Responses to Emerald Farms February 21, 2007 Petition to Intervene

Application for Certification (06-AFC-9)

for

COLUSA GENERATING STATION

Colusa County, California

March 23, 2007

Prepared for:

E&L Westcoast, LLC

Prepared by:

URS

Emerald Farms
ATTN: Allen Etchepare
4599 McDermott Road
Maxwell, CA 95955

Dear Mr. Etchepare:

We received your February 21, 2007 Petition to Intervene in the Application For Certification for the Colusa Generating Station (CGS). I appreciate that you also communicated your concerns to us prior to filing. That has given us additional time to research your concerns and prepare a response that we hope you will find complete. By copy of this letter, we will also be submitting this response to the docket at the California Energy Commission.

Enclosed you will find detailed responses to the concerns raised during our conversations and in your Petition. In summary, we do not believe this project will have an adverse impact on your property or business. Some of the points you brought up are not typically addressed on other projects and have required some time to complete the research needed to demonstrate that. This is particularly true of the air quality concerns. We appreciate your patience while we have undertaken this analysis. To briefly summarize our responses to your four issues:

1) AIR QUALITY: Emissions from the CGS will have no adverse impacts on agricultural resources or operations. Pollutant levels emitted from the CGS will not violate any ambient air quality standards established by the U.S. Environmental Protection Agency or the California Air Resources Board. These levels are explicitly set at levels to protect both human health and crops. Of particular concern to you, based on our meeting, was the effect of a possible increase in ozone due to the operation of the CGS. But, as we demonstrate in our response, both local and regional ozone concentrations are expected to decrease as a result of plant operation.

2) NOISE: As stated in the AFC (Section 8.5.2.2), noise levels inside the closest residence would be 36 dBA at night with the CGS in operation. The interior residential noise environment should not exceed 45 dBA according to the U.S. Department of Housing and Urban Development. CGS operations fall well short of that threshold. For comparison, a level of 60 dBA is the approximate sound level of a normal voice.

3) ELECTROMAGNETIC FIELD: Electromagnetic interference is negligible outside of the CGS, with the only potential being near existing power transmission lines. At a distance of 30 meters from a transmission line, one would expect an electric field of 0.3 milligauss and a magnetic field of 7.1 milligauss. This is the approximate discharge from a color television. There will be no effect on radio transmissions from CGS since the transmission lines are already rated for a maximum voltage of 230 kV and our operations will not increase that threshold. No interference to GPS or laser communications is possible due to the extremely

high frequency (1.38 GHz) and line of sight nature of this technology (CGS emits a frequency of only 60 Hz).

4) LAND USE: The CGS is not expected to negatively effect the marketability of local property. This project is consistent with existing land uses in the area and with County policy on the siting of power plants. Furthermore, it will be located adjacent to the Delevan Compressor Station, which is a similar type of facility.

Further details on these topics are provided in the attached document. I would expect that you would have some questions pertaining to this submittal. We would be happy to meet with you to discuss these responses and answer any other questions you may have. Thank you for your thoughtful review of these issues.

Sincerely,

Andrew Welch
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1. AIR QUALITY

IMPACT OF COLUSA GENERATING STATION ON AMBIENT OZONE

As a result of daily operations, the proposed Colusa Generating Station (CGS) will emit carbon monoxide (CO), oxides of nitrogen (NO_X), oxides of sulfur (SO_X), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs). As discussed in the related portion of this response, *Agricultural Resource Impact Analysis* (beginning on page 1-6), pollutant modeling and analyses demonstrate that air and soil concentrations[1] of these pollutants will be below applicable crop-protective ambient air quality standards.

Another pollutant that is of concern for its impacts is O_3, which can be formed from precursors emitted from the project. Local and regional O_3 concentrations are expected to decrease as a result of the proposed CGS. The basis for the expected regional decrease in O_3 concentration, as a result of the CGS, is the focus of this paper.

The Applicant demonstrates in this document that both the immediate and regional O_3 concentrations are predicted to decrease. Hence, no impacts to agricultural resources associated with increased O_3 concentrations are anticipated.

Potential Impacts of O_3

Scientific research and regulatory agency publications have shown that ground level O_3 can have adverse effects on public health, sensitive populations (i.e., asthmatics, children, and the elderly), and public welfare (visibility, animals, crops, vegetation, and buildings). Two recent and comprehensive publications on the effects of O_3 are the U.S. Environmental Protection Agency's criteria document (U.S. EPA, 2006a) and staff paper (U.S. EPA, 2007). These documents will serve as the bases for the U.S. EPA's upcoming decision-making process to either revise or retain the current primary and secondary National Ambient Air Quality Standards (NAAQS) for O_3. As used in this document, O_3 refers to ground level ozone found in the earth's troposphere.

Based on the information found in the U.S. EPA reports and elsewhere in the literature, it is clear that the formation of O_3 (by atmospheric reactions) involves two main classes of precursor pollutants, VOCs and NO_X. The proposed CGS will emit both VOCs and NO_X as a result of the combustion of fuels for daily operations. Therefore, it may seem logical to conclude that an increase in O_3 will occur on both an immediate scale (in the direct vicinity surrounding the CGS) and a regional scale (throughout the air basin) as a result of the proposed CGS.

O_3 Concentration Decreases in the Immediate Vicinity of the CGS

According to a U.S. EPA report (U.S. EPA, 2006b, p. AX2-3), "Tropospheric photochemistry leading to the formation of O_3 and other photochemical air pollutants is complex, involving thousands of chemical reactions and thousands of stable and reactive intermediate products." Two of the primary classes of compounds involved in these reactions are NO_X and VOCs. This analysis focuses on NO_X because of the role played by the reaction of NO_X compounds in the reduction of O_3 concentrations surrounding the emission source.

[1] Concentrations in soil were not predicted for CO, NO_X, SO_X, PM_{10}, and O_3, due to a lack of soil benchmarks (i.e., soil-related pathways are expected to be minor).

NO_X emissions are a class of precursor pollutants comprised of two compounds: nitric oxide (NO) and nitrogen dioxide (NO_2). Although at high concentrations both NO_X compounds are potentially harmful, "...the ambient levels of NO_X are usually well below the concentrations believed to contribute to adverse health effects. The low ambient concentrations are due primarily to the relatively rapid reactions that occur when NO and NO_2 are emitted into the atmosphere. The main reason for regulating NO_X emissions is the suppression of these atmospheric reactions, which create ozone and other reaction products that are associated with adverse health effects. Nitrogen oxides are one of the most important reactants in O_3 formation" (U.S. EPA, 2006c).

One of the fundamental paths for O_3 production is the photochemical reaction of NO_2 by solar radiation in the ultraviolet spectrum to yield NO and a ground-state oxygen ($O^\bullet$) atom. In simplified terms, this means that NO_2 reacts in the presence of sunlight to form NO and $O^\bullet$ as shown by Reaction 1. In order to stage this discussion, it is important to point out that stack emissions of NO_X are generally approximated at 90 percent NO and 10 percent NO_2 (U.S. EPA, 2004).

