CO concentrations in Pima County have declined in the past three decades. This has been attributed to the use of cleaner burning oxygenated fuels, fuel efficient computer controlled vehicles, locally adopted Clean Air and Travel Reduction Programs, and various local traffic control measures.

Pima County was at one time designated nonattainment for the CO NAAQS and is operating under the auspices of the CO Limited Maintenance Plan (LMP). No exceedances of the CO NAAQS have been recorded in Tucson since 1988. Pima County's status for CO was reclassified to attainment with the implementation of the CO LMP on April 25, 2000 by EPA. The CO LMP was developed in conjunction with the Pima Association of Governments and approved by EPA to help mitigate any future violations.

According to EPA, the entire country now has air quality that meets current CO standards. Most sites have measured concentrations below the national standards since the early 1990s and improvements in motor vehicle emissions controls have contributed to significant reductions in ambient concentrations since that time. National data show a 73% decrease in CO (8-hour concentrations) between 1990 and 2010 and a 54% decrease between 2000 and 2010.

Because Tucson is a larger metropolitan area with higher traffic levels than the Bowie Power Station site, other CO monitoring sites in nearby states were examined to identify sources of monitoring data that are representative of the rural Bowie area. The only significant source of CO emissions in the immediate vicinity of Bowie is Interstate 10 (I-10), which has measured annual average daily traffic (AADT) volumes of 11,000-13,000 vehicles per day in recent years.

CO monitoring locations in Arizona, New Mexico, Colorado, Wyoming, Utah, and southern California were examined to identify sources of representative monitoring data for use in connection with the Bowie PSD permitting process. CO concentrations would be expected to be influenced by climate (colder areas have poorer winter dispersion, more fuel is burned to start motor vehicles, and emission control devices on vehicles operate less efficiently in cold weather), elevation (less oxygen in the air means less complete combustion, although this is mitigated in some areas by oxygenated fuel requirements), and population and traffic volumes on nearby roads, both of which relate to probable mobile source emissions. As a result of these factors, candidate sites were chosen that were located in cities smaller than Tucson or outside cities, that were inland, and that were near paved roadways, and that were therefore similar to the conditions facing the Bowie Power Station. This resulted in a list of 18 sites that were examined in more detail. The most recent three years of CO monitoring data (if available) were collected for these sites.

The 18 sites included the five Tucson monitoring locations, five in inland southern California (near Fresno, Barstow, Lancaster, Lake Elsinore, and Palm Springs), one site in rural southwestern Colorado (27 kilometers outside Durango), five sites near Albuquerque, New Mexico, and two sites in southern Wyoming (one in Cheyenne and one sited near oil and gas development in Sweetwater County). Population ranged from over 900,000 in Tucson to a site 26 kilometers from a town of 12,500. Elevations ranged from 89 meters to over 1,900 meters. Distances to the nearest road and to the largest road within a few kilometers also varied. The climate varied from hot, desert locales (Tucson, Barstow, Palm Springs) to cold winter areas (Colorado and Wyoming sites).

All sites show CO concentrations well below the NAAQS. Over the most recent three years, all sites show 1-hour CO concentrations below 10% of the NAAQS, and 8-hour concentrations are no more than 25% of the NAAQS. As demonstrated by the varied climate, population, elevation, and nearby traffic at the 18 stations analyzed, CO concentrations can be expected to be generally low and relatively insensitive to variations in population or traffic beyond the immediate vicinity of the monitor.

Based on population density, climate, proximity to roads with similar traffic volumes, elevation, and the presence of other potential contributors of CO, seven of the monitoring sites were chosen for further analysis as potential representative sites for CO data for the Bowie Power Station. The data on each site are shown in Table E3-2. It is worth noting that it would be reasonable to select any of these seven stations as having "representative" data such that its use in connection with the Bowie PSD permitting process satisfies the preconstruction monitoring requirements.

## Table E3-2. Potentially Representative CO Monitoring Locations

| AQS Site ID/Name | City/State | Nearest Population Center | Elevation (m MSL) | Nearest AADT | % 1-hr CO NAAQS | % 8-hr CO NAAQS | Notes |
|---|---|---|---|---|---|---|---|
| 04-019-1011 22nd & Craycroft | Tucson,AZ | Tucson (980,263) | 789 | 20,180 | 5% | 11% | Nearest traffic count (3.9 km from monitor) likely higher than actual traffic near monitor. Neighborhood scale monitor. |
| 04-019-1021 Cherry & Glenn | Tucson,AZ | Tucson (980,263) | 732 | 12,845 | 5% | 14% | Traffic count located 4.2 km from monitor. Neighborhood scale monitor. |
| 04-019-1028 Children's Park NCore | Tucson,AZ | Tucson (980,263) | 703 | 43,605 | 3% | 7% | Traffic count located 445 m south of monitor. Neighborhood scale monitor. |
| 06-071-0001 200 E. Buena Vista | Barstow, CA | Barstow (22,639) | 690 | 18,000 | 6% | 10% | Traffic count 1 km from site. Siting criteria and measurement scale unknown. |
| 08-067-7001 Ignacio | 27 km from Durango, CO | Durango (16,887) | 1,983 | 10,400 | 3% | 7% | Sum of two traffic counts (monitor is between) located 1.5 km and 2.3 km from monitor. Neighborhood scale monitor. |
| 56-021-0100 North Cheyenne Soccer Complex | Cheyenne, WY | Cheyenne (91,738) | 1,848 | 5,650 | 2% | 4% | Nearest traffic counts 4-5 km from monitor. |
| 56-037-0870 Tata Gaseous | 25.8 km from Green River, WY | Green River (12,515) | 1,912 | 6,289 | 3% | 12% | Traffic count at nearest intersection with I-80, 5 km. |
| **Bowie Power Station** | **Bowie, AZ** | **Bowie (<1,000)** | **1,139** | **11,000-13,000** | **NA** | **NA** | **4 km to I-10.** |

Notes:

| | | | | | |
|---|---|---|---|---|---|
| AADT | = | Annual average daily traffic | AQS | = | Air Quality System |
| AZ | = | Arizona | CA | = | California |
| CO | = | Carbon monoxide, Colorado | km | = | Kilometer |
| m | = | Meter | MSL | = | (Above) Mean sea level |
| NAAQS | = | National Ambient Air Quality Standard | WY | = | Wyoming |

Based on the factors found in EPA guidance, NACAA guidance, and relevant EAB decisions, the CO monitoring location identified as most representative of the Bowie Power Station location is located at 22nd and Craycroft in Pima County. This site is one of the oldest in the Pima County monitoring network, originally established in 1973, and has operated continuously to the present. The site is situated in a predominately residential area with commercial activity lining nearby arterial routes.

The NACAA Representative Background Concentrations Subgroup recommended that the factors to be considered in determining whether a monitoring site is representative of the maximum impact area for a proposed source should include: 1) proximity to the source modeled (the nearest monitoring site is preferable); 2) similarity of the surrounding sources, and 3) conservativeness of the background concentrations. With respect to the first criterion, the 22nd and Craycroft monitor and the other Tucson monitors are those in closest proximity to Bowie (approximately 80 mi west of Bowie). The climate is similar and the monitor is located at an elevation that is only a few hundred meters below that of Bowie, both factors that influence CO emissions.

With respect to the second criterion, similarity of surrounding sources, traffic is the primary CO source at each location. Local traffic is more important in determining representativeness than traffic over a larger area. The *Integrated Science Assessment for Carbon Monoxide* (ISA; EPA 2010a) cites studies showing that CO concentrations decrease sharply, even exponentially, with downwind distance from a highway. For example, one study showed "on road" CO concentrations 10 times higher than upwind concentrations, while at 300 m downwind, the concentrations were reduced to only twice the upwind concentrations. The traffic monitor closest to the 22nd and Craycroft CO monitor has a traffic count of approximately 20,000 AADT vs 11,000-13,000 on I-10 at Bowie. In each case, the highway being measured is approximately 4 km from the CO monitoring site. Based on street maps, it is expected that traffic in the immediate vicinity of the 22nd and Craycroft monitor would be lower than the closest traffic count and the same would be true at the Bowie Power Station location.

The 22nd and Craycroft monitor is considered a "neighborhood" scale monitor. The ISA notes that neighborhood scale CO monitors are sited to measure representative concentrations within a 0.5-4.0 km radius and, "For the [Code of Federal Regulations]-defined neighborhood scale monitoring, the minimum monitor distance from a major roadway is directly related to the average daily traffic counts on that roadway, to ensure that measurements are not substantially influenced by any one roadway.

With respect to the third criterion, it is expected that the CO concentrations at the 22nd and Craycroft monitor would be conservative relative to Bowie simply because of the larger urban area it is located in.

Use of data from a monitor site that is not adjacent or in the immediate vicinity of the source is appropriate where, as here, the source is in a rural and remote area and not located in a multisource area. Moreover, the sites identified in Table E3-2 are indicative of CO concentrations that would be representative of the maximum impact area associated with the Bowie Power Station. Thus, per EPA guidance, NACAA guidance, and long-standing EPA and ADEQ practice, any of the sites in Table E3-2 could be considered to have representative CO data. The 22nd and Craycroft monitor has been identified as the most representative due to the similarities in terrain, meteorological conditions, and proximity to comparable traffic concentrations and has been approved by ADEQ for use in the modeling analyses for the proposed Bowie Power Station.

### E3.1.5 Nitrogen Dioxide

In Arizona, $NO_2$ has only been monitored in urban areas such as Tucson and Phoenix, which would not be representative of $NO_2$ concentrations in the project area. Consequently, $NO_2$ ambient air quality data from Deming, New Mexico was proposed and approved by ADEQ as representative monitoring data for use in a previous permit application for the Bowie Power Station. The Deming data have been updated for this permit application.

Deming is a city of around 15,000 located due east of Bowie along I-10, approximately 104 mi (168 km) from Bowie. $NO_2$ data have been collected at this location since July 2006. The monitor is a State and Local Air Monitoring Station (SLAMS) site where $NO_2$ is monitored using the Federal Reference Method. It is operated by the New Mexico Environment Department (NMED).

ADEQ has provided a current list of permitted sources within 50 km of Bowie. Those sources are listed in Table E3-3. Stationary $NO_x$ sources located within 50 km of Deming are shown in Table E3-4. Information about each facility's distance from the Deming monitor, permitted hours of operation, equipment type, and allowable $NO_x$ emissions were taken from NMED's MergeMaster database (current to August 2013), and supplemented with information contained in public notices and communication with NMED employees.

Figures E3-4 and E3-5 show the location and relative size (based on allowable tons of $NO_x$ emissions per year) of various $NO_x$ sources in the vicinity of the Bowie project and of the Deming monitor, along with the distribution of winds at Bowie and Deming.

The 1-hour $NO_2$ NAAQS is largely focused on concerns about short-term impacts from $NO_x$ emissions due to heavy traffic and traffic hot spots. Both the Bowie Power Station and the Deming monitor are located near a major Interstate highway, I-10. The Deming monitor is located approximately 2 km from I-10, while the Bowie Power Station will be located approximately 4 km from I-10. Traffic volume on the portion of I-10 that runs through Bowie, Arizona is slightly lower than the link that runs through Deming, New Mexico (see *http://dot.state.nm.us/en/Planning.html#Data* and *www.azdot.gov/mpd/data/aadt.asp*), based on the most recent data available:

- I-10 Bowie:

  2010: 13,195 AADT

  2011: 12,119 AADT

  2012: 11,420 AADT

- I-10 Deming:

  2010: 18,730 AADT

  2011: 18,696 AADT

  2012: 17,595 AADT

$NO_x$ sources in the vicinity of the Deming monitor, along with closer proximity to a major highway, and a larger local population suggest that the Deming monitor provides a representative but conservative estimate of background $NO_2$ in the vicinity of Bowie.

## Table E3-3. $NO_x$ Emission Sources near Bowie Power Station

| Source | Distance (km) | Hours per Year | Facility/Equipment Type | $NO_x$ Potential to Emit (tpy) |
|---|---|---|---|---|
| Pistachio Corporation of Arizona | 7.6 | 8760 | Natural gas roaster; natural gas dryers (2.33-8.1 MMBtu/hr), silos<br>Total facility fuel use is limited by permit condition | 16.9 |
| Level 3 Communications | 16.9 | 8760 | Telecommunications facility | 3.5 |
| EPNG-Bowie Compressor Station | 18.9 | 8760 | Natural gas turbine, 9,800 hp; two generators (96-226 hp) | 316 |
| EPNG-Cimarron Compressor Station | 28.0 | 8760 | Natural gas turbine, 11,080 hp; auxiliary natural gas generator, 588 hp | 50 |
| Biad Chili San SImon | 32.4 | Unknown | Food and beverage processing | 30.3 |
| EPNG-Willcox Compressor Station | 32.4 | 8760 | Two natural gas turbines (> 10,000 hp each); natural gas emergency generator (>1,000 hp) | 487 |
| Westlawn Chapel & Mortuary | 34.4 | 8760 | Natural gas cremator | 0.09 |
| Willcox Greenhouse #1 | 40.1 | 8760 | Natural gas boilers (16 MMBtu/hr, 12 MMBtu/hr); diesel generators (366 hp, 158 hp) | 15.7 |
| Kansas Settlement Gin | 41.8 | 8760 | 3 MMBtu/hr and 2 MMBtu/hr natural gas heaters | 3.0[a] |
| EPNG-San Simon Compressor Station | 42.4 | 8760 | Three natural gas turbines, 4,920 hp each | 261 |
| Sunizona Greenhouses | 43.8 | 8760 | 15 natural gas boilers (0.25-4.2 MMBtu/hr); 300 hp natural gas generator; 4.2 MMBtu/hr wood-fired boiler | 14.8 |
| Eurofresh Farms | 44.3 | 8760 | 18 dual fuel (primarily natural gas) boilers (~ 40 MMBtu/hr each); 12 diesel generators (800-1,600 hp each); one standby generator | 141.7 |
| Federal Bureau of Prisons-FCI Safford | 44.7 | 500 | Emergency diesel generator, 1,200 hp | 13.3 |
| Faria Dairy | 44.9 | Unknown | Commercial animal feeding operation | 4.5 |
| Apache Generating Station | 50.1 | 8760 | One 75 MW steam unit (natural gas), two 195 MW steam units (coal, natural gas); three simple-cycle gas turbines, one 10.4 MW, 19.8 MW, 64.9 MW (natural gas, fuel oil); one 44 MW simple-cycle gas turbine (natural gas, diesel combination); one diesel startup engine, 430 hp | 14,065 |

[a] Potential to emit (PTE); higher annual inventory value used in 20D calculations; see Section 5.4

Notes:

| | | | | | |
|---|---|---|---|---|---|
| hp | = | Horsepower | km | = | Kilometer |
| MMBtu/hr | = | Million British thermal units per hour | MW | = | Megawatt |
| $NO_x$ | = | Oxides of nitrogen | tpy | = | Tons per year |

## Table E3-4. $NO_x$ Emission Sources near Deming Monitor

| Source | Distance (km) | Hours per Year | Equipment Type | $NO_x$ Potential to Emit (tpy) |
|---|---|---|---|---|
| Deming Chili Jalapeno Processing Plant | 1.3 | 8760 | Boilers, dehydrators, roasters | 55 |
| Desert Valley Inc. | 2.1 | 4380 | Concrete batch plant | 95 |
| Luna Energy Facility | 7.3 | 8760 | Combined-cycle, gas turbine facility (2 GE 7FAs, 2 heat recovery steam generators (HRSGs) with duct burners, 1 steam turbine generator, 1 aux boiler) Became operational in April 2006 | 250 |
| Fisher S&G NM Inc. | 11.2 | 5000 | Asphalt plant | 150 |
| Turner Sand and Gravel Deming Pit | 13.1 | 2000 | Diesel generator (Deutz engine) | 16 |
| St. Cloud Mining Company | 16.4 | 8760 | Crushing/screening | 95 |
| Dicaperl Minerals | 16.5 | 8760 | Diesel generators | 194 |
| James Hamilton Construction | 22.4 | 2640 | 650 ton per hour asphalt plant | 42 |
| Deming Compressor Station | 25.7 | 8760 | 21 natural gas-fired internal combustion (IC) compressor engines, 1,100 hp each Deming facility has been operating in a backup capacity since 2004; station was abandoned December 22, 2011 | 331 |
| Florida Compressor Station | 28.7 | 8760 | Natural gas-fired turbines (three 7,100 hp, one 1,000 hp, one 15,000 hp); one natural gas IC engine (215-585 hp) Florida facility has been operating since 2000 | 935 |
| Deming Sand & Gravel | 28.6 | 4380 | Sand and gravel | 95 |
| MSCI | 31.2 | 4380 | Asphalt plant and generator | 108 |
| Southwest Concrete and Paving | 33.2 | 4380 | Quarrying, crushing, screening facility | 95 |
| Southwest Concrete and Paving | 33.5 | 4380 | Hot mix asphalt plant | 95 |

Notes:

| | | |
|---|---|---|
| hp | = | Horsepower |
| HRSG | = | Heat recovery steam generator |
| km | = | Kilometer |
| $NO_x$ | = | Oxides of nitrogen |
| tpy | = | Tons per year |

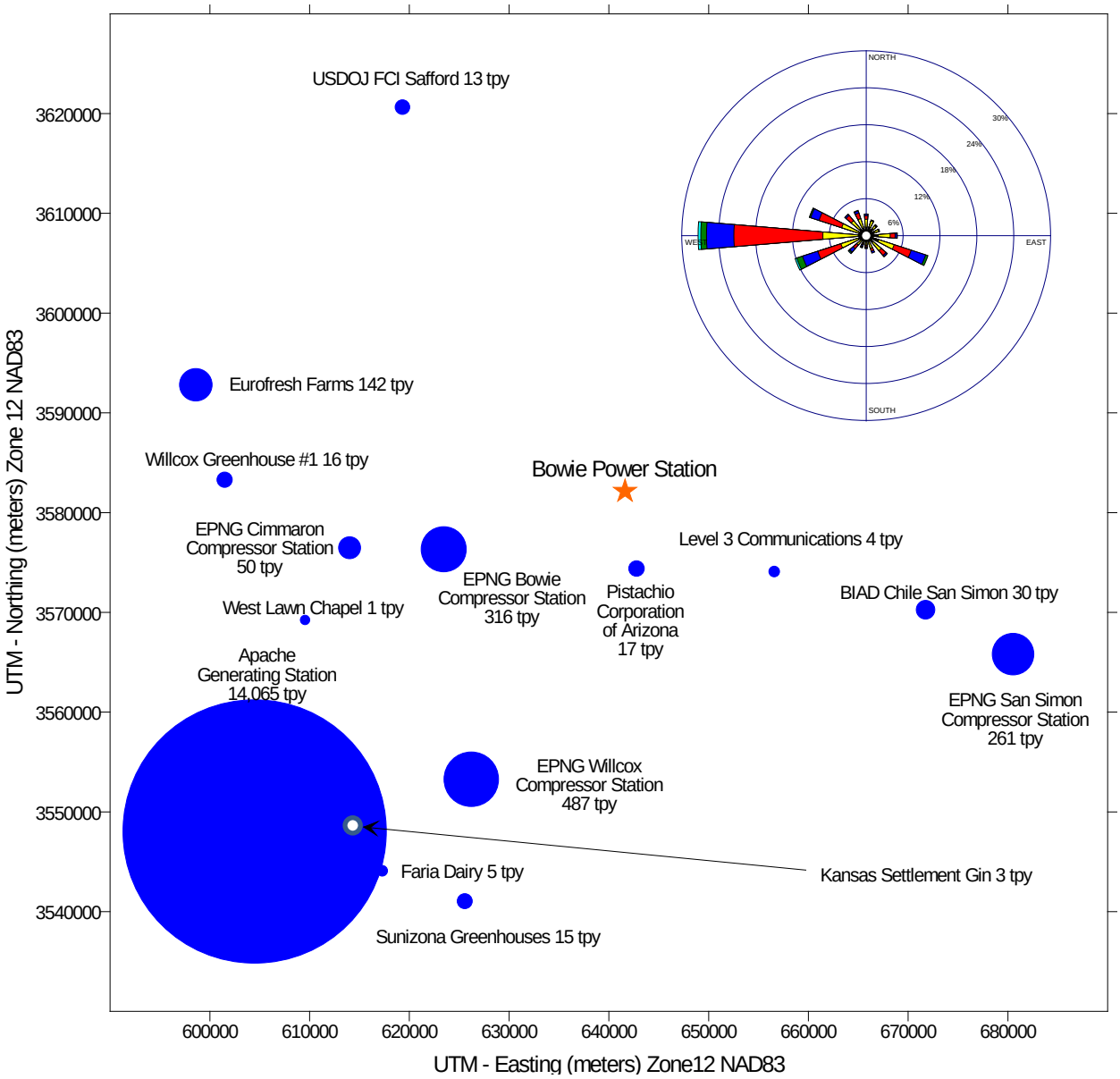



**Figure E3-4. $NO_x$ Sources within 50 Kilometers of Bowie Power Station**

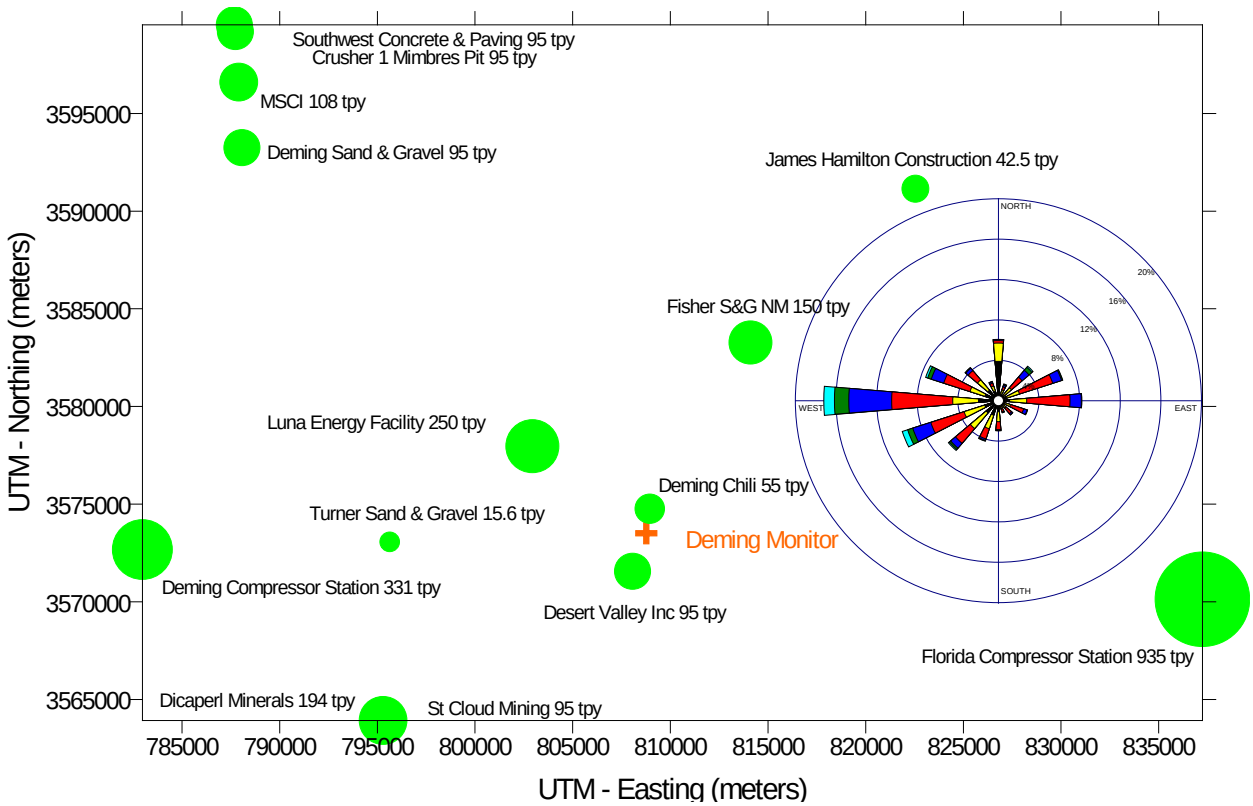



**Figure E3-5. $NO_x$ Sources within 50 Kilometers of Deming Monitor**

## E3.2 Post-Construction Air Quality Monitoring

Post-construction monitoring is required at the discretion of the Director. No post-construction monitoring is proposed for the project at this time.

## E3.3 Meteorological Monitoring

Bowie Power Station, LLC began collecting meteorological data on the proposed plant site in late April 2001. A 12-month dataset has been approved by ADEQ for use with AERMOD (see Section 5.2.3 for more information) for modeling impacts within 50 km of the plant.

The on-site meteorological station was sited and the data were collected in accordance with *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA 2000). The following parameters were measured:

- Wind speed;
- Wind direction;
- Standard deviation of wind direction;
- Standard deviation of wind speed;
- Maximum 1-second wind speed;
- Air temperature;
- Relative humidity;
- Solar radiation;
- Barometric pressure; and
- Precipitation.

The major parameters needed for modeling were measured at a 10-meter (m) level. Data completeness for all parameters exceeded 99%.

The data have been reprocessed using the most recent version of the AERMOD Meteorological Preprocessor (AERMET; 12345) (see Section 5.2 for more information).

## E3.4 Background Concentrations

Background sources include all sources of air pollution other than those explicitly modeled (i.e., the proposed project, and those sources identified as “nearby” sources). Typically the impacts of non-nearby background sources are accounted for by using appropriate, monitored air quality data (i.e., a background concentration).

Title 40 of the Code of Federal Regulation (CFR), Part 50, Appendix W, Section 8.2 discusses requirements for background air quality concentrations that are “an essential part of the total air quality concentration to be considered in determining source impacts.” Appendix W indicates, “Typically, air quality data should be used to establish background concentrations in the vicinity of the source(s) under consideration.” For isolated single sources, such as the proposed Bowie Power Station, two options are presented: 1) Use air quality data collected in the vicinity of the source to determine the background concentrations for the averaging times of concern, or 2) If there are no monitors located in the vicinity of the source, a “regional site” may be used to determine background. A “regional site” is one that is located away from the area of interest but it impacted by similar natural and distant man-made sources.

For use in modeling compliance for 1-hour $NO_2$, EPA suggests using background $NO_2$ data that vary by season and hour of the day. The 98th percentiles of the daily maximum hourly $NO_2$ data from the Deming monitor for 2010-2012 were averaged by season and hour of day for use in the modeling analysis in accordance with "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-Hour $NO_2$ National Ambient Air Quality Standard," March 1, 2011 (EPA 2011). The proposed background concentrations, based on the representative monitors identified in Section E3.1, are shown in Tables E3-5 and E3-6.

## Table E3-5. Background Concentrations

| Pollutant | Averaging Period | Station Location/ID | Data Used | Background Value |
|---|---|---|---|---|
| $PM_{10}$ | 24-hour | Chiricahua NM | Average of maximum values 2009-2011 | 43 μg/m$^3$ |
| | Annual | | Average 2009-2011 | 8.3 μg/m$^3$ |
| $PM_{2.5}$ | 24-hour | Chiricahua NM | Average of 2009-2011 98th percentile values | 9.0 μg/m$^3$ |
| | Annual | | Average 2009-2011 | 3.5 μg/m$^3$ |
| CO | 1-hour | Pima County, 22nd and Craycroft | Maximum 2010-2012 | 2,414 μg/m$^3$ |
| | 8-hour | | Maximum 2010-2012 | 1,264 μg/m$^3$ |
| $NO_2$ | 1-hour | Deming, New Mexico SLAMS station | Average of 2010-2012 98th percentile values | Varies by season and hour of day. See Table 3-5 |
| | Annual | | Maximum 2010-2012 | 8.6 μg/m$^3$ |
| SO2 | 1-hour | Pima County, 22nd and Craycroft | Average of 2008-2010 99th percentile values | 22.6 μg/m$^3$ |
| | 3-hour | | Maximum 2008-2010 | 37.7 μg/m$^3$ |
| | 24-hour | | Maximum 2008-2010 | 10.5 μg/m$^3$ |
| | Annual | | Maximum 2008-2010 | 2.3 μg/m$^3$ |
| Ozone | 8-hour | Chiricahua NM | Average 2010-2012 4th high | 73 ppb |

Notes:

CO = Carbon monoxide
NM = National Monument
$NO_2$ = Nitrogen dioxide
$PM_{10}$ = Particulate matter less than 10 micrometers
$PM_{2.5}$ = Particulate matter less than 2.5 micrometers
ppb = Parts per billion
μg/m$^3$ = Micrograms per cubic meter

## Table E3-6. Background Concentrations for 1-Hour $NO_2$ Analysis

| Hour of the Day | Winter (ppm) | Spring (ppm) | Summer (ppm) | Fall (ppm) |
|---|---|---|---|---|
| 1 | 0.0190 | 0.0163 | 0.0130 | 0.0183 |
| 2 | 0.0177 | 0.0143 | 0.0133 | 0.0150 |
| 3 | 0.0180 | 0.0147 | 0.0130 | 0.0153 |
| 4 | 0.0173 | 0.0150 | 0.0130 | 0.0160 |
| 5 | 0.0177 | 0.0177 | 0.0140 | 0.0167 |
| 6 | 0.0167 | 0.0197 | 0.0140 | 0.0177 |
| 7 | 0.0177 | 0.0200 | 0.0130 | 0.0183 |
| 8 | 0.0183 | 0.0177 | 0.0097 | 0.0180 |
| 9 | 0.0183 | 0.0127 | 0.0067 | 0.0163 |
| 10 | 0.0163 | 0.0060 | 0.0040 | 0.0120 |
| 11 | 0.0120 | 0.0030 | 0.0033 | 0.0050 |
| 12 | 0.0063 | 0.0017 | 0.0030 | 0.0033 |
| 13 | 0.0043 | 0.0013 | 0.0027 | 0.0023 |
| 14 | 0.0033 | 0.0013 | 0.0023 | 0.0023 |
| 15 | 0.0030 | 0.0010 | 0.0023 | 0.0020 |
| 16 | 0.0027 | 0.0010 | 0.0027 | 0.0020 |
| 17 | 0.0040 | 0.0013 | 0.0023 | 0.0030 |
| 18 | 0.0093 | 0.0020 | 0.0027 | 0.0090 |
| 19 | 0.0183 | 0.0057 | 0.0040 | 0.0193 |
| 20 | 0.0253 | 0.0117 | 0.0077 | 0.0263 |
| 21 | 0.0247 | 0.0203 | 0.0147 | 0.0267 |
| 22 | 0.0247 | 0.0220 | 0.0157 | 0.0250 |
| 23 | 0.0233 | 0.0243 | 0.0173 | 0.0223 |
| 24 | 0.0200 | 0.0173 | 0.0190 | 0.0200 |

Notes:

$NO_2$ = Nitrogen dioxide
ppm = Parts per million

# E4.0 PROJECT EMISSION SOURCES

The major emissions sources associated with the Bowie Power Station and their maximum annual emissions are summarized in Table E4-1.

**Table E4-1. Expected Annual Criteria Pollutant Emissions**

| Emission Unit Type | $NO_x$ (tpy) | CO (tpy) | VOC (tpy) | $SO_2$ (tpy) | $PM_{10}/PM_{2.5}$ (tpy) |
|---|---|---|---|---|---|
| 7FA.04 Turbines and Duct Burners (2 of Each) | 138.9 | 161.1 | 33.7 | 30.0 | 62.5[a] |
| Auxiliary Boiler | 0.4 | 0.4 | <0.1 | <0.1 | <0.1 |
| Emergency Fire Pump | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Evaporation Pond | -- | -- | Negligible | -- | -- |
| Cooling Tower | -- | -- | 0.6 | -- | 3.8/1.8 |
| **Totals** | **139.4** | **161.5** | **34.4** | **30.0** | **66.4/64.4** |

[a] $PM_{2.5}$ assumed = $PM_{10}$.

Notes:

CO = Carbon monoxide
$NO_x$ = Oxides of nitrogen
$PM_{10}$ = Particulate matter less than 10 micrometers
$PM_{2.5}$ = Particulate matter less than 2.5 micrometers
$SO_2$ = Sulfur dioxide
tpy = Tons per year
VOC = Volatile organic compounds

Raw materials used to produce electricity are natural gas and water. The combustion turbines are equipped with dry low $NO_x$ (DLN) combustors. SCR systems will be used to control $NO_x$ and oxidation catalysts will be used to control CO, VOCs, and organic HAPs from the turbines and duct burners. The SCR systems will use industrial-grade aqueous ammonia.

The power generating unit will consist of two combustion turbines, two HRSGs equipped with duct firing (each 420 MMBtu/hr heat input), and one steam turbine electric generator. A process flow diagram illustrating the generating unit configuration is provided in Figure E4-1.

Each turbine will exhaust through a HRSG. Each HRSG will be equipped with a duct firing system. Steam from the two HRSGs will be directed to the steam turbine electric generator. Exhaust from each HRSG will exit through a stack.

Load and ambient temperature affect turbine and duct burner $NO_x$, CO, and VOC emissions. Annual turbine and duct burner emissions for these pollutants were calculated based on an average annual ambient temperature of 59°F. The turbine and duct burner annual emission calculations are based on a 95% capacity factor for the turbines, 4,224 hours of duct firing, 325 hours of startup, and 91.25 hours of shutdown for each turbine/duct burner pair.

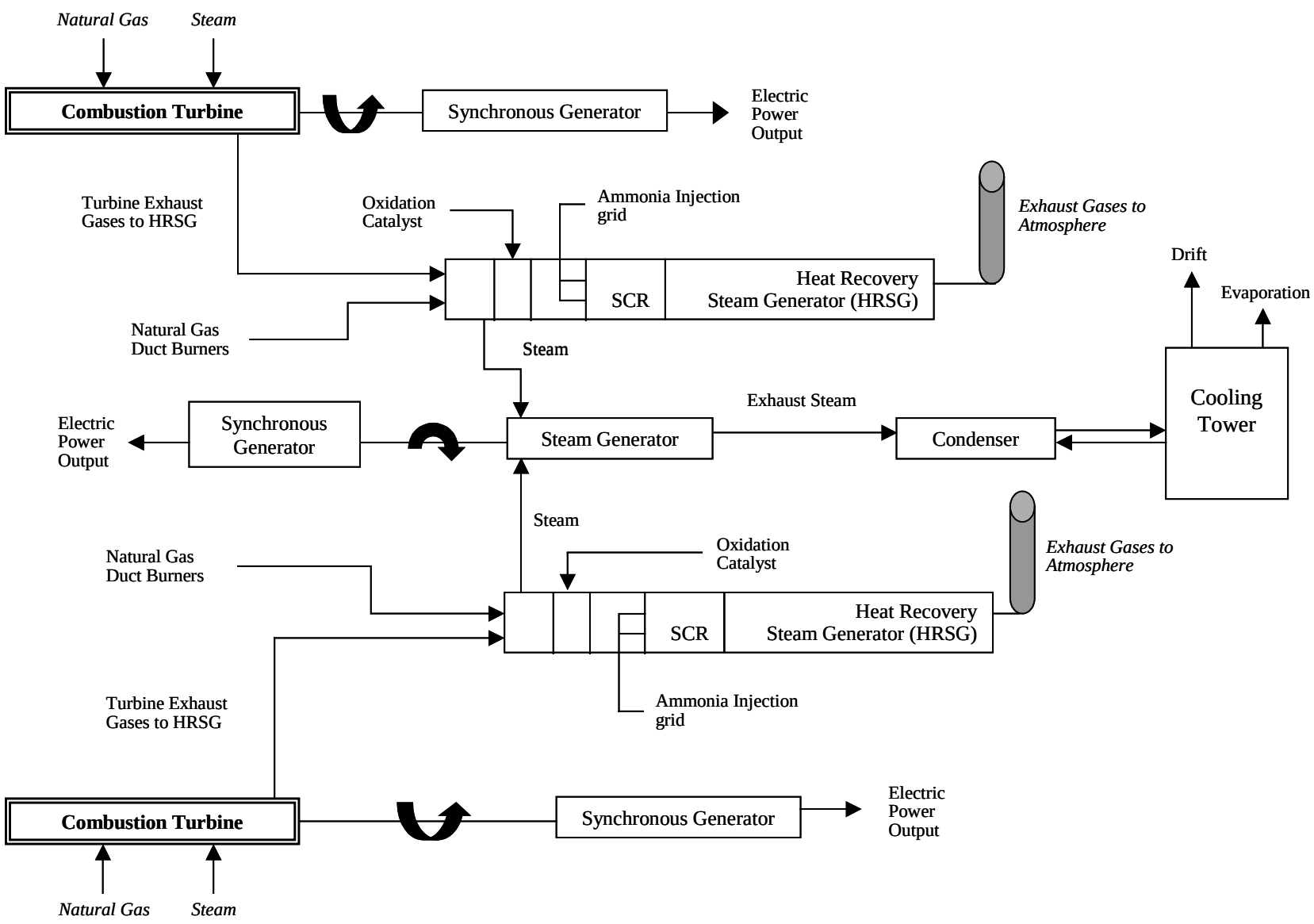



**Figure E4-1. Process Flow Diagram**

Turbine emissions profiles also vary during startup and shutdown. In general, $NO_x$, CO, and VOC emissions are higher during a startup or shutdown than during normal operations, while $SO_2$ and $PM_{10}$ emissions are the same or lower. A cold or warm start will produce higher emissions of $NO_x$, CO, and VOC than a shutdown event. A cold or warm start (of both turbines) will take approximately one hour with the "fast start" configuration, while a hot start will take 30 minutes. Shutdown takes approximately one-quarter an hour. Annual emissions for the turbines include emissions from startups and shutdowns for each turbine.

Duct burner emissions do not vary with ambient temperature, nor do the duct burners operate at partial loads. The duct burners will burn natural gas.

Auxiliary fuel-burning equipment at the site will include a natural gas-fired auxiliary boiler (50 MMBtu/hr heat input) and a diesel-fired emergency fire pump (260 hp). The auxiliary boiler will be equipped with low $NO_x$ burners to minimize $NO_x$ emissions. The diesel fire pump will meet required emission limits based on the compression-ignition internal combustion engine New Source Performance Standard, 40 CFR 60, Subpart IIII.

The cooling tower will be a source of $PM_{10}/PM_{2.5}$ and VOC emissions. The evaporation pond will also be a negligible source of fugitive VOC emissions.

# E5.0 CLASS II AREA ANALYSES

## E5.1 Scope and Model Selection

Air quality impacts in the Class II areas surrounding the Bowie Power Station were determined with the most recent version of the AMS/EPA Regulatory Model (AERMOD; 12345). Except for the treatment of $NO_x$ to $NO_2$ conversion, AERMOD was used with regulatory default options.

## E5.2 AERMOD Setup and Application

### E5.2.1 Receptors

A receptor grid, or network, defines the locations of predicted air concentrations that are used to assess compliance with the relevant standards or guidelines. All coordinates used in the modeling are referenced to North American Datum 1983 (NAD83). The network used Cartesian (X, Y) receptors.

The following receptor network was used for this analysis:

- 25-m spaced receptors along the process area boundary;
- 100-m spaced receptors out to 1 km from the process area boundary;
- 250-m spaced receptors from beyond 1 km to 3 km from the process area boundary;
- 500-m spaced receptors from beyond 3 km to 10 km from the process area boundary;
- 1,000-m spaced receptors from beyond 10 km to 25 km from the process area boundary; and
- 2,500-m spaced receptors from beyond 25 km to 50 km from the process area boundary.

Figure E5-1 shows the process area boundary receptors and the close-in receptor grid. Per the Modeling Protocol approved for this project, if any maximum impact exceeded 90% of an applicable limitation or significance level, where the Bowie Power Station contributed at least 3% of the total impact, a refined receptor grid would be defined around the maximum impact receptor with 25-m spacing. However, no impacts met this condition and no refined receptor grids were necessary.

#### E5.2.1.1 Discrete Receptors

Maximum impacts associated with Indian reservations within 50 km of a project are typically determined. However, because the nearest Indian reservation is located approximately 75 km from the project site, no receptors were needed in this category.

#### E5.2.1.2 Nonattainment Area Boundary Receptors

There are no nonattainment areas within 50 km of the Bowie project location and therefore no special receptors to calculate nonattainment impacts were required.

#### E5.2.1.3 Receptor Elevations

Receptors were modeled with terrain elevations interpolated from US Geological Survey (USGS) National Elevation Dataset (NED) data. The downloaded NED data have been processed in AERMAP (version 11103). The extent of the domain is sufficient to capture all necessary critical hill height information for AERMOD.

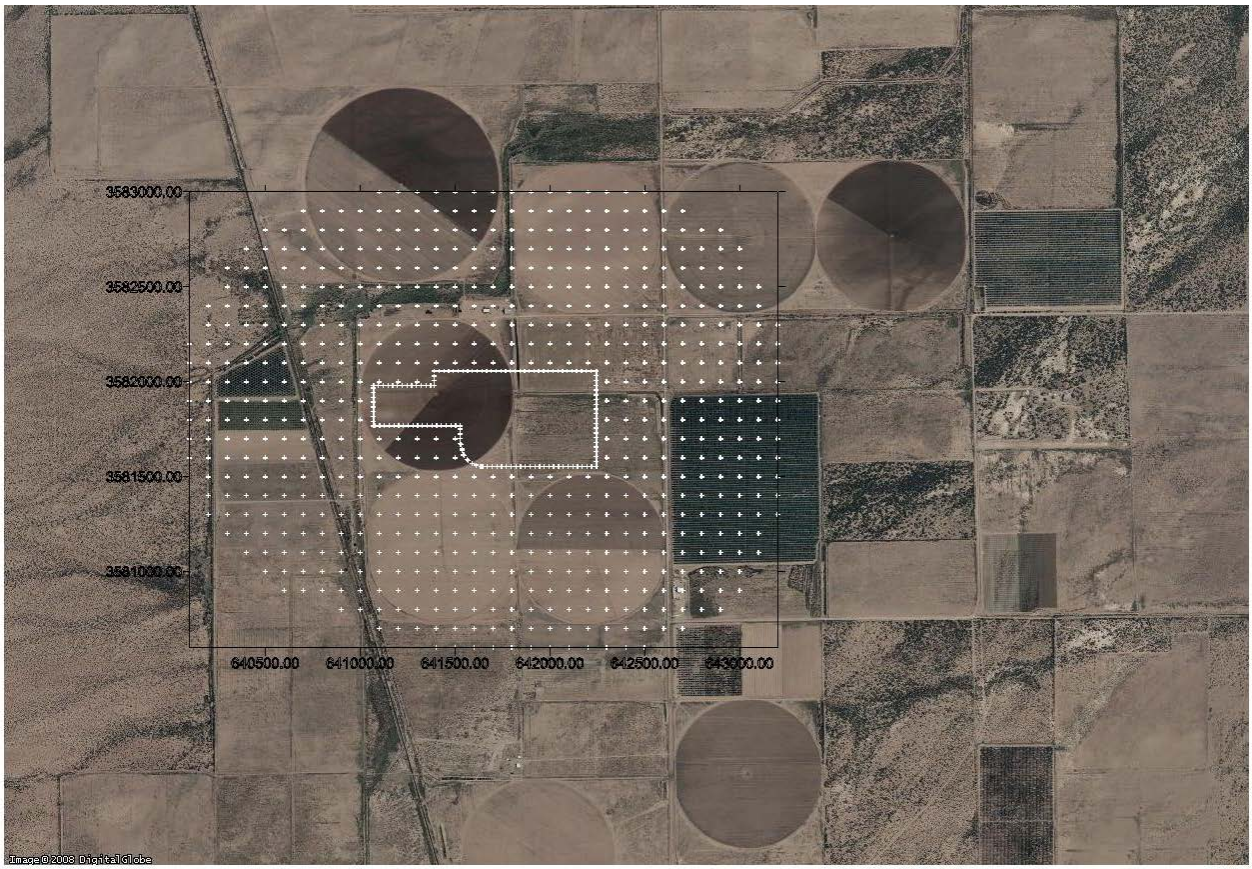



**Figure E5-1. Process Boundary and Close-in Receptor Grid**

### E5.2.2 Source Characteristics

This section describes how the project emission sources were characterized for modeling.

#### E5.2.2.1 Source Locations

The emission sources described in Section 4.0 are located within the process area boundary as shown in Figures E1-2 and E1-3. The locations of the major emission sources and structures are shown in Figure E5-2.

#### E5.2.2.2 Turbine/Duct Burner Emission Scenarios

The pollutants emitted by the proposed project are subject to standards or guidelines with differing averaging periods. Consequently, the emissions modeled included the planned annual operation of each emission source for prediction of annual average impacts and "worst-case" short-term emissions for prediction of short-term maximum concentrations.

The averaging periods and scenarios that were modeled are described below.

- For $NO_x$, annual average emissions were modeled for comparison with ambient $NO_2$ standards, PSD increments, and SILs. Annual average emissions were also used to address soil and vegetation impacts. Worst-case 1-hour $NO_x$ emissions were used to determine compliance with the 1-hour NAAQS. Emissions were varied seasonally and matched to seasonal variations in stack parameters (see discussion below). In accordance with EPA's guidance on modeling intermittent sources (EPA 2011), the fire pump was not included in the 1-hour $NO_x$ modeling but was included in 24-hour (visibility) and annual $NO_x$ scenarios.
- For CO, maximum 1-hour emissions were modeled for comparison with ambient standards and for soils and vegetation analyses, and were paired with worst-case 1-hour and 8-hour stack parameters, determined through screening.
- For $SO_2$, annual average emissions were modeled for comparison with ambient $SO_2$ standards and SILs. For comparison with 24-hour standards, multiple scenarios were defined because there is a trade-off between emission levels and dispersion for various operational scenarios. These included a scenario based on maximum normal operation emissions (100% load with duct firing), paired with corresponding stack parameters, varied seasonally. A second scenario paired minimum compliance load emissions and stack parameters, varied seasonally.

  For comparison with the 1-hour and 3-hour $SO_2$ ambient standards, multiple scenarios were again defined. These included a maximum normal operations emissions scenario, paired with corresponding stack parameters, varied seasonally; a startup emissions scenario, paired with corresponding stack parameters, varied seasonally; and a minimum compliance load emissions scenario, paired with corresponding stack parameters, varied seasonally.

  In accordance with EPA's guidance on modeling intermittent sources (EPA 2011), the fire pump was not included in the 1-hour $SO_2$ modeling but was included in 3-hour, 24-hour, and annual $SO_2$ scenarios.

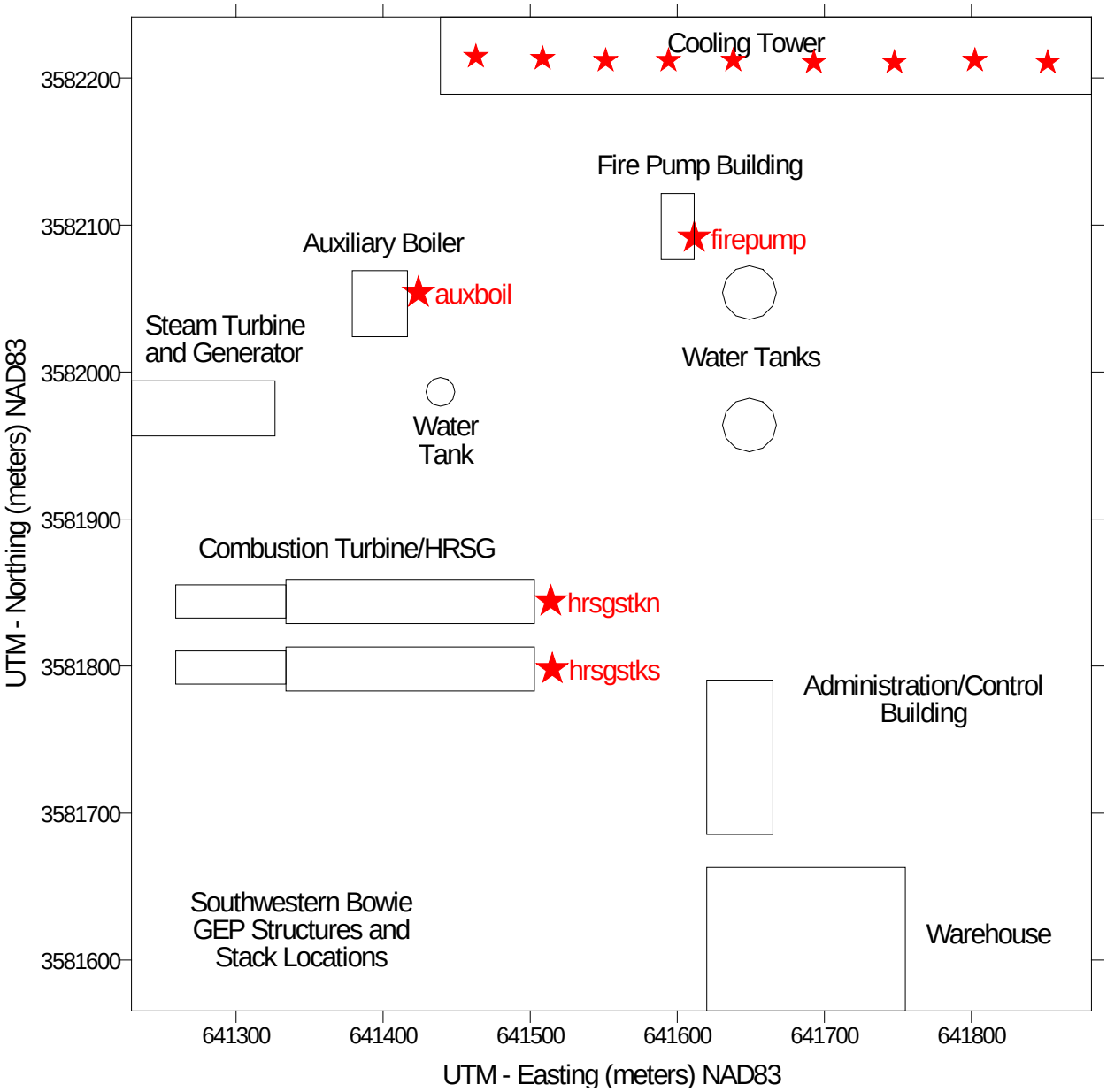



**Figure E5-2. Location of Major Emission Points and Structures**

- For $PM_{10}$, both 24-hour emissions and annual average emissions were modeled for comparison with ambient standards, PSD increments, and SILs. Both 24-hour and annual emissions were also used to evaluate impacts to soils and vegetation. $PM_{2.5}$ emissions are assumed to be the same as $PM_{10}$ emissions for the turbines and duct burners; therefore, the $PM_{10}$ 24-hour and annual turbine/duct burner emissions were also used for comparison with $PM_{2.5}$ 24-hour and annual standards, PSD increments, and SILs. Cooling tower $PM_{2.5}$ emissions were calculated as outlined below.

  Two 24-hour turbine/duct burner emission scenarios were defined for $PM_{10}/PM_{2.5}$. These were a scenario based on maximum normal operation emissions (100% load with duct firing), paired with corresponding stack parameters, varied seasonally and a scenario that paired minimum compliance load emissions and stack parameters, varied seasonally.

### E5.2.2.3 Cooling Tower Emissions

Cooling tower emissions of $PM_{10}$ and $PM_{2.5}$ were calculated based on water flowrate, total dissolved solids (TDS) in the water, and the efficiency of the drift eliminators. Particle size distribution was calculated using the method presented in "Calculating Realistic $PM_{10}$ Emissions from Cooling Towers," Joel Reisman and Gordon Frisbie, *Environmental Progress*, Volume 21, Issue 2, pages 127-130, July 2002.

### E5.2.2.4 Turbine/Duct Burner Stack Parameters

For the combustion turbines, exit temperature and exit velocity will vary slightly with whether or not the duct burners are operating, during startup and shutdown, with load, and with ambient temperature (see Table E5-1). Screening analyses were used to determine the worst-case dispersion conditions that lead to the highest impacts for a given emission rate and operating scenario. (See Attachment E3 – Turbine and Duct Burner Screening Stack Parameters and Supporting Information for a listing of the conditions modeled. Load screening modeling files have been provided with this permit application.) For CO, the exhaust parameters modeled represented a "worst-case" profile of possible parameters; that is, the worst-case dispersion parameters were paired with worst-case emissions to return maximum modeled concentrations. More realistic combinations of emissions and stack parameters were used for other pollutants.

Stack parameters and emissions were varied seasonally for 24-hour $PM_{10}/PM_{2.5}$, 1-hour $NO_2$, and 1-hour, 3-hour, and 24-hour $SO_2$ modeling. Stack parameters and emissions for 10˚F were used for months with average minimum temperatures below freezing (December and January), 102˚F parameters/emissions were used for months with average maximum temperatures higher than 90˚F (June, July, August, and September), and 59˚F parameters/emissions were used for the remaining months (February, March, April, May, October, and November).

For annual averaging periods, stack parameters were based on an ambient temperature of 59˚F and a weighted average of exit temperatures and exit velocities based on the number of hours during the year for a given operating condition (i.e., turbine normal operation, duct firing, startup, and shutdown).

**Table E5-1. Turbine/Duct Burner Stack Parameter Variation**

| Load | Ambient Temperature (°F) | Duct Burners? | Temperature (K) | Exit Velocity (m/s) |
|---|---|---|---|---|
| 100% | 102 | Yes | 353.76 | 18.90 |
| | 59 | Yes | 352.87 | 19.81 |
| | 10 | Yes | 352.71 | 21.33 |
| | 102 | No | 362.76 | 19.20 |
| | 59 | No | 361.71 | 20.12 |
| | 10 | No | 361.71 | 21.64 |
| 80% | 102 | No | 358.48 | 14.93 |
| | 59 | No | 357.87 | 16.46 |
| | 10 | No | 358.26 | 17.68 |
| Minimum compliance load | 102 | No | 358.21 | 13.72 |
| | 59 | No | 355.32 | 13.11 |
| | 10 | No | 356.09 | 15.24 |
| Startup | 102 | No | 359.04 | 15.12 |
| | 59 | No | 356.04 | 15.94 |
| | 10 | No | 354.76 | 17.04 |

Notes:
K = Kelvin
m/s = Meters per second

### E5.2.2.5 Other Stack Parameters

- The following were modeled as point sources using expected physical stack heights, exit velocities, temperatures, and diameters:
- Auxiliary boiler;
- Cooling tower cells; and
- Fire pump.

All point sources are within good engineering stack height and were modeled at their physical height. Stack parameters are shown in Table E5-2.

**Table E5-2. Stack Parameters**

| Source | Stack Height (m) | Stack Diameter (m) | Temperature (K) | Velocity (m/s) |
|---|---|---|---|---|
| Turbine/Duct Burner | 54.86 | 5.49 | Varies | Varies |
| Auxiliary Boiler | 13.7 | 0.76 | 422.04 | 15.24 |
| Fire Pump | 10.67 | 0.13 | 809.26 | 65.23 |
| Cooling Tower[a] | 14.00 | 10.00 | 294.26 | 8.59 |

[a] Each cell
Notes:
K = Kelvin
m = Meters
m/s = Meters per second

### E5.2.3 Meteorological Data

One year of site-specific meteorological data (April 2001-April 2002) was collected at the Bowie Power Station site and has been used to model Class II impacts in the vicinity of the Bowie Power Station project. The most recent version of AERMET (12345) has been used to prepare the data for modeling.

#### E5.2.3.1 On-Site Data

The raw data were edited to remove headers and were converted to the appropriate units for input to AERMET. The following parameters have been used from the on-site data set: wind speed, wind direction, standard deviation of wind direction, air temperature, relative humidity, barometric pressure, and precipitation. ADEQ previously reviewed the on-site data collected and approved it for use in modeling impacts from the Bowie Power Station. Data completeness for all parameters used for modeling exceeds 99% for all quarters. Figure E5-3 shows the wind frequency distribution for the Bowie site.

#### E5.2.3.2 Surface Data

Surface data from the Safford, Arizona, airport, located approximately 53 km north of the project site, were obtained from the National Climatic Data Center (NCDC) and converted to CD144 format. Cloud cover data from Safford were used in the meteorological data processing rather than on-site solar radiation data. The Safford Municipal Airport Station is the closest station to Bowie that collects cloud cover data. Further, Safford and Bowie are in similar topographic settings, both being located within the San Simon Valley, and share similar climatology (see Table E5-3). Data capture for the Safford site for the period of record of the Bowie data set exceeds 98%.

#### E5.2.3.3 Upper Air Data

The closest National Weather Service (NWS) station to the project site that routinely performs upper air soundings is the NWS station in Tucson. Tucson International Airport is located approximately 138 km to the west-southwest of the project site. Sounding data were downloaded from the NCDC Web site for 2001-2002 in FSL format.

#### E5.2.3.4 Processing

Data were extracted from the upper air and surface files for the appropriate time period and read from the on-site data file, then merged in AERMET.

Surface characteristics were defined by sector and seasons based on aerial photographs and land use data around the project site. An aerial photograph of the site and surrounding area with the sectors marked is shown in Figure E5-4. Geo-registered land use and land cover files were obtained from the USGS and the 1992 National Land Cover Dataset (NLCD) data files were used as input to AERSURFACE along with the sector information. The site is surrounded by desert shrubland and cultivated fields. Sectors 1 and 2 (see Figure E5-4) are dominated by cultivated fields, while sectors 3 and 4 consist primarily of desert shrubland. The seasonal surface characteristics within the appropriate areas (1 km for surface roughness and 10 km for albedo and Bowen ratio) were determined in AERSURFACE and those geophysical values were input to the Stage 3 AERMET processing.

The geophysical parameters used in the AERMET processing are shown in Table E5-4. The geophysical parameters vary monthly.

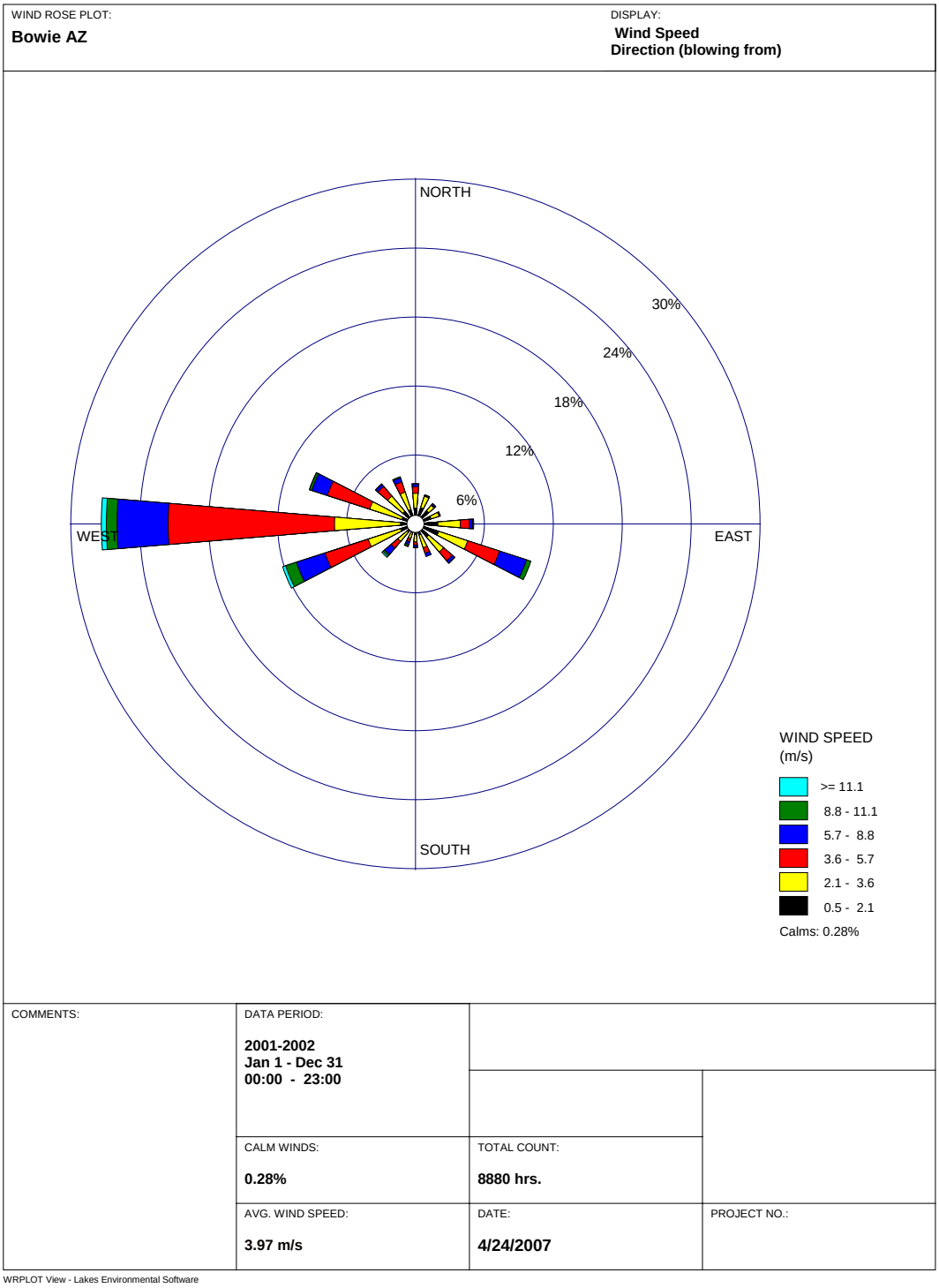



**Figure E5-3. Bowie Wind Rose**

## Table E5-3. Comparison of Bowie and Safford Monthly Climate Summaries[a]

| BOWIE, ARIZONA (020958)<br>Period of Record : 1/1/1899 to 12/31/2005 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Annual** |
| Average Maximum Temperature (F) | 61.1 | 65.7 | 71.9 | 80.2 | 89.1 | 98.3 | 98.2 | 95.5 | 91.7 | 82.1 | 69.2 | 60.3 | 80.3 |
| Average Minimum Temperature (F) | 30.8 | 34.3 | 38.7 | 44.6 | 52.7 | 61.9 | 67.4 | 65.7 | 59.4 | 48.2 | 36.7 | 31.1 | 47.6 |
| Average Total Precipitation (inches) | 0.82 | 0.79 | 0.61 | 0.27 | 0.23 | 0.36 | 2.05 | 2.09 | 1.05 | 0.87 | 0.62 | 0.94 | 10.68 |
| Average Total Snowfall (inches) | 0.6 | 0.3 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.4 | 1.8 |
| Average Snow Depth (inches) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| SAFFORD, ARIZONA (027388)<br>Period of Record : 8/1/1898 to 6/30/1973 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Annual** |
| Average Maximum Temperature (F) | 61.1 | 65.9 | 71.7 | 80.7 | 89.4 | 98.3 | 99.5 | 96.5 | 93.1 | 83 | 70.2 | 61.1 | 80.9 |
| Average Minimum Temperature (F) | 28.9 | 32.2 | 37 | 43.3 | 51.1 | 60.1 | 68.9 | 67.2 | 60.1 | 47.3 | 35.6 | 29.2 | 46.7 |
| Average Total Precipitation (inches) | 0.58 | 0.59 | 0.65 | 0.23 | 0.09 | 0.23 | 1.9 | 1.57 | 1.03 | 0.72 | 0.54 | 0.78 | 8.91 |
| Average Total Snowfall (inches) | 0.6 | 0.2 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.7 | 1.8 |
| Average Snow Depth (inches) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Western Regional Climate Center (www.wrcc.dri.edu/)

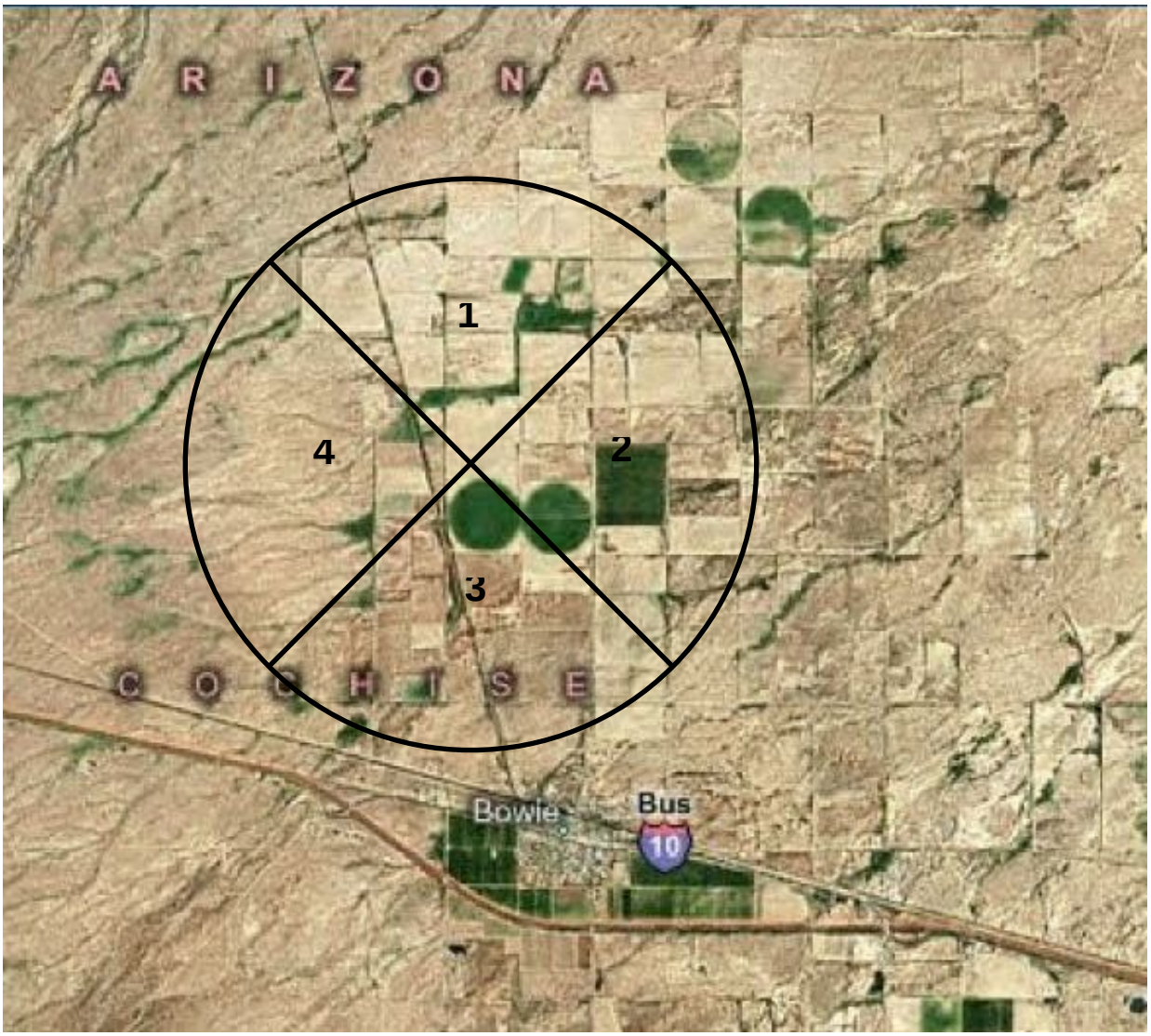



**Figure E5-4. Aerial of Sectors and Land Use near Bowie Project Site**

## Table E5-4. Albedo, Bowen Ratio, and Roughness Values

| Sector Definitions | | |
|---|---|---|
| **Sector Number** | **From (degrees)** | **To (degrees)** |
| 1 | 45 | 135 |
| 2 | 135 | 225 |
| 3 | 225 | 315 |
| 4 | 315 | 45 |

| Monthly Surface Parameters by Sector | | | | |
|---|---|---|---|---|
| **Month** | **Sector** | **Albedo** | **Bowen Ratio** | **Roughness** |
| 1 | 1 | 0.22 | 2.42 | 0.021 |
| 1 | 2 | 0.22 | 2.42 | 0.02 |
| 1 | 3 | 0.22 | 2.42 | 0.02 |
| 1 | 4 | 0.22 | 2.42 | 0.021 |
| 2 | 1 | 0.22 | 2.42 | 0.021 |
| 2 | 2 | 0.22 | 2.42 | 0.02 |
| 2 | 3 | 0.22 | 2.42 | 0.02 |
| 2 | 4 | 0.22 | 2.42 | 0.021 |
| 3 | 1 | 0.2 | 1.14 | 0.032 |
| 3 | 2 | 0.2 | 1.14 | 0.03 |
| 3 | 3 | 0.2 | 1.14 | 0.03 |
| 3 | 4 | 0.2 | 1.14 | 0.032 |
| 4 | 1 | 0.2 | 1.14 | 0.032 |
| 4 | 2 | 0.2 | 1.14 | 0.03 |
| 4 | 3 | 0.2 | 1.14 | 0.03 |
| 4 | 4 | 0.2 | 1.14 | 0.032 |
| 5 | 1 | 0.2 | 1.14 | 0.032 |
| 5 | 2 | 0.2 | 1.14 | 0.03 |
| 5 | 3 | 0.2 | 1.14 | 0.03 |
| 5 | 4 | 0.2 | 1.14 | 0.032 |
| 6 | 1 | 0.23 | 1.67 | 0.173 |
| 6 | 2 | 0.23 | 1.67 | 0.189 |
| 6 | 3 | 0.23 | 1.67 | 0.186 |
| 6 | 4 | 0.23 | 1.67 | 0.192 |
| 7 | 1 | 0.23 | 1.67 | 0.173 |
| 7 | 2 | 0.23 | 1.67 | 0.189 |
| 7 | 3 | 0.23 | 1.67 | 0.186 |
| 7 | 4 | 0.23 | 1.67 | 0.192 |
| 8 | 1 | 0.23 | 1.67 | 0.173 |
| 8 | 2 | 0.23 | 1.67 | 0.189 |
| 8 | 3 | 0.23 | 1.67 | 0.186 |
| 8 | 4 | 0.23 | 1.67 | 0.192 |
| 9 | 1 | 0.23 | 2.42 | 0.173 |
| 9 | 2 | 0.23 | 2.42 | 0.189 |
| 9 | 3 | 0.23 | 2.42 | 0.186 |
| 9 | 4 | 0.23 | 2.42 | 0.192 |
| 10 | 1 | 0.23 | 2.42 | 0.173 |
| 10 | 2 | 0.23 | 2.42 | 0.189 |
| 10 | 3 | 0.23 | 2.42 | 0.186 |
| 10 | 4 | 0.23 | 2.42 | 0.192 |

**Table E5-4. Continued**

| Month | Sector | Albedo | Bowen Ratio | Roughness |
|---|---|---|---|---|
| 11 | 1 | 0.23 | 2.42 | 0.173 |
| 11 | 2 | 0.23 | 2.42 | 0.189 |
| 11 | 3 | 0.23 | 2.42 | 0.186 |
| 11 | 4 | 0.23 | 2.42 | 0.192 |
| 12 | 1 | 0.22 | 2.42 | 0.021 |
| 12 | 2 | 0.22 | 2.42 | 0.02 |
| 12 | 3 | 0.22 | 2.42 | 0.02 |
| 12 | 4 | 0.22 | 2.42 | 0.021 |

## E5.3 Building Wake Downwash

Downwash parameters for the Bowie Power Station structures were determined with the EPA Building Profile Input Program (BPIP)-PRIME. Each structure corner coordinate and elevation was used as input to the program and wind direction-specific building parameters have been output in a format used by AERMOD. As shown in Figures E1-2 and E1-3, there are many structures that will be located at the site. Only those with the likelihood to influence emission sources (i.e., within 5L in accordance with the Good Engineering Practice (GEP) regulations in 40 CFR 51.100) have been included in the analysis.

## E5.4 AERMOD Impact Analysis

The dispersion modeling analysis required for major sources subject to PSD review typically involves two phases. The objective of the first phase is to perform a conservative, screening-level analysis (preliminary analysis) of the impacts of the proposed project alone, to determine whether the predicted impacts are expected to be significant. If no significant impacts are predicted for a particular pollutant, no further analysis is required for that pollutant.

If significant ambient impacts are predicted, then a full impact analysis must be completed for that pollutant. This requires conducting a NAAQS/AAAQS analysis for the pollutant, in which other emission sources in the area are modeled, and conducting a PSD increment analysis for the pollutant that incorporates emissions from other increment-affecting sources in the area. Procedures for performing preliminary and full analyses are outlined in ADEQ's modeling guidance (ADEQ 2004).

Table E5-5 summarizes the air quality standards and thresholds to which the project is subject.

VOC emissions were not modeled for this project because project emissions were not significant for VOC and also because VOC is a reactive pollutant that is regulated only as a precursor to ozone. VOCs are considered regional pollutants and VOC emissions and impacts are most appropriately evaluated on a regional basis, rather than by modeling emissions from a single facility.

### E5.4.1 Preliminary Analysis

#### E.5.4.1.1 General Analysis Methods

A screening analysis was conducted for all pollutants and averaging periods. The highest predicted impact at any point on the receptor grid was used for comparison with the modeling SILs identified in Table E5-5.

## Table E5-5. Air Quality Significance Levels, Standards, and Increments

| Averaging Period/ Pollutant | Class II Modeling Significant Impact Level ($\mu g/m^3$) | Class II PSD Increment ($\mu g/m^3$) | Class I Modeling Significant Impact Level ($\mu g/m^3$) | Class I PSD Increment ($\mu g/m^3$) | Limiting National or Arizona Ambient Air Quality Standard ($\mu g/m^3$) |
|---|---|---|---|---|---|
| 1-hour $NO_2$ | 7.5 | NA | NA | NA | 188.7[a] (100 ppb) |
| Annual $NO_2$ | 1 | 25 | 0.1 | 2.5 | 100 |
| 1-hour $SO_2$ | 8 | NA | NA | NA | 196.4[b] (75 ppb) |
| 3-hour $SO_2$ | 25 | 512[c] | 1.0 | 25[c] | 1,300[c] |
| 24-hour $SO_2$ | 5 | 91[c] | 0.2 | 5[c] | 365[c,d] |
| Annual $SO_2$ | 1 | 20 | 0.1 | 2 | 80[d] |
| 24-hour $PM_{10}$ | 5 | 30[e] | 0.3 | 8[e] | 150[e] |
| Annual $PM_{10}$ | 1 | 17 | 0.2 | 4 | 50[f] |
| 24-hour $PM_{2.5}$ | 1.2 | 9[c,] | 0.07 | 2[c,] | 35[g] |
| Annual $PM_{2.5}$ | 0.3 | 4 | 0.06 | 1 | 12[h] |
| 1-hour CO | 2,000 | NA | NA | NA | 40,000[c] |
| 8-hour CO | 500 | NA | NA | NA | 10,000[c] |

Note: Lead and ozone standards not shown. Project will not emit significant amounts of lead; ozone is more appropriately modeled in regional analyses.

[a] The 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations must not exceed the standard.

[b] The 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations must not exceed the standard.

[c] Not to be exceeded more than once per year.

[d] National standard will be revoked following a transition period.

[e] Not to be exceeded more than once per year on average over three years.

[f] National standard revoked effective December 17, 2006; annual AAAQS is still listed at R18-2-201(A)(1)(a).

[g] The 3-year average of the 98th percentile of 24-hour concentrations must not exceed the standard.

[h] Revised standard promulgated December 14, 2012. The 3-year average of the weighted annual mean must not exceed the standard.

Notes:

| | | |
|---|---|---|
| $\mu g/m^3$ | = | Micrograms per cubic meter |
| CO | = | Carbon monoxide |
| NA | = | Not applicable |
| $NO_2$ | = | Nitrogen dioxide |
| $PM_{10}$ | = | Particulate matter less than 10 micrometers |
| $PM_{2.5}$ | = | Particulate matter less than 2.5 micrometers |
| ppb | = | Parts per billion |
| PSD | = | Prevention of Significant Deterioration |
| $SO_2$ | = | Sulfur dioxide |

The Plume Volume Molar Ratio Method (PVMRM) option in AERMOD was used to account for the after stack conversion of emitted $NO_x$ to downwind $NO_2$. This option requires an hourly ozone data file. Hourly ozone data from the Chiricahua NM monitoring station matching the Bowie meteorological data set time period were used. The hourly ozone data obtained included periods of missing data. Nearly all these periods were of short duration lasting a couple of hours and were associated with late night calibration procedures. For these short periods, the missing values were filled by interpolation between the preceding and following hour valid data. There were two extended periods of missing data including May 12 - May 15, 2001 and January 1 - January 8, 2002. During these periods, valid preceding hourly data were inserted on a daily basis. That is, the missing hourly values were filled using valid daily values from the preceding 24-hour period for the matching hour (i.e., valid data from hour 9 was inserted for the missing hour 9 value, etc.). This 24-hour block of data was repeated until valid data were again available.

The use of PVMRM also requires use of an in-stack ratio for each source. The California Air Pollution Control Officers Association (CAPCOA) has produced a guidance document titled "Modeling Compliance of the Federal 1-Hour $NO_2$ NAAQS" (CAPCOA 2011) that includes recommended in-stack ratios in Appendix C. The following recommended in-stack $NO_2/NO_x$ ratios were used for the Bowie sources:

- The natural gas boiler default factor of 0.1 was used for the auxiliary boiler;
- The diesel internal combustion engine default factor of 0.2 was used for the fire pump; and
- The GE natural gas turbine recommended ratio of 0.091 was used for the turbines/HRSGs.