Reaction 1. $NO_2 + sunlight \rightarrow NO + O^\bullet$

The $O^\bullet$ atom in this reaction will then react with molecular oxygen (O_2) to form O_3, as shown in Reaction 2.

Reaction 2. $O^\bullet + O_2 + Air \rightarrow O_3 + Air$

It is important to point out that O_3 also reacts with NO, as shown in Reaction 3, to reform NO_2.

Reaction 3. $NO + O_3 \rightarrow NO_2 + O_2$

Hence, Reactions 1 through 3 represent no net production of O_3. Because the stack emissions of NO_X are 90 percent NO, and NO rapidly reacts with O_3, "this reaction [Reaction 3] is responsible for O_3 decreases found near sources of NO (e.g., highways), especially at night" (U.S. EPA, 2006b, p. AX2-5). Hence, the cumulative effect of this relationship is an initial decrease in O_3 in the immediate vicinity of the source.

Theoretically, NO and NO_2 will over time continue to disperse from the emission source to a regional scale. As this occurs, a conversion to and net gain of O_3 begins to occur due to the increased presence of reactive radical species that provide an alternative path to O_3 formation. These species form as reactive VOCs oxidize through atmospheric reactions. The role of VOCs in the accumulation of O_3 is briefly discussed in the subsequent section.

Reaction 3 and the reduction of O_3 close to sources of NO is a widely recognized phenomenon and is also the basis for specific emissions modeling efforts approved by the U.S. EPA. Two such specific modeling methods are the Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM). OLM (the model approved by the regulatory agencies reviewing this application) and PVMRM modeling allow the user to predict NO_2 concentration levels at specified receptor sites. The models determine the amount of NO_2 in the atmosphere due to an emission source based on the source's initial emission rate and the conversion of NO to NO_2 as shown in Reaction 3 (note that the initial emissions at the stack are approximately 90 percent NO). As a plume of stack gas disperses from the source, NO will convert to NO_2 based on the

available amount of O_3 in that plume of air. Hence, the plume will initially reduce O_3 as it disperses from the source.

The purpose of relating this information is not to describe the methodology of these models, but to demonstrate the validity of Reaction 3 and its role in O_3 concentration reductions close to emission sources of NO.

The information provided above supports the conclusion that the immediate area surrounding the proposed CGS will experience decreased concentrations of O_3 as Reactions 1 through 3 proceed. This is in large part due to the prevalence of Reaction 3 in the immediate area, which is favored by NO_X in the stack gas being overwhelmingly NO and the fact that Reaction 3 can proceed independently without intermediate reactions or sunlight. As NO and NO_2 disperse on a regional scale into the Sacramento Valley Air Basin, other reactants (discussed in the next section) aid in and favor the formation of O_3. However, the Applicant has taken measures to offset precursor emissions to decrease O_3 on a regional scale.

Contrary to this conclusion, the Applicant demonstrates in this document that both the immediate (due to the chemistry of the O_3 formation) and regional (due to emissions offset measures taken by the Applicant) O_3 concentrations are predicted to decrease.

Regional O_3 Concentration Decreases

The Applicant will mitigate regional increases in O_3 concentrations by purchasing both stationary source and agricultural burning cessation emission reduction credits (ERCs). Agricultural burning of crop stubble is a is common practice and is a significant source of air pollution in many parts of Colusa County and surrounding counties, which are part of the Sacramento Valley Air Basin.

The regional atmospheric reaction of O_3 precursor pollutants is a complex scenario and a detailed explanation of this chemistry is beyond the scope of this discussion. For more information on this topic, please refer to the U.S. EPA's criteria document (2006a) and staff paper (2007). An overly simplified regional scale scenario of the formation of O_3 is presented in this document, which depicts O_3 formation through four of the fundamental reactions involved in O_3 formation (Reactions 1 through 4).

Of particular interest is the contribution of VOCs in the generation of O_3. According to the U.S. EPA (2006b, p. AX2-5), "The oxidation of reactive VOCs leads to the formation of reactive radical species that allow the conversion of NO to NO_2 without the participation of O_3," as shown in Reaction 4.

Reaction 4. $$NO \xrightarrow{HO_2^{\bullet}, RO_2^{\bullet}} NO_2$$

"O_3 can, therefore, accumulate as NO_2 photolyzes as in reaction AX2-1 [shown as Reaction 1] followed by reaction AX2-2 [shown as Reaction 2]" (U.S. EPA, 2006b, p. AX2-5).

In simplified terms, VOCs react and form reactive species that allow the conversion of NO to NO_2 without reducing existing O_3 levels (which occurs in Reaction 3); hence, as NO_2 reacts to form O_3, an increase in O_3 concentrations occurs. The rate of O_3 formation by this mechanism is slower because of the intermediate reactions required. It is therefore a larger contributor to O_3 formation on a regional scale. Based on the information presented above, which is derived

from U.S. EPA's criteria document (2006a) and staff paper (2007), a clear relation has been established between NO_X, VOCs, and the formation of O_3.

O_3 is not directly emitted from the proposed CGS's combustion sources. However, the chemistry of O_3 formation presented above provides a scientific basis for U.S. EPA's and other air regulatory agencies' regulation of VOCs and NO_X in an effort to curtail O_3 concentration levels. As mentioned previously, the proposed CGS will emit both VOCs and NO_X, but ERCs to be provided by the Applicant will result in net decrease of these emissions within the air basin.

The Applicant has proposed more VOC ERCs than necessary to offset all of the CGS VOC emissions. Under regulations adopted recognizing the contributions of both VOC and NO_X to O_3 formation discussed above, the excess VOC ERCs may be added to the proposed NO_X ERCs to offset NO_X emissions from the CGS.

A summary of CGS's ERC offsets, emissions, and offset ratios is provided in Tables 1 through 3.

Table 1
Total ERC Offsets (actual tons)

Pollutant	1st Quarter (tons)	2nd Quarter (tons)	3rd Quarter (tons)	4th Quarter (tons)	Annual (tons)
NO_X	38.8	35.3	26.4	40.9	141.4
VOC	62.9	60.3	54.8	64.8	242.8
				Sum (tons)	**384.2**

Table 2
CGS Annual Controlled Project Emissions

Pollutant	1st Quarter (tons)	2nd Quarter (tons)	3rd Quarter (tons)	4th Quarter (tons)	Annual (tons)
NO_X	45.77	43.77	51.57	44.47	185.6
VOC	12.51	11.81	12.01	11.91	48.2
				Sum (tons)	**233.8**

Table 3
Offset Ratio

Pollutant	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual
NO_X	0.85	0.81	0.51	0.92	0.76
VOC	5.03	5.11	4.57	5.44	5.03
				Sum	**1.6**

As shown, CGS's proposed offsets will result in a net reduction of O_3 precursors in the Sacramento Valley Air Basin by a factor of 1.6. Therefore, it is expected that a regional reduction of O_3 concentrations will occur.