In accordance with EPA's guidance on modeling intermittent sources (EPA 2011), the fire pump was not included in the 1-hour $SO_2$ or $NO_2$ modeling but was included in modeling all other pollutants and averaging periods.

### E5.4.1.2 $PM_{2.5}$ Analysis Methods

Due to the potentially large contributions of secondary $PM_{2.5}$ to total ambient $PM_{2.5}$ concentrations, EPA has provided draft guidance that includes analyses of both primary and secondary $PM_{2.5}$ from proposed new major sources, such as the Bowie Power Station (EPA 2013). AERMOD was used to analyze primary $PM_{2.5}$ emissions, while potential secondary $PM_{2.5}$ from emissions of precursors ($NO_x$, $SO_2$) from the project was assessed in a qualitative fashion.

In determining whether a full analysis is needed for $PM_{2.5}$, EPA's draft guidance suggests that the applicable SIL value from the vacated sections (*Sierra Club v. EPA*, No. 10-1413) of 40 CFR 50.166(k)(2) and 52.21(k)(2) should only be used if the difference between the $PM_{2.5}$ NAAQS and the measured $PM_{2.5}$ background concentrations are greater than the SIL:

- Annual $PM_{2.5}$ NAAQS: 12 $\mu g/m^3$; SIL 0.3 $\mu g/m^3$. Measured background (2009-2011 average at Chiricahua NM) is 3.5 $\mu g/m^3$. Therefore, the difference is larger than the SIL and the numeric value of the SIL may be appropriate for use in determining whether a source may forego cumulative modeling.
- 24-hour $PM_{2.5}$ NAAQS: 35 $\mu g/m^3$; SIL 1.2 $\mu g/m^3$. Measured background (2009-2011 98th percentile average at Chiricahua NM) is 9.0 $\mu g/m^3$. Therefore, the difference is larger than the SIL and the numeric value of the SIL may be appropriate for use in determining whether a source may forego cumulative modeling.

As discussed in Section E3.1.2, $PM_{2.5}$ monitoring data from the Chiricahua NM is expected to be representative of the contribution of existing sources to $PM_{2.5}$ concentrations in the Bowie Power Station

impact area. Analyses of the direct $PM_{25}$ impacts from the Bowie Power Station in conjunction with sulfate and nitrate impacts from the station, along with a comparison with patterns evident in speciated $PM_{2.5}$ data from the Chiricahua NM IMPROVE monitoring system, are discussed below in Section E5.4.1.4.

### E5.4.1.3 Preliminary Analysis Results

Table E5-6 presents the results of the preliminary analysis. All impacts shown are the maximum impacts (1st high impacts) over the receptor grid.

**Table E5-6. Results of Preliminary Class II Analysis**

| Averaging Period/ Pollutant | Maximum Predicted Impact ($\mu g/m^3$) | Class II Modeling Significance Level ($\mu g/m^3$) | Significant Monitoring Level ($\mu g/m^3$) |
|---|---|---|---|
| 1-hour $NO_2$ | 84.34 | 7.5 | NA |
| Annual $NO_2$ | 0.27 | 1 | 14 |
| 1-hour $SO_2$ | 5.13 | 8 | NA |
| 3-hour $SO_2$ | 1.75 | 25 | NA |
| 24-hour $SO_2$ | 0.35 | 5 | NA |
| Annual $SO_2$ | 0.06 | 1 | NA |
| 24-hour $PM_{10}$ | 1.81 | 5 | 10 |
| Annual $PM_{10}$ | 0.26 | 1 | NA |
| 24-hour $PM_{2.5}$ | 1.07 | 1.2 | NA |
| Annual $PM_{2.5}$ | 0.16 | 0.3 | NA |
| 1-hour CO | 439.4 | 2,000 | NA |
| 8-hour CO | 85.10 | 500 | 575 |

Notes:

$\mu g/m^3$ = Micrograms per cubic meter
CO = Carbon monoxide
NA = Not applicable
$NO_2$ = Nitrogen dioxide
$PM_{10}$ = Particulate matter less than 10 micrometers
$PM_{2.5}$ = Particulate matter less than 2.5 micrometers

### E5.4.1.4 Secondary $PM_{2.5}$

A qualitative analysis of secondary $PM_{2.5}$ from the Bowie Power Station was developed to evaluate whether secondary $PM_{2.5}$ contributions from sulfate and nitrate formation, in conjunction with primary $PM_{2.5}$ impacts and background $PM_{2.5}$, might cause or contribute to a NAAQS exceedance. Additional information may be found in Attachment E6 and with the modeling files submitted with this application.

As discussed in Section E3.1.2, particulate matter is composed of multiple chemicals, largely sulfate, organic carbon, and nitrate, in combinations that differ by geographic region. Non-coastal rural areas are dominated by sulfate, organic carbon, and black carbon, while nitrate-containing particles are important in parts of the west. Almost all sulfate originates from $SO_2$ oxidation mediated by ammonia. While 95% of $SO_2$ sources are anthropogenic, from fossil fuel combustion, the majority of ammonia sources are related to agricultural activities. Ammonium nitrate forms from the reversible reaction of gas-phase ammonia and nitric acid. Essentially all particle nitrate is derived from atmospheric oxidation of $NO_x$. The major anthropogenic source of $NO_x$ is fossil fuel combustion. Organic carbon may be primary and/or secondary, of biogenic (vegetative material, biogenic gases, spontaneous forest fires) and

anthropogenic (fossil fuel combustion, prescribed fires, cooking) origin. Black carbon originates as ultrafine or fine particles from primary sources during incomplete combustion of carbon-based fuels. (NARSTO 2004).

Most of the observed $PM_{2.5}$ mass usually originates as precursor gases and, through various physiochemical processes, is transferred to the condensed phase as secondary particulate matter. (NARSTO 2004). The typically smaller spatial variations of $PM_{2.5}$ compared to $PM_{10}$ are consistent with the long atmospheric residence time of fine particles, which permits transport over distances of 10 to 1,000 km and leads to more uniform mass concentrations. (NARSTO 2004)

### Bowie Primary $PM_{2.5}$ Impacts

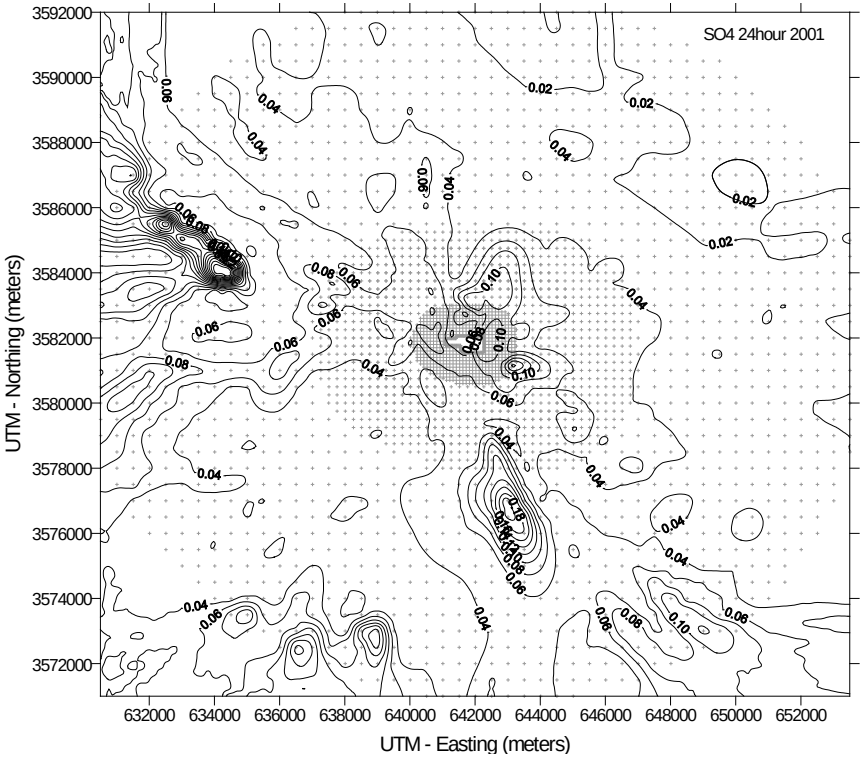
Examination of the maximum direct impacts of $PM_{2.5}$ emitted by the Bowie Power Station shows that the highest annual and 24-hour impacts occur close to the facility (<1 km from the turbine stacks). On an annual basis, at or beyond 1 km, impacts are reduced to 79% of the maximum impact (42% of the SIL) and at or beyond 2 km, impacts are only 37% of the maximum impact (20% of the SIL).

A similar pattern is observed for the 24-hour scenarios. Maximum impacts again occur within <1 km of the turbine stacks. At or beyond 1 km, impacts are reduced to 80%-82% of the maximum impact (70%-71% of the SIL) and at or beyond 2 km, impacts are 55%-57% of the maximum impacts (47%-515 of the SIL).

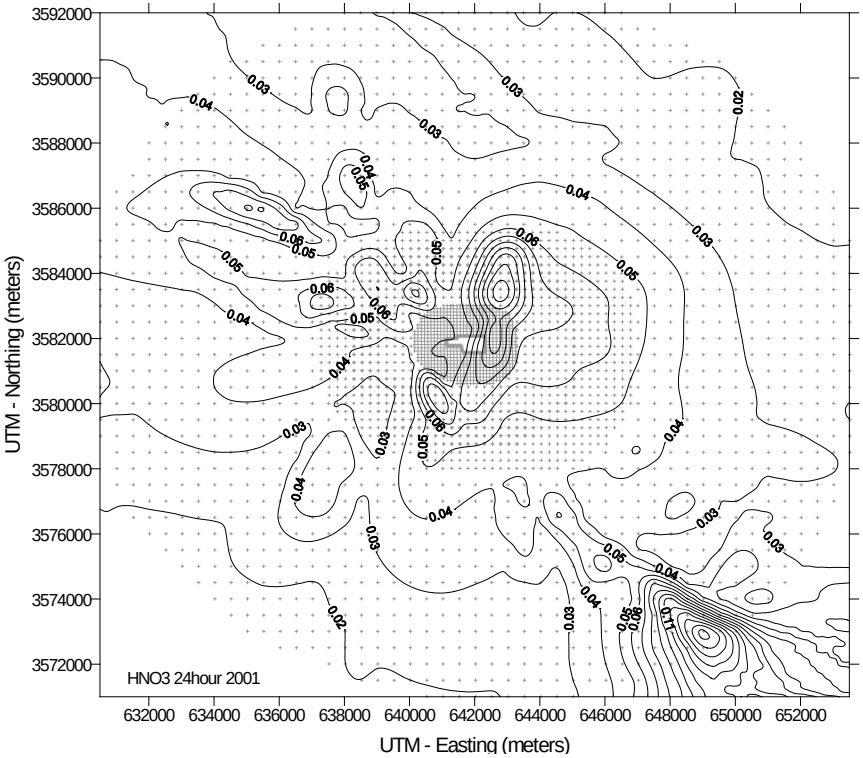
Maximum annual and 24-hour impacts of directly emitted $PM_{2.5}$ are not dominated by any one source but, instead, are a composite of the turbine emissions and the cooling tower emissions, with both the auxiliary boiler and fire pump having much smaller contributions. Maximum short-term impacts (both scenarios) occur on breezy days (average wind speed 5-6.5 m/s, up to 8-10 m/s maximum hourly winds) with lower wind speeds at night. Daytime stability conditions are fairly neutral (Pasquill-Gifford C-D). The days on which the maximum five concentrations occurred for each 24-hour scenario included both clear and partly cloudy days, all with low to moderate relative humidity (12%-55%). Winds were from the east to southeast on two of the three maximum impact days (4 of 10 maximum impacts occurred on these days), while they were from the west on the third day identified (6 of 10 maximum impacts). The 10 maximum modeled 24-hour impacts all occurred in fall (September-November).

### Bowie Sulfate and Nitrate Impacts

Calpuff was used to evaluate sulfate and nitrate impacts from the Bowie Power Station. Seasonal short-term and an annual scenario were modeled corresponding to the scenarios used to determine direct $PM_{2.5}$ impacts using AERMOD using 2001 meteorological data. As noted above, maximum $PM_{2.5}$ impacts from the facility occur within 1 km of the turbine stacks. In contrast, maximum sulfate and nitrate concentrations, on both a short-term and annual basis, occur further downwind. Maximum annual and short-term sulfate impacts were projected to occur about 6.9 km downwind from the source. For nitrate, the location of maximum impacts varied with the scenario. On an annual basis, maximum nitrate occurred 11.6 km from the facility. Short-term nitrate maxima ranged from 3.6-10.2 km from the facility under the minimum compliance load scenario and from 10.9-11.6 km from the facility under the maximum emissions scenario (which resulted in higher direct $PM_{2.5}$ impacts than the minimum compliance load scenario). Figure E5-4 shows representative plots of 24-hour sulfate and nitrate impacts from Bowie. The outline of the facility boundary is shown in the center of each plot for comparison. As noted, maximum direct $PM_{2.5}$ impacts will occur close to the facility boundary shown in the figures. Maximum sulfate and nitrate, in contrast, occur at greater distances. As a result, maximum direct $PM_{2.5}$ impacts from the Bowie Power Station will not directly add to maximum secondary $PM_{2.5}$ impacts from the facility; instead, lower combined impacts would be expected.




**Sulfate**




**Nitrate**

**Figure E5-5. Representative Patterns of 24-Hour Sulfate and Nitrate from Bowie Power Station Emissions**

## Background $PM_{2.5}$

$PM_{2.5}$ data from the Chiricahua NM monitoring location for 2009-2011 are expected to be representative of background $PM_{2.5}$ in the area surrounding the Bowie Power Station, including the locations where maximum $PM_{2.5}$ impacts are predicted to occur. Both the Chiricahua NM site and the proposed Bowie Power Station location are rural areas without significant nearby population. The surrounding land use in each case includes a mixture of desert and agriculture, both of which are sources of directly emitted $PM_{2.5}$.

Speciated $PM_{2.5}$ data from the Chiricahua NM IMPROVE monitoring system (see Figure E5-5) show that the major components of $PM_{2.5}$ (excluding periodic contributions from wildfires) are ammonium sulfate (37%), soil (33%), and organic matter (25%). Ammonium nitrate provides 6% of total $PM_{2.5}$ at this location.

On an annual average basis, contributions to annual $PM_{2.5}$ concentrations at Chiricahua NM are highest in the summer and spring, with lower contributions in winter and fall. The distributions of the components of fine particles also differ by season, with ammonium nitrate showing maximum contributions in the winter, soil and sea salt showing maximum contributions in the spring, ammonium sulfate elemental carbon, and organic carbon showing maximum contributions in the summer, and none of the constituents showing maximum contributions in the fall. This is shown graphically in Figure E5-6, which shows the components of fine particulate matter for each season, weighted by each season's contribution to overall annual average concentrations.

With respect to maximum short-term $PM_{2.5}$ concentrations, the five highest concentrations from each year in the 2009-2011 Chiricahua NM dataset were examined. Maximum 24-hour $PM_{2.5}$ concentrations occurred most often in summer (60%) and spring (33%), with only 7% of maximum 24-hour concentrations occurring in winter and no maximum concentrations occurring in fall. This is in contrast to Bowie's direct $PM_{2.5}$ maximum concentrations, which were all predicted to occur during the fall season.

As with the annual average, the components of $PM_{2.5}$ also showed seasonal variation on a short-term basis. Ammonium nitrate short-term concentrations were highest in winter, both elemental and organic carbon were highest in summer, soils concentrations were highest in spring, and ammonium sulfate showed peaks in fall and summer. These patterns are shown graphically in Figure E5-7.

Relative to short-term maximum impacts from directly emitted $PM_{2.5}$ from the Bowie Power Station, maximum 24-hour $PM_{2.5}$ concentrations at Chiricahua NM occur at lower wind speeds (3.8 m/s average versus 5-6.5 m/s at Bowie) and under somewhat less stable daytime conditions (mostly Pasquill-Gifford B stability versus C-D at Bowie).

Source apportionment data from the Western Regional Air Partnership (WRAP) Technical Support System (TSS), developed through regional CAMx modeling to identify the sources and regions contributing to regional haze in the WRAP region (*http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx*), indicate that less than 10% of sulfate at Chiricahua NM on an annual basis is from Arizona sources, in spite of the fact that Chiricahua NM is located less than 50 km from a large source of $SO_2$ emissions (Apache Generating Station; 13,500 tons per year [tpy] $SO_2$ emissions). Based on 2008 modeling data, Arizona $SO_2$ emissions totaled approximately 85,000 tpy. It is unlikely that a relatively small source of $SO_2$ emissions such as the Bowie Power Station (approximately 30 tpy or 0.035% of Arizona emissions) would appreciably increase $PM_{2.5}$ from ammonium sulfate in the project area.

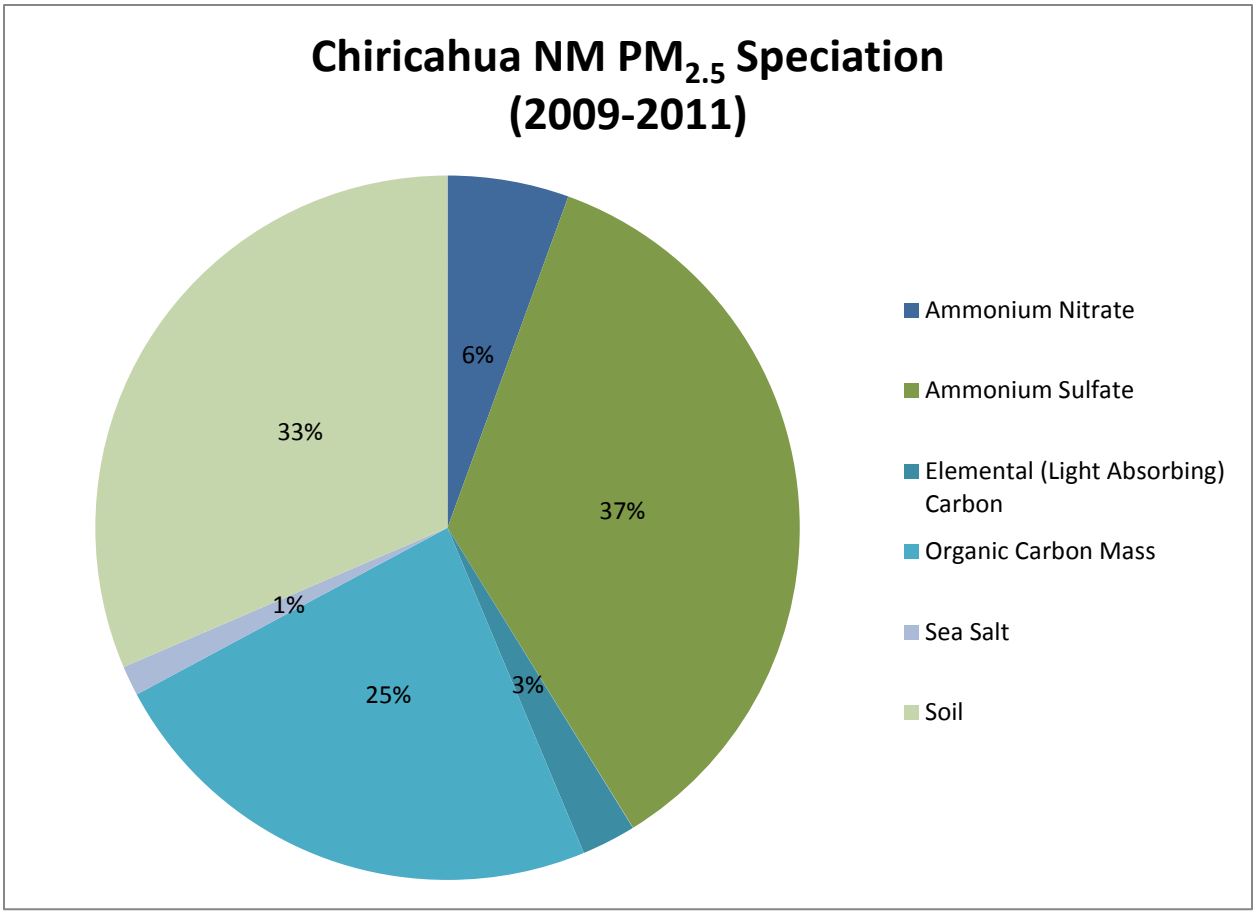



**Figure E5-6. $PM_{2.5}$ Speciation at Chiricahua National Monument**

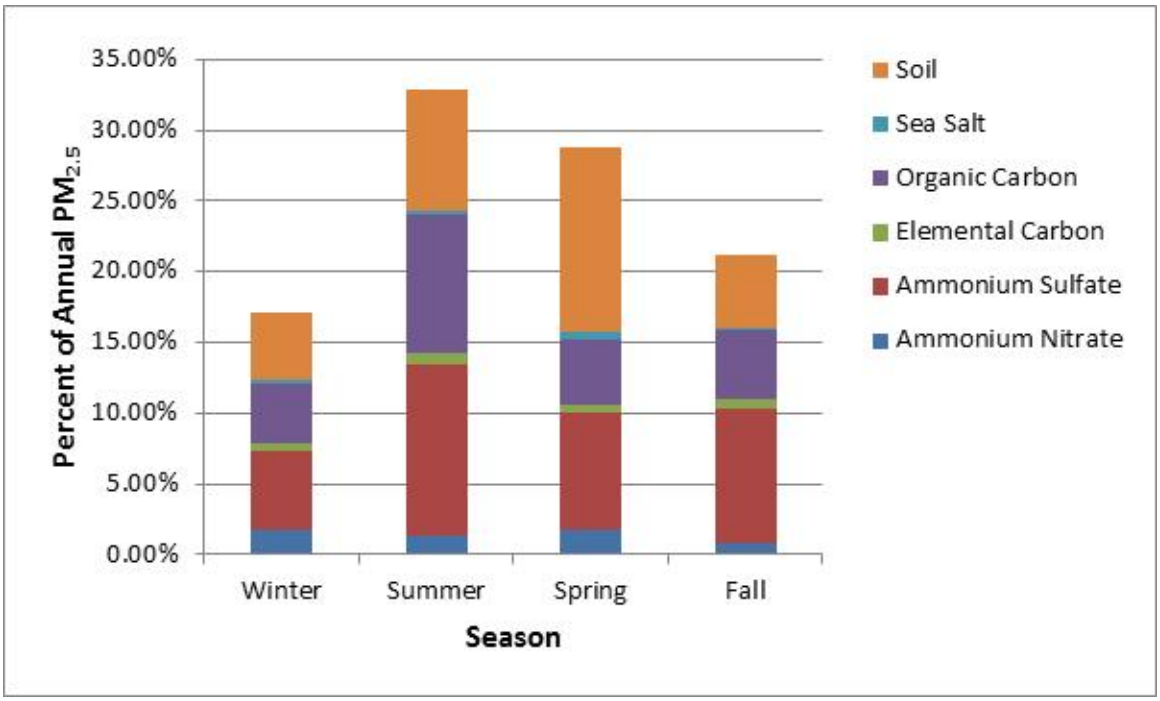



**Figure E5-7. Seasonal Contributions to Annual $PM_{2.5}$ at Chiricahua NM**

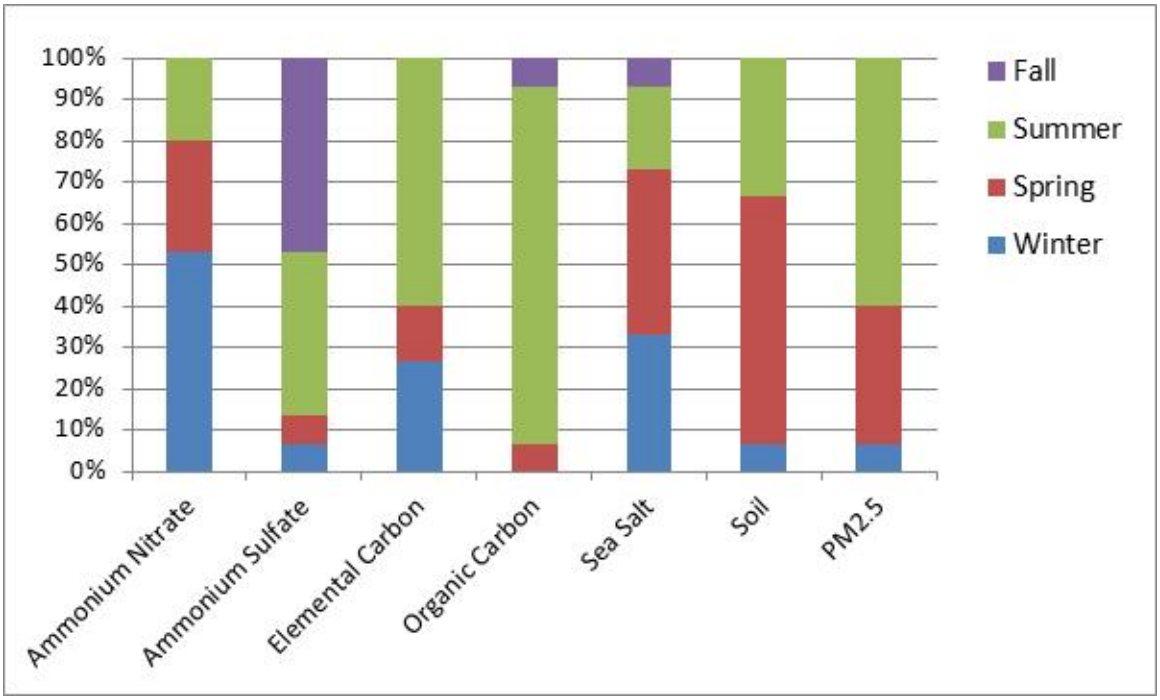



**Figure E5-8. Seasonal Distribution of Maximum 24-Hour Concentrations at Chiricahua NM**

TSS source apportionment modeling shows that approximately 29% of nitrate at Chiricahua NM is derived from the Arizona source region (*http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx*). But nitrate is a relatively minor component of total $PM_{2.5}$ at Chiricahua NM, contributing only 6% of $PM_{2.5}$, and, as with $SO_2$, the monitoring location is located less than 50 km from a large source of $NO_x$ emissions (Apache Generating Station, 14,000 tpy $NO_x$). Arizona $NO_x$ emissions totaled approximately 293,000 tpy based on 2008 modeling scenarios. Again, it appears that an additional 139 tpy $NO_x$ (0.048%of Arizona emissions) from the Bowie Power Station would be unlikely to appreciably increase $PM_{2.5}$ from ammonium nitrate in the project area.

### Summary and Conclusions

Maximum direct $PM_{2.5}$ impacts from to the Bowie Power Station are below the 24-hour and annual SILs and, therefore, well below the NAAQS levels. It is unlikely that secondary $PM_{2.5}$ from the Bowie facility would cause or contribute to an exceedance of the NAAQS for the following reasons:

- Maximum impacts of directly emitted $PM_{2.5}$ from the Bowie Power Station occur close to the facility (< 1 km) on both a short-term and annual basis. In contrast, sulfate and nitrate that form from precursor emissions from the Bowie Power Station occur farther downwind (4-12 km from the facility) as the chemical reactions occur during transport.
- Maximum 24-hour $PM_{2.5}$ impacts from the Bowie Power Station occur during the fall season. In contrast, maximum background $PM_{2.5}$, as measured at Chiricahua NM, occurs largely in summer and spring and not during the fall season.
- Chiricahua NM $PM_{2.5}$ consists primarily of ammonium sulfate (37%), soil (33%), and organic carbon (25%). Ammonium nitrate is a small component (6%). In contrast, the Bowie Power Station is a small source of SO2 (30 tpy), the primary ammonium sulfate precursor.
- Meteorological conditions that lead to maximum short-term $PM_{2.5}$ from the Bowie Power Station (breezy, stable) differ somewhat from the conditions that lead to maximum short-term $PM_{2.5}$ at Chiricahua NM (lower wind speeds, less stable conditions).
  - Less than 10% of sulfate at Chiricahua NM on an annual basis is from Arizona sources, in spite of the fact that Chiricahua NM is located less than 50 km from a large source of $SO_2$ emissions. Arizona $SO_2$ emissions totaled approximately 85,000 tpy. It is unlikely that a relatively small source of $SO_2$ emissions such as the Bowie Power Station (approximately 30 tpy or 0.035% of Arizona emissions) would appreciably increase $PM_{2.5}$ from ammonium sulfate in the project area.
  - Approximately 29% of nitrate at Chiricahua NM is derived from the Arizona source region. Nitrate is a relatively minor component of total $PM_{2.5}$ at Chiricahua NM, in spite of the fact that Chiricahua NM is located less than 50 km from a large source of $NO_x$ emissions. Arizona $NO_x$ emissions total approximately 293,000 tpy. An additional 139 tpy $NO_x$ (0.048%of Arizona emissions) from the Bowie Power Station would be unlikely to appreciably increase $PM_{2.5}$ from ammonium nitrate in the project area.

## E5.4.2 Full Impact Analyses

A full impact analysis was performed for 1-hour $NO_2$, the only pollutant and averaging period for which the preliminary analysis predicts an impact above the SIL.

Impacts above the SIL were predicted out to approximately 50 km from the Bowie Power Station. Therefore, sources were examined that are within approximately 100 km for possible inclusion in the cumulative analysis.

Appendix W suggests that nearby and other sources that should be included in the modeled inventory for a full analysis are those that establish "a significant concentration gradient in the vicinity of the source." Appendix W also suggests that the number of such sources is expected to be small."

EPA's March 1, 2011 guidance document, "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-Hour $NO_2$ National Ambient Air Quality Standard" (EPA 2011) further discusses the concept of "significant concentration gradient" and notes that "... the emphasis on determining which nearby sources to include in the modeling analysis should focus on the area within about 10 kilometers of the project location in most cases." The guidance suggests tools to inform a case-specific exercise of professional judgment to determine which sources should be explicitly modeled in a full impact assessment. These include isopleth plots of project impacts, examination of impact patterns with respect to terrain, identification of the controlling meteorological conditions for project impacts, examination of the location of nearby sources and the background monitoring station relative to the project impact plots, wind roses, pollution roses, etc. The guidance goes on to state, " Many of the challenges ... related to cumulative assessments arise in the context of how best to combine a monitored and modeled contribution to account for background concentrations ... [to avoid] the potential for double counting of impacts from modeled sources that may be contributing to the monitored concentrations."

ADEQ's modeling guidance (ADEQ 2004) suggests that an analysis of emissions vs. distance is appropriate for screening out regional sources that are unlikely to have a significant impact in the project vicinity. The guidance describes the "20D" approach to determine whether to include a regional source in the analysis. The "20D" approach assumes a linear inverse proportional relationship between source emissions and impacts with distance. A "20D" facility-level screening approach is used to eliminate a majority of regional facilities from the NAAQS/AAAQS modeling analysis that would not be expected to have a significant impact on analysis results. Under this approach, the applicant may exclude sources that have potential allowable emissions (Q) in tons per year that are less than 20 times the distance ("20D") between the two sources in kilometers. Those sources that are not eliminated using the "20D" approach should be modeled in the full NAAQS/AAAQS analysis.

The "20D" analysis method was originally developed by the State of North Carolina using Gaussian Plume principles and has been adopted by several other state agencies, in addition to ADEQ. The screening-level modeling that resulted in the "20D" concept was based on an effective stack height of 10 m, D (neutral) stability, a 2.5 m/s wind speed, and a mixing height of 300 m. The State of North Caroline states that the method is conservative because of the restrictive source characteristics chosen and, consequently, actual modeled concentrations will most likely be lower than the "20D" method would indicate.

An examination of isopleths of 1-hour $NO_2$ impacts from the Bowie Power Station (see Attachments) and the plot file show that maximum impacts occur to the southwest and west-northwest of the facility at a distance of 10-14 km due to impaction on higher terrain (maximum impact is approximately 45% of 1-hour $NO_2$ NAAQS at a distance of 13.9 km). A secondary maximum impact zone is observed close to the facility ( <1 km) at or just beyond the fenceline (highest "close in" impact is approximately 28% of 1-hour $NO_2$ NAAQS at a distance of 0.3 km). Maximum 1-hour $NO_2$ impacts decrease rapidly beyond a distance of around 13-14 km from the source.

ADEQ provided current data on Arizona sources within approximately 100 km of the Bowie Power Station, while the NMED, Air Quality Bureau provided data for sources in New Mexico within 110 km of Bowie. Based on EPA and ADEQ guidance, all sources within 10 km of the Bowie Power

Station site were included in the cumulative modeling and a "20D" analysis was used to screen more distant sources.

The Pistachio Corporation of Arizona facility is located 7.6 km south of Bowie, with a $NO_x$ potential to emit (PTE) of approximately 16.9 tpy. The facility's roaster, dryers, and silos were included in the cumulative modeling.

The only source with a Q/D score >20 is the Apache Generating Station, located 50.1 km to the southwest of Bowie. The station's three steam turbines, four gas turbines, and a startup diesel engine (total $NO_x$ PTE of 14,065 tpy) were included in the modeling.

Two additional sources with Q/D scores between 15 and 20 km from Bowie were included in the modeling, both compressor stations operated by El Paso Natural Gas (EPNG). The EPNG Willcox Compressor Station is located 32.4 km south-southwest of Bowie ($NO_x$ PTE 487 tpy), while the EPNG Bowie Compressor Station is located 18.9 km west-southwest of Bowie (total $NO_x$ PTE 316 tpy; turbine $NO_x$ PTE 274 tpy). All other sources in Arizona and New Mexico had Q/D scores <10 and were not included in the modeling as they are unlikely to result in a significant concentration gradient in the vicinity of the Bowie project.

The additional sources included in the 1-hour $NO_2$ full analysis are shown in Tables E5-7 and E5-8. As with the Bowie Power Station, emergency generators were excluded from the 1-hour $NO_2$ cumulative modeling.

### Table E5-7. Additional Sources for Full Analysis 1-Hour $NO_2$

| Facility | Distance (km) | $NO_x$ Potential to Emit (tpy) | Q/D[a] |
|---|---|---|---|
| Pistachio Corporation of Arizona | 7.6 | 16.9 | 2.2 |
| EPNG-Bowie Compressor Station | 18.9 | 316 | 16.7 |
| EPNG-Willcox Compressor Station | 32.4 | 487 | 15.0 |
| Apache Generating Station | 50.1 | 14,065 | 280.5 |

[a] Q is the source's maximum allowable emissions in tons per year, D is the distance between the source and the Bowie Power Station in kilometers.

Notes:

km = Kilometers

tpy = Tons per year

The cumulative 1-hour $NO_2$ assessment used the model (AERMOD), receptor grid, options, and meteorological data that were used for the Bowie Power Station preliminary analysis. The receptors modeled were limited to those that showed a maximum impact above the 1-hour $NO_x$ SIL in the preliminary (Bowie Power Station only) analysis.

The AERMOD model has incorporated options to allow modeling compliance with the 1-hour $NO_2$ standard. Specifying "NO2" as the pollutant to be modeled invokes these options. The 98th percentile (high, 8th high) of the daily maximum 1-hour values from the Bowie project plus other nearby sources was modeled. Background $NO_2$ concentrations that vary by season and hour of the day (see Table E3-5) were added to the combined impact within the model. The total maximum 98th percentile (high, 8th high) of the daily maximum concentrations, including background, has been compared with the 1-hour $NO_2$ standard.

The results indicate that the 1-hour $NO_2$ NAAQS would potentially be exceeded at one receptor and for up to two hours per year. The largest contributor to the potential exceedance is the Apache Generating Station.

## Table E5-8. Additional Sources Modeled

| Emission Unit | $NO_x$ Emission Rate (g/s) | In-Stack Ratio (fuel) | Stack Height (m) | Stack Diameter (m) | Temperature (K) | Velocity (m/s) |
|---|---|---|---|---|---|---|
| **Pistachio Corporation of Arizona** | | | | | | |
| Roaster | 0.02 | 0.5 (natural gas) | 6.4 | 1.11 | 293.0 | 0.01 |
| Dryers | 0.73 | 0.12 (natural gas) | Volume source | 7.62 m release height | 5.46 m initial lateral dimension | 3.40 m initial vertical dimension |
| Silos | 0.09 | 0.5 (natural gas) | Volume source | 10.97 m release height | 8.65 m initial lateral dimension | 5.10 m initial vertical dimension |
| **EPNG Willcox Compressor Station** | | | | | | |
| GE turbine 1 | 8.6 | 0.091 (natural gas) | 15.2 | 2.3 | 616.5 | 18.6 |
| GE turbine 2 | 8.6 | 0.091 (natural gas) | 15.2 | 2.3 | 616.5 | 18.6 |
| **EPNG Bowie Compressor Station** | | | | | | |
| GE turbine | 7.9 | 0.091 (natural gas) | 11.6 | 1.2 | 609.8 | 6.4 |
| **Apache Generating Station** | | | | | | |
| Steam Unit 1 | 29.1 | 0.1 (natural gas) | 47.9 | 2.4 | 409.3 | 27.3 |
| Steam Unit 2 | 119.0 | 0.5 (coal) | 121.9 | 5.1 | 355.9 | 15.8 |
| Steam Unit 3 | 119.0 | 0.5 (coal) | 121.9 | 5.1 | 358.2 | 16.8 |
| Gas Turbine 1 | 18.5 | 0.5 (oil) | 11.0 | 3.8 | 733.2 | 27.3 |
| Gas Turbine 2 | 29.0 | 0.5 (oil) | 10.4 | 4.0 | 583.2 | 17.1 |
| Gas Turbine 3 | 87.1 | 0.5 (oil) | 11.0 | 6.2 | 752.2 | 6.3 |
| Gas Turbine 4 | 1.1 | 0.5 (natural gas and diesel) | 30.5 | 1.5 | 706.5 | 27.4 |
| Startup Engine | 1.9 | 0.2 (diesel) | 1.8 | 0.3 | 650.0 | 18.1 |

Notes:

| | | |
|---|---|---|
| GE | = | General Electric |
| g/s | = | Grams per second |
| K | = | Kelvin |
| m | = | Meters |
| m/s | = | Meters per second |

Bowie's contribution to impacts above 90% of the NAAQS was determined using the "MAXDCONT" option in AERMOD. There were no impacts with a total concentration (including background) that exceeded 90% of the 1-hour NAAQS where Bowie's contribution was greater than 3% of the total impact; therefore, no refined grids were developed.

The maximum 1-hour $NO_2$ concentration predicted by the model, including background, was 192.32 µg/m$^3$ (the 1-hour $NO_2$ NAAQS is 188.7 µg/m$^3$). A total of two hours were predicted to exceed the NAAQS and the largest contribution to any of the potential exceedances by the Bowie Power Station was 0.00151 µg/m$^3$, well below the SIL of 7.5 µg/m$^3$. The Bowie Power Station will not cause or contribute to any exceedance of the 1-hour $NO_2$ NAAQS.

### E5.4.3 Increment Analysis

The preliminary analysis did not show any pollutants/averaging periods that exceeded a SIL for which Class II increments have been defined. Therefore, no increment consumption analysis was performed.

# E6.0 CLASS I AREA ANALYSES

The proposed project site is located within 100 km of four Class I areas in Arizona, the Chiricahua NM, the Chiricahua Wilderness Area (WA), the Galiuro WA, and the Saguaro NP East Unit. The closest Class I area in New Mexico, the Gila WA, is 116 km from the project.

Table E 6-1 shows the approximate distances to the Class I areas within 100 km and each area's Federal Land Manager (FLM).

**Table E6-1. Distances to Closest Class I Areas**

| Areas | Approximate Distance from Project Site (kilometers) | Federal Land Manager |
|---|---|---|
| Chiricahua NM | 38 | National Park Service |
| Chiricahua WA | 47 | USDA Forest Service |
| Galiuro WA | 73 | USDA Forest Service |
| Saguaro NP East Unit | 99 | National Park Service |

Notes:
NP = National Park
NM = National Monument
USDA = US Department of Agriculture
WA = Wilderness Area

The Federal Land Managers' *Air Quality Related Values Work Group (FLAG) Phase I Report – Revised (2010)* (FLAG 2010) guidance incorporates findings from recent scientific studies and methodologies for conducting visibility analyses based on experience gained through implementation of the Regional Haze Rule. The guidance sets a threshold ratio of emissions to distance, below which AQRV review is not required for any Class I area greater than 50 km from the source. Specifically, if Q (tpy)/D (km) < 10, no AQRV analysis is required, where Q is the emissions increase of $SO_2$, $NO_x$, $PM_{10}$, and sulfuric acid mist, combined in tons per year and D is the nearest distance to a Class I area in kilometers. If Q/D is less than 10 for a Class I Area, then presumptively, there is no adverse impact and no Class I AQRV analysis is required.

Using expected annual emissions may underestimate potential visibility impacts because visibility is assessed on a 24-hour basis. Therefore, a worst-case 24-hour visibility scenario has been defined and used to estimate a conservative value of "Q" in tons per year for the Bowie project. Worst-case 24-hour $NO_x$ emissions for turbines and duct burners include three hot starts, two shutdowns, and the highest normal operation emission rate for the remaining hours in a 24-hour period. Emissions of $SO_2$/SO4 and $PM_{10}$ were based on the same operating scenario. The auxiliary boiler was assumed to run for 12 hours and the emergency fire pump for 4 hours in the worst-case 24-hour period, while cooling tower emissions will be continuous. Combining emissions from all project sources and converting to tons per year gives a combined emissions rate (Q) of 310 tpy.

The FLM guidance cited above suggests an emission (Q) over distance (D) screening threshold of 10. Applying this to the annualized aggregate emission rate suggests that for any Class I area beyond around 31 km, impacts are unlikely. Consequently, AQRVs were only be analyzed at the two Class I areas located less than 50 km from the Bowie Power Station, Chiricahua NM and Chiricahua WA.

The Fort Bowie National Historic Site is located approximately 23 km to the south-southeast of the proposed project location. Although the historic site is not a Class I area, the National Park Service (NPS) has previously asked that visibility impacts be assessed there.

PSD Class I increment consumption was also assessed at Chiricahua NM and Chiricahua WA.

## E6.1 Class I Analysis Methods

For $NO_2$, $PM_{10}$, and $PM_{2.5}$, impacts from the project were estimated within Chiricahua NM and Chiricahua WA for comparison with Class I significance levels (there are no CO increments or AQRVs, and $SO_2$ emissions from the Bowie Power Station are below PSD significant emission rates). Project impacts on visibility and acid deposition were also assessed at these locations. Impacts on applicable AQRVs, deposition, and increments were calculated at NPS-provided Class I area receptor locations, converted to the appropriate grid locations.

An analysis of the proposed source's effect on Class I increments and AQRVs in the Chiricahua WA was made using the most recent EPA-approved version of the long-range transport model CALPUFF (version 5.8). The nearest boundary of the Chiricahua WA is approximately 47 km from the project site, while the farthest edge is approximately 77 km. CALPUFF was applied for the Bowie project to estimate impacts at the Chiricahua WA, including for receptors within 50 km of the Bowie project site.

Given that Chiricahua NM lies completely within 50 km of the project site, however, only AERMOD was used to predict impacts for comparison with the $NO_2$, $PM_{10}$, and $PM_{2.5}$ Class I significance levels shown in Table E5-5 at this Class I area. Deposition impacts at this Class I area were assessed with CALPUFF because AERMOD lacks the required chemical processing capabilities for this type of impact analysis.

### E6.1.1 Emissions and Stack Parameters

To determine compliance with Class I significance levels (increments) at Chiricahua NM and Chiricahua WA, the Bowie Power Station sources was modeled using the emission scenarios and stack parameters described in Section E5.2.2. The visibility scenario described below was used to model visibility impacts at the Chiricahua WA. The annual average scenarios described in Section E5.2.2 were used to determine acid deposition impacts at both Class I areas.

Visibility impacts are based on 24-hour emission scenarios. The scenarios used for these analyses represent concurrent emissions of $NO_x$, $SO_2$, and $PM_{10}$. As noted in Section E5.2.2, $NO_x$ emissions are higher during startup and shutdown events, while $SO_2$ and $PM_{10}$ emissions vary only slightly. Maximum visibility impacts were therefore expected to result from a 24-hour scenario that includes three hot starts and two shutdowns for each turbine/duct burner pair, with maximum normal operation emissions for the rest of the 24-hour period. The modeled CALPUFF parameters are shown in Tables E6-2 and E6-3.

### E6.1.2 CALPUFF Methodology

CALPUFF (version 5.8, level 070623) was used to assess Class I increment, visibility, and acid deposition impacts at Chiricahua WA and to assess acid deposition at Chiricahua NM.

#### E6.1.2.1 CALMET

The CALPUFF model relies on meteorological and geophysical inputs to provide land use, terrain, and wind and temperature field parameters. These inputs are provided by the CALMET program, which processes the varying geophysical parameters and surface and upper air measurements into CALPUFF-ready formats.

## Table E6-2. CALPUFF Modeled Stack Parameter Inputs

| Source | Source | Location | | Stack Height (m) | Base Elevation (m-msl) | Stack Diameter (m) | Velocity (m/s) | Temperature (K) | Downwash |
|---|---|---|---|---|---|---|---|---|---|
| | | X (km) | Y (km) | | | | | | |
| Hrsgn | North turbine/ duct burner | 167.0308 | 99.981 | 54.86 | 1139 | 5.49 | 13.28 (visibility scenario) 18.10 (annual scenarios) Varies seasonally for $PM_{10}/PM_{2.5}$ short-term scenarios | 355.36 (visibility scenario) 355.23 (annual scenarios) Varies seasonally for $PM_{10}/PM_{2.5}$ short-term scenarios | 1 |
| Hrsgs | South turbine/ duct burner | 167.0308 | 99.942 | | | | | | 1 |
| Auxboil | Auxiliary boiler | 167.005 | 100.049 | 13.7 | 1139 | 0.76 | 15.24 | 422.04 | 1 |
| Firepump | Fire water pump | 167.060 | 100.060 | 10.67 | 1139 | 0.13 | 65.23 | 809.26 | 1 |
| Cooltwr | Cooling tower cells (all) | 167.076 | 100.096 | 14.00 | 1139 | 10.0 | 8.59 | 294.26 | 1 |

Notes:

| | | |
|---|---|---|
| hr | = | Hour |
| K | = | Kelvin |
| km | = | Kilometers |
| m | = | Meters |
| msl | = | Above mean sea level |
| m/s | = | Meters per second |

## Table E6-3. Emission Rates Modeled

| Stack IDs | Source | Emission Scenario | $SO_2$ (lb/hr) | $SO_4$ (lb/hr) | $NO_x$ (lb/hr) | $HNO_3$ (lb/hr) | $NO_3$ (lb/hr) | SOA (lb/hr) | PMF[a] (lb/hr) | PMC (lb/hr) | EC (lb/hr) | OC (lb/hr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hrsgn/Hrsgs | North/south turbines/duct burners | Visibility scenario | 2.71 | 2.03 | 22.0 | 0.0 | 0.0 | 4.22 | 2.08 | 6.25 | 2.08 | 4.22 |
| | | Annual emission rates/deposition | 2.28 | 1.71 | 15.86 | 0.0 | 0.0 | 3.65 | 7.14/1.79 | 0.0/5.36 | 1.79 | 3.65 |
| | | 24-hour emission rates (Scenario 1/ Scenario 2) | -- | -- | -- | -- | -- | -- | -- | 8.50/6.50 | -- | -- |
| Auxboil | Auxiliary boiler | Visibility scenario | 0.05 | 0.0 | 0.90 | 0.0 | 0.0 | 0.0 | 0.18 | 0.0 | 0.0 | 0.0 |
| | | Annual emission rates/deposition | 0.006 | 0.0 | 0.09 | 0.0 | 0.0 | 0.0 | 0.02 | 0.0 | 0.0 | 0.0 |
| | | 24-hour emission rates (Scenario 1/ Scenario 2) | -- | -- | -- | -- | -- | -- | -- | 0.18/0.18 | -- | -- |
| Firepump | Fire water pump | Visibility scenario | 0.0005 | 0.0 | 0.01 | 0.0 | 0.0 | 0.0 | 0.01 | 0.0 | 0.0 | 0.0 |
| | | Annual emission rates/deposition | 0.00004 | 0.0 | 0.01 | 0.0 | 0.0 | 0.0 | 0.0008 | 0.0 | 0.0 | 0.0 |
| | | 24-hour emission rates (Scenario 1/ Scenario 2) | -- | -- | -- | -- | -- | -- | -- | 0.01/0.1 | -- | -- |
| Cooltwr | Cooling tower cells (total of 9 cells) | All | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 | 0.0 |

[a] $PM_{10}$ and $PM_{2.5}$ emissions are the same for all sources except the cooling tower and for the turbines/duct burners for the visibility scenario only. $PM_{10}$ emissions have been conservatively modeled for the cooling tower to represent both $PM_{10}$ and $PM_{2.5}$.

Notes:

| | | |
|---|---|---|
| EC | = | Elemental carbon |
| $HNO_3$ | = | Nitric acid |
| lb/hr | = | Pounds per hour |
| $NO_x$ | = | Oxides of nitrogen |
| $NO_3$ | = | Nitrate |
| OC | = | Organic carbon |
| PMC | = | Particulate matter coarse |
| PMF | = | Particulate matter fine |
| SOA | = | Secondary organic aerosol |
| $SO_2$ | = | Sulfur dioxide |
| $SO_4$ | = | Sulfate |

There are several steps needed to provide this CALPUFF-ready format, including developing terrain and land use information (geo.dat) and compiling surface meteorological parameters (surf.dat), upper air data (ua.dat), and surface measured precipitation data (precip.dat). Augmenting the upper air data is a set of diagnostic wind, temperature, and other parameter fields available from mesocale modeled (MM) domains such as MM5.

The CALMET processor was run in 2007 in accordance with a protocol submitted to the ADEQ for a previous Bowie project. The input files (geo, MM5, surface and upper air meteorological and precipitation data) used in support of the 2007 CALMET processing were also used for the current assessment. The MM5 data sets used in the 2007 CALMET processing were based on the 2001 EPA 36 km MM5 data set, the 2002 WRAP 12 km MM5 data set, and the 2003 Midwest Regional Planning Organization (MRPO) 36 km MM5 data set. CALMET was run for each month for the two years with 36-km MM data but for every two weeks for the single year (2002) with 12-km MM data.

These data sets were used in an approved manner as input to CALMET along with four surface meteorological stations (DUG, SAD, SUC, and TUS), one upper air station (TUS), and 11 precipitation stations. The Lambert Conformal Coordinate (LCC) projected domain consists of 75 NX grid cells and 60 NY grid cells spaced 4 km apart, in accordance with recent EPA guidance.

Specific values used in the 2007 CALMET processing included R1 of 30 km and R2 of 50 km, RMAX1 of 30 km and RMAX2 of 100 km. These values differ from more recent CALMET guidance (Tyler Fox, August 31, 2009 Memorandum: "Clarification on EPA- FLM Recommended Settings for CALMET"; EPA 2009). The CALMET data was reprocessed for 2001-2003 using the current regulatory version of the model (version 5.8, level 070623) in accordance with the revised guidance using the switch settings as recommended in the EPA memorandum. All CALMET input files are being provided with this permit application, including the MM5 data, the meteorological data files (surf, precip, ua), and geophysical files (geo). The CALMET output file was used in CALPUFF along with the same grid settings.

#### E6.1.2.2 CALPUFF/CALPOST

Each year of the three year meteorological records (2001-2003) was run in CALMET to generate CALPUFF-needed files. Each of the years was used to generate CALPUFF output files based on modeling the proposed Bowie emissions and values of each modeled pollutant (primary and secondary) were calculated at each receptor location.

The same data set from Chiricahua NM discussed previously was used in CALPUFF as the hourly ozone file. Missing values were filled using the same procedure as outlined for the PVMRM approach in AERMOD so that complete hourly ozone data was available as background to apply to the CALPUFF calculations.

Results of the CALPUFF model were passed along to CALPOST (version 6.221, level 082724). CALPOST was used to calculate annual aggregate species values (total sulfur and total nitrogen) to compare to deposition thresholds. Short-term and annual increment impacts were calculated for each receptor and maximum values determined for comparison with EPA threshold values. CALPOST was also used to generate visibility impact projections.

#### E6.1.2.3 Visibility/Haze Assessment

Emission rates of criteria pollutants were apportioned in accordance with NPS guidance for applicable sources such as the combustion turbines to account for varying particulate matter speciation and associated extinction coefficients and emission rates. NPS guidance for natural gas-fired combustion turbines was used in CALPUFF to account for varying emitted particle sizes and the potential effects on

light scattering and visibility. For those sources without such speciation guidance, standard emission rates were used.

The visibility assessment employed the MVISBK 8, sub-mode 5 approach, which uses Class I-specific values of annual natural background concentrations, monthly f(RH) values for hygroscopic species, and Rayleigh conditions. Appropriate values for each specific Class I area were obtained from the 2010 FLAG (FLAG 2010) guidance. The 98th percentile change in light extinction was compared to the annual average natural condition value for each Class I area to determine whether the 5% visibility threshold for concern will be exceeded.

## E6.2 Class I Determinations

This section discusses the determinations that were made for project impacts at each Class I area.

### E6.2.1 Comparison with Significance Levels

Maximum impacts predicted in each Class I area for each pollutant and averaging period were compared to the Class I significance levels shown in Table E5-5. The results are shown in Table E6-4.

**Table E6-4. Results of Class I Significant Impact Analysis**

| Averaging Period/ Pollutant | Maximum Predicted Impact Chiricahua NM[a] ($\mu g/m^3$) | Maximum Predicted Impact Chiricahua WA[b] ($\mu g/m^3$) | Class I Modeling Significance Level ($\mu g/m^3$) |
|---|---|---|---|
| Annual $NO_2$ | 0.002 | 0.010 | 0.1 |
| 24-hour $PM_{10}$ | 0.013 | 0.059 | 0.3 |
| Annual $PM_{10}$ | 0.001 | 0.006 | 0.2 |
| 24-hour $PM_{2.5}$ | 0.012 | 0.059 | 0.07 |
| Annual $PM_{2.5}$ | 0.001 | 0.006 | 0.06 |

[a] Maximum impacts for 1-year of site-specific meteorological data determined with AERMOD
[b] Maximum impacts for 2001-2003 as determined with CALPUFF/CALPOST
Notes:

| | | |
|---|---|---|
| $\mu g/m^3$ | = | Micrograms per cubic meter |
| $NO_2$ | = | Nitrogen dioxide |
| $PM_{10}$ | = | Particulate matter less than 10 micrometers |
| $PM_{2.5}$ | = | Particulate matter less than 2.5 micrometer |

Because no maximum Class I impact exceeded a SIL, no Class I increment consumption analysis was performed. Because no maximum impact exceeded 90% of any SIL value, no refined receptor grids were developed.

### E6.2.2 Nitrogen Deposition

The CALPUFF model was used to estimate nitrogen deposition within the respective Class I areas (to accommodate the atmospheric chemistry, CALPUFF was used to assess deposition within Chiricahua NM as well). CALPOST version (version 6.221, level 082724) was used to calculate annual aggregate species values to compare to deposition analysis thresholds. Deposition values were compared to the NPS Deposition Analysis Thresholds (DATs) for the western United States of 0.005 kilograms per hectare per year. The results of the analysis are shown in Table E6-5.

**Table E6-5. Deposition Impacts**

| Deposition | 2001 (kg/ha/yr) | 2002 (kg/ha/yr) | 2003 (kg/ha/yr) | Deposition Analysis Threshold (kg/ha/yr) |
|---|---|---|---|---|
| **Chiricahua Wilderness Area** | | | | |
| Total Nitrogen | 0.001 | 0.002 | 0.002 | 0.005 |
| **Chiricahua National Monument** | | | | |
| Total Nitrogen | 0.001 | 0.003 | 0.002 | 0.005 |

Notes:
kg/ha/yr = Kilogram per hectare per year

### E6.2.3 Visibility Impacts beyond 50 Kilometers

For Chiricahua WA, impacts to visibility were determined using the CALPUFF modeling system as described above. The visibility assessment employed the MVISBK 8, sub-mode 5 approach, as outlined above.

The results of the visibility assessment at Chiricahua WA are shown in Table E6-6. No "bright line" standards have been defined that determine whether a change in light extinction is acceptable or unacceptable. Decisions regarding the importance of a predicted effect are made on a case-by-case basis by the FLM responsible for a given Class I area. FLM policy has generally considered impacts below 5% to be insignificant, while impacts above 10% may be considered unacceptable.

For the Chiricahua WA, impacts for all three years are below the 5% threshold.

**Table E6-6. Chiricahua Wilderness Area Visibility Analysis**

| Change in Light Extinction | 2001 | 2002 | 2003 |
|---|---|---|---|
| Maximum % Change | 2.06 | 3.45 | 3.89 |
| Days > 5% | 0 | 0 | 0 |
| Days > 10% | 0 | 0 | 0 |

Note:
% = Percent

### E6.2.4 Visibility Impacts within 50 Kilometers

VISCREEN was used to assess visibility impacts in the Chiricahua NM and Fort Bowie National Historic Site. The VISCREEN model is a simple screening technique used to estimate the mass of pollutant in the atmosphere and its ability to scatter or absorb light and, therefore, to affect visibility. The VISCREEN model calculates rudimentary scattering and absorption coefficients and these values are compared to screening threshold levels to determine the potential magnitude and type of visibility impairment.

The analyses reported here focused on potential coherent plume impacts in relatively nearby areas (within 50 km), rather than uniform haze impacts in distant areas. Coherent plume impacts occur when a visible plume or colored layer is visible against the sky or distant terrain features. Coherent plume impacts may occur in areas that are close to a source of pollutants, while uniform haze may occur further downwind. Two measures of potential plume effects are used. One is a measure of plume contrast, which is the change in light extinction coefficient between views against a background feature (either sky or terrain) and views against the plume. The other measure is delta E, the total color contrast, which takes

into account plume intensity, color, and brightness. If the plume is brighter than its background, it will have a positive contrast. If the plume is darker than its background, it will have a negative contrast. VISCREEN assumes that a terrain object is black, which maximizes the contrast.

VISCREEN reports two tests: one for plumes located inside the area of interest and one for plumes located outside the boundaries of the area of interest. The latter is only appropriate for Class I areas where "integral vistas" of objects outside the area are of concern, while the former is appropriate for all Class I areas.

The VISCREEN model uses the plantwide emission rates of the primary scattering pollutants, $NO_x$ and $PM_{10}$, coupled with default coefficients, conservative atmospheric dispersion parameters, and distance-dependent lines of sight to calculate the visual impairment values. The values used as input to VISCREEN for the Bowie assessment are shown in Table E6-7. A Level I screening analysis was performed for two locations, the Chiricahua NM Class I area and the Fort Bowie National Historic Site. Although Fort Bowie National Historic Site is not a Class I area, the NPS has asked that visibility impacts be assessed there. The nearest edge of this historic site is located approximately 23 km to the south-southeast of the proposed project location.

The results of the Level I assessment at each location are shown in Tables E6-8 and E6-9. The results suggest that some of the screening thresholds may be exceeded under the conservative assumptions inherent in Level I screening. Because of these potential Level I screening exceedances, a Level II analysis was completed, again using VISCREEN.

### Table E6-7. Bowie Power Station VISCREEN Input Parameters

| Parameter | Fort Bowie NHS | Chiricahua NM |
|---|---|---|
| Modeled Emission Rates (lb/hr): | | |
| $PM_{10}$ | 17.75 | 17.75 |
| $NO_x$ | 45.11 | 45.11 |
| Minimum Distance to Site(km) | 25 | 38.4 |
| Maximum Distance to Site (km) | 26 | 46.4 |
| Background Visual Range (km) | 263 | 263 |
| **Level I Dispersion Parameters** | | |
| Stability Class | 6 (F) | 6 (F) |
| Wind Speed (m/s) | 1 | 1 |
| **Level II Dispersion Parameters** | | |
| Stability Class | 5 (E) | 5 (E) |
| Wind Speed (m/s) | 2 | 2 |

Notes:

| | | |
|---|---|---|
| km | = | Kilometers |
| lb/hr | = | Pounds per hour |
| m/s | = | Meters per second |
| NHS | = | National Historic Site |
| NM | = | National Monument |
| $NO_x$ | = | Oxides of nitrogen |
| $PM_{10}$ | = | Particulate matter less than 10 micrometers |

## Table E6-8. Chiricahua NM VISCREEN Level I Model Results

| Maximum Visual Impacts INSIDE Class I Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Screening Criteria ARE Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 128 | 46.4 | 41 | 2 | 2.427* | 0.05 | 0.052* |
| SKY | 140 | 128 | 46.4 | 41 | 2 | 0.859 | 0.05 | -0.017 |
| TERRAIN | 10 | 84 | 38.4 | 84 | 2 | 6.229* | 0.05 | 0.044 |
| TERRAIN | 140 | 84 | 38.4 | 84 | 2 | 0.277 | 0.05 | 0.003 |
| **Maximum Visual Impacts OUTSIDE Class I Area** | | | | | | | | |
| Screening Criteria ARE Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 0 | 1 | 168 | 2 | 27.289* | 0.05 | 0.636* |
| SKY | 140 | 0 | 1 | 168 | 2 | 5.061* | 0.05 | -0.151* |
| TERRAIN | 10 | 0 | 1 | 168 | 2 | 29.023* | 0.05 | 0.329* |
| TERRAIN | 140 | 0 | 1 | 168 | 2 | 5.508* | 0.05 | 0.106* |

Notes:
NM = National Monument

## Table E6-9. Fort Bowie NHS VISCREEN Level I Model Results

| Maximum Visual Impacts INSIDE Class I Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Screening Criteria ARE Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 96 | 26 | 73 | 2 | 2.232* | 0.05 | 0.050 |
| SKY | 140 | 96 | 26 | 73 | 2 | 0.940 | 0.05 | -0.016 |
| TERRAIN | 10 | 84 | 25 | 84 | 2 | 9.280* | 0.05 | 0.056* |
| TERRAIN | 140 | 84 | 25 | 84 | 2 | 0.361 | 0.05 | 0.003 |
| **Maximum Visual Impacts OUTSIDE Class I Area** | | | | | | | | |
| Screening Criteria ARE Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 0 | 1 | 168 | 2 | 29.536* | 0.05 | 0.767* |
| SKY | 140 | 0 | 1 | 168 | 2 | 5.880* | 0.05 | -0.182* |
| TERRAIN | 10 | 0 | 1 | 168 | 2 | 37.894* | 0.05 | 0.422* |
| TERRAIN | 140 | 0 | 1 | 168 | 2 | 6.335* | 0.05 | 0.105* |

Notes:
NHS = National Historic Site

The Level II analysis uses many of the same inputs as the Level I analysis, but allows the program inputs to be adjusted to incorporate more specific (less conservative) assumptions. Some of the primary assumptions in VISCREEN Level I include the dispersive capacity of the atmosphere as Level I assumes a very stable, non-dispersive environment.

To determine an appropriate Level II dispersion environment, the hourly meteorological data is sorted by wind direction so that only those wind directions that could reasonably transport plumes toward the area of study or concern are examined. Those periods are then divided into four, 6-hour daily time periods (the local hours of 1-6, 7-12, 13-18, and 19-24).

Dispersion is characterized by the product $\sigma y \sigma z u$, where $\sigma y$ and $\sigma z$ are the Pasquill-Gifford horizontal and vertical diffusion coefficients for the given stability class and distance to the observer, and u is the wind speed for the wind speed category in the joint frequency table. In the *Workbook for Plume Visual Impact Screening and Analysis* (EPA 1992), the worst-case meteorological condition is defined as the combination of stability class and wind speed that has a $\sigma y \sigma z u$ product with a cumulative probability of 1% (joint conditions occurring less than 90 hours per year), where higher stability class numbers and lower wind speeds provide poorer dispersion. For each of the defined time periods, the cumulative frequency of occurrence of the 16 VISCREEN meteorological conditions was calculated and the condition that represented 1% of the values processed was determined. The most restrictive of the 1% values was then used in the Level II analysis.

Because of the stability inherent in nighttime hours, the 1% value is typically found to occur at night and this was the case for the Bowie assessment. For the hours 1-6, the 1% conditions were stability class E (5) and a wind speed of 3-4 meters per second (m/s). For the hours 7-12, the 1% conditions were stability class D (4) and a wind speed of 4-5 m/s. For the hours 13-18, the 1% conditions were also stability class D (4) and a wind speed of 4-5 m/s. And for the hours 19-24, the 1% conditions were stability class E (5) and a wind speed of 2-3 m/s. The most restrictive dispersion parameters associated with the cumulative 1% frequency distribution for the four time periods were those associated with the hours of 19-24.

The results of the Level II assessment are shown in Tables E6-10 and E6-11. Using the Level II approach, the visual screening criteria are not exceeded in the Chiricahua NM Class I area. Impacts at the Fort Bowie National Historical Site are also presented. Visibility effects thresholds have not been established for Class II areas and the Level I and II procedures automatically compare the impacts against Class I thresholds. Note that the Class I screening values are not necessarily appropriate for Class II areas such as Fort Bowie.

## Table E6-10. Chiricahua NM VISCREEN Level II Model Results

| Maximum Visual Impacts INSIDE Class I Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Screening Criteria ARE NOT Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 128 | 46.4 | 41 | 2 | 0.697 | 0.05 | 0.015 |
| SKY | 140 | 128 | 46.4 | 41 | 2 | 0.245 | 0.05 | -0.005 |
| TERRAIN | 10 | 84 | 38.4 | 84 | 2 | 1.812 | 0.05 | 0.012 |
| TERRAIN | 140 | 84 | 38.4 | 84 | 2 | 0.074 | 0.05 | 0.001 |
| **Maximum Visual Impacts OUTSIDE Class I Area** | | | | | | | | |
| Screening Criteria ARE Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 0 | 1 | 168 | 2 | 11.147* | 0.05 | 0.222* |
| SKY | 140 | 0 | 1 | 168 | 2 | 1.932 | 0.05 | -0.063* |
| TERRAIN | 10 | 0 | 1 | 168 | 2 | 15.565* | 0.05 | 0.162* |
| TERRAIN | 140 | 0 | 1 | 168 | 2 | 1.967 | 0.05 | 0.038 |

Notes:
NM = National Monument

## Table E6-11. Fort Bowie NHS VISCREEN Level II Model Results

| Maximum Visual Impacts INSIDE Class I Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Screening Criteria ARE Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 96 | 26 | 73 | 2 | 0.621 | 0.05 | 0.014 |
| SKY | 140 | 96 | 26 | 73 | 2 | 0.259 | 0.05 | -0.004 |
| TERRAIN | 10 | 84 | 25 | 84 | 2 | 2.903* | 0.05 | 0.016 |
| TERRAIN | 140 | 84 | 25 | 84 | 2 | 0.099 | 0.05 | 0.011 |
| **Maximum Visual Impacts OUTSIDE Class I Area** | | | | | | | | |
| Screening Criteria ARE Exceeded (*) | | | | | | | | |
| Background | Theta | Azi | Distance | Alpha | Screening Criteria: Delta E | Bowie Power Station Plume | Screening Criteria: Contrast | Bowie Power Station Plume |
| SKY | 10 | 0 | 1 | 168 | 2 | 12.134* | 0.05 | 0.268* |
| SKY | 140 | 0 | 1 | 168 | 2 | 2.561* | 0.05 | -0.075* |
| TERRAIN | 10 | 0 | 1 | 168 | 2 | 21.914* | 0.05 | 0.215* |
| TERRAIN | 140 | 0 | 1 | 168 | 2 | 2.443* | 0.05 | 0.036 |

Notes:
NHS = National Historic Site

# E7.0 ADDITIONAL IMPACT ANALYSES

The PSD regulations codified at 40 CFR 52.21(o) require the applicant to conduct an analysis of the impact that would occur to soils and vegetation of significant commercial or recreational value as a result of the project. As stated in 40 CFR 52.21(o), the applicant is not required to analyze the impact on vegetation that has no significant commercial or recreational value. The applicant is also required to analyze general commercial, residential, industrial, and other growth associated with the project.

## E7.1 Growth Analysis

The purpose of the growth analysis is to project the industrial, commercial, and residential growth, and related emissions, that are anticipated to occur in the area due to the construction of the new proposed project. The emissions associated with such projected growth are those not directly related to the new source or modification.

Construction of the Bowie natural gas-fired, combined-cycle project is not expected to result in any significant industrial, commercial, or residential development. Construction of the project is expected to result in approximately 25 new, permanent employment opportunities for plant operations. It is anticipated that the personnel hired and involved in the construction phase of the project would be drawn, in large part, from the surrounding communities, as would some of the operations personnel. As such, no significant increase in air pollutant emissions indirectly associated with the proposed project is expected to occur.

## E7.2 Soils and Vegetation Analysis

An examination of the Bowie natural gas-fired combined-cycle plant's potential impact to sensitive soils or vegetation in the project vicinity has been prepared. The intent of this requirement is to address the potential impact of the proposed project's emissions on sensitive soils and vegetation of commercial or recreational value that occur in the project's impact area. In the 2006 case *In re: Indeck-Elwood, LLC* (PSD Appeal No. 03-04), the EAB referenced the PSD "other impacts analysis" procedures in the 1990 *Draft New Source Review Workshop Manual* (NSR Manual). The NSR Manual states that an analysis of soil and vegetation air pollution impacts "should be based on an inventory of the soil and vegetation types found in the impact area."

Much of the land in Cochise County is under cultivation. Information on the general crops grown in Cochise County was obtained from the National Agricultural Statistics Service. Crops harvested in 2007 included barley, corn, cotton, beans, alfalfa hay, oats, sorghum, wheat, vegetables like chili peppers, and pecans, as well as greenhouse crops. The principal crops cultivated in the project area in 2007 included forage crops (hay and grass), corn, and pecans.

EPA provides criteria for evaluating impacts on soils and vegetation in *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (Screening Procedure; EPA 450/2-81-078). The NSR Manual also states that "For most types of soil and vegetation, ambient concentrations of criteria pollutants below the secondary [NAAQS] will not result in harmful effects." NAAQS secondary standards are intended to protect public welfare, including the consideration of economic interests, vegetation, and visibility. While ambient concentrations of criteria pollutants below the secondary NAAQS are expected to be protective of most soil types and vegetation, this may not be true for particularly sensitive soils or plant species (EPA 1998).

Table E7-1 lists the EPA suggested criteria for impacts to vegetation from the pollutants emitted by the proposed Bowie project. The thresholds shown represent the minimum exposure levels at which visible damage to or growth retardation of plants may occur. The data reflect studies that were conducted

primarily in crops of commercial value. Also shown for comparison with project impacts are the secondary NAAQS levels. All concentrations, including background, are well below the EPA effects criteria.

### Table E7-1. Maximum Project Impacts and Thresholds for Impacts to Vegetation

| Parameter | Maximum Impact Plus Background Concentration ($\mu g/m^3$) | Secondary National Ambient Air Quality Standard ($\mu g/m^3$) | Threshold for Impact to Vegetation ($\mu g/m^3$)[a] |
|---|---|---|---|
| 1-hour $NO_2$[b] | 380.5 (1st high) | NA | 3,760 (4-hour average)<br>564 (1-month) |
| Annual $NO_2$ | 8.9 | 100 | 94 |
| 24-hour $PM_{10}$ | 44.8 | 150 | NA |
| 24-hour $PM_{2.5}$ | 10.1 | 35 | NA |
| Annual $PM_{2.5}$ | 3.7 | 15 | NA |
| 1-hour CO | 2,853 | 40,000 | NA |
| 8-hour CO | 1,349.1 | 10,000 | 1,800,000[c] |

[a] From *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals*, EPA 450/2-81-078, December 12, 1980.
[b] Includes nearby sources in addition to Bowie Power Station.
[c] Threshold is for 1-week exposure; 8-hour project impacts conservatively used for comparison.
Notes:

| | | |
|---|---|---|
| $\mu g/m^3$ | = | Micrograms per cubic meter |
| CO | = | Carbon monoxide |
| $NO_2$ | = | Nitrogen dioxide |
| NA | = | Not applicable |
| $PM_{10}$ | = | Particulate matter less than or equal to 10 micrometers |
| $PM_{2.5}$ | = | Particulate matter less than or equal to 2.5 micrometers |

Field corn has been reported as having a resistant sensitivity to $NO_2$, while cotton has been categorized as intermediate sensitivity (EPA 1980). Alfalfa and barley have been categorized as more sensitive crops to pollutant effects (EPA 1980). The exact tolerance of a given crop is dependent on the particular horticultural variety. Table E7-2 shows specific crop effect levels related to $NO_2$ exposure. No data were found on the sensitivity of pecans to air pollutant exposure.

The thresholds shown in Tables E7-1 and E7-2 reflect a subset of the literature available on the impact of pollutants on plants. However, based on a comparison of maximum predicted concentrations to the thresholds shown in Tables E7-1 and E7-2, it is unlikely that the project's impacts would adversely affect crops grown in the area.

In 2003, the US Department of Agriculture (USDA) prepared an inventory of the soils in the San Simon area of Arizona, which includes the Bowie project site. In all, 45 soil types were identified. Table E7-3 presents information on the predominant types of soil and the ecological sites present in the area of the Bowie project site. A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil. Air pollutants may impact the stability of soil systems including increased soil temperature, moisture stress, and runoff and erosion due to damaged vegetative cover.

## Table E7-2. Comparison of Maximum Project Impacts with Effect Levels for Specific Plants

| Pollutant | Averaging Period | Maximum Predicted Impact + Background ($\mu g/m^3$) | Effect Level ($\mu g/m^3$) | Potential Effect |
|---|---|---|---|---|
| $NO_2$ | 1-Hour | 380.5 (1st high)[a] | 20,527 corn[b] | 1% leaf area injury |
| | | | 32,842 cotton[b] | 28 % leaf area injury |
| | | | 26,685 wheat[b] | 34% leaf area injury |
| | | | 4,105 alfalfa[c] | 15% photosynthesis inhibition |
| | | | 12,316 cotton[b] | 2% leaf area injury |

[a] Includes nearby source contribution as well as Bowie Power Station and background.
[b] Data from *Responses of Plants to Air Pollution* (Mudd and Kozlowski, 1975).
[c] Hill and Bennett, 1970. Based on 2-hour exposure for alfalfa and 4-hour exposure for cotton. Maximum 1-hour impact used for comparison.
Notes:

% = Percent
$\mu g/m^3$ = Micrograms per cubic meter
$NO_2$ = Nitrogen dioxide

## Table E7-3. Major Soil Types near Bowie Project Site[a]

| Map Unit Delineation (Ecological Site) | Acres | Percent of Total | pH |
|---|---|---|---|
| Tres Hermanos gravelly loam (limy fan) | 130,246.8 | 9.7 | 7.9-8.4 |
| Atascosa-Graham-Rock outcrop complex (volcanic hills and basalt hills) | 113,737.2 | 8.5 | 6.1-7.8 |
| Atascosa-Chiricahua-Rock outcrop complex (granitic hills) | 67,978.6 | 5.1 | 6.1-7.8 |
| Graham-rock outcrop complex (basalt hills) | 68,280.8 | 5.1 | 6.6-7.8 |
| Continental-Tubac complex (loamy upland) | 60,395.7 | 4.5 | 6.1-7.3 |
| Pima-Grabe association (loamy swales) | 55,646.0 | 4.2 | 7.4-8.4 |
| Sonoita gravelly sandy loam (sandy loam upland) | 54,846.0 | 4.1 | 6.1-7.3 |
| Tubac soils (loamy upland) | 55,079.1 | 4.1 | 7.4-7.8 |
| Eba gravelly sandy loam (clay loam upland) | 50,352.5 | 3.8 | 6.1-7.3 |
| White House-Forrest association (clay loam upland) | 43,802.9 | 3.3 | 5.6-7.3 |
| Comoro soils (sandy loam) | 42,812.4 | 3.2 | 7.9-8.4 |

[a] From US Department of Agriculture Web Soil Survey, San Simon Area of Arizona (USDA 2013).

Table E7-3 also provides the pH range of the predominant soils in the area. A pH range of 6 to 7 is generally most favorable for plant growth because most plant nutrients are readily available in this range. Soils that have a pH below 5.5 generally have a low availability of calcium, magnesium, and phosphorous. Additionally, many heavy metals become more water soluble under acid conditions and can move downward with water through the soil and, in some cases, can move to aquifers, surface streams, or lakes. In natural systems, the pH is affected by the mineralogy, climate, and weathering. Human management of the soil often alters the natural pH because of acid-forming nitrogen fertilizers, or removal of bases (potassium, calcium, and magnesium). All of the 45 soil types identified in the San Simon area of Arizona have a pH >5.5 and are therefore not overly sensitive to acidic pollutant

concentrations or deposition. As shown in Table 7-1, pollutant concentrations are well below the secondary NAAQS, indicating that adverse impacts to most soils are unlikely.

EPA has concluded that there is no comprehensive understanding of particulate matter deposition effects on crops. The phytotoxic response due to a given mass concentration of airborne particulate matter differs widely depending on the composition. Currently, there is no evidence to demonstrate that the exposure of foliage to ambient concentrations of particulate matter elicits more than a minimal response. EPA has concluded that, as long as particulate matter concentrations remain below the NAAQS levels shown in Table E7-1, there will be no adverse effects on vegetation or foliage (EPA 2004; EPA 2010b).

The possible effects of deposition of trace metals to soils and subsequent uptake by plants was also screened using procedures outlined in the Screening Procedure document. The screening document indicates that plant and animal communities appear to be affected before noticeable accumulations of trace elements occur in soil. Therefore, the approach outlined in which the soil acts as an intermediary in the transfer of deposited trace elements to plants "appears reasonable as a first attempt at identifying the air quality related values associated with soils."