Conclusion

Through the information provided in this document, the Applicant has demonstrated that the proposed CGS project will not contribute to adverse effects associated with elevated O_3 concentrations either in the immediate vicinity or on a regional scale. Because of the nature of the chemical reactions, there is a reduction in O_3 in the vicinity of the Project. On a regional basis, the emissions are offset through the use of Emission Reduction Credits in excess of the Project's emissions. The emissions controls and offsets are therefore protective of the agricultural resources as well as the human population.

References

U.S. EPA (U.S. Environmental Protection Agency), 2004. Addendum, User's Guide for the AMS/EPA Regulatory Model – AERMOD, Environmental Protection Agency 454/B-03-001. September 2004.

U.S. EPA (U.S. Environmental Protection Agency), 2006a. Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final). March 2006.

U.S. EPA (U.S. Environmental Protection Agency), 2006b. Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final) Volume 2 of 3. February 2006.

U.S. EPA (U.S. Environmental Protection Agency), 2006c. Module 6: Air Pollutants and Control Techniques, Nitrogen Oxides Characteristics, March 1, 2006. URL: http://www.epa.gov/eogapti1/module6/nitrogen/character/character.htm#lesson.

U.S. EPA (U.S. Environmental Protection Agency), 2007. Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information. OAQPS Staff Paper (Final), January 2007.

AGRICULTURAL RESOURCE IMPACT ANALYSIS

The operation of the proposed Colusa Generating Station (CGS) will not have an adverse impact on agricultural resources or operations. The pollutant ground-level concentrations resulting from the generating station, even during the worst-case operational and meteorological scenarios, will be below available crop-protective ambient air quality standards and below the concentrations shown through independent studies to produce no significant loss of yield of agricultural crops. In particular, the existing ozone concentrations will not increase as a result of CGS operations. This is discussed in the previous portion of this response, *Impact of Colusa Generating Station on Ambient Ozone* (see page 1-1). These conclusions are based both on the existing analysis comparing the air quality impacts of the proposed project to the applicable standards as reported in the Application for Certification (AFC) filed with the California Energy Commission (CEC) under Docket No. 06-AFC-9, and on further analysis reported here comparing the air quality impacts of the proposed project to results of agricultural studies. Each of these is discussed below.

It is important to note that the impacts discussed below are evaluated as if only increases to emissions would occur. However, emission reductions will be required as a condition of certification for many of the pollutants potentially emitted from the plant. These pollutants include oxides of nitrogen (NO_X), sulfur dioxide (SO_2), volatile organic compounds (VOCs), and particulate matter less than 10 microns in diameter (PM_{10}). These reductions will originate from the cessation of agricultural burning and from emission reductions at stationary sources within the region. By regulation, nearby reductions must equal at least 120 percent of the increases, and reductions farther away must equal at least 150 percent of the increases, resulting in a net reduction of emissions within the air basin.

Analyses Included in the Application for Certification

The potential impacts to air quality in the ambient air surrounding the proposed Colusa Generating Station caused by its operational emissions were evaluated for compliance with air quality standards in the AFC (Section 8.1.2.4). The impacts, when evaluated in combination with the existing measured background concentrations of air pollutants, were found not to cause any new violation of any ambient air quality standard established by the U.S. Environmental Protection Agency (U.S. EPA) or contribute significantly to any existing violation of any air quality standard established by the California Air Resources Board. Implicit in this analysis is the evaluation of soils, crops, and vegetation, and finding that no significant potential impact will occur to these resources. The air quality standards are explicitly set at levels to protect both human health and crops.[2] Impacts of the Colusa Generating Station emissions were compared

[2] In accordance with Sections 108 and 109 of the Clean Air Act (Act) the U.S. EPA has established, and periodically reviews, national ambient air quality standards (NAAQS) for air pollutants. Section 108 (42 U.S.C. 7408) directs the Administrator of the U.S. EPA to identify pollutants which "may reasonably be anticipated to endanger public health and welfare" and to issue air quality criteria for them. These air quality criteria are to "accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of [a] pollutant in the ambient air . . . ." Section 109 (42 U.S.C. 7409) directs the Administrator to propose and promulgate "primary" and "secondary" NAAQS for pollutants identified under Section 108. Section 109(b)(1) defines a primary standard as one "the attainment and maintenance of which, in the judgment of the Administrator, based on the criteria and allowing for an adequate margin of safety, [are] requisite to protect public health." A secondary standard, as defined in Section 109(b)(2), must "specify a level of air quality the attainment and maintenance of which, in the judgment of the Administrator, based on [the] criteria, are requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of [the] pollutant in the ambient air." Welfare effects, as defined in Section 302(h)[42 U.S.C. 7602(h)], include, but are not limited to, "effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being."

in the AFC to both the primary and the secondary national ambient air quality standards (NAAQS), which are identical for many pollutants.

The impacts to air quality–related values were also evaluated in the AFC (Section 8.1.2.5). Impacts from normal plant operations on total nitrogen and sulfur deposition were compared to U.S. Forest Service Class I Wilderness significant impact thresholds for vegetation and ecosystems for wilderness areas. These thresholds are intended to provide a worst-case analysis for highly sensitive ecosystems. All impacts are well below U.S. Forest Service significance criteria. This indicates that crops, native vegetation, wildlife, and soils in the project vicinity would not be adversely affected by NO_X or sulfur dioxide (SO_2) emissions.

Further Analysis on Air Quality Impacts and Crops

As a supplement to the air quality impact analysis in the AFC, further analysis on potential air quality impacts to crops and vegetation was performed to address concerns raised by local farmers. Air pollutants emitted from the stacks of the proposed generating station may be transported to the surrounding agricultural lands, and some may eventually deposit and accumulate on aboveground crop surfaces, as well as in soils. Therefore, the three media of concern identified for this supplemental analysis are air, plants (crops), and soil. Although the potential for bioaccumulation via root uptake is low for most chemicals of potential concern (COPCs) addressed in this evaluation, some COPCs, e.g., polycyclic aromatic hydrocarbons (PAHs), could bioaccumulate in plants at a minimal level (refer to the Uncertainties section, below). Bioaccumulation may also occur through exposure to COPCs that deposit on plant foliage or produce and are subsequently incorporated into plant tissues.

To address this secondary pathway, i.e., exposure through bioaccumulation, a quantitative analysis was also performed for the protection of human health and herbivorous wildlife that could consume crop or plant materials containing site-related COPCs. Soil benchmarks protective of birds and mammals were used for part of this analysis. Because there are no readily available soil or produce thresholds for the site-related COPCs that are protective of a locally grown produce consumption scenario for humans, U.S. EPA Region 9 Preliminary Remedial Goals (PRGs) for a residential exposure scenario were used (U.S. EPA, 2004a). Although the exposure pathways addressed in the residential PRGs do not include the consumption of produce, these screening levels are typically used as soil benchmarks protective of children and adults under unrestricted land use (i.e., residential land use). In addition, the air quality impact analysis performed in the AFC provides a quantitative evaluation of the potential for impacts to human health based on use of air quality standards and other criteria.