Only a few of the trace metals addressed in the screening procedure will be emitted by the project, primarily from the turbines and duct burners. The screening procedure for deposited trace metals requires an estimation of annual average concentrations of these pollutants. The maximum annual average $NO_2$ impacts (Table E5-6) were used in conjunction with scaling factors for cadmium, cobalt, lead, manganese, and nickel derived from the ratio of their expected emissions rates to the $NO_x$ emission rate from the turbines and duct burners to determine maximum ambient trace element concentrations. For selenium, which will only be emitted from the cooling tower, the maximum annual average $PM_{10}$ impacts from the cooling tower were used in conjunction with scaling factors derived from the ratio of expected selenium emissions rates to the $PM_{10}$ emission rate from the cooling tower to determine maximum ambient trace element concentrations. The screening procedure then outlines the calculations of trace element deposition and trace element concentrations in plant tissues, using very conservative assumptions. Finally, the estimated trace element concentrations in soil and plant tissues are compared with three types of effects screening levels for direct effects on plant tissues and with potential effects on animals eating the plants. If the derived concentrations are below all three screening levels, no adverse impacts are expected. The trace element screening calculations are shown in Attachment E7 - Trace Element Deposition. The results, and comparison with effects screening levels, are shown in Table E7-4.

Because the trace metal deposition and tissue concentrations values are well below all effects screening levels, the Bowie Power Station will not have an adverse impact due to trace metal deposition.

Small amounts of beryllium (Be) will also be emitted from the cooling tower. The screening procedures document referenced above provides a monthly ambient air concentration of 0.01 $\mu g/m^3$ Be to use for comparison with project impacts in a screening analysis for direct ambient impacts to animals. The maximum monthly Be concentration due to the Bowie project were estimated to be 0.0000014 $\mu g/m^3$, well below the screening concentration. Therefore, no adverse effects are expected due to Be emissions.

## Table E7-4. Screening Procedure for Trace Metal Impacts

| Trace Element/Parameter | Value (ppmw) | Soil Screening Concentration (ppmw)[a] | Plant Tissue Screening Concentration (ppmw)[a] | Animal Ingestion Screening Concentration (ppmw)[a] |
|---|---|---|---|---|
| Cadmium deposition (DC): Source only | 0.001 | 2.5 | -- | -- |
| Cadmium deposition (DC): With background | 0.03 | 2.5 | -- | -- |
| Cadmium tissue concentration (TC): Source only | 0.01 | -- | 3 | 15 |
| Cadmium tissue concentration (TC): With background | 0.32 | -- | 3 | 15 |
| Cobalt deposition (DC): Source only | 0.00008 | -- | -- | -- |
| Cobalt tissue concentration (TC): Source only | 0.000009 | -- | 19 | 1-3 |
| Lead deposition (DC): Source only | 0.0005 | 1,000 | -- | -- |
| Lead deposition (DC): With background | 2.58 | 1,000 | -- | -- |
| Lead tissue concentration (TC): Source only | 0.0002 | -- | 126 | 80-150 |
| Lead tissue concentration (TC): With background | 1.16 | -- | 126 | 80-150 |
| Manganese deposition (DC): Source only | 0.0004 | 2.5 | -- | -- |
| Manganese deposition (DC): With background | 0.57 | 2.5 | -- | -- |
| Manganese tissue concentration (TC): Source only | 0.00002 | -- | 400 | 500-5,000 |
| Manganese tissue concentration (TC): With background | 0.04 | -- | 400 | 500-5,000 |
| Nickel deposition (DC): Source only | 0.00009 | 500 | -- | -- |
| Nickel tissue concentration (TC): Source only | 0.00009 | -- | 60 | 1,000 |
| Selenium deposition (DC): Source only | 0.0008 | 13 | -- | -- |
| Selenium tissue concentration (TC): Source only | 0.0008 | -- | 100 | 8 |

[a] From *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals*, EPA 450/2-81-078, December 12, 1980.

Notes:

DC = Deposited concentration
ppmw = Parts per million by weight
TC = Tissue concentration

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# ATTACHMENT E1 – MODELING DATA SUMMARY

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| Base Elevation | 1139.00 | meters |
|---|---|---|

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ | 1-hour | NAAQS Vegetation and Soils Impacts | Turbines and Duct Burners | 101.32 | 1.28E+01 | 54.86 | 354.76 | 17.04 | 5.49 | Hot Start - 10°F ambient used for months with average minimum temperature below freezing (December, January) | Startup Stack Parameters - 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 87.08 | 1.10E+01 | | 356.04 | 15.94 | | Hot Start - 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) | Startup Stack Parameters - 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) |
| | | | | 92.82 | 1.17E+01 | | 359.04 | 15.12 | | Hot Start - 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) | Startup Stack Parameters - 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 1.80 | 2.27E-01 | 13.70 | 422.04 | 15.24 | 0.76 | Normal Operation | |
| | 24-hour (Scenario 1) (Operating Scenario for Emissions and Stack Parameter Scenario match $SO_2$ and $PM_{2.5}$ scenario 1) | Secondary $PM_{2.5}$ Impacts | Turbines and Duct Burners | 15.60 | 1.97E+00 | 54.86 | 352.71 | 21.33 | 5.49 | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) |
| | | | | 14.70 | 1.85E+00 | | 352.87 | 19.81 | | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 14.00 | 1.76E+00 | | 353.76 | 18.90 | | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.90 | 1.13E-01 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.21 | 2.65E-02 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |
| | 24-hour (Scenario 2) (Operating Scenario for Emissions and Stack Parameter Scenario match SO2 and PM2.5 scenario 2) | Secondary $PM_{2.5}$ Impacts | Turbines and Duct Burners | 9.10 | 1.15E+00 | 54.86 | 356.09 | 15.24 | 5.49 | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 7.40 | 9.32E-01 | | 355.32 | 13.11 | | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 7.40 | 9.32E-01 | | 358.21 | 13.72 | | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.90 | 1.13E-01 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.21 | 2.65E-02 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| Base Elevation | 1139.00 | meters |
|---|---|---|

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ (continued) | Annual | NAAQS/AAAQS, Class I & II Increments, $NO_x$ Deposition, Vegetation and Soils Impacts | Turbines and Duct Burners | 15.86 | 2.00E+00 | 54.86 | 355.23 | 18.10 | 5.49 | Annual average | Weighted average stack parameters 59°F ambient |
| | | | Auxiliary Boiler | 0.09 | 1.17E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Annual average | |
| | | | Emergency Fire Pump | 0.01 | 1.81E-03 | 10.67 | 809.26 | 65.23 | 0.13 | Annual average | |
| CO | 1-hour and 8-hour | NAAQS/AAAQS, Vegetation and Soils Impacts | Turbines and Duct Burners | 262.28 | 3.30E+01 | 54.86 | 355.32 | 13.11 | 5.49 | Conservatively use Hot Start 10°F | Worst-case Stack Parameters - 59°F ambient, minimum compliance load |
| | | | Auxiliary Boiler | 1.85 | 2.33E-01 | 13.70 | 422.04 | 15.24 | 0.76 | Conservatively assume Normal Operation for all 8 hours | |
| | | | Emergency Fire Pump | 0.81 | 1.02E-01 | 10.67 | 809.26 | 65.23 | 0.13 | Conservatively assume Normal Operation for all 8 hours | |
| $SO_2$ | 1-hour and 3-hour (Scenario 1) | NAAQS/AAAQS | Turbines and Duct Burners | 4.10 | 5.17E-01 | 54.86 | 352.71 | 21.33 | 5.49 | Normal Operation - 100% load with duct firing, 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - 100% load with duct firing, 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 3.80 | 4.79E-01 | | 352.87 | 19.81 | | Normal Operation - 100% load with duct firing, 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) | Normal Operation - 100% load with duct firing, 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) |
| | | | | 3.60 | 4.54E-01 | | 353.76 | 18.90 | | Normal Operation - 100% load with duct firing, 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) | Normal Operation - 100% load with duct firing, 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 0.11 | 1.37E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Normal Operation | |
| | | | Emergency Fire Pump - 3-hour only | 0.003 | 3.98E-04 | 10.67 | 809.26 | 65.23 | 0.13 | Normal Operation | |
| | 1-hour and 3-hour (Scenario 2) | NAAQS/AAAQS | Turbines and Duct Burners | 3.60 | 4.54E-01 | 54.86 | 354.76 | 17.04 | 5.49 | Startup - 10°F ambient used for months with average minimum temperature below freezing (December, January) | Startup Stack Parameters - 10°F, used for months with average minimum temperature below freezing (December, January) |
| | | | | 3.40 | 4.28E-01 | | 356.04 | 15.94 | | Startup - 59°F ambient used for months where 10°F or 102°F not used (February, March, April, May, October, November) | Startup Stack Parameters - 59°F used for months where 10°F or 102°F not used (February, March, April, May, October, November) |
| | | | | 3.20 | 4.03E-01 | | 359.04 | 15.12 | | Startup - 102°F ambient used for months with average maximum high over 90°F (June, July, August, September) | Startup Stack Parameters - 102°F used for months with average maximum high over 90°F (June, July, August, September) |
| | | | Auxiliary Boiler | 0.11 | 1.37E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Normal Operation | |
| | | | Emergency Fire Pump - 3-hour only | 0.003 | 3.98E-04 | 10.67 | 809.26 | 65.23 | 0.13 | Normal Operation | |

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| Base Elevation | 1139.00 | meters |
|---|---|---|

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $SO_2$ (continued) | 1-hour and 3-hour (Scenario 3) | NAAQS/AAAQS | Turbines and Duct Burners | 2.60 | 3.28E-01 | 54.86 | 356.09 | 15.24 | 5.49 | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 2.10 | 2.65E-01 | | 355.32 | 13.11 | | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 2.10 | 2.65E-01 | | 358.21 | 13.72 | | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.11 | 1.37E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Normal Operation | |
| | | | Emergency Fire Pump - 3-hour only | 0.003 | 3.98E-04 | 10.67 | 809.26 | 65.23 | 0.13 | Normal Operation | |
| | 24-hour (Scenario 1) | NAAQS/AAAQS | Turbines and Duct Burners | 4.10 | 5.17E-01 | 54.86 | 352.71 | 21.33 | 5.49 | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) |
| | | | | 3.80 | 4.79E-01 | | 352.87 | 19.81 | | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 3.60 | 4.54E-01 | | 353.76 | 18.90 | | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.05 | 6.85E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.0005 | 6.63E-05 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| Base Elevation | 1139.00 | meters |
|---|---|---|

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SO2 (continued) | 24-hour (Scenario 2) | NAAQS/AAAQS | Turbines and Duct Burners | 2.60 | 3.28E-01 | 54.86 | 356.09 | 15.24 | 5.49 | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 2.10 | 2.65E-01 | | 355.32 | 13.11 | | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 2.10 | 2.65E-01 | | 358.21 | 13.72 | | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.05 | 6.85E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.0005 | 6.63E-05 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |
| | Annual | NAAQS/AAAQS | Turbines and Duct Burners | 3.42 | 4.32E-01 | 54.86 | 355.23 | 18.10 | 5.49 | Annual Average | Weighted average stack parameters 59°F |
| | | | Auxiliary Boiler | 0.006 | 7.04E-04 | 13.70 | 422.04 | 15.24 | 0.76 | Annual Average | |
| | | | Emergency Fire Pump | 0.00004 | 4.54E-06 | 10.67 | 809.26 | 65.23 | 0.13 | Annual Average | |
| $PM_{10}$ | 24-hour (Scenario 1) | NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts | Turbines and Duct Burners | 8.50 | 1.07E+00 | 54.86 | 352.71 | 21.33 | 5.49 | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) |
| | | | | 8.50 | 1.07E+00 | | 352.87 | 19.81 | | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 8.50 | 1.07E+00 | | 353.76 | 18.90 | | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |
| | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 14.00 | 294.26 | 8.59 | 10.00 | Operation for 24 hours | |

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| Base Elevation | 1139.00 | meters |
|---|---|---|

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $PM_{10}$ (continued) | 24-hour (Scenario 2) | NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts | Turbines and Duct Burners | 6.50 | 8.19E-01 | 54.86 | 356.09 | 15.24 | 5.49 | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 6.50 | 8.19E-01 | | 355.32 | 13.11 | | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 6.50 | 8.19E-01 | | 358.21 | 13.72 | | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | Operation for 4 hours | |
| | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 14.00 | 294.26 | 8.59 | 10.00 | Operation for 24 hours | |
| | Annual | NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts | Turbines and Duct Burners | 7.14 | 9.00E-01 | 54.86 | 355.23 | 18.10 | 5.49 | Annual average | Weighted average stack parameters 59°F |
| | | | Auxiliary Boiler | 0.02 | 2.27E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Annual average | |
| | | | Emergency Fire Pump | 0.0008 | 9.73E-05 | 10.67 | 809.26 | 65.23 | 0.13 | Annual average | |
| | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 14.00 | 294.26 | 8.59 | 10.00 | Annual average | |
| $PM_{2.5}$ | 24-hour (Scenario 1) | NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts | Turbines and Duct Burners | 8.50 | 1.07E+00 | 54.86 | 352.71 | 21.33 | 5.49 | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) | Normal Operation - 10°F ambient, 100% load with duct firing used for months with average minimum temperature below freezing (December, January) |
| | | | | 8.50 | 1.07E+00 | | 352.87 | 19.81 | | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - 59°F ambient, 100% load with duct firing used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 8.50 | 1.07E+00 | | 353.76 | 18.90 | | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - 102°F ambient, 100% load with duct firing used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| | | | Cooling Tower[a] | 0.05 | 5.83E-03 | 14.00 | 294.26 | 8.59 | 10.00 | Normal Operation | |

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| Base Elevation | 1139.00 | meters |
|---|---|---|

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ (continued) | 24-hour (Scenario 2) | NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts | Turbines and Duct Burners | 6.50 | 8.19E-01 | 54.86 | 356.09 | 15.24 | 5.49 | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) | Normal Operation - Minimum Compliance Load 10°F ambient used for months with average minimum temperature below freezing (December, January) |
| | | | | 6.50 | 8.19E-01 | | 355.32 | 13.11 | | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) | Normal Operation - Minimum Compliance Load 59°F ambient used for months where 10oF or 102oF not used (February, March, April, May, October, November) |
| | | | | 6.50 | 8.19E-01 | | 358.21 | 13.72 | | Normal Operation - Minimum Compliance Load 102°F ambient used for months with average maximum high over 90oF (June, July, August, September) | Normal Operation - Minimum Compliance Load 102oF ambient used for months with average maximum high over 90oF (June, July, August, September) |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| | | | Cooling Tower[a] | 0.05 | 5.83E-03 | 14.00 | 294.26 | 8.59 | 10.00 | Normal Operation | |
| | Annual | NAAQS/AAAQS, Class I & II Increments, Vegetation and Soils Impacts | Turbines and Duct Burners | 7.14 | 9.00E-01 | 54.86 | 355.23 | 18.10 | 5.49 | Annual average | Weighted average stack parameters at 59°F ambient |
| | | | Auxiliary Boiler | 0.02 | 2.27E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Annual average | |
| | | | Emergency Fire Pump | 0.0008 | 9.73E-05 | 10.67 | 809.26 | 65.23 | 0.13 | Annual average | |
| | | | Cooling Tower[a] | 0.046 | 5.83E-03 | 14.00 | 294.26 | 8.59 | 10.00 | Annual average | |

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| Base Elevation | 1139.00 | meters |
|---|---|---|

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $NO_x$ | 24-hour | Visibility Impacts | Turbines and Duct Burners | 22.00 | 2.77E+00 | 54.86 | 355.36 | 13.28 | 5.49 | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 10°F ambient | Weighted average stack parameters at minimum compliance load 59°F ambient |
| | | | Auxiliary Boiler | 0.90 | 1.13E-01 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.21 | 2.65E-02 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| $SO_2$ | | | Turbines and Duct Burners | 4.06 | 5.11E-01 | 54.86 | 355.36 | 13.28 | 5.49 | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, all 10°F ambient | Weighted average stack parameters at minimum compliance load 59°F ambient |
| | | | Auxiliary Boiler | 0.05 | 6.85E-03 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.0005 | 6.63E-05 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| $PM_{10}/PM_{2.5}$ | | | Turbines and Duct Burners | 8.33 | 1.05E+00 | 54.86 | 355.36 | 13.28 | 5.49 | Each turbine - 3 hot starts, 2 shutdowns, remaining hours normal operation maximum emission rate of 100% load with duct firing, emissions assumed to be the same at all temperatures | Weighted average stack parameters at minimum compliance load 59°F ambient |
| | | | Auxiliary Boiler | 0.18 | 2.20E-02 | 13.70 | 422.04 | 15.24 | 0.76 | Assume Normal Operation for 12 hours | |
| | | | Emergency Fire Pump | 0.01 | 1.42E-03 | 10.67 | 809.26 | 65.23 | 0.13 | 4 hours of operation | |
| | | | Cooling Tower[a] | 0.10 | 1.22E-02 | 14.00 | 294.26 | 8.59 | 10.00 | Normal Operation | |

[a]There are 9 cooling tower cells. Data shown are for each cell

**BOWIE POWER STATION**
**MODELING DATA SUMMARY**

| | | |
|---|---|---|
| Base Elevation | 1139.00 | meters |

| Pollutant | Averaging Periods | Modeling Scenario(s) | Emission Unit | Emission Rate (lb/hour) | Emission Rate (g/sec) | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) | Operating Scenario for Emissions | Stack Parameter Scenario |
|---|---|---|---|---|---|---|---|---|---|---|---|

Maximum Turbine Short-term Emission Rates:
$NO_x$ - Maximum emission rate occurs during hot starts. Hot start emission rates are much higher than normal operation emission rates.
CO - Maximum emission rate occurs during hot starts
$PM_{10}/PM_{2.5}$ - Maximum emission rate occurs at 100% turbine load plus duct firing,. Startup emission are assumed to equal normal operation emissions without duct firing, maximum emission rate occurs at 100% turbine load.
$SO_2$ - Maximum emission rate occurs at 100% turbine load plus duct firing,. Startup emission are assumed to equal normal operation emissions without duct firing, maximum emission rate occurs at 100% turbine load

Worst-Case Turbine Stack Parameters from Screening Modeling occur at:
59°F ambient temperature, minimum compliance load case

Short-term Emission Rates for turbines are from spreadsheets titled "Turbine and Duct Burner Hourly Emissions" and "Turbine Startup Emissions"

Short-term Emission rates for non-turbine emission units are from "One Hour Emission Criteria Pollutant Emission Summary"

24-hour Average Emission Rate for auxiliary boiler and fire pump $SO_2$ and $PM_{10}/PM_{2.5}$

$$\frac{\text{lb}}{\text{hour}} = \frac{\text{lb}}{\text{hour}} \times \frac{\text{hours of operation}}{\text{24 hours}}$$

24-hour Emission Rates for visibility impacts are from "24-Hour Modeling Scenario Emissions"

Annual Average Emission Rates are from "Annual Project Criteria Pollutant Emissions"
Annual Averages Emissions

$$\frac{\text{lb}}{\text{hour}} = \frac{\text{tons}}{\text{year}} \times \frac{\text{year}}{\text{8760 hours}} \times \frac{\text{2000 lb}}{\text{ton}}$$

Cooling Tower Emissions are divided by 9 to apportion the emissions among the 9 cooling tower cells

$$\frac{\text{grams}}{\text{second}} = \frac{\text{lb}}{\text{hour}} \times \frac{\text{453.59 grams}}{\text{lb}} \times \frac{\text{hour}}{\text{3600 seconds}}$$

Short-term stack parameters are from the spreadsheet titled "Turbine Stack Parameters"

Annual stack parameters are from the spreadsheet titled "Turbine and Duct Burner Annual Weighted Average Stack Parameters"

# ATTACHMENT E2 – 24-HOUR MODELING SCENARIO EMISSIONS

## BOWIE STATION
## 24-HOUR VISIBILITY MODELING SCENARIO EMISSIONS

24-Hour $NO_x$ Emission Scenario

For the 24-hour modeling scenario assume that a designated number of turbines go through hot, warm, or cold startup during the 24-hour period. For the remaining hours, assume the turbine emits at the maximum rate.

| | | |
|---|---|---|
| Total Number of Turbines = | 2 | |
| Number of Turbines Undergoing Hot Start during 24 hour period = | 2 | |
| Hours in Hot Startup For Each Turbine in startup mode during 24 hour period = | 1.5 | 3 hot starts each turbine |
| Number of Turbines Undergoing Warm Start during 24 hour period = | 0 | |
| Hours in Warm Startup For Each Turbine in startup mode during 24 hour period = | 0 | |
| Number of Turbines Undergoing Cold Start during 24 hour period = | 0 | |
| Hours in Cold Startup For Each Turbine in startup mode during 24 hour period = | 0 | |
| Number of Turbines Undergoing Shutdown during 24 hours period = | 2.0 | |
| Hours in Shutdown for Each Turbine during 24 hour period = | 0.50 | 2 shutdowns each turbine |
| Hours of Operation Each Auxiliary Boiler in 24 hour period = | 12 | |
| Hours of Operation of Emergency Fire Pump in 24 hour period = | 4 | |
| Hours of Operation of Cooling Towers in 24 hour period = | 24 | |

| | $NO_x$ | VOCs | $SO_2$ [a] | $PM_{10}$ [a] | |
|---|---|---|---|---|---|
| Turbine Emissions (lb) | | | | | |
| Total Emissions from Hot Starts | 303.96 | 52.68 | 10.80 | 19.50 | lb |
| Total Emissions from Warm Starts | 0.00 | 0.00 | 0.00 | 0.00 | lb |
| Total Emissions from Cold Starts | 0.00 | 0.00 | 0.00 | 0.00 | lb |
| Total Emissions for Shutdown | 65.76 | 25.72 | 3.60 | 6.50 | lb |
| Emissions from normal operation [b] | 686.40 | 180.40 | 180.40 | 374.00 | lb |
| Total Turbine and Duct Burner Emissions during 24-hour period | 1,056.12 | 258.80 | 194.80 | 400.00 | lb |
| Average Emission Rate Each Turbine and Duct Burner Pair (lb/hour) | 22.00 | 5.39 | 4.06 | 8.33 | lb/hour |

[a] Startup and shutdown emissions from $SO_2$ and $PM_{10}$ are assumed to be equivalent to the maximum turbine only (no duct firing) normal operation emissions

[b] Includes duct burner emissions.

| **Pounds/Hour Per Hour Per Piece of Equipment** | Emissions (lb/hour) | | | |
|---|---|---|---|---|
| | $NO_x$ | VOCs | $SO_2$ | $PM_{10}$ |
| Per Turbine and Duct Burner (average 24-hour emission rate, startup for designated number of hours, normal operation for remaining hours) | 22.00 | 5.39 | 4.06 | 8.33 |
| Auxiliary Boiler | 0.90 | 0.10 | 0.05 | 0.18 |
| Emergency Fire Pump | 0.21 | 0.01 | 0.0005 | 0.01 |
| Cooling Tower | -- | 0.15 | -- | 0.87 |

## BOWIE STATION
## 24-HOUR VISIBILITY MODELING SCENARIO EMISSIONS

**Tons/Day**

| **Equipment** | |
|---|---|
| Turbines and Duct Burners | 2 |
| Auxiliary Boilers | 1 |
| Emergency Fire Pumps | 1 |
| Cooling Towers | 1 |

| **Tons Per Day Per Piece of Equipment** | **Emissions (tons/day)** | | | |
|---|---|---|---|---|
| | **$NO_x$** | **VOCs** | **$SO_2$** | **$PM_{10}$** |
| Per Turbine and Duct Burner (startup for designated number of hours, normal operation for remaining hours) | 0.26 | 0.06 | 0.05 | 0.10 |
| Per Auxiliary Boiler | 0.01 | 0.001 | 0.0007 | 0.002 |
| Per Emergency Fire Pump | 0.003 | 0.0001 | 0.00001 | 0.0001 |
| Per Cooling Tower | -- | 0.002 | -- | 0.010 |

| **Tons Per Day For All Pieces of Equipment** | **Emissions (tons/day)** | | | |
|---|---|---|---|---|
| | **$NO_x$** | **VOCs** | **$SO_2$** | **$PM_{10}$** |
| All Turbine and Duct Burners (startup for designated number of hours, normal operation for remaining hours) | 0.53 | 0.13 | 0.10 | 0.20 |
| Auxiliary Boiler | 0.01 | 0.001 | 0.001 | 0.002 |
| Emergency Fire Pump | 0.00 | 0.0001 | 0.000 | 0.0001 |
| Cooling Tower | -- | 0.002 | -- | 0.010 |

**24 - Hour $NO_x$ Emission Rate Calculation for Turbines**

**Emissions Start (lb) = # of turbines in start x $\frac{\text{hours in startup}}{\text{turbine}}$ x $\frac{\text{lb}}{\text{hour}}$**

**Emissions Shutdown (lb) = # of turbines in shutdown x $\frac{\text{hours in shutdown}}{\text{turbine}}$ x $\frac{\text{shutdown}}{\text{hour}}$ x $\frac{\text{lb}}{\text{shutdown}}$**

**Emissions from Normal Operation for Turbines (lb) = # of turbines x $\frac{\text{(24 hours - hours in startup and shutdown)}}{\text{turbine}}$ x $\frac{\text{lb}}{\text{hour}}$ (controlled) normal operation**

**Total Emissions 24-hour Period = Emissions from Hot Starts + Emissions from Warm Starts + Emissions from Cold Starts + Emissions from Shutdowns + Emissions from Normal Operation for Turbines**

**Average Emission Rate Each Turbine $\frac{\text{lb}}{\text{hour}}$ = lb all turbines for 24 hour period x $\frac{1}{\text{24 hours}}$ x $\frac{1}{\text{\# of turbines}}$**

**Conversion from lb/hour to tons/day**

**$\frac{\text{tons}}{\text{day}}$ = $\frac{\text{lb}}{\text{hour}}$ x $\frac{\text{hours}}{\text{day}}$ x $\frac{\text{tons}}{\text{2000 lb}}$**

**Calculation of Emissions in tons/day from all equipment**

**$\frac{\text{tons}}{\text{day}}$ = $\frac{\text{tons}}{\text{day}}$ x # of pieces of Equipment**

# ATTACHMENT E3 – TURBINE AND DUCT BURNER LOAD SCREENING STACK PARAMETERS AND LOAD SCREENING RESULTS

## BOWIE POWER STATION
## TURBINE AND DUCT BURNER SCREENING STACK PARAMETERS

| | | |
|---|---|---|
| Base Elevation | 1139 | meters |

| Load | Ambient Temperature (°F) | Duct Burners | Stack Height (m) | Stack Exit Temperature (K) | Exit Velocity (m/sec) | Stack Diameter (m) |
|---|---|---|---|---|---|---|
| 100% | 10 | Yes | 54.86 | 352.71 | 21.33 | 5.49 |
| 100% | 59 | Yes | 54.86 | 352.87 | 19.81 | 5.49 |
| 100% | 102 | Yes | 54.86 | 353.76 | 18.90 | 5.49 |
| 100% | 10 | No | 54.86 | 361.82 | 21.64 | 5.49 |
| 100% | 59 | No | 54.86 | 361.71 | 20.12 | 5.49 |
| 100% | 102 | No | 54.86 | 362.76 | 19.20 | 5.49 |
| 80% | 10 | No | 54.86 | 358.26 | 17.68 | 5.49 |
| 80% | 59 | No | 54.86 | 357.87 | 16.46 | 5.49 |
| 80% | 102 | No | 54.86 | 358.48 | 14.93 | 5.49 |
| Minimum Compliance Load | 10 | No | 54.86 | 356.09 | 15.24 | 5.49 |
| Minimum Compliance Load | 59 | No | 54.86 | 355.32 | 13.11 | 5.49 |
| Minimum Compliance Load | 102 | No | 54.86 | 358.21 | 13.72 | 5.49 |
| Startup | 10 | No | 54.86 | 354.76 | 17.04 | 5.49 |
| Startup | 59 | No | 54.86 | 356.04 | 15.94 | 5.49 |
| Startup | 102 | No | 54.86 | 359.04 | 15.12 | 5.49 |

Stack Parameters are from spreadsheet titled "Turbine+Duct Burner Info"

**Load Screening Results**

**Summary of Highest 1-Hr Results**

| Source ID | Source Description | 1-hr concentration ($\mu g/m^3/g/s$) | Notes |
|---|---|---|---|
| 100102NY | 100% load, 102˚F ambient, with duct burning | 5.33612 | Max 100% load |
| 100059NY | 100% load, 59˚F ambient, with duct burning | 5.29013 | |
| 100010NY | 100% load, 10˚F ambient, with duct burning | 5.26973 | |
| 100102NN | 100% load, 102˚F ambient, without duct burning | 5.25272 | |
| 100059NN | 100% load, 59˚F ambient, without duct burning | 5.22297 | |
| 100010NN | 100% load, 10˚F ambient, without duct burning | 5.1314 | |
| 080102NN | 80% load, 102˚F ambient, without duct burning | 6.07349 | |
| 080059NN | 80% load, 59˚F ambient, without duct burning | 5.70655 | |
| 080010NN | 80% load, 10˚F ambient, without duct burning | 5.35535 | |
| MCL102NN | Minimum compliance load, 102˚F ambient, without duct burning | 6.37409 | |
| MCL059NN | Minimum compliance load, 59˚F ambient, without duct burning | 6.67492 | Max normal operations |
| MCL010NN | Minimum compliance load, 10˚F ambient, without duct burning | 6.11805 | |
| SU0102NN | Startup, 102˚F ambient, without duct burning | 5.99605 | Max startup |
| SU0059NN | Startup, 59˚F ambient, without duct burning | 5.94722 | |
| SU0010NN | Startup, 10˚F ambient, without duct burning | 5.74328 | |

**Load Screening Results**

**Summary of Highest 3-Hr Results**

| Source ID | Source Description | 3-hr concentration ($\mu g/m^3/g/s$) | Notes |
|---|---|---|---|
| 100102NY | 100% load, 102˚F ambient, with duct burning | 1.78108 | |
| 100059NY | 100% load, 59˚F ambient, with duct burning | 1.78184 | Max 100% load |
| 100010NY | 100% load, 10˚F ambient, with duct burning | 1.77433 | |
| 100102NN | 100% load, 102˚F ambient, without duct burning | 1.76847 | |
| 100059NN | 100% load, 59˚F ambient, without duct burning | 1.75815 | |
| 100010NN | 100% load, 10˚F ambient, without duct burning | 1.72665 | |
| 080102NN | 80% load, 102˚F ambient, without duct burning | 2.02749 | |
| 080059NN | 80% load, 59˚F ambient, without duct burning | 1.90484 | |
| 080010NN | 80% load, 10˚F ambient, without duct burning | 1.78751 | |
| MCL102NN | Minimum compliance load, 102˚F ambient, without duct burning | 2.12805 | |
| MCL059NN | Minimum compliance load, 59˚F ambient, without duct burning | 2.22752 | Max normal operations |
| MCL010NN | Minimum compliance load, 10˚F ambient, without duct burning | 2.04238 | |
| SU0102NN | Startup, 102˚F ambient, without duct burning | 2.0016 | Max startup |
| SU0059NN | Startup, 59˚F ambient, without duct burning | 1.98527 | |
| SU0010NN | Startup, 10˚F ambient, without duct burning | 1.9171 | |

**Load Screening Results**

**Summary of Highest 8-Hr Results**

| Source ID | Source Description | 8-hr concentration ($\mu g/m^3/g/s$) | Notes |
|---|---|---|---|
| 100102NY | 100% load, 102˚F ambient, with duct burning | 1.03626 | Max 100% load |
| 100059NY | 100% load, 59˚F ambient, with duct burning | 1.01065 | |
| 100010NY | 100% load, 10˚F ambient, with duct burning | 0.96198 | |
| 100102NN | 100% load, 102˚F ambient, without duct burning | 0.96654 | |
| 100059NN | 100% load, 59˚F ambient, without duct burning | 0.94243 | |
| 100010NN | 100% load, 10˚F ambient, without duct burning | 0.89511 | |
| 080102NN | 80% load, 102˚F ambient, without duct burning | 1.1658 | |
| 080059NN | 80% load, 59˚F ambient, without duct burning | 1.10178 | |
| 080010NN | 80% load, 10˚F ambient, without duct burning | 1.05011 | |
| MCL102NN | Minimum compliance load, 102˚F ambient, without duct burning | 1.22832 | |
| MCL059NN | Minimum compliance load, 59˚F ambient, without duct burning | 1.28464 | Max normal operations |
| MCL010NN | Minimum compliance load, 10˚F ambient, without duct burning | 1.16916 | |
| SU0102NN | Startup, 102˚F ambient, without duct burning | 1.15278 | Max startup |
| SU0059NN | Startup, 59˚F ambient, without duct burning | 1.13768 | |
| SU0010NN | Startup, 10˚F ambient, without duct burning | 1.10038 | |

**Load Screening Results**

**Summary of Highest 24-Hr Results**

| Source ID | Source Description | 24-hr concentration ($\mu g/m^3/g/s$) | Notes |
|---|---|---|---|
| 100102NY | 100% load, 102˚F ambient, with duct burning | 0.38142 | Max 100% load |
| 100059NY | 100% load, 59˚F ambient, with duct burning | 0.37236 | |
| 100010NY | 100% load, 10˚F ambient, with duct burning | 0.35489 | |
| 100102NN | 100% load, 102˚F ambient, without duct burning | 0.35512 | |
| 100059NN | 100% load, 59˚F ambient, without duct burning | 0.34668 | |
| 100010NN | 100% load, 10˚F ambient, without duct burning | 0.32984 | |
| 080102NN | 80% load, 102˚F ambient, without duct burning | 0.43017 | |
| 080059NN | 80% load, 59˚F ambient, without duct burning | 0.40457 | |
| 080010NN | 80% load, 10˚F ambient, without duct burning | 0.38559 | |
| MCL102NN | Minimum compliance load, 102˚F ambient, without duct burning | 0.45528 | |
| MCL059NN | Minimum compliance load, 59˚F ambient, without duct burning | 0.47843 | Max normal operations |
| MCL010NN | Minimum compliance load, 10˚F ambient, without duct burning | 0.43176 | |
| SU0102NN | Startup, 102˚F ambient, without duct burning | 0.42489 | Max startup |
| SU0059NN | Startup, 59˚F ambient, without duct burning | 0.41911 | |
| SU0010NN | Startup, 10˚F ambient, without duct burning | 0.40423 | |

# ATTACHMENT E4 – TURBINE AND DUCT BURNER WEIGHTED AVERAGE STACK PARAMETERS

**BOWIE POWER STATION**
**TURBINE AND DUCT BURNER WEIGHTED AVERAGE STACK PARAMETERS**

**Annual**

**Ambient Temperature** 59°F

| Configuration | Load | Stack Temperature (K) | Exit Velocity (meters/sec) | Hours per Year | |
|---|---|---|---|---|---|
| Cold Startup | Startup | 356.04 | 15.94 | 325 | |
| Turbine + Duct Firing | 100% | 352.87 | 19.81 | 4224.0 | |
| Turbine | 80% | 357.87 | 16.46 | 3681.8 | Assumed for all turbine-only hours |
| Turbine | Shutdown | 355.32 | 13.11 | 91.3 | Use for shutdown hours |
| Weighted Average | | **355.23** | **18.10** | | |
| | | **°F** | **feet/sec** | | For "Emission Sources" Forms |
| | | 179.75 | 59.40 | | |

**Three Hot Starts, Two Shutdowns + Turbine Operation at Minimum Compliance Load**

| | 59°F | | | |
|---|---|---|---|---|
| | Stack Temperature (K) | Exit Velocity (meters/sec) | Duration (hours) | |
| Three Hot Starts | 356.04 | 15.94 | 1.50 | Use Cold Start Data |
| Two Shutdowns | 355.32 | 13.11 | 0.50 | Use Minimum Compliance Load Data |
| Normal Operation without Duct Firing - Minimum Compliance Load | 355.32 | 13.11 | 22.00 | |
| Weighted Average | **355.36** | **13.28** | | |

Stack data is from "Turbine Stack Parameters" spreadsheet

Hours per year are from "Turbine and Duct Burner Annual" spreadsheet

Startup and shutdown durations are from "Turbine Startup Emissions" spreadsheet

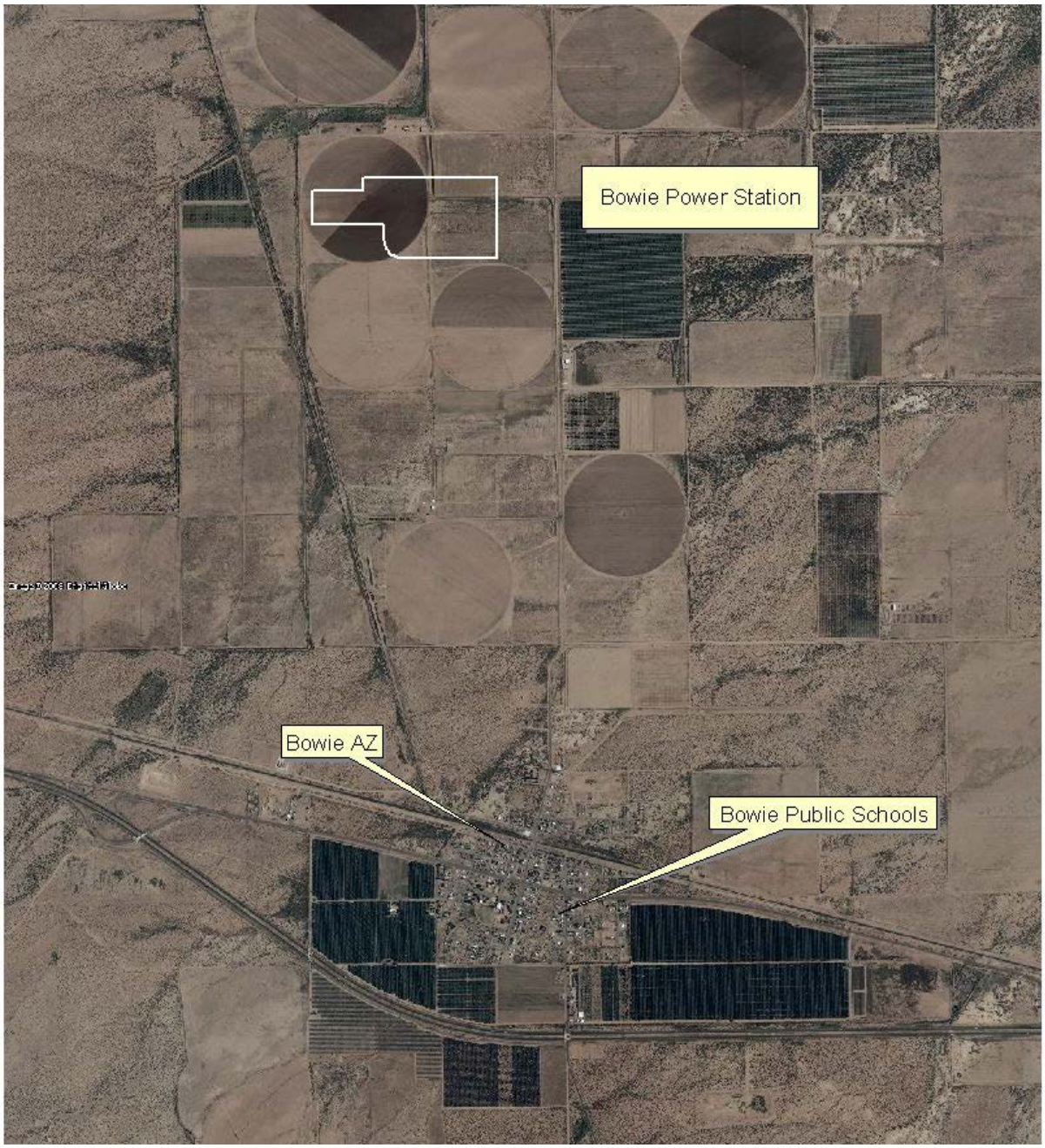
$$\text{Weighted Average Temperature} = \frac{\Sigma(\text{Configuration Temperature} \times \text{Configuration Hours})}{\text{Total Hours}}$$

$$\text{Weighted Average Exit Velocity} = \frac{\Sigma(\text{Configuration Exit Velocity} \times \text{Configuration Hours})}{\text{Total Hours}}$$

$$^{o}F = ((K - 273.15) \times \frac{9}{5}) + 32$$

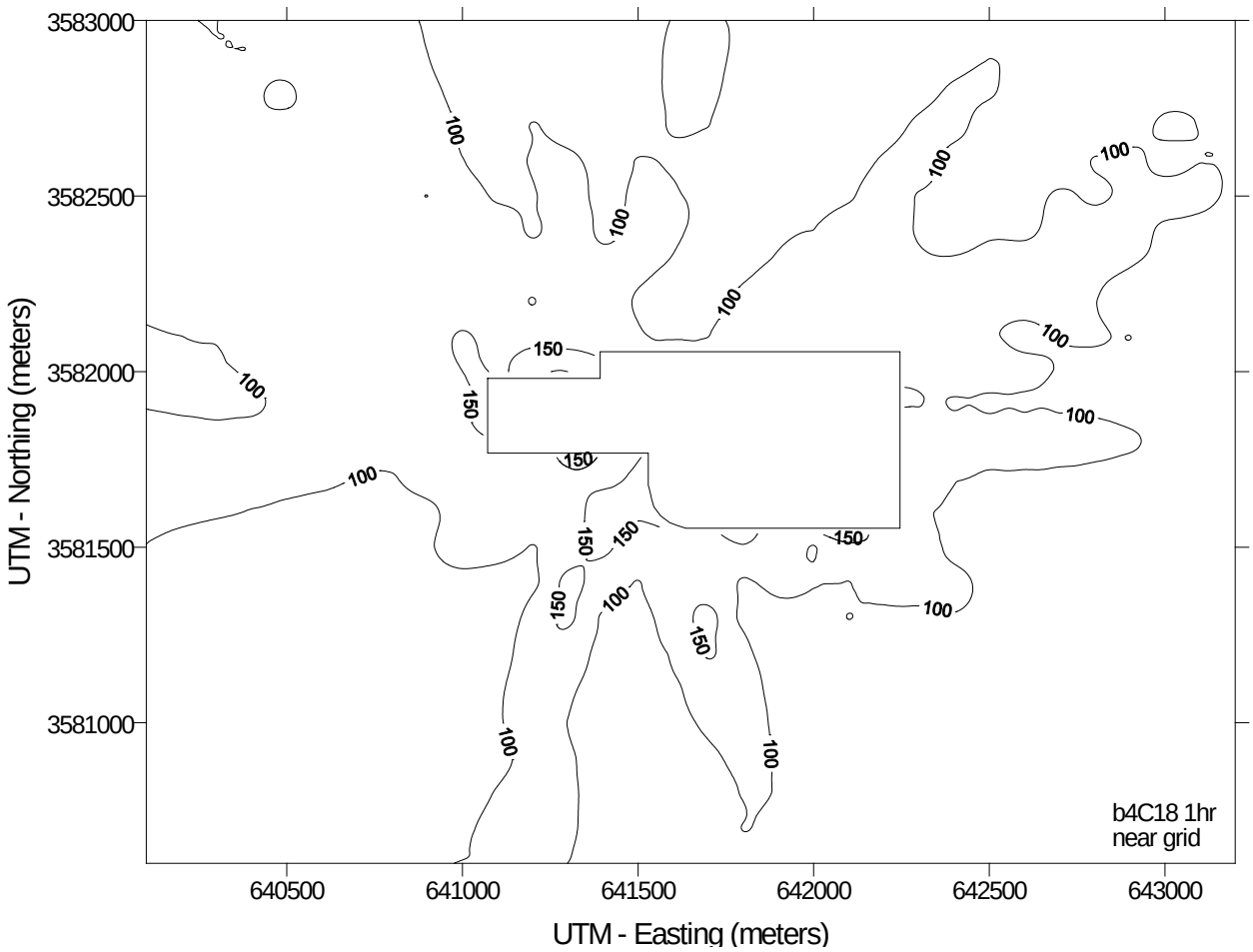
$$\frac{\text{feet}}{\text{second}} = \frac{\text{meters}}{\text{second}} \times \frac{3.281\ \text{feet}}{\text{meters}}$$

# ATTACHMENT E5 – ISOPLETH MAPS

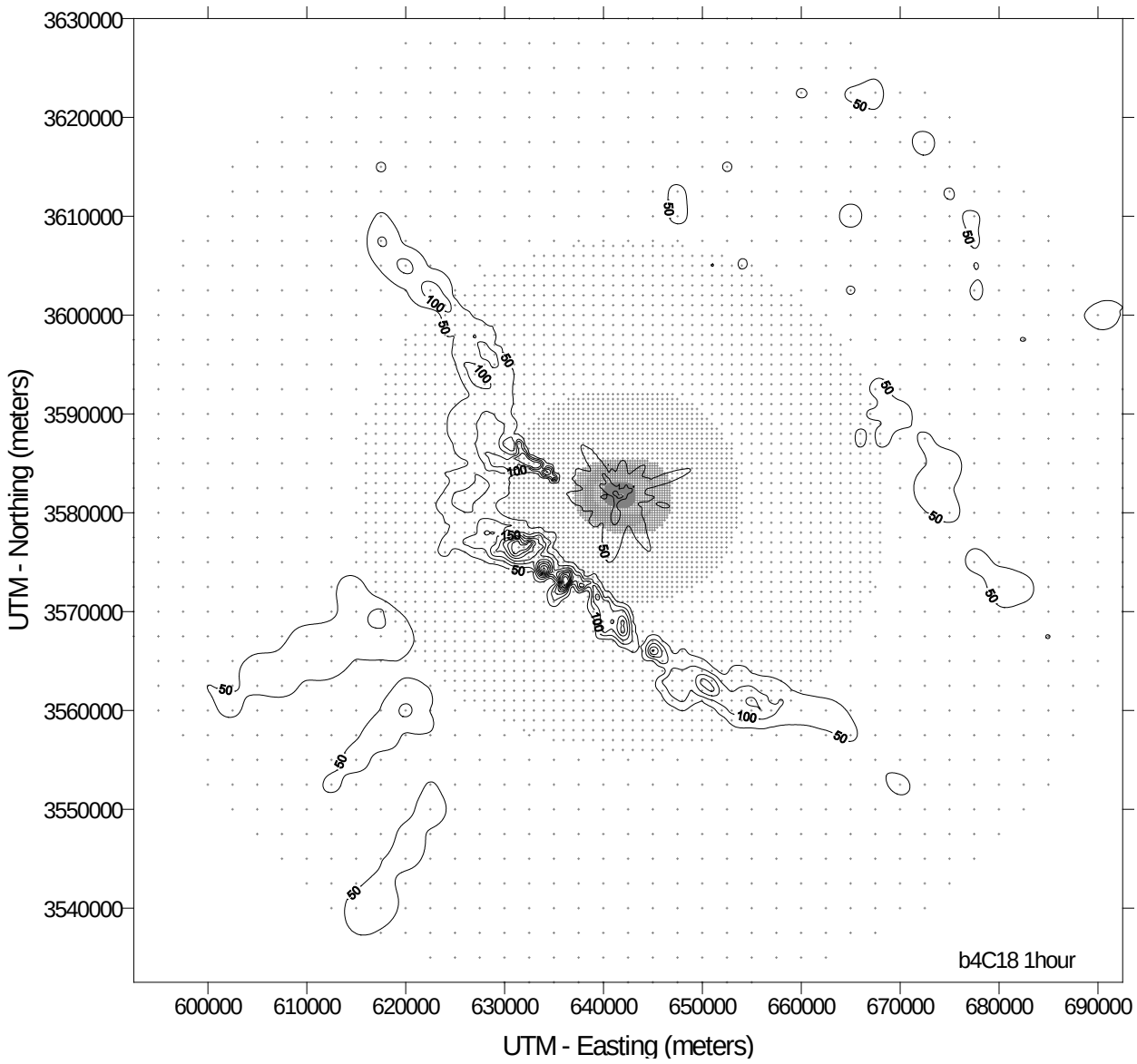



**Location of Bowie, Arizona and Nearest School**

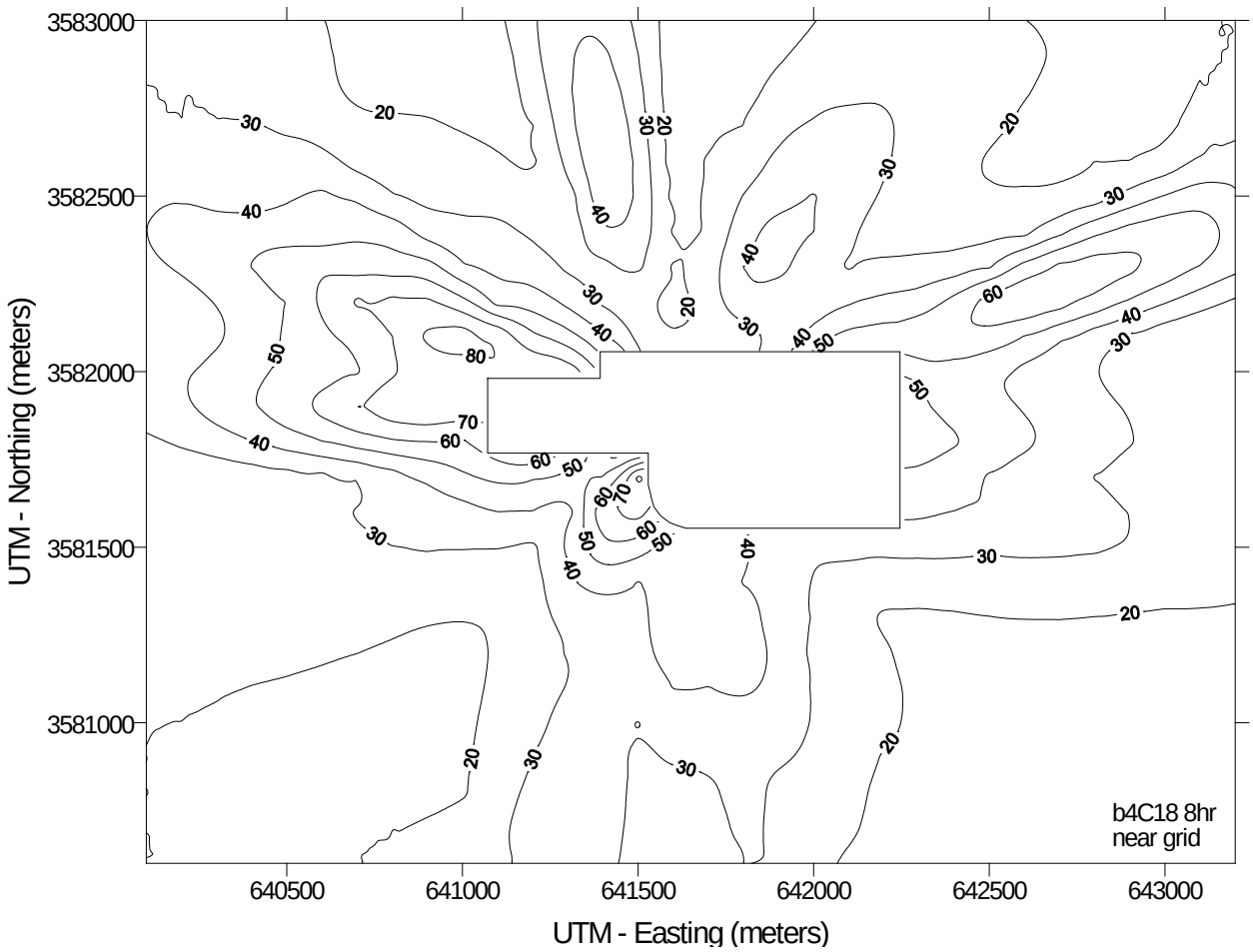
**Location of Nearby Businesses**



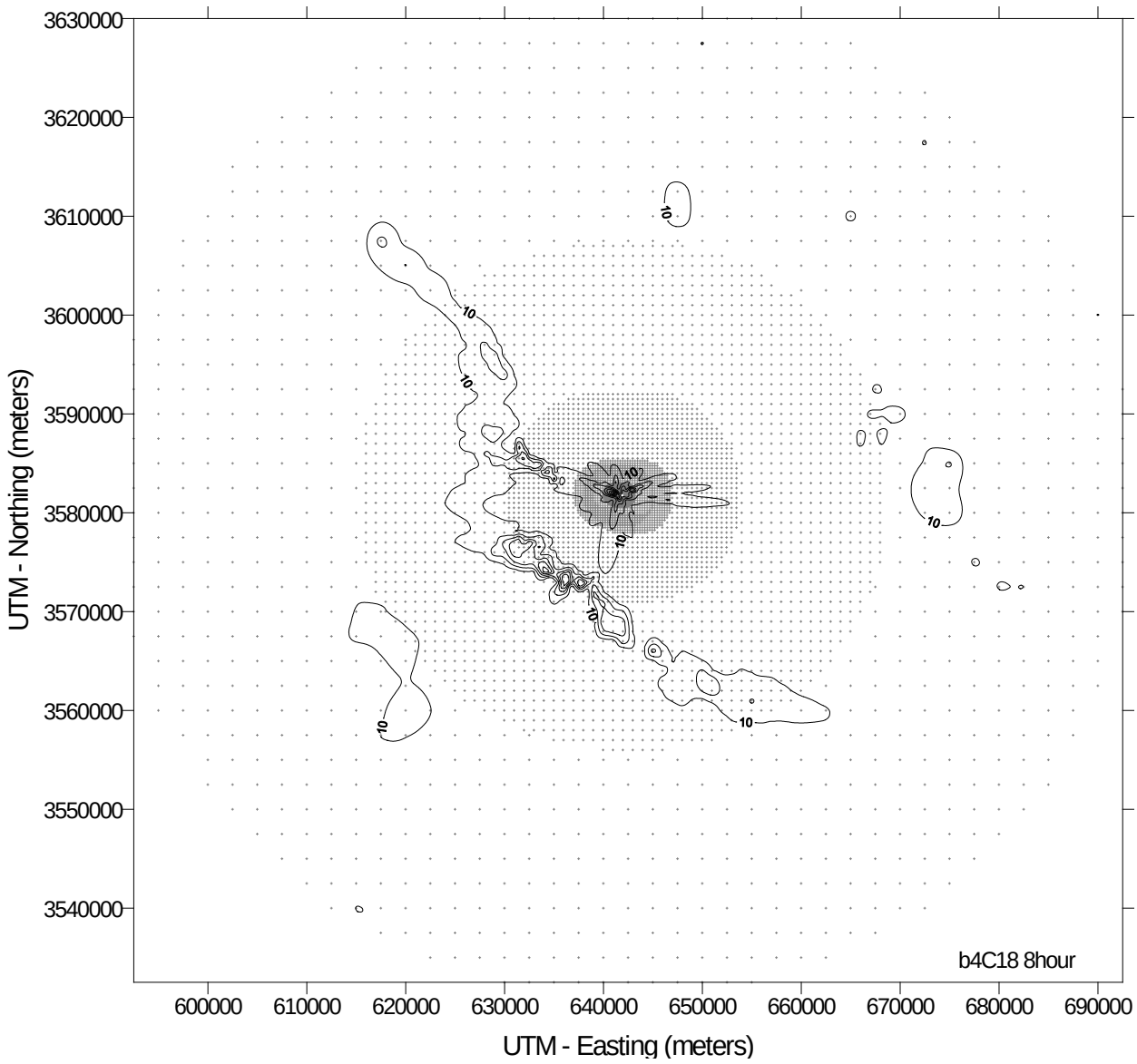

**1-Hour Carbon Monoxide Concentrations, Near Receptor Grid**



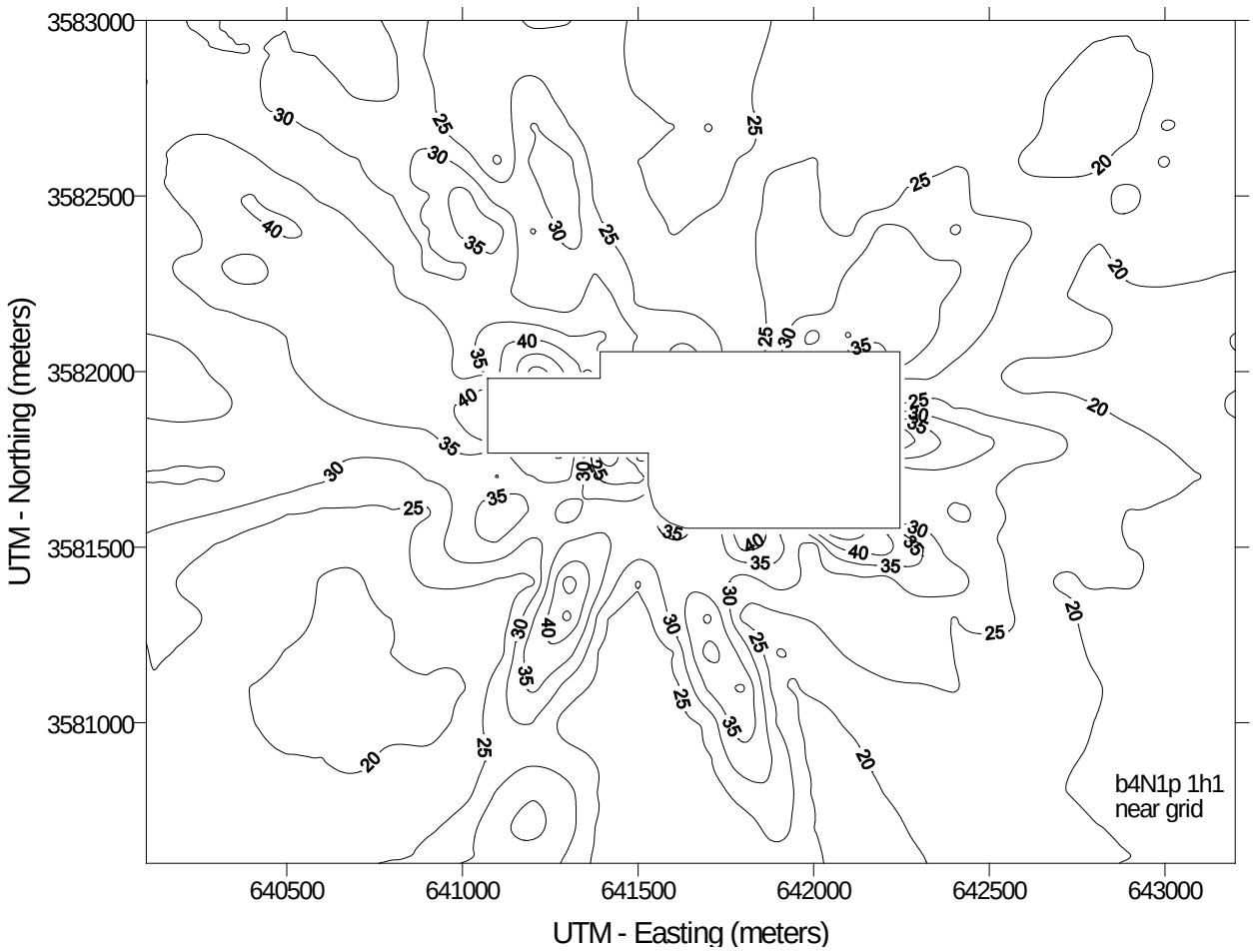

**1-Hour Carbon Monoxide Concentrations, Full Receptor Grid**




**8-Hour Carbon Monoxide Concentrations, Near Receptor Grid**

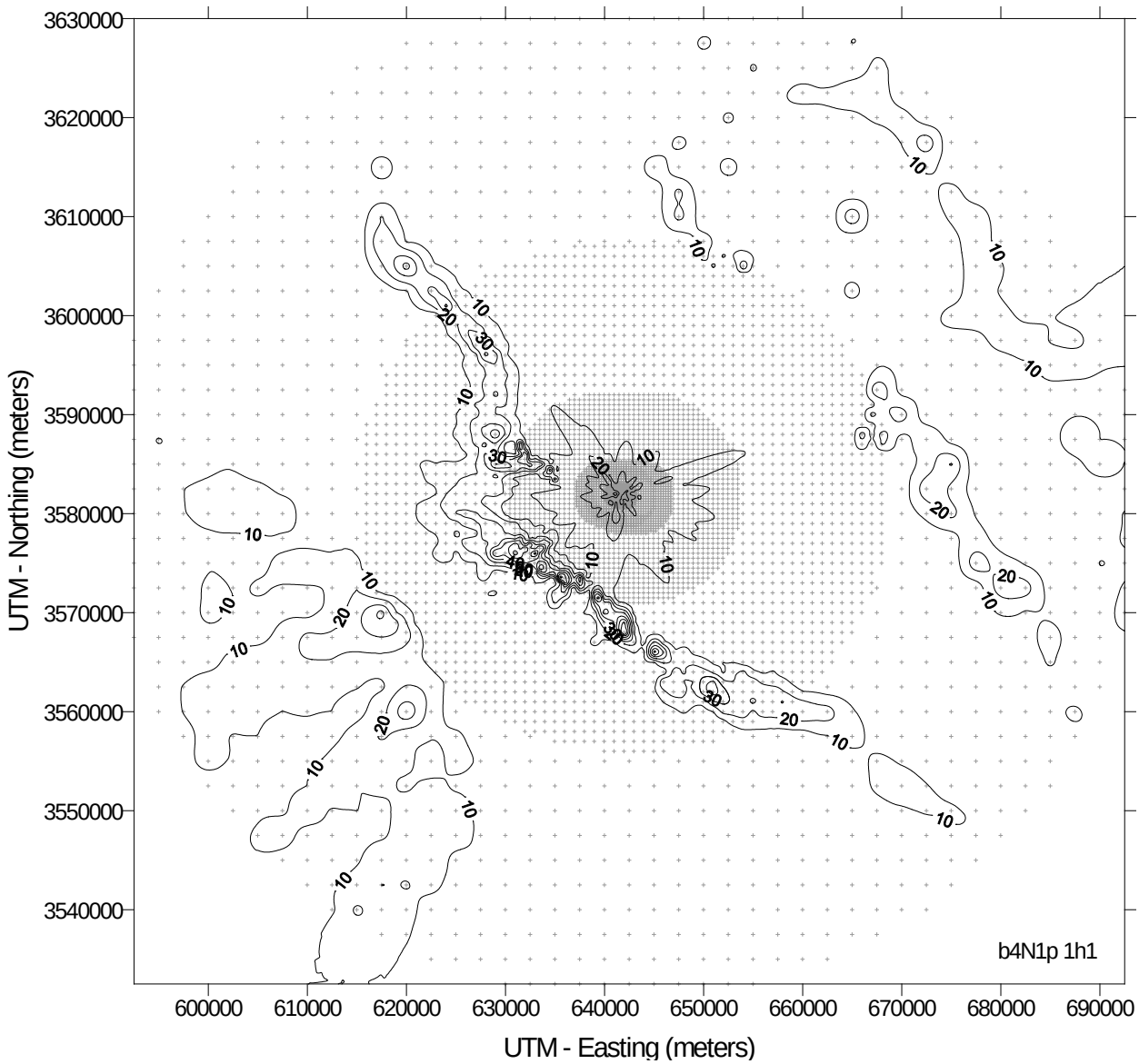



**8-Hour Carbon Monoxide Concentrations, Full Receptor Grid**



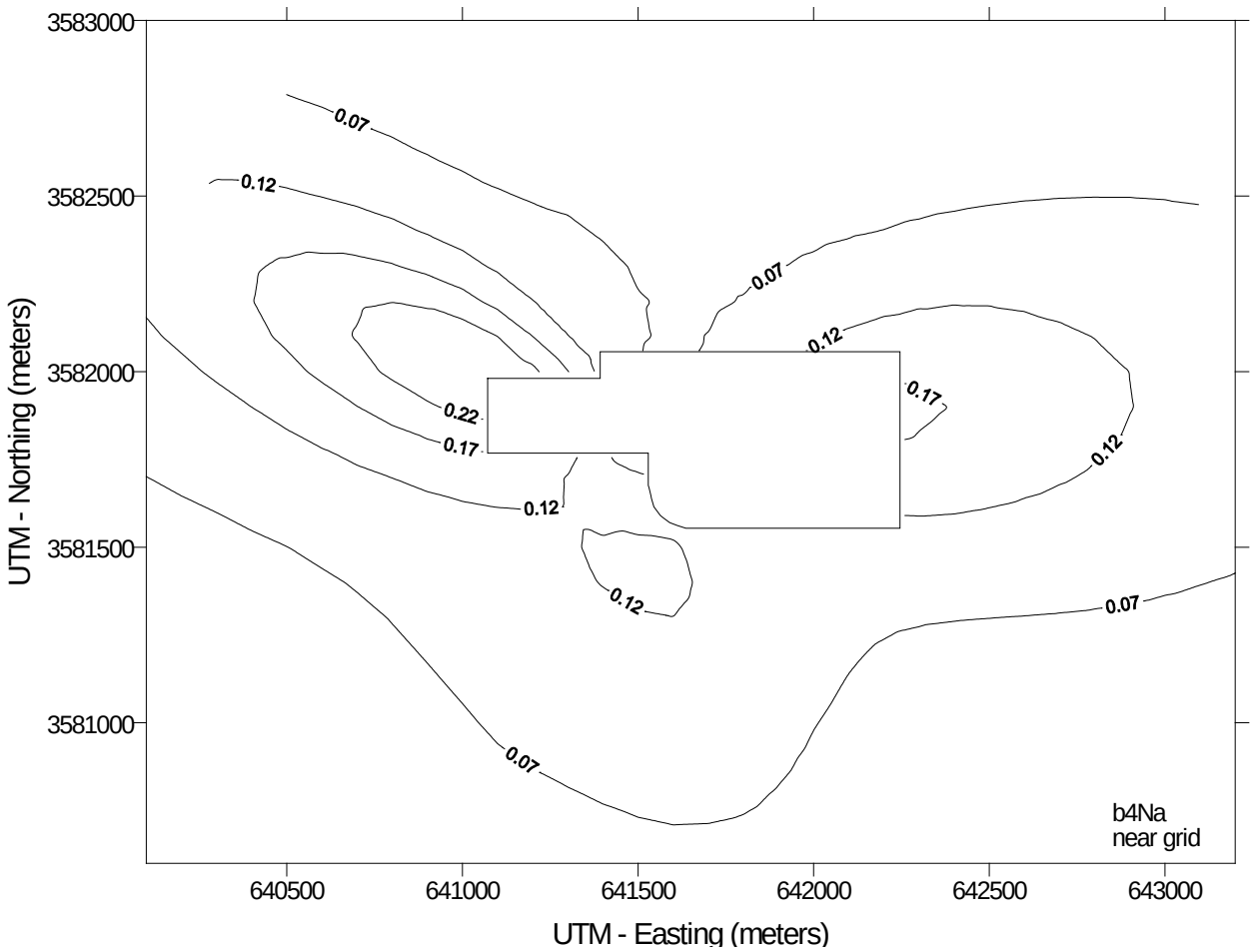

**Note: Plot shows first high concentrations**

## 1-Hour Nitrogen Dioxide Concentrations (Bowie Power Station Only), Near Receptor Grid

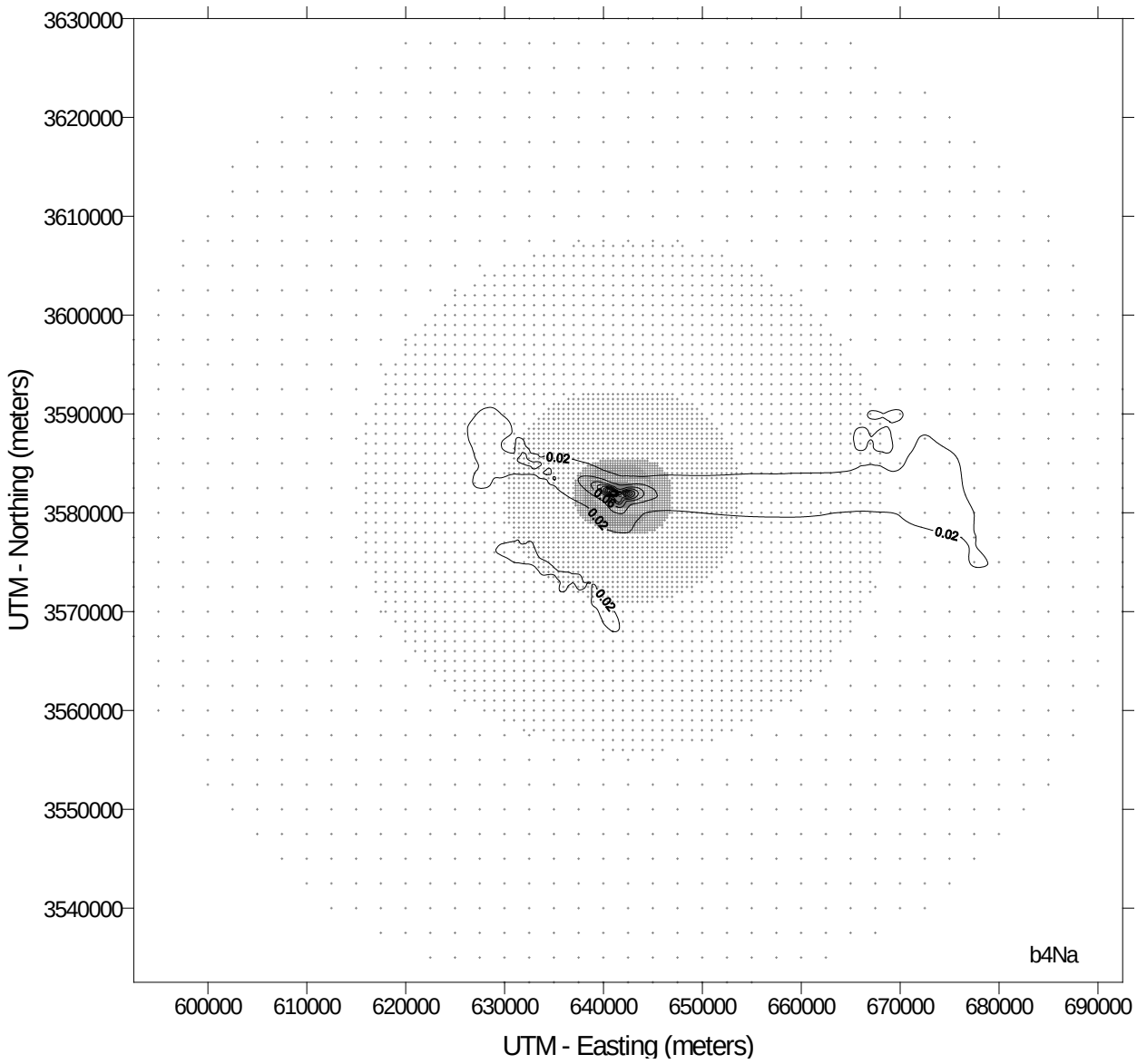



**Note: Plot shows first high concentrations**

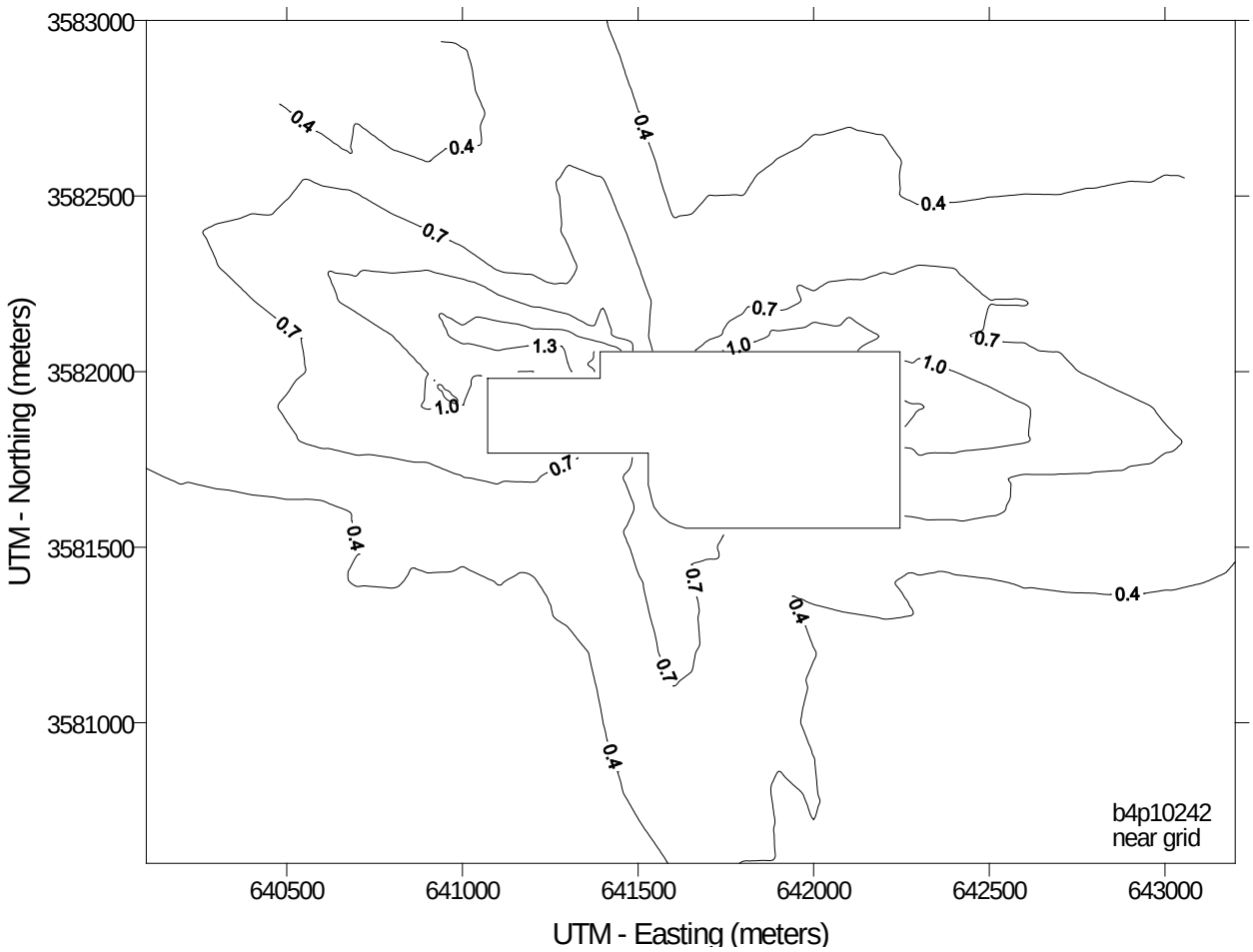
## 1-Hour Nitrogen Dioxide Concentrations (Bowie Power Station Only), Full Receptor Grid