Development of Exposure Point Concentrations in Air and Soil

A risk-based screening approach was performed to further evaluate the potential for impacts to agricultural resources in the area as a result of construction of the proposed generating station. The first step in this supplemental screening analysis was to generate exposure point concentrations (EPCs) in air and soil (via deposition) for comparison to the appropriate benchmarks protective of the receptor groups of interest: crops, plants, humans, and wildlife. As shown in Table 4, both criteria air pollutants (CO, NO_2, SO_2, PM_{10}, and ozone) and toxic air pollutants (twelve VOCs and eight PAHs) were identified as COPCs.

EPCs in Air. The maximum annual average pollutant concentrations in air expressed as micrograms per cubic meter ($\mu g/m^3$) that are expected to result from operation of the CGS (Table 4) are those that were reported in AFC (see AFC Table 8.1-24). In addition, maximum

1-hour and 24-hour averages are presented in Table 4 for certain criteria air pollutants to accommodate the study durations associated with the selected air screening benchmarks for these COPCs.

The maximum air concentrations predicted for the site are intentionally conservative estimates that are likely to over-predict actual EPCs to which receptors may be subjected. As discussed in detail in the AFC, the "Total Predicted Concentration" column in Table 8.1-24 is the worst-case CGS impact added to the worst-case background measurement for criteria air pollutants. Background concentrations were not considered for the toxic air pollutants. The worst-case CGS impact was determined by looking at all types of operating scenarios, including startup, shutdown and part load, and all types of meteorological conditions, including inversions. The worst-case background measurement for the criteria air pollutants was the highest concentration reported within the past three years. In addition, the location of the maximum impact from the CGS is typically close to the generating station. Concentrations decrease with increased distance from the plant. Using the maximum concentration to represent the concentration at all crop locations is also a conservative assumption that was used for all COPCs. Therefore, actual receptor exposures will most likely be lower than those shown in Table 4.

Project-specific impacts of ozone were not modeled, as ozone is more appropriately evaluated on a regional scale. However, the offsets provided by the Applicant will reduce ozone precursors. A more detailed explanation of ozone formation and precursor offsets is discussed in the first portion of this response to Item 1, *Impact of Colusa Generating Station on Ambient Ozone* (see page 1-1). The concentrations of ozone in air presented in Table 4 represent the highest background concentrations measured in 1-hour and 8-hour periods on a regional basis between 2003 and 2005.

EPCs in Soil. Total predicted concentrations in soil presented in Table 4 were calculated by first multiplying the maximum annual average concentrations in air by a worst-case deposition velocity of 2 centimeters per second (cm/sec), as recommended by the Office of Environmental Health Hazard Assessment (OEHHA) and California Air Resources Board (CARB) (OEHHA and CARB 2003). This calculation generates a worst-case annual deposition rate. Adjustments to the units of the resulting deposition rates for each COPC were made to convert these rates to grams per square meter per year ($g/m^{2-}year$). Finally, the annual predicted concentrations in soil were calculated by applying soil depth and density defaults of 0.15 meter (or 6 inches) and 1,601.86 kilograms per cubic meter (kg/m^3) to the annual deposition rates. Since the predicted soil concentrations were calculated by applying conservative deposition rates to the estimated worst-case air concentrations, the COPC concentrations estimated for soil are also representative of worst-case conditions.

A brief online review of root depth zones for crops revealed that most agricultural crops have roots extending to 4 or 5 feet below ground surface (bgs), but some even extend to 6 feet if unrestricted (Westland Water District, 2007). Some vegetables have shallower root depth zones, such as cole crops (cabbage, broccoli, Brussels sprouts, and cauliflower), onions, and radishes, which only extend to 1 foot bgs (Sanders, 1993). One of the assumptions inherent in the air-to-soil model used to predict COPC concentrations for the site is that concentrations in soil decrease with increasing depth. In other words, COPC concentrations in soil resulting from atmospheric deposition tend to attenuate as they migrate below the soil surface. Therefore, use of a soil depth of 6 inches bgs in the model to predict soil concentrations is expected to overestimate the actual exposure level for most crops because their roots extend much deeper.

However, the conservative root depth zone of 6 inches was used to be protective of all possible crops and plants.

Soil concentrations were not predicted for the criteria air pollutants because soil-related pathways are expected to be minor for this group of COPCs. In addition, lack of soil screening benchmarks for these COPCs precludes the need for EPCs in soil.

The modeled air and soil concentrations for the site shown in Table 4 were used as the EPCs in this supplemental analysis and were compared to the air and soil screening benchmarks discussed below. The following section describes the benchmark selection process and presents the final benchmarks for each COPC.

Identification of Air and Soil Screening Benchmarks

The air and soil screening benchmarks selected for use in this evaluation are presented in Tables 5 through 8. As air-based benchmarks protective of crops and plants were not identified for the toxic air pollutants (VOCs and PAHs), only benchmarks for criteria air pollutants (NO_2, SO_2, and ozone) are shown in Table 5. No benchmarks protective of plants were found for CO and $PM_{10.}$ Similarly, Table 6 presents the soil-based benchmarks protective of crops and plants for the toxic air pollutants only, as no benchmarks were identified for the criteria air pollutants. Table 9 provides a brief summary of the information available in the sources and studies reviewed during the selection of air and soil screening benchmarks for crops and plants.

Tables 7 and 8 present the soil and air screening benchmarks protective of humans and wildlife, and Table 10 summarizes the available wildlife benchmarks reviewed during the literature searches.

Screening Benchmarks for Plants. In the process of selecting air-based benchmarks for crops, independent studies were reviewed in which the effects on various agricultural products from exposure to different criteria air pollutants, both individually and in various combinations. Many of these studies were conducted in conjunction with the development of the ambient air quality standards. The studies most applicable to the analysis at hand are those that report pollutant concentrations that produce a “no effect” endpoint for plant growth or yield, or visible signs of stress to foliage or roots (in other words, studies wherein the research sought to quantify level(s) of pollutants that would be “safe” with respect to exposure to crops). However, air concentrations associated with some measurable effect were also reviewed, as some “effect levels” are lower than “no effect levels” depending on the particular crop species evaluated in the study, as well as other factors that may influence the study endpoints that are not always well understood in terms of contributing to crop sensitivity to pollutant exposure (i.e., soil nutrient levels, temperature, soil pH, moisture content, etc.). Therefore, the general approach for identifying appropriate air-based benchmarks for plants involved compiling studies demonstrating no effects and effect levels (when lower than no effect levels) for all crop species provided in the documents listed below. Study duration was also considered in terms of comparability to predicted site concentrations. Professional judgment was used to select the most appropriate studies for this supplemental analysis.