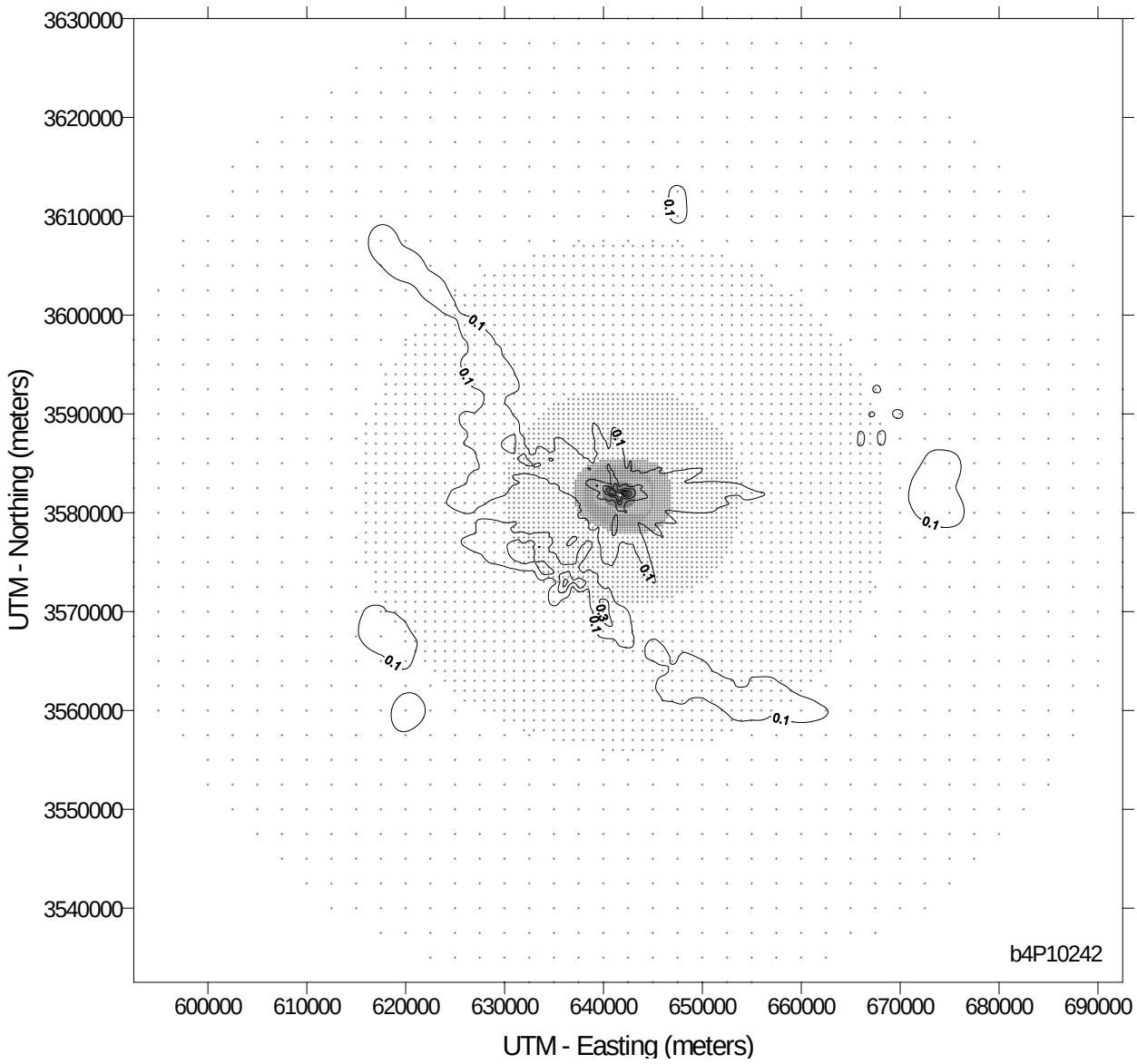

**Annual Nitrogen Dioxide Concentrations, Near Receptor Grid**



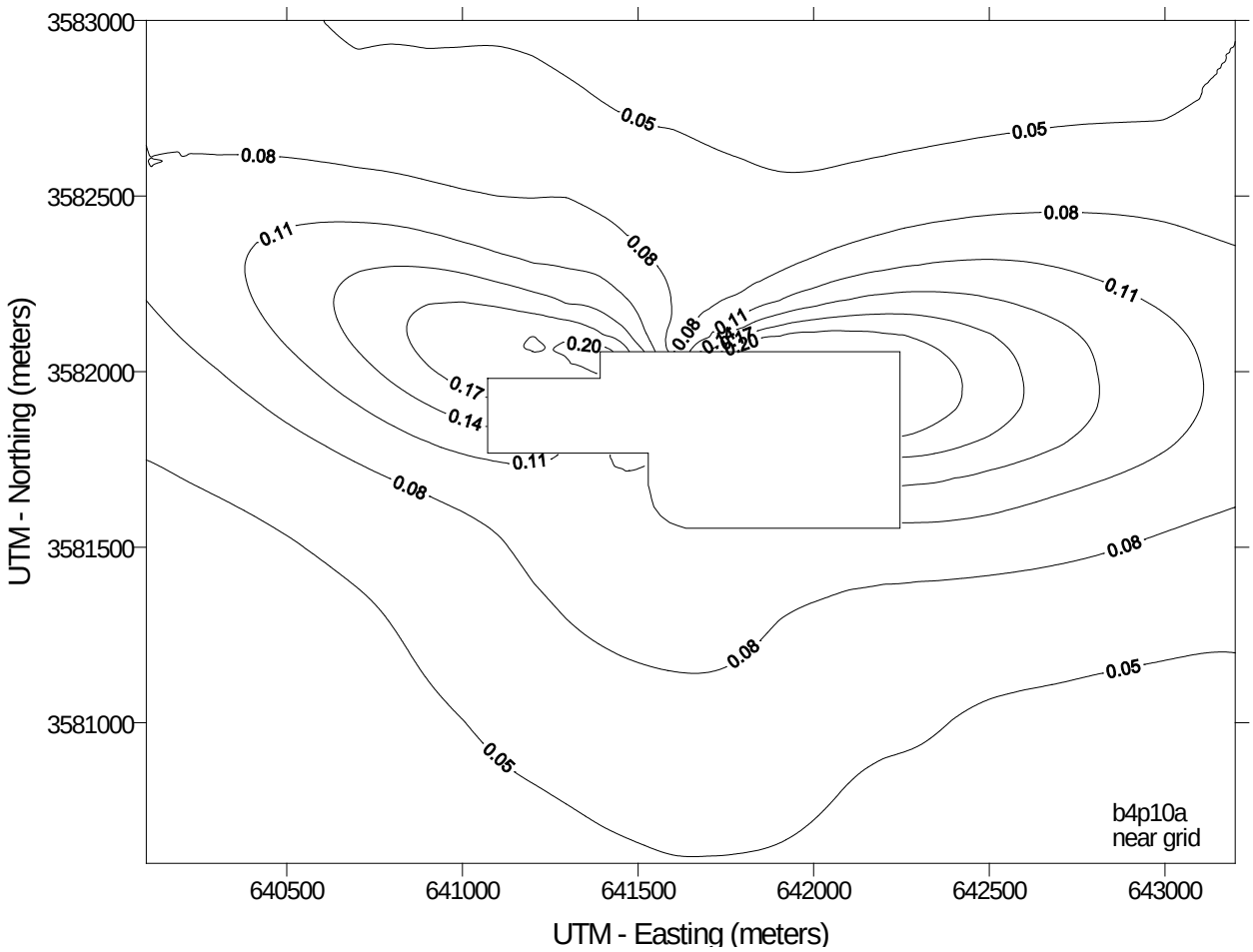

**Annual Nitrogen Dioxide Concentrations, Full Receptor Grid**



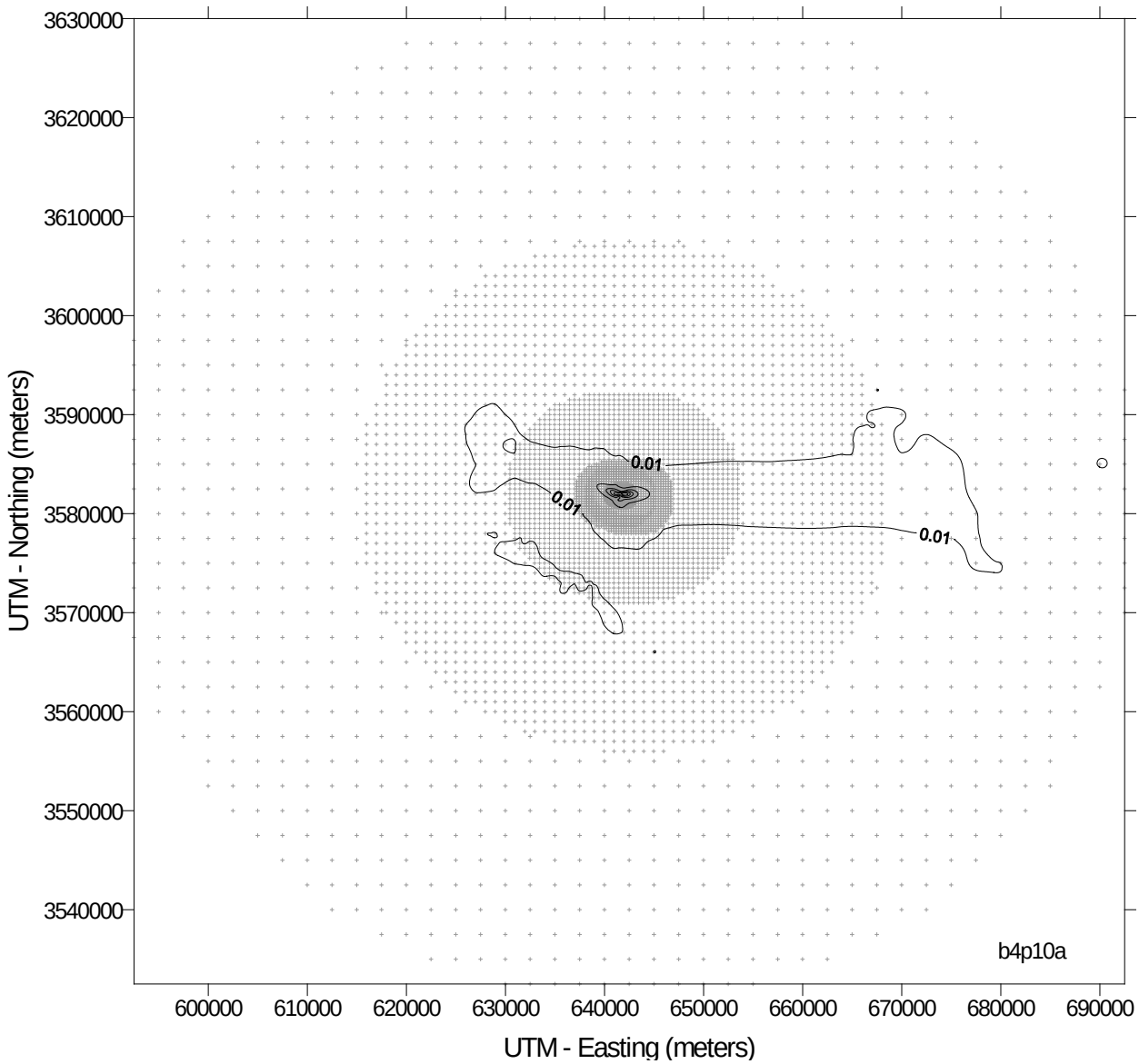

**24-Hour $PM_{10}$ Concentrations (Maximum Scenario), Near Receptor Grid**



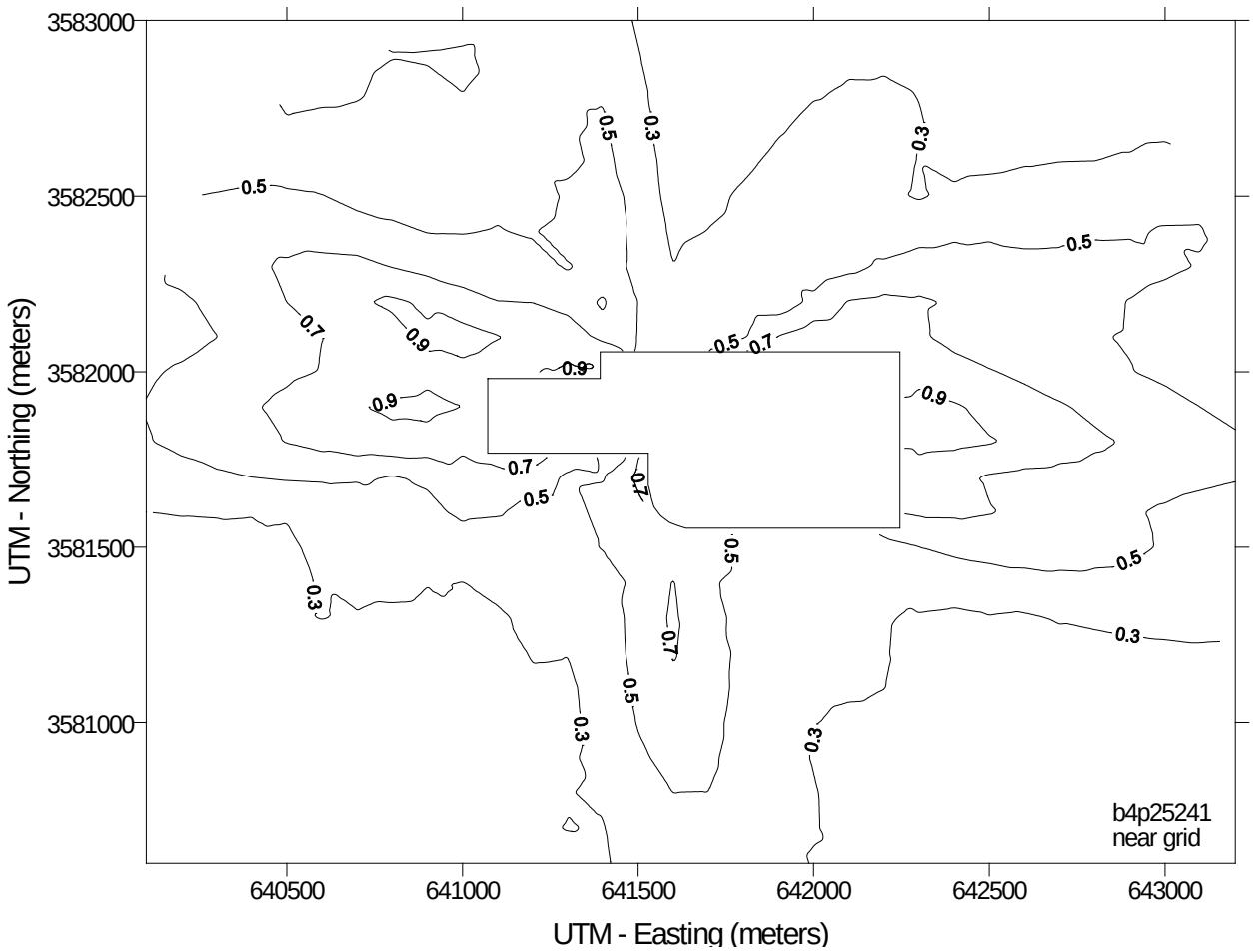

**24-Hour $PM_{10}$ Concentrations (Maximum Scenario), Full Receptor Grid**



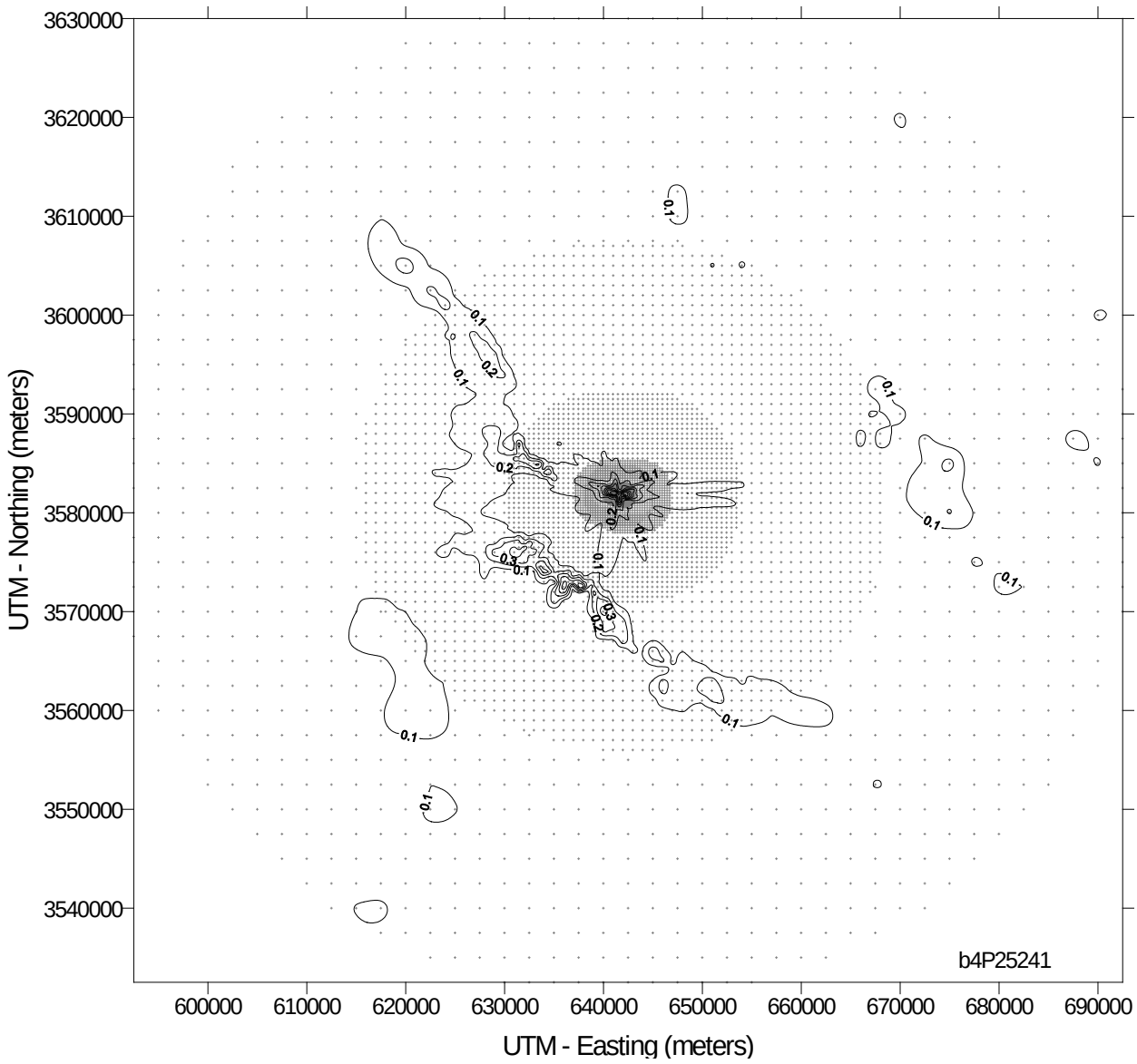

**Annual $PM_{10}$ Concentrations, Near Receptor Grid**



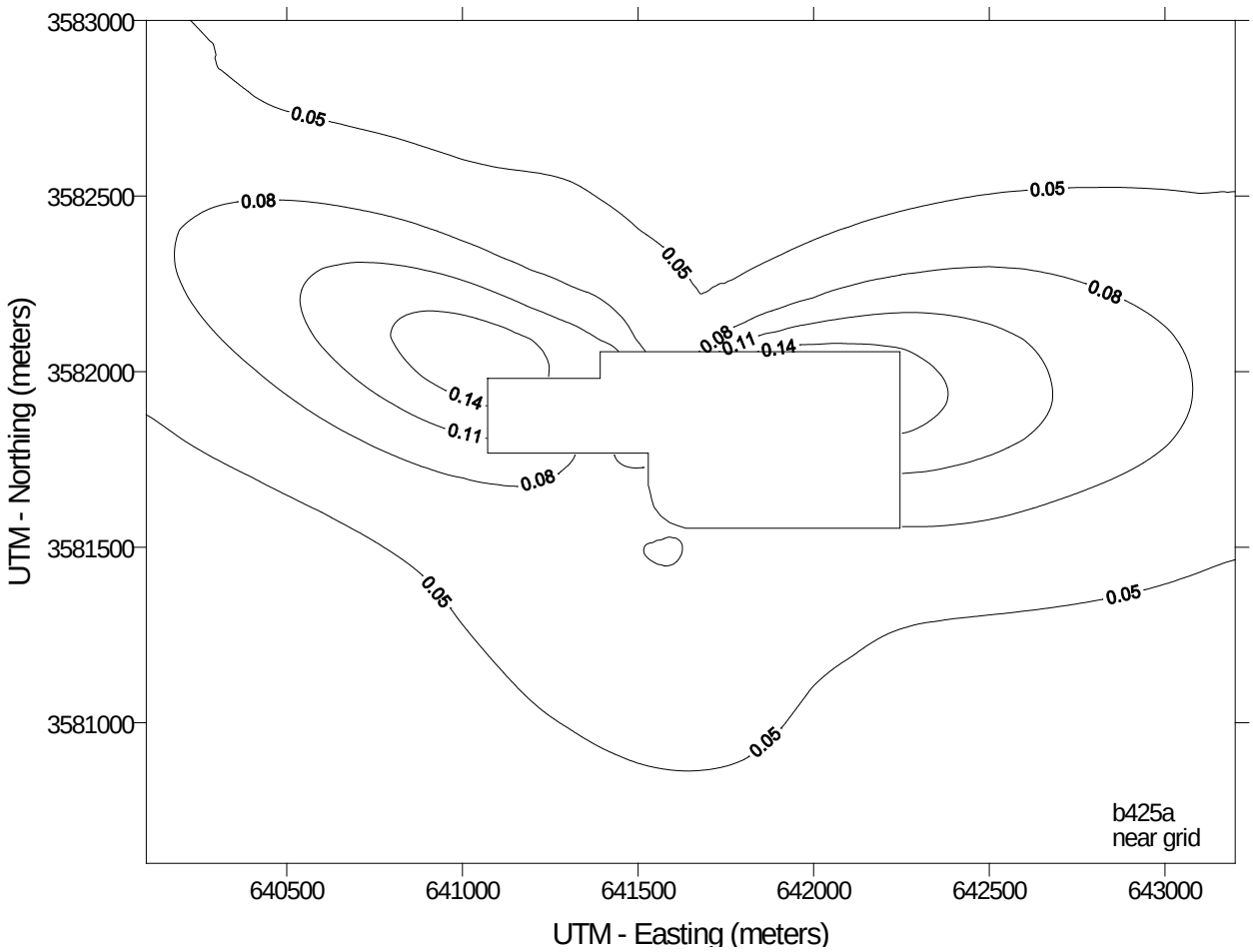

**Annual $PM_{10}$ Concentrations, Full Receptor Grid**



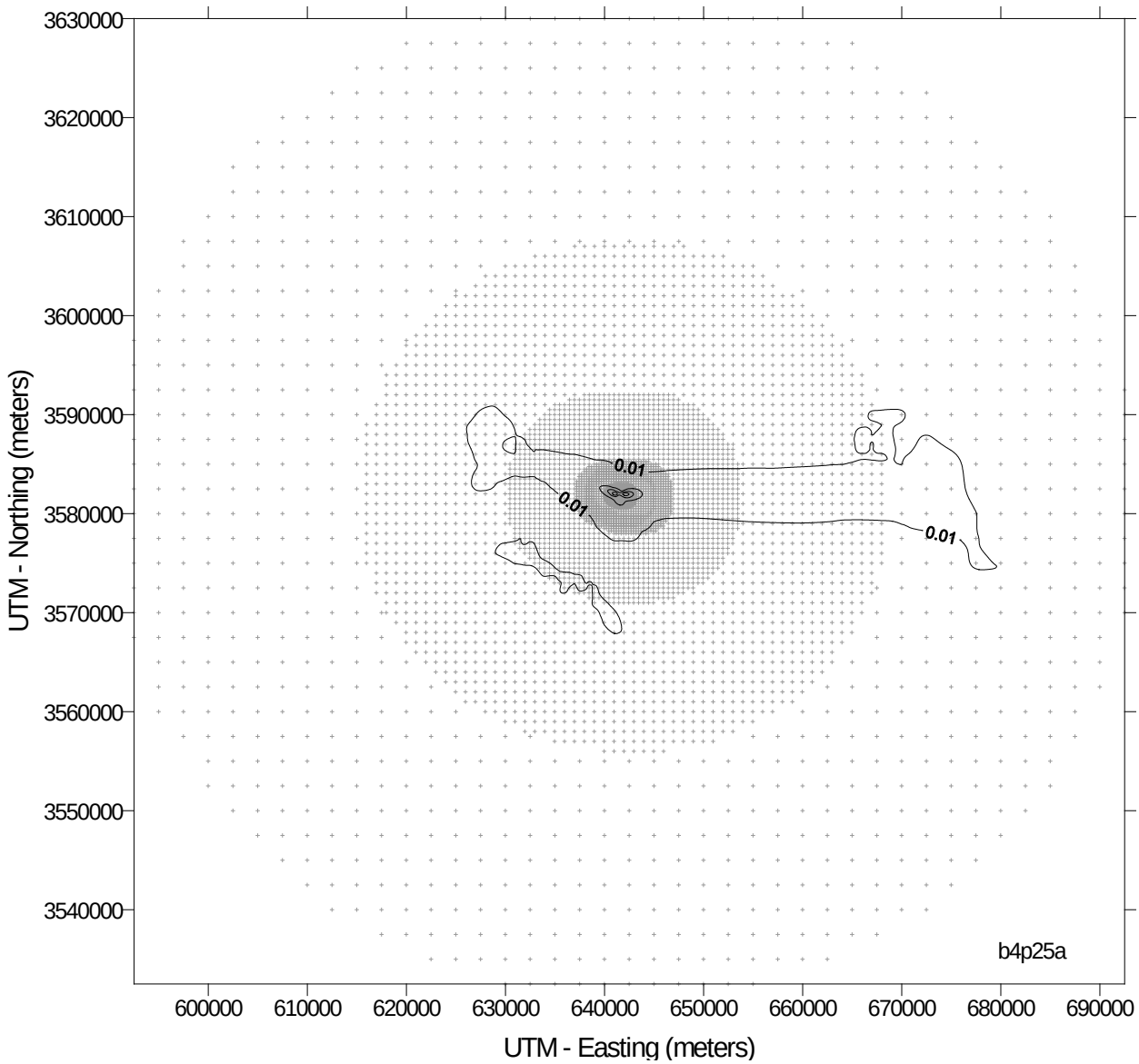

**24-Hour $PM_{2.5}$ Concentrations (Maximum Scenario), Near Receptor Grid**



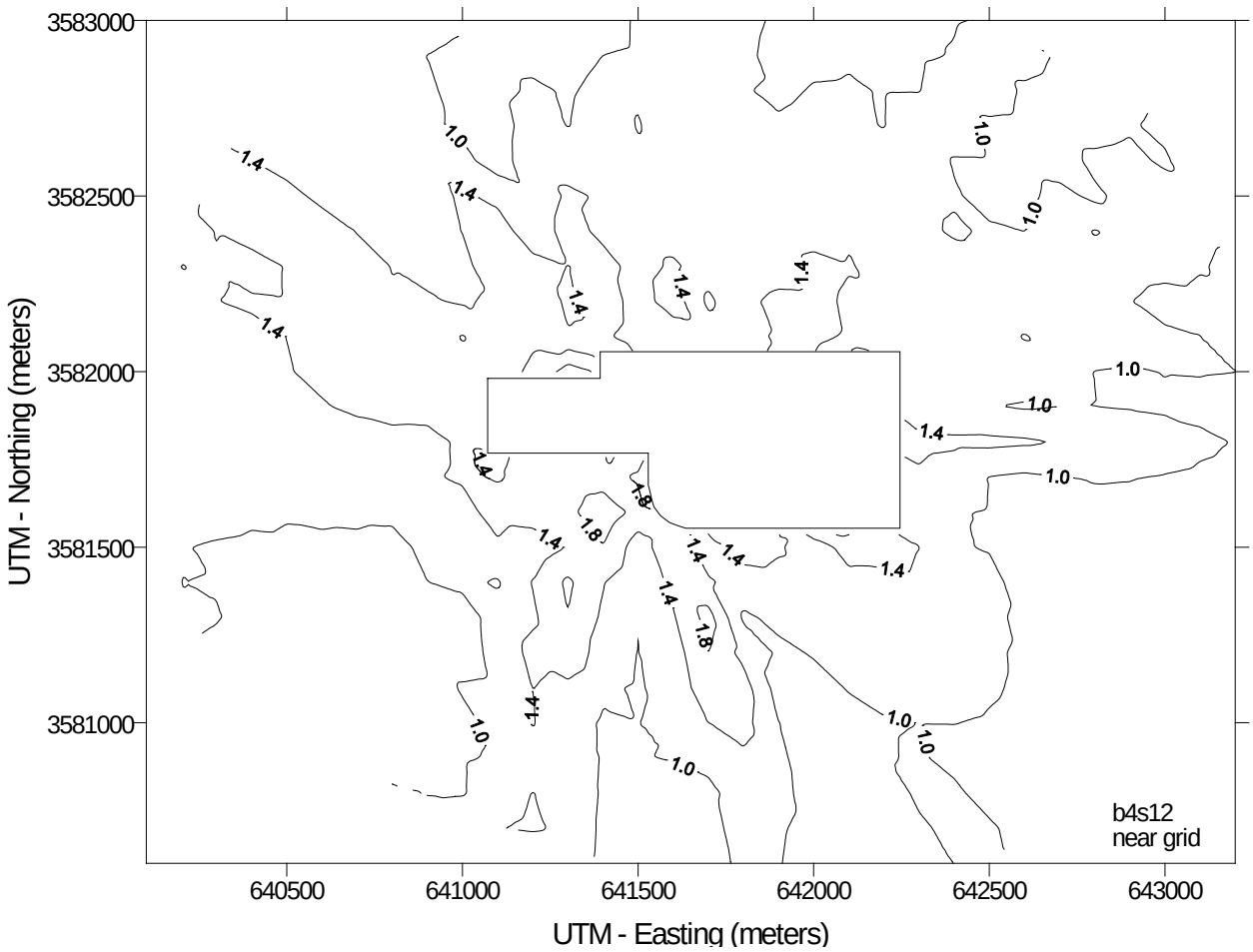

**24-Hour $PM_{2.5}$ Concentrations (Maximum Scenario), Full Receptor Grid**



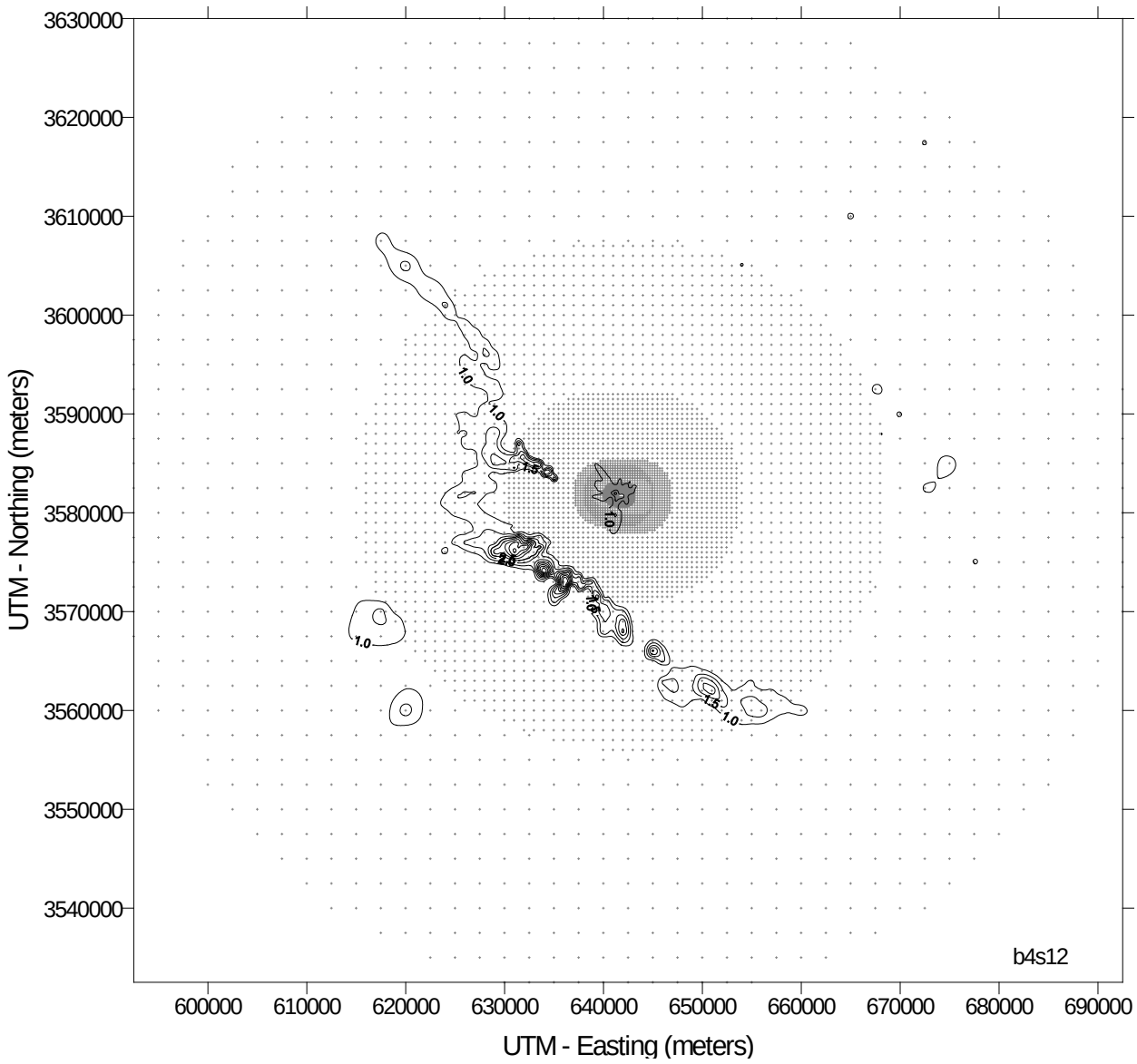

**Annual $PM_{2.5}$ Concentrations, Near Receptor Grid**



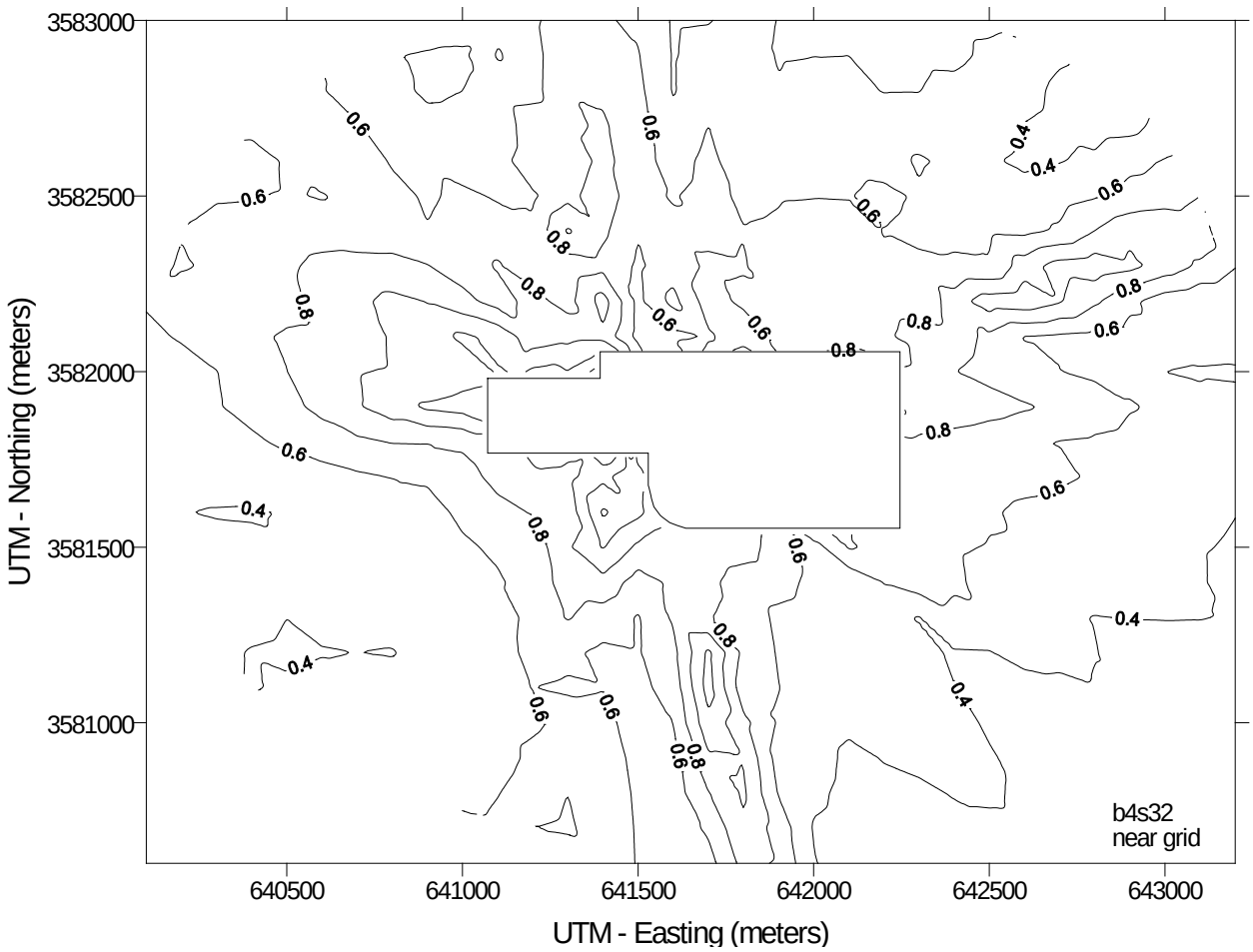

**Annual $PM_{2.5}$ Concentrations, Full Receptor Grid**



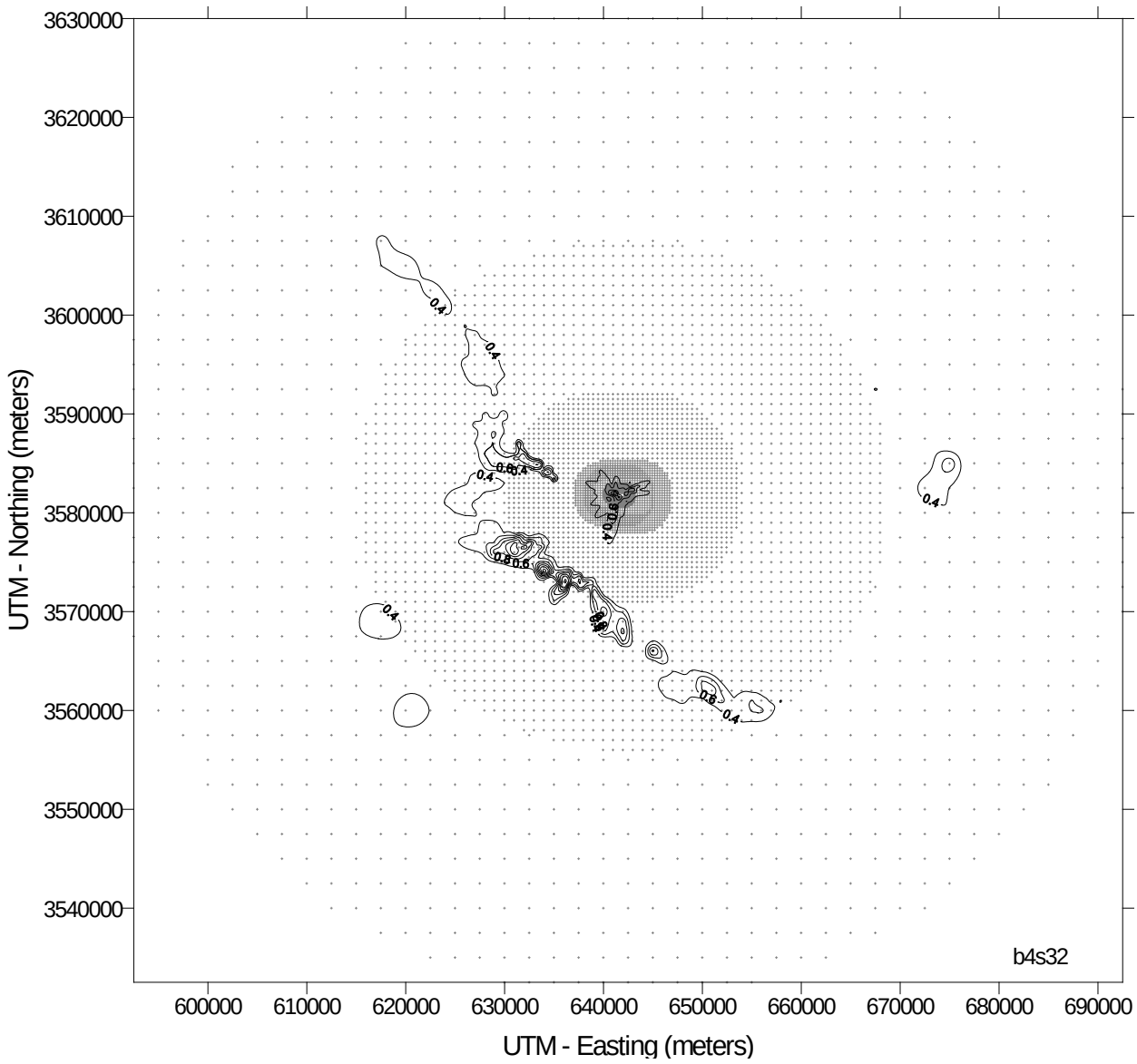

**1-Hour $SO_2$ Concentrations (Maximum Scenario), Near Receptor Grid**



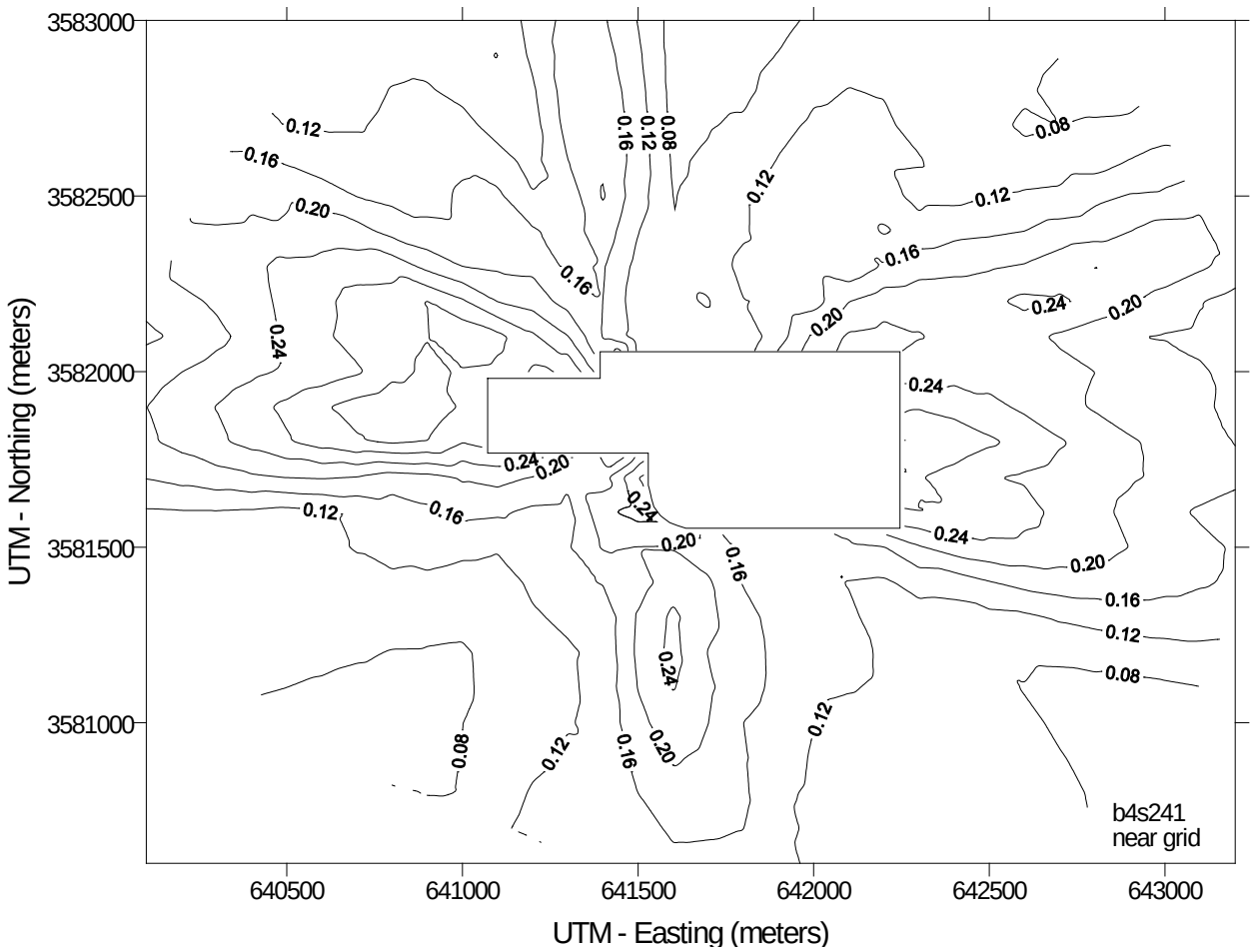

**1-Hour $SO_2$ Concentrations (Maximum Scenario), Full Receptor Grid**



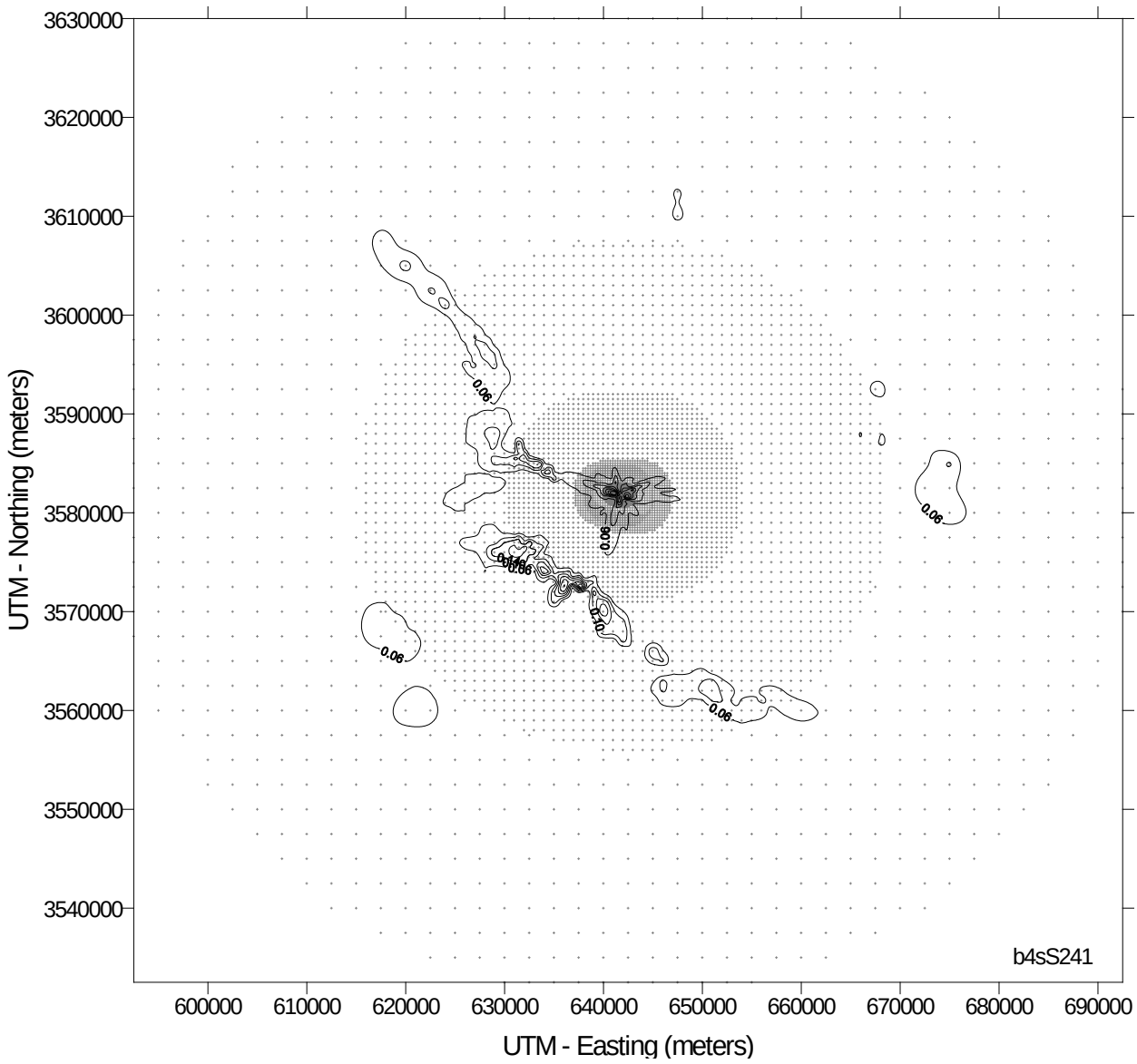

**3-Hour $SO_2$ Concentrations (Maximum Scenario), Near Receptor Grid**



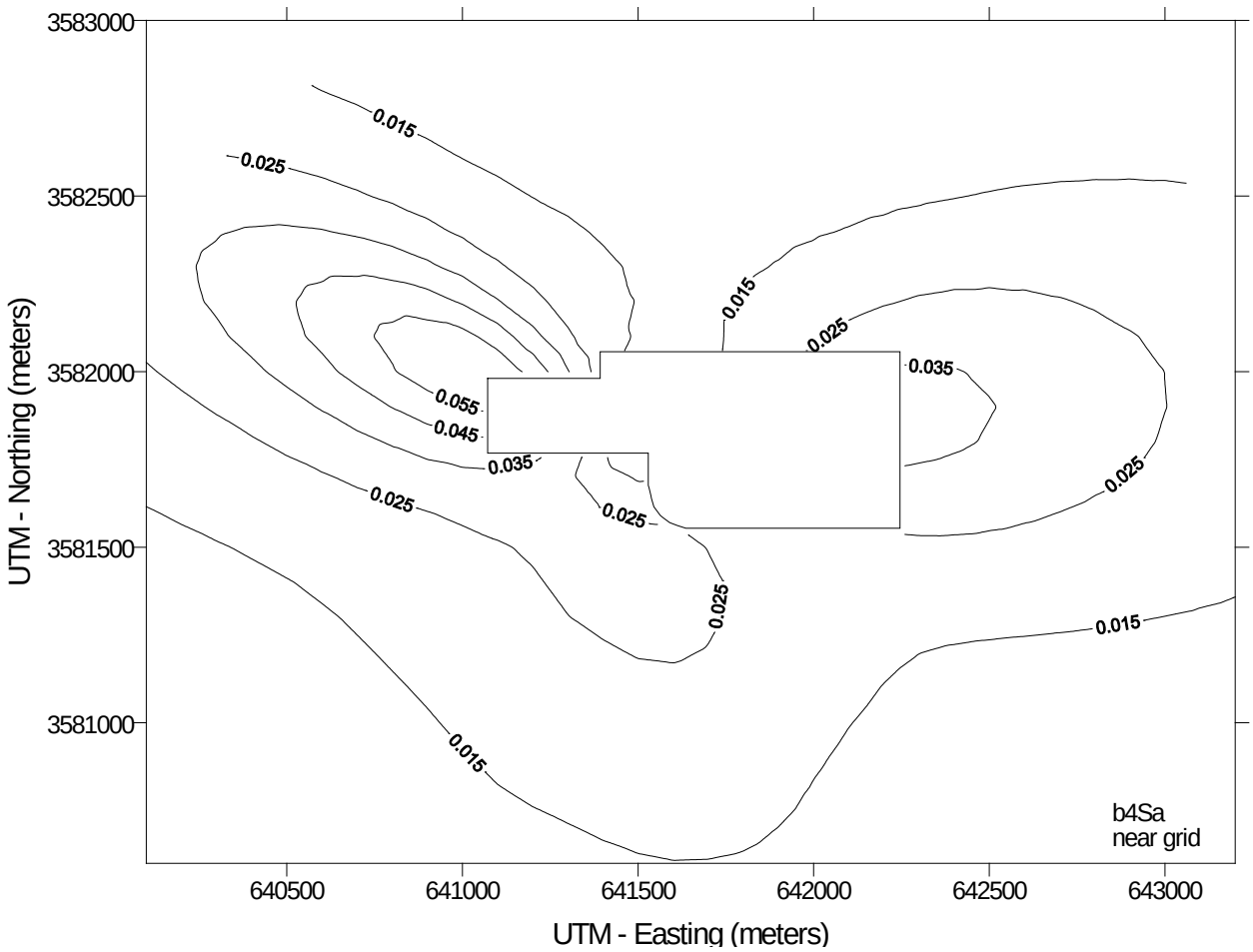

**3-Hour $SO_2$ Concentrations (Maximum Scenario), Full Receptor Grid**



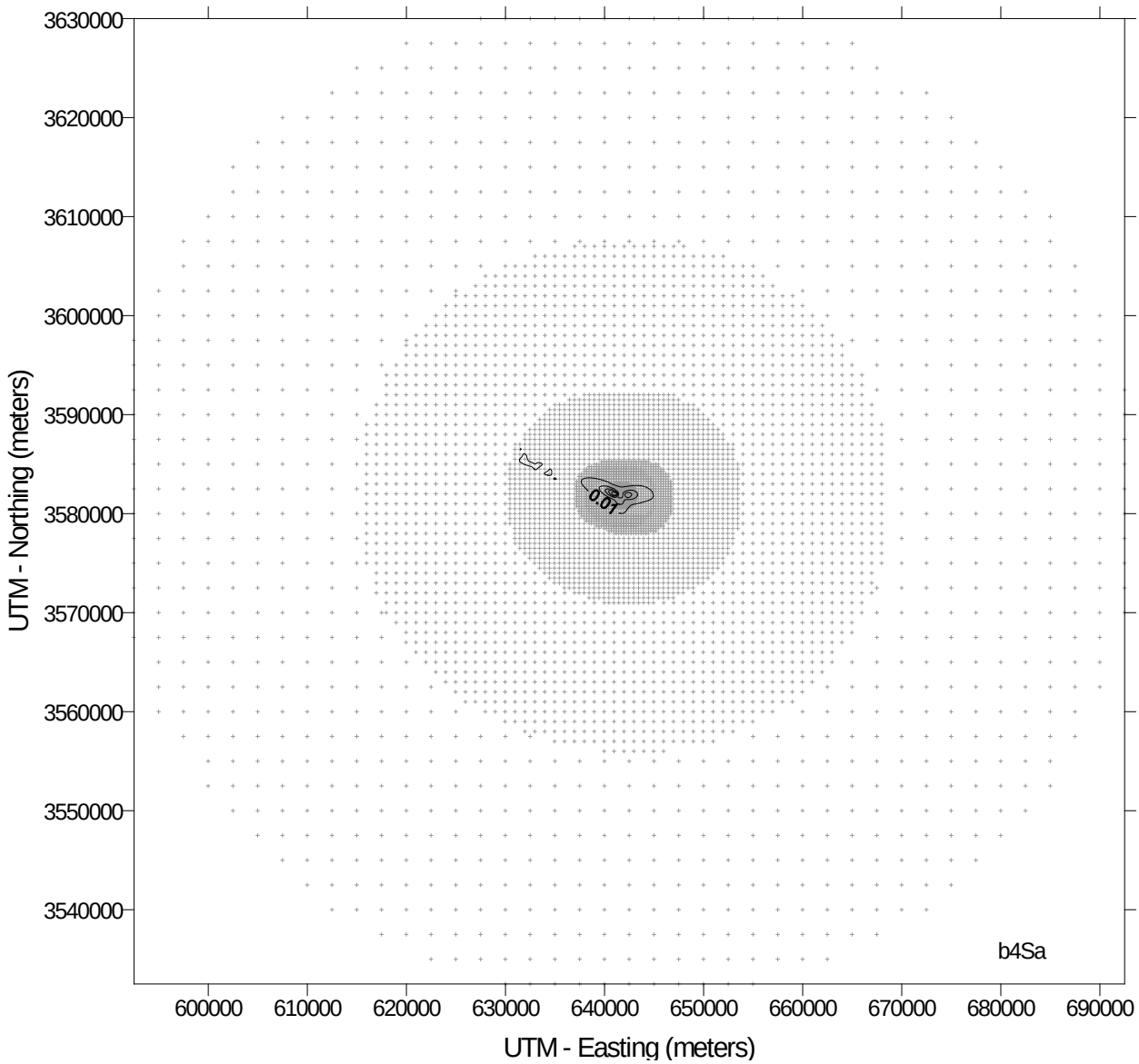

**24-Hour $SO_2$ Concentrations (Maximum Scenario), Near Receptor Grid**




**24-Hour $SO_2$ Concentrations (Maximum Scenario), Full Receptor Grid**




**Annual $SO_2$ Concentrations, Near Receptor Grid**




**Annual $SO_2$ Concentrations, Full Receptor Grid**

# ATTACHMENT E6 – SECONDARY $PM_{2.5}$

## BOWIE $PM_{2.5}$ MODELING RESULTS

### Table 1. $PM_{2.5}$ 24-Hour Modeling Results Maximum Concentrations

| Scenario | Maximum Five Concentrations ($\mu g/m^3$) | Year/Month/Day | Season |
|---|---|---|---|
| Scenario 1 (with duct firing) | 1.06639 | 01/09/07 | Fall |
| | 1.04575 | 01/09/07 | Fall |
| | 1.02967 | 01/09/07 | Fall |
| | 0.97903 | 01/10/01 | Fall |
| | 0.97515 | 01/09/07 | Fall |
| Scenario 2 (minimum compliance load) | 1.02672 | 01/11/04 | Fall |
| | 1.01694 | 01/09/07 | Fall |
| | 1.00445 | 01/10/01 | Fall |
| | 1.00014 | 01/09/07 | Fall |
| | 0.98641 | 01/11/04 | Fall |

## $PM_{2.5}$ BACKGROUND DATA

Chiricahua NM IMPROVE data were obtained for 2009, 2010, and 2011 for the following pollutants: 1) $PM_{2.5}$, 2) ammonium nitrate (6% of total $PM_{2.5}$ for 2009-2011), 3) ammonium sulfate (37%), 4) elemental (light absorbing) carbon (3%), 5) organic carbon mass (25%), 6) sea salt (1%), and 7) soil (33%). The maximum concentrations for each season for each year were identified, as well as the highest 15 concentrations for each pollutant.

Figure 1 presents the 15 highest concentrations for each pollutant by season. For $PM_{2.5}$, 9 of 15 high concentrations occurred in summer (JJA). For ammonium nitrate, 8 of 15 high concentrations occurred in winter (DJF). Ammonium sulfate had the highest measurements in fall (SON), with 7 of 15 measurements, and summer (6 of 15 measurements). The highest concentrations of elemental carbon and organic carbon occurred in summer (9 of 15 measurements and 13 of 15 measurements, respectively). Sea salt high concentrations were split between spring (MAM), with 6 of 15 measurements, and winter (5 of 15 measurements). High soil concentrations occurred in spring (9 of 15 measurements).

To determine the weather conditions present when the Chiricahua NM monitor measured high concentrations of $PM_{2.5}$ and its constituents, remote automatic weather stations (RAWS) data from the nearby Rucker, Arizona station were obtained.

The Rucker, Arizona RAWS is just south of Chiricahua NM, and is located at a similar elevation. Meteorological data for the Rucker, Arizona RAWS were collected for the maximum concentrations for each season for each year, as well as the highest 15 concentrations for each pollutant. In all, Rucker, Arizona station meteorological data were collected for 132 dates in 2009, 2010, and 2011.

Table 2 shows the averages for the Rucker, Arizona meteorological data for the 15 highest concentrations for $PM_{2.5}$ and its constituents by season. The 105 high concentrations (all constituents) occurred in the following seasons: summer 48 (46%); spring 28 (27%); winter 20 (19%); and fall 9 (8%).

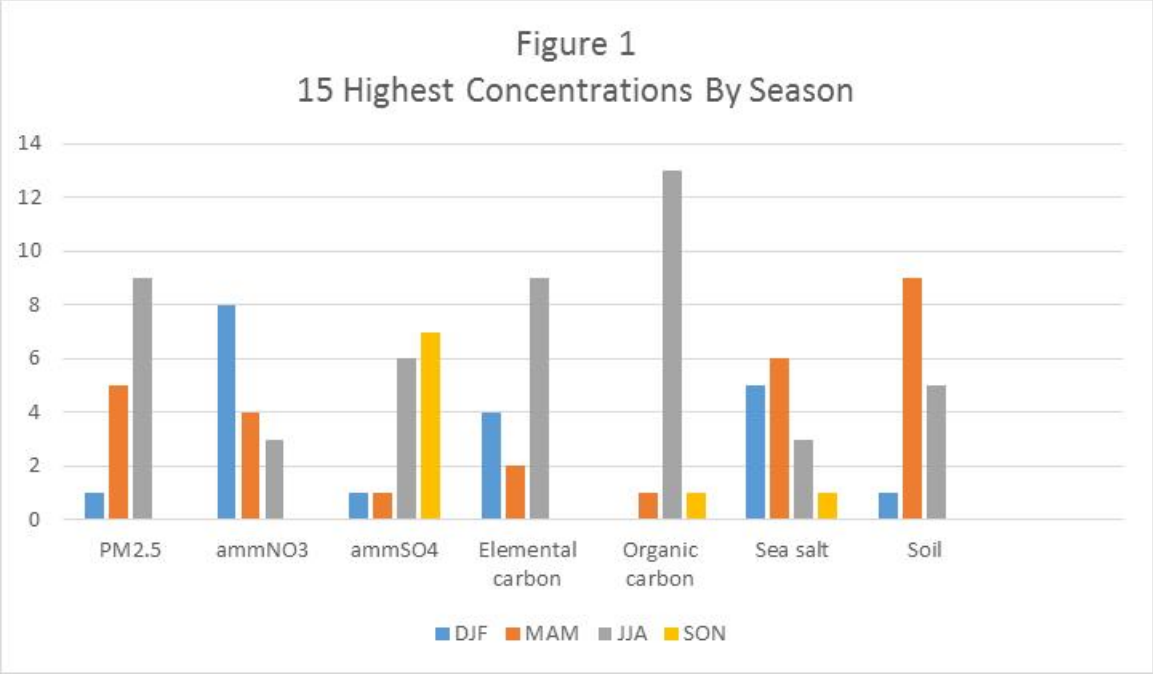


Figure 1
15 Highest Concentrations By Season
14
12
10
8
6
4
2
0
PM2.5
ammNO3
ammSO4
Elemental carbon
Organic carbon
Sea salt
Soil
DJF
MAM
JJA
SON

## Table 2. 15 Highest Concentrations at Chiricahua NM by Pollutant

| Pollutant | Season (# values) | Solar radiation (Langleys) | Average Wind Speed (mph) | Maximum Wind Speed (mph) | Temperature (deg F) | RH (%) |
|---|---|---|---|---|---|---|
| $PM_{2.5}$ | Fall (1) | 453.4 | 11.9 | 42.0 | 49.4 | 24.0 |
| | Summer (9) | 669.1 | 7.2 | 26.6 | 78.7 | 24.9 |
| | Spring (5) | 691.0 | 10.1 | 34.8 | 58.8 | 21.2 |
| | Fall (0) | — | — | — | — | — |
| Ammonium Nitrate | Winter (8) | 294.0 | 6.0 | 21.0 | 38.0 | 68.5 |
| | Summer (3) | 644.5 | 6.7 | 23.7 | 72.4 | 53.0 |
| | Spring (4) | 630.2 | 9.6 | 32.0 | 49.1 | 35.3 |
| | Fall (0) | — | — | — | — | — |
| Ammonium Sulfate | Winter (1) | 255.0 | 5.5 | 22.0 | 51.9 | 46.0 |
| | Summer (6) | 661.8 | 7.5 | 26.2 | 73.2 | 43.8 |
| | Spring (1) | 739.8 | 8.0 | 29.0 | 64.9 | 24.0 |
| | Fall (7) | 421.7 | 5.9 | 23.4 | 66.2 | 48.9 |
| Elemental Carbon | Winter (4) | 244.1 | 4.9 | 18.3 | 48.4 | 55.3 |
| | Summer (9) | 651.2 | 7.2 | 27.7 | 76.3 | 22.2 |
| | Spring (2) | 721.0 | 9.7 | 34.0 | 63.4 | 20.0 |
| | Fall (0) | — | — | — | — | — |
| Organic Carbon | Winter (0) | — | — | — | — | — |
| | Summer (13) | 623.8 | 6.7 | 25.8 | 76.1 | 27.9 |
| | Spring (1) | 702.2 | 11.3 | 39.0 | 61.8 | 16.0 |
| | Fall (1) | 386.9 | 4.0 | 20.0 | 66.9 | 66.0 |
| Sea Salt | Winter (5) | 373.4 | 8.4 | 31.2 | 41.6 | 37.0 |
| | Summer (3) | 766.8 | 6.1 | 21.7 | 70.8 | 24.7 |
| | Spring (6) | 652.6 | 10.3 | 33.7 | 57.7 | 27.5 |
| | Fall (1) | 202.0 | 11.4 | 47.0 | 44.6 | 68.0 |
| Soil | Winter (1) | 453.4 | 11.9 | 42.0 | 49.4 | 24.0 |
| | Summer (5) | 645.6 | 7.0 | 27.0 | 77.0 | 34.2 |
| | Spring (9) | 668.4 | 10.2 | 35.4 | 59.1 | 21.0 |
| | Fall (0) | — | — | — | — | — |

Notes:

deg F = Degrees Fahrenheit
mph = = Miles per hour

# ATTACHMENT E7 – TRACE METALS DEPOSITION

**BOWIE POWER STATION**
**Metal Deposition Calculations**

| Calculated Scaling Factors for Trace Metal Emissions to Apply to NO2 Annual Impacts | | | | | |
|---|---|---|---|---|---|
| **Emission Rates[1]** | | | **Scaling Factors** | | |
| NOx[1] | 139.40 | ton/yr | | | From turbines/duct burners |
| Cadmium | 0.002 | ton/yr | 1.40E-05 | Cd/NOx | From all project sources |
| Cobalt | 0.0001 | ton/yr | 1.04E-06 | Co/NOx | From all project sources |
| Lead | 0.0009 | ton/yr | 6.55E-06 | Pb/NOx | From all project sources |
| Manganese | 0.0007 | ton/yr | 4.70E-06 | MN/NOx | From all project sources |
| Nickel | 0.004 | ton/yr | 2.69E-05 | NI/NOx | From all project sources |

| Annual Pollutant Concentrations | | |
|---|---|---|
| Maximum annual $NO_2$ impact: | 0.27219 | ug/m3 |
| **Pollutant** | | |
| Cadmium | 3.80E-06 | ug/m3 |
| Cobalt | 2.83E-07 | ug/m3 |
| Lead | 1.78E-06 | ug/m3 |
| Manganese | 1.28E-06 | ug/m3 |
| Nickel | 7.32E-06 | ug/m3 |

[1]Emission rates are from the spreadsheet titled "Bowie Model 4 Emissions 2013"

**To calculate scaling factors:**

$$\text{Scaling factor} = \frac{\text{pollutant emission rate (tons/year)}}{\text{NOx emission rate (tons/year)}}$$

**To calculate annual pollutant concentrations:**

The following taken from *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA-450/2-81-078), 12/12/80
See Section 5.1 for step by step instructions

| Air Quality Data | | | | |
|---|---|---|---|---|
| **Compound** | **Max[1]** | **Min[2]** | **Concentration** | **County** |
| Background Cd[a] | 0.0001 | 0.0001 | ug/m3 | Apache County |
| Background Co | None available | None available | | |
| Background Pb[b] | 0.009 | 0.009 | ug/m3 | Cochise County |
| Background Mn[c] | 0.004 | 0.002 | ug/m3 | Apache County |
| Background Ni | None available | None available | | |

[1]Geometic Mean
[2]Use minimum geo mean per screening doc
[a]From App C, Table C-2, Screening procedure document
[b]From App C, Table C-5, Screening procedure document
[c]From App C, Table C-6, Screening procedure document

| Deposition Concentration Values | | | | | |
|---|---|---|---|---|---|
| "Source" and "With Background" | | | | | |
| Compound | Deposition Concentration | | | Background Concentration Value | |
| Cd ppmw= | 21.5 * (40/3) * | 0.0000038 | source only (calculation) | | |
| | 0.0011 | ppmw | source only | | |
| | 0.0298 | ppmw | with background | 0.0001 | ug/m3 |
| Co ppmw= | 21.5 * (40/3) * | 0.0000003 | source only (calculation) | | |
| | 0.0001 | ppmw | source only | | |
| Pb ppmw= | 21.5 * (40/3) * | 0.0000018 | source only (calculation) | | |
| | 0.0005 | ppmw | source only | | |
| | 2.5805 | ppmw | with background | 0.009 | ug/m3 |
| Mn ppmw= | 21.5 * (40/3) * | 0.0000013 | source only (calculation) | | |
| | 0.0004 | ppmw | source only | | |