A summary of the research studies on criteria pollutants and crops reviewed by U.S. EPA in support of the development of the NAAQS discussed above and other studies is presented in Table 9. Studies on crops presented in the air quality criteria documents and related reports were reviewed in the development of air-based screening benchmarks:

- Air Quality Criteria for Oxides of Nitrogen (U.S. EPA, 1993).
- Air Quality Criteria for Carbon Monoxide (U.S. EPA, 2000).
- Air Quality Criteria for Particulate Matter and Sulfur Oxides (Final) (U.S. EPA, 1982).
- Air Quality Criteria for Particulate Matter (U.S. EPA, 2004b).
- Air Pollution Effects on Terrestrial Ecosystems (U.S. EPA, 1983).
- Air Quality Criteria for Ozone and Other Photochemical Oxidants (U.S. EPA, 1986, 2006).

Table 6 does not present an exhaustive listing of all studies that may pertain to this subject. However, the data found regarding phytotoxic effects on specific crop species were deemed adequate for the selection of no-effects or lowest-effects benchmarks for three of the five criteria air pollutants (NO_X, SO_X, and ozone).

The U.S. EPA sulfur oxide criteria document (U.S. EPA, 1982) provides the following overview of the response of plants to SO_2 exposure.

> "…Entrance of SO_2 into the plant through leaf openings called stomata, and contact within the leaf with wet cellular membranes and subsequent liquid phase reactions results in the formation of sulfite and sulfate compounds. The formation of these compounds can initiate changes within the plant metabolic systems that will produce physiological dysfunctions. If sufficient physiological modifications occur, plant homeostasis or equilibrium is disturbed and visible symptoms of injury may occur and plant recovery is less probable.
>
> Several plant responses to exposure to SO_2 and related sulfur compounds are possible: (1) fertilizer effects appearing as increased growth and yield; (2) no detectable responses; (3) injury manifested as growth and yield reductions without visible symptom expression on the foliage or with only very minor foliar symptoms that are difficult to attribute to air pollution without comparing them to a control set of plants grown in pollution-free conditions; (4) injury exhibited as chronic or acute symptoms on foliage with or without associated reductions in growth and yield; and (5) death of plants and plant communities."

The U.S. EPA nitrogen oxide criteria document (U.S. EPA, 1993) provides the following overview of the response of plants to NO_2 exposure.

> "Of the various nitrogen oxides (NO_X) in the ambient air, only nitric oxide (NO) and nitrogen dioxide (NO_2) have been considered important phytotoxicants; however, there is growing concern that nitric acid (HNO_3) may also impact vegetation.
>
> Of the three major atmospheric pollutants (O_3, NO_2, and SO_2), NO_2 is the least likely to cause visible injury because of both its relatively low phytotoxicity and its low ambient concentrations. In combination with other pollutants, however, NO_2 has the potential to modify the injury associated with the other gases. Most descriptions of injury arise from controlled environmental studies.
>
> The occurrence and magnitude of the vegetational effects depend on the concentration of the pollutant, the duration of the exposure, the length of time between exposures, and the various environmental and biological factors that influence the response. Biochemical changes within the plants can be expressed as visible foliar injury,

> premature senescence, increased leaf abscission, and altered plant growth and yield. These changes at the individual plant level may lead to altered reproduction, changes in competitive ability or reduction of plant vigor. The linkages among altered biochemical processes, foliar injury, and reduced plant yield are not well understood. Likewise, no clear relationship exists between foliar injury and reduced plant yield for species in which the foliage is not part of the yield. However, when found, the injury is usually associated with and confined to areas near specific industrial sources."

No phytotoxicity data were readily available on PM_{10}, or CO effects to crops. However, the fact that the identified pollutant studies provide support that the NAAQS are crop protective, coupled with demonstrated compliance with the NAAQS for PM_{10} and CO (see AFC Section 8.1) ensures that PM_{10} and CO impacts to crops will also be insignificant. The U.S. EPA PM_{10} and CO criteria documents make the following statements regarding research on the effects on plants from these two pollutants.

> "Though effects of specific chemical fractions of PM have been described, there has been relatively little research aimed at defining the effects of unspeciated PM on Plants or ecosystems…While size is related to the mode and magnitude of deposition to vegetated landscapes and may be a useful surrogate for chemical constitution, PM size classes do not necessarily have specific differential relevance for vegetative effects…Therefore, assessment of atmospheric PM deposition and effects on vegetation unavoidably include discussion of NO_{3-} and SO_4^{2-} and associated compounds involved in acidic and acidifying deposition" (U.S. EPA, 2004b).

> "Because plants can both metabolize and produce CO, trace levels are considered a normal constituent of the natural environment. Although ambient concentrations of CO in the vicinity of urban and industrial areas can exceed global background levels, there are no reports of these currently measured levels of CO producing any adverse effects on plants or microorganisms" (U.S. EPA, 2000).

Soil-based benchmarks protective of crops and plants were drawn from the following sources:

- Oak Ridge National Laboratory (ORNL) Risk Assessment Information System (RAIS) database query January 2007.
- Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (U.S. EPA, 1999).
- U.S. EPA Region 5 Soil Ecological Screening Levels (U.S. EPA, 2003).
- U.S. EPA ECOTOX database query, January 2007.

The final soil benchmarks are shown in Table 6 and more detailed information regarding the benchmark and source for each COPC is provided in Table 9. For most COPCs, only one of the sources listed above provided a corresponding benchmark. In the event that more than one benchmark was available, the lowest value was selected. The plant or crop species used in the study upon which the benchmark was derived, as well as the test endpoints, are provided when available.

In the absence of plant-specific soil benchmarks for formaldehyde, benzene, and ethylbenzene, generic benchmarks presented by the Dutch Target values and Dutch Intervention Values were used. Dutch Target Values for soil are related to negligible risk for ecosystems. This is assumed to be 1 percent of the Maximal Permissible Risk (MPR) level for ecosystems, where MPR is the concentration expected to be hazardous for 5 percent of the species in the

ecosystem, or the 95 percent protection level. The relationship between soil concentration and irreparable damage to terrestrial species composition and the relationship between soil concentration and adverse effects on microbial and enzymatic processes were derived to quantify the ecotoxicological effects on ecosystems. The ecological Intervention Value is the concentration expected to be hazardous to 50 percent of the species in the ecosystem. It cannot be assumed that sensitive species will be protected at the Intervention levels.

Screening Benchmarks for Humans. As discussed previously, some of the site-related COPCs (i.e., HPAHs) have the potential to bioaccumulate in crops either through soil-to-root uptake or direct contact of airborne particulates with aboveground foliage. Consumers of these crops might then be exposed to site-related COPCs; therefore, the level of exposure and risk for human consumers of locally grown produce was examined. The U.S. EPA Region 9 PRGs protective of a residential land use scenario (U.S. EPA, 2004) were compared to predicted site soil concentrations in the absence of generic benchmarks relevant to a locally grown (or even homegrown) produce consumption scenario. Although the residential PRGs do not specifically address this secondary pathway, they are typically among the most widely used available soil benchmarks protective of humans and are commonly used to assess the potential for unrestricted land use at properties throughout California. The California-modified PRGs, which are based on Cal-EPA's toxicity values, were used when available.

No threshold levels or standards specific to toxic and bioaccumulative contaminants in produce were identified for the COPCs related to the site. FDA Action Levels or Tolerance Levels and Market Basket values are available only for a limited number of chemicals known to be highly persistent and biomagnify in the environment, including mercury, PCBs, dioxins, and pesticides. Therefore, the residential PRGs were selected to evaluate human exposure to COPCs in crops in the absence of more appropriate benchmarks.

The residential PRGs are based on the following exposure pathways: incidental soil ingestion, dermal contact with soil, inhalation of soil particles (dust), and inhalation of volatile organic compounds entering the atmosphere from soil. Based on the assumption that soil and plant tissue concentrations originating from atmospheric deposition of site-related COPCs are basically equivalent, the incidental soil ingestion pathway included in the residential PRGs indirectly addresses produce consumption although the actual exposure level would depend upon the amount of unwashed produce consumed. As demonstrated in the U.S. EPA's Ecological Soil Screening Levels (EcoSSLs) Guidance (2005), none of the HPAHs are known to be highly bioaccumulative in plant tissues, and readily available soil-to-plant uptake factors in the EcoSSLs report derived from measured data range from 0.11 to 0.31 for the HPAHs associated with the site. These values are below one, indicating that HPAH concentrations in soil are higher than concentrations in co-located plant tissues.

The residential PRGs are based on the assumption that individuals spend a large portion of their lives in one dwelling and are exposed regularly to chemicals in soil at that property through incidental ingestion. Given that crop tissue concentrations are comparable to, and likely less than, soil concentrations, and the frequency and duration of exposure to locally grown produce may be less than exposure to soil at a residence, use of the PRGs is still expected to provide an adequately conservative analysis for site soils and crops. Similarly, the PRGs for ambient air are based on a residential scenario using Superfund exposure factors and were also included in the screening evaluation for humans to supplement the air quality impact analysis performed in the AFC.

Screening Benchmarks for Wildlife. Screening benchmarks protective of wildlife were selected from the following sources:

- U.S. EPA Region 5 Ecological Screening Levels (ESLs) for Soil and Air (August 2003); http://www.epa.gov/Region5/rcraca/edql.htm
- U.S. EPA Region 4 Soil Screening Benchmarks (SSBs) (November 2001); http://rais.ornl.gov/homepage/eco_tool.shtml
- Oregon Department of Environmental Quality (ODEQ) Level II Soil Screening Level Values (SLVs) for birds and mammals (December 2001); http://www.deq.state.or.us/wmc/pubs/docs/cu/GuidanceEcologicalRisk.pdf.

The final soil benchmarks are shown in Table 8 and more detailed information regarding the benchmark and source for each COPC is provided in Table 10. Only U.S. EPA Region 5 provides air-based benchmarks, which are also presented in Tables 8 and 10. The Region 5 ESLs for air are based on toxicological data that was extrapolated to the wildlife receptor selected by U.S. EPA (mink or belted kingfisher). It was assumed that the use of uncertainty factors provided a conservative approach and would account for any respiratory differences and responses between species.

For most COPCs, only one of the sources listed above provided a corresponding benchmark. In the event that more than one benchmark was available, the lowest value was selected. The animal species upon which the benchmark was derived are provided when available. Soil benchmarks protective of birds were not available for any of the COPCs, which introduces an uncertainty in the evaluation for this receptor group.

The benchmark sources listed above provide initial screening levels that were developed to focus an evaluation on the pathways and COPCs that require further investigation. The Region 5 ESLs, Region 4 SSBs, and ODEQ Level II SLVs correspond to contaminant levels associated with a low probability of unacceptable risks to ecological receptors. No soil benchmarks were identified for six of the VOCs, and therefore, these COPCs could not be quantitatively evaluated.

Uncertainties

- The EPCs calculated for air and soil include worst-case assumptions and total exposure that includes background for criteria pollutants, which likely overestimates actual exposure levels to which receptors are subjected.

- A soil depth of 6 inches was assumed for purposes of calculating deposition rates and soil concentrations. As previously described, most agricultural crops have roots extending to 4 or 5 feet bgs, but some even extend to 6 feet if unrestricted (Westland Water District, 2007). Certain vegetables have shallower root depth zones. The model used to predict COPC concentrations in site soil operates on the assumption that concentrations in soil decrease with increasing soil depth (concentrations attenuate with increasing migration below the soil surface). Therefore, use of a soil depth of 6 inches bgs in the model to predict soil concentrations is expected overestimate the actual exposure level for most crops.

- Although the bioaccumulation pathway for wildlife was evaluated for the toxic air criteria pollutants, HPAHs, and especially VOCs, are not expected to

bioaccumulate to significant levels in plant materials. Therefore, minimal exposure to wildlife (and humans) that consume plants or crops is likely to occur. Although plants can absorb PAHs from soils through their roots, and translocate them to other plant parts such as developing shoots, both LMW and HMW PAHs are microbially degraded. Uptake rates are generally governed by PAH concentration, PAH water solubility, soil type, and PAH physicochemical state (vapor or particulate). Lower molecular weight (LMW) PAHs absorbed more readily than higher molecular weight (HMW) PAHs (U.S. EPA, 2007). All but one of the eight site-related PAHs is an HMW PAH.

Concentrations of PAHs in plants are generally much lower than in co-located soil, and paired plant tissue and soil samples are often poorly correlated because of deposition and absorption of atmospheric PAHs (U.S. EPA, 2007). Readily available soil to plant uptake factors in EPA's EcoSSLs guidance derived from measured data range from 0.11 to 0.31 for the HPAHs associated with the site, demonstrating a low potential for bioaccumulation in plants (U.S. EPA, 2005).

- For the toxic air pollutants, the soil and air benchmarks are primarily based on studies for mammals (see Table 7). This may over- or under-predict the potential level of impact to birds.

- Air concentrations from studies reviewed for benchmarks (Table 6) were converted to $\mu g/m^3$ from ppb or ppm using U.S. EPA's recommended conversion factors presented on the Air Quality Standards website, when the conversion was not already provided by the study author. The conversion factors used in the studies for which the unit conversion was already performed may deviate slightly from U.S. EPA's recommended factors.

- A quantitative evaluation could not be performed for all COPCs and media due to a lack of appropriate benchmarks.

Results and Conclusions

As demonstrated in Tables 2 through 5, all air and soil concentrations predicted for the COPCs identified for the site are below the available corresponding screening benchmarks, with the exception of ozone. However, regional ozone levels are expected to decrease as a result of the ozone precursor offsets provided by the Applicant, as discussed in the previous portion of this response, *Impact of Colusa Generating Station on Ambient Ozone* (see page 1-1). Most predicted site concentrations are orders of magnitude below the screening benchmarks.