| | 0.5737 | ppmw | with background | 0.002 | ug/m3 |
| Ni ppmw= | 21.5 * (40/3) * | 0.0000073 | source only | | |
| | 0.0021 | ppmw | source only | | |

**To calculate deposition:**
DC (ppmw) = 21.5* (N/d)*X

DC= deposited concentration (ppmw) over source lifetime
N= expected lifetime of source (40 years default)
d= depth of soil thru which deposited material is distributed (3 cm default)
X= annual average ambient concentration (ug/m3)

**For compounds with background concentration:**
X=annual average ambient concentration+background concentration value

Taken from screening procedure document page 35, eq 5-1

| Endogenous Soil Concentrations[1] | | |
|---|---|---|
| Cd | 0.06 | ppmw |
| Co | 8 | ppmw |
| Pb | 10 | ppmw |
| Mn | 850 | ppmw |
| Ni | 40 | ppmw |

| Percent Increase Over Endogenous Soil Concentration | | | |
|---|---|---|---|
| Cd | 1.8179 | % | source only |
| | 49.6 | % | w/ background |
| Co | 0.0010 | % | source only |
| Pb | 0.0051 | % | source only |
| | 25.8051 | % | w/ background |
| Mn | 0.0000 | % | source only |
| | 0.1 | % | w/ background |
| Ni | 0.0052 | % | source only |

[1]Screening procedure document, Table 3.5 'Range of Endogenous Soil Concentrations of Selected Elements '

**To calculate increase over endogenous soil concentrations:**
% increase = [DC(ppmw)*100]/[endogenous concentration(ppmw)]

| Tissue Concentrations (ppmw) | | |
|---|---|---|
| Pollutant | Concentration | Situation |
| Cd | 0.01167 | source only |
| | 0.31840 | w/ background |
| Co | 0.00001 | source only |
| Pb | 0.00023 | source only |
| | 1.16123 | w/ background |
| Mn | 0.00002 | source only |
| | 0.03786 | w/ background |
| Ni | 0.00009 | source only |

**To calculate tissue concentrations:**
TC = DC(ppmw)*Concentration Ratio (CR)

Values for CR can be found in the screening procedures document, Table 3.6

Screening procedures document, pg 37, eq 5-5

| Comparison to Screen Levels (all values ppmw) | | | | | |
|---|---|---|---|---|---|
| Trace element | Comparison | DC or TC (as stated) | Screening concentration | Reference | Conclusion |
| Cd | DC source only to soil screen | 0.0011 | 2.5 | T3.4 | below screening concentration |
| Cd | DC w/ background to soil screen | 0.0298 | 2.5 | T3.4 | below screening concentration |
| Cd | TC source only to tissue screen | 0.01167 | 3 | T3.4 | below screening concentration |
| Cd | TC w/ background to tissue screen | 0.31840 | 3 | T3.4 | below screening concentration |
| Cd | TC source only to animal screen | 0.01167 | 15 | T3.7 | below screening concentration |
| Cd | TC w/ background to animal screen | 0.31840 | 15 | T3.7 | below screening concentration |
| Co | DC source only to soil screen | 0.00008 | NA | T3.4 | NA |
| Co | TC source only to tissue screen | 0.000009 | 19 | T3.4 | below screening concentration |
| Co | TC source only to animal screen | 0.000009 | 1-3 | T3.7 | below screening concentration |
| Pb | DC source only to soil screen | 0.0005 | 1000 | T3.4 | below screening concentration |
| Pb | DC w/ background to soil screen | 2.5805 | 1000 | T3.4 | below screening concentration |
| Pb | TC source only to tissue screen | 0.00023 | 126 | T3.4 | below screening concentration |
| Pb | TC w/ background to tissue screen | 1.16123 | 126 | T3.4 | below screening concentration |
| Pb | TC source only to animal screen | 0.00023 | 80-150 | T3.7 | below screening concentration |
| Pb | TC w/ background to animal screen | 1.16123 | 80-150 | T3.7 | below screening concentration |

| Comparison to Screen Levels (continued) [all values ppmw] | | | | | |
|---|---|---|---|---|---|
| **Trace element** | **Comparison** | **DC or TC (as stated)** | **Screening concentration** | **Reference** | **Conclusion** |
| Mn | DC source only to soil screen | 0.0004 | 2.5 | T3.4 | below screening concentration |
| Mn | DC w/ background to soil screen | 0.5737 | 2.5 | T3.4 | below screening concentration |
| Mn | TC source only to tissue screen | 0.00002 | 400 | T3.4 | below screening concentration |
| Mn | TC w/ background to tissue screen | 0.03786 | 400 | T3.4 | below screening concentration |
| Mn | TC source only to animal screen | 0.00002 | 500-5000 | T3.7 | below screening concentration |
| Mn | TC w/ background to animal screen | 0.03786 | 500-5000 | T3.7 | below screening concentration |
| Ni | DC source only to soil screen | 0.00009 | 500 | T3.4 | below screening concentration |
| Ni | TC source only to tissue screen | 0.00009 | 60 | T3.4 | below screening concentration |
| Ni | TC source only to animal screen | 0.00009 | 1000 | T3.7 | below screening concentration |

**BOWIE POWER STATION**
**Metal Deposition Calculations--Cooling Tower Only**

| Calculated Scaling Factors for Trace Metal Emissions from Cooling Tower to Apply to PM10 Annual Impacts | | | | | |
|---|---|---|---|---|---|
| Emission Rates[1] | | | Scaling Factors | | |
| PM10[1] | 3.83 | ton/yr | | | From cooling tower |
| Selenium | 5.05E-05 | ton/yr | 1.32E-05 | Se/PM10 | From cooling tower |

| Annual Pollutant Concentrations | | |
|---|---|---|
| Maximum annual $PM_{10}$ impact: | 0.213 | ug/m3 |
| **Pollutant** | | |
| Selenium | 2.81E-06 | ug/m3 |

[1]Emission rates are from the spreadsheet titled "Bowie Model 4 Emissions 2013"

**To calculate scaling factors:**
Scaling factor = pollutant emission rate (tons/year) / PM10 emission rate (tons/year)

**To calculate annual pollutant concentrations:**
Annual conc. = Max. $PM_{10}$ impact (ug/m3) *Pollutant scaling factor

The following taken from *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA-450/2-81-078), 12/12/80
See Section 5.1 for step by step instructions

| Air Quality Data | | | | |
|---|---|---|---|---|
| **Compound** | **Max[1]** | **Min[2]** | **Concentration** | **County** |
| Background Se | None available | None available | N/A | N/A |

[1]Geometic Mean
[2]Use minimum geo mean per screening doc

| Deposition Concentration Values | | | | | | |
|---|---|---|---|---|---|---|
| "Source" and "With Background" | | | | | | |
| Compound | Deposition Concentration | | | | Background Concentration Value | |
| Se ppmw= | 21.5 * (40/3) * | 0.0000028 | source only (calculation) | | | |
| | 0.00081 | ppmw | source only | | | |

**To calculate deposition:**
DC (ppmw) = 21.5* (N/d)*X

DC= deposited concentration (ppmw) over source lifetime
N= expected lifetime of source (40 years default)
d= depth of soil thru which deposited material is distributed (3 cm default)
X= annual average ambient concentration (ug/m3)

**For compounds with background concentration:**
X=annual average ambient concentration+background concentration value

Taken from screening procedure document page 35, eq 5-1

| Endogenous Soil Concentrations[1] | | |
|---|---|---|
| Se | 0.5 | ppmw |

| Percent Increase Over Endogenous Soil Concentration | | | |
|---|---|---|---|
| Se | 0.1611 | % | source only |

[1]Screening procedure document, Table 3.5 'Range of Endogenous Soil Concentrations of Selected Elements '

**To calculate increase over endogenous soil concentrations:**
% increase = [DC(ppmw)*100]/[endogenous concentration(ppmw)]

| Tissue Concentrations (ppmw) | | |
|---|---|---|
| Pollutant | Concentration | Situation |
| Se | 0.00081 | source only |

**To calculate tissue concentrations:**
TC = DC(ppmw)*Concentration Ratio (CR)

Values for CR can be found in the screening procedures document, Table 3.6

| Comparison to Screen Levels (all values ppmw) | | | | | |
|---|---|---|---|---|---|
| **Trace element** | **Comparison** | **DC or TC (as stated)** | **Screening concentration** | **Reference** | **Conclusion** |
| Se | DC source only to soil screen | 0.0008 | 13 | T3.4 | below screening concentration |
| Se | TC source only to tissue screen | 0.00081 | 100 | T3.4 | below screening concentration |
| Se | TC source only to animal screen | 0.00081 | 5 | T3.7 | below screening concentration |

**BOWIE POWER STATION**
**Metal Deposition Calculations–Cooling Tower Only**

| Calculated Scaling Factors for Trace Metal Emissions from Cooling Tower to Apply to PM10 Annual Impacts | | | | | |
|---|---|---|---|---|---|
| Emission Rates[1] | | | Scaling Factors | | |
| PM10[1] | 3.83 | ton/yr | | | From cooling tower |
| Beryllium | 1.26E-05 | ton/yr | 3.30E-06 | Be/PM10 | From cooling tower |

| Annual Pollutant Concetrations | | |
|---|---|---|
| Maximum monthly $PM_{10}$ impact: | 0.41499 | ug/m3 |
| **Pollutant** | | |
| Beryllium | 1.37E-06 | ug/m3 |

[1]Emission rates are from the spreadsheet titled "Bowie Model 4 Emissions 2013"

**To calculate scaling factors:**
Scaling factor = pollutant emission rate (tons/year) / PM10 emission rate (tons/year)

**To calculate annual pollutant concentrations:**
Annual conc. = Max. $PM_{10}$ impact (ug/m3) *Pollutant scaling factor

The following taken from *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals* (EPA-450/2-81-078), 12/12/80
See Section 5.1 for step by step instructions

| Air Quality Data | | | | |
|---|---|---|---|---|
| **Compound** | **Max[1]** | **Min[2]** | **Concentration** | **County** |
| Background Be | None available | None available | | |

[1]Geometic Mean
[2]Use minimum geo mean per screening doc

Compare estimated project related impact with screening concentration for exposure to amboient air concentraitons (Table 3.1)

Maximum monthly project Be concentration: 1.37E-06 ug/m3
Screening concentration from Table 3.1: 0.01 ug/m3
Below screening concentration