Based on the findings of this supplemental analysis and the fact that a conservative approach is taken towards the uncertainties regarding estimation of exposure and effects err on the conservative end, operation of the proposed CGS is not expected to have any impact on agricultural resources or operations. Furthermore, no adverse effects to the plant and animal communities that may be present in the vicinity of the site or humans that consume locally grown produce are likely to occur.

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Table 4
Estimated Exposure Point Concentrations in Air and Soil from Routine Operations of the Colusa Generating Station (CGS)

Based on 5-Year Maximum Modeled Rates					
COPCs	CAS #	Maximum Annual Average Concentration in Air ($\mu g/m^3$)[1]	Deposition Rate[2,6] ($\mu g/m^2 \cdot sec$)	Deposition Rate[6] ($g/m^2 \cdot yr$)	Total Predicted Annual Concentration in Soil[3,6] ($mg/kg \cdot yr$)
CRITERIA AIR POLLUTANTS					
Carbon Monoxide (CO)	630080	(7,840)	not required	not required	not required
Nitrogen Dioxide (NO_2)	10102440	27 (456.8)	not required	not required	not required
Sulfur Dioxide (SO_2)	7446095	2.6 (20, 8.1)	not required	not required	not required
Particulate Matter (PM_{10})		26	not required	not required	not required
Ozone	10028-15-6	180 (148)	not required	not required	not required
TOXIC AIR POLLUTANTS					
Volatile Organic Compounds					
1,3-Butadiene	106990	0.00000572	1.144E-07	3.60772E-06	0.000015
Acetaldehyde[5]	75070	0.00618	0.0001236	0.00389785	0.016
Acrolein	107028	0.000852	0.00001704	0.000537373	0.0022
Ammonia	7664417	0.342	0.00684	0.21570624	0.88
Benzene[5]	71432	0.000603	0.00001206	0.000380324	0.0016
Ethylbenzene	100414	0.000807	0.00001614	0.000508991	0.0021
Formaldehyde[5]	50000	0.0414	0.000828	0.026111808	0.11
Hexane	110543	0.0117	0.000234	0.007379424	0.030
Propylene	115071	0.0349	0.000698	0.022012128	0.090
Propylene oxide	75569	0.00215	0.000043	0.001356048	0.0056
Toluene	108883	0.00321	0.0000642	0.002024611	0.0083
Xylenes	1330207	0.00118	0.0000236	0.00074425	0.0030
Polycyclic Aromatic Hydrocarbons					
Benzo(a)anthracene	56553	0.00000102	2.04E-08	6.43334E-07	0.0000026
Benzo(a)pyrene	50328	0.000000284	5.68E-09	1.79124E-07	0.00000073
Benzo(b)fluoranthene	205992	0.00000051	1.02E-08	3.21667E-07	0.0000013
Benzo(k)fluoranthene	207089	0.000000497	9.94E-09	3.13468E-07	0.0000013
Chrysene	218019	0.00000114	2.28E-08	7.19021E-07	0.0000029
Dibenz(a,h)anthracene	53703	0.00000106	2.12E-08	6.68563E-07	0.0000027
Indeno(1,2,3-cd)pyrene	193395	0.00000106	2.12E-08	6.68563E-07	0.0000027
Naphthalene	91203	0.0000749	0.000001498	4.72409E-05	0.00019

Table 4
Estimated Exposure Point Concentrations in Air and Soil from Routine Operations of the Colusa Generating Station (CGS)

Notes:

Not required = Concentrations in soil were not predicted for the criteria air pollutants due to a lack of soil benchmarks for these COPCs (soil-related pathways are expected to be minor).

COPCs = Chemicals of Potential Concern

$\mu g/m^2 \cdot sec$ = micrograms per square meter · second

$\mu g/m^3$ = micrograms per cubic meter

$g/m^2 \cdot yr$ = grams per square meter · year

mg/kg · yr = milligrams pollutant per kilogram soil · year

SCR = selective catalytic reduction

[1] Criteria air pollutants are shown as the sum of the maximum modeled impact and the monitored background concentrations. Background concentrations were not added to modeled concentrations of toxic air pollutants. Annual averages are used for all COPCs, except for carbon monoxide, which is an 8-hour averaging period. These calculations are highly conservative, as it is unlikely that the criteria pollutants will deposit in the soil.

Maximum 1-hour averages shown in parentheses for carbon monoxide, nitrogen dioxide, and sulfur dioxide; Maximum 24-hour average also shown for sulfur dioxide.

[2] This calculation is performed assuming a deposition velocity of:

2 cm/sec converted to m/sec Worst-case deposition velocity as recommended by the California Air Resources Board (CARB)

[3] This calculation is performed assuming the following soil depth and density:

0.15 m Soil Depth (or 6 inches)

1601.86 kg/m^3 Soil Density

[4] Annual emissions from GCS CTG/HRSG and auxiliary boiler

[5] Project-specific impacts of ozone were not modeled. The concentrations presented represent the highest background concentration measured in 1-hour and 8-hour (shown in parentheses) periods on a regional basis between 2003 and 2005.

[6] The following provides an example calculation for ammonia:

Deposition Rate Calculation

$$DR1\left(\frac{\mu g}{m^2 \cdot sec}\right) = MAC\left(\frac{\mu g}{m^3}\right) \times DV\left(\frac{m}{sec}\right)$$

DR1	0.00684	= Deposition Rate
MAC	0.342	= Maximum Annual Average Concentration in Air (ammonia shown)
DV	0.02	= Deposition Velocity (converted to m/sec from value shown in Note 2)

Table 4
Estimated Exposure Point Concentrations in Air and Soil from Routine Operations of the Colusa Generating Station (CGS)

Conversion of Deposition Rate Units

$$DR2\left(\frac{g}{m^2 \cdot yr}\right) = DR1\left(\frac{\mu g}{m^2 \cdot sec}\right) \div UC1\left(\frac{g}{\mu g}\right) \times UC2\left(\frac{sec}{min}\right) \times UC3\left(\frac{min}{hr}\right) \times UC4\left(\frac{hr}{day}\right) \times UC5\left(\frac{day}{yr}\right)$$

DR2	0.21570624	= Deposition Rate (corrected units)
DR1	0.00684	= Deposition Rate
UC1	1000000	= Unit Conversion From Microgram To Gram
UC2	60	= Unit Conversion From Second To Minute
UC3	60	= Unit Conversion From Minute To Hour
UC4	24	= Unit Conversion From Hour To Day
UC5	365	= Unit Conversion From Day To Year

Total Predicted Annual Concentration in Soil

$$SCONC\left(\frac{mg}{kg\ soil \cdot yr}\right) = DR2\left(\frac{g}{m^2 \cdot yr}\right) \times UC6\left(\frac{mg}{g}\right) \div SDEP\left(\frac{1}{m}\right) \div SDEN\left(\frac{m^3\ soil}{kg\ soil}\right)$$

SCONC	0.88	= Total Predicted Annual Concentration in Soil
DR2	0.21570624	= Deposition Rate (corrected units)
UC6	1000	= Unit Conversion From Gram To Microgram
SDEP	0.15	= Soil Depth
SDEN	1601.86	= Soil Density

Table 5
Comparison of No Effects-Based Air Screening Benchmarks to
Predicted Concentrations of Criteria Air Pollutants for the Colusa Generating Station[1]

COPCs and Duration of Exposure	Study Characteristics for Selected Air Screening Benchmarks [2]				Colusa Power Plant			COPC Predicted Air Conc. Exceeds Study Conc?
	Duration	Plant	"No Effects" or "Lowest Effects" Concentration ($\mu g/m^3$)	Effect	Duration	Total Predicted Concentration [3] ($\mu g/m^3$)	Total as Percent of Study [4]	
Criteria Air Pollutants								
NO_x Short term	1-hour and 3-hour	Radish, Swiss Chard, Peas	Up to 1,880	No visible foliar injury	1-hour	456.8	24%	No
NO_x Long term	128 days	Tomato	470	Reduction in growth and yield	Annual	27	5.7%	No
SO_2 Short term	1-hour	Radish	1,950	First signs of visible foliar injury	1-hour	20	1.0%	No
SO_2 Daily/Subchronic	24 hours	Swiss Chard, Pepper	786	No foliar injury observed	24 hours*	8.1	1.0%	No
	72 hours	Wheat and Barley	260	No foliar injury observed			3.1%	No
	4 days	Bushbean	200	No effects on yield			4.1%	No
Ozone Short term	1-hour	Agricultural crops	Up to 500	No visible foliar injury	Highest hour measured between 2003 and 2005 was 180 (0.09 ppm) or 36% of the study concentration.			No
Ozone Long term	4 to 6 hours per day (chronic exposure period)	Soybean, Corn	Between 98 and 196	No reduction in yield (for sensitive crop species)	Highest 8-hour period measured between 2003 and 2005 was 148 (0.074 ppm), which is approximately 1.5 times greater than the low end of the no effects range, but below the high end of the range (76% of the study concentration).			**Yes**
Criteria Air Pollutant Combinations								
NO_2 and SO_2, Short term	1-hour	Radish	NO_2 – 940	First signs of foliar injury	1-hour	NO_2 – 456.8	NO_2 – 49%	No
			SO_2 – 1,130			SO_2 – 20	SO_2 – 1.8%	
NO_2, SO_2, and O_3, Short term	2-hour	Radish, Pepper, Tomato	NO_2 – 560	Extensive leaf damage [5]	1-hour	NO_2 – 456.8	NO_2 – 82%	No
			SO_2 – 310			SO_2 – 20	SO_2 – 6.5%	
			O_3 – 200			O_3 – 180	O_3 – 90%	

Notes:
COPCs = Chemicals of Potential Concern

* Although the exposure duration associated with the predicted site concentration is less than the duration of the test studies (72 hours, 4 days), this approach results in an over-estimation of risk. Predicted site concentrations decrease over time and, therefore, site concentrations for 72 hours or 4 days would be lower than for 24 hours.
1 = For more information on these studies and additional studies see Table 5.
2 = Air concentrations from the literature and database research corresponding to "No Effects" were selected as the final screening benchmarks.
3 = Drawn from Table 1.
4 = Total as Percent of Study = Total Predicted Site Concentration / Study Concentration
5 = This three-pollutant combination study is included (even though it is not a "no effect" result) because pollutant concentrations appear to be relatively close to predicted CGS levels. However, the study used a 2-hour exposure, which if 2-hour impact was available for the CGS, would show reduced concentrations.

Table 6
Comparison of Soil Screening Levels Protective of Plants to Predicted Soil Concentrations for the Colusa Generating Station

COPCs	Soil Screening Benchmarks Protective of Plants[1,2] (mg/kg)	Total Predicted Concentration in Soil[3] (mg/kg · yr)	COPC Soil Concentration Exceeds Plant Screening Level?
Toxic Air Pollutants			
Volatile Organic Compounds			
1,3-Butadiene	NA	0.000015	NE
Acetaldehyde	NA	0.016	NE
Acrolein	NA	0.0022	NE
Ammonia	NA	0.88	NE
Benzene	0.01 [4]	0.0016	No
Ethylbenzene	0.03 [4]	0.0021	No
Formaldehyde	0.3 [4]	0.11	No
Hexane	NA	0.030	NE
Propylene	NA	0.090	NE
Propylene oxide	NA	0.0056	NE
Toluene	200 [4]	0.0083	No
Xylenes	10 [5]	0.0030	No
Polycyclic Aromatic Hydrocarbons			
Benzo(a)anthracene	1.2 [6]	0.0000026	No
Benzo(a)pyrene	1.2 [6]	0.00000073	No
Benzo(b)fluoranthene	1.2 [6]	0.0000013	No
Benzo(k)fluoranthene	1.2 [6]	0.0000013	No
Chrysene	1.2 [6]	0.0000029	No
Dibenz(a,h)anthracene	1.2 [6]	0.0000027	No
Indeno(1,2,3-cd)pyrene	1.2 [6]	0.0000027	No
Naphthalene	32 [7]	0.00019	No

Notes:
COPCs = Chemicals of Potential Concern
NA = Screening benchmark not available.
NE = Not evaluated
1 = For more information on these studies and additional studies see Table 6.
2 = Lowest soil screening level from literature and database research was selected as the final benchmark.
3 = Calculated in Table 1.
4 = Oak Ridge National Laboratory RAIS database query January 2007. Plant Screening Benchmarks used when available. General soil screening benchmarks used in the absence of plant-specific values: benzene, ethylbenzene, and formaldehyde.
5 = USEPA Region 5 Soil Ecological Screening Level (August 2003). Based on exposure to plants.
6 = USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.
7 = USEPA ECOTOX database January query 2007.

Table 7
Comparison of Soil and Air Screening Benchmarks Protective of Humans to Predicted Concentrations for the Colusa Generating Station

COPCs	Soil			Air		
	Soil Screening Benchmarks Protective of Humans[1] (mg/kg)	Total Predicted Concentration in Soil[2] (mg/kg · yr)	COPC Soil Concentration Exceeds Human Benchmark?	Air Screening Benchmarks Protective of Humans[1] (μg/m³)	Maximum Annual Average Concentration in Air (μg/m³)	COPC Air Concentration Exceeds Human Benchmark?
Toxic Air Pollutants						
Volatile Organic Compounds						
1,3-Butadiene	0.01 [3]	0.000015	No	0.01 [3]	0.00000572	No
Acetaldehyde	11	0.016	No	0.87	0.00618	No
Acrolein	0.1	0.0022	No	0.021	0.000852	No
Ammonia	NA	0.88	NE	100	0.342	No
Benzene	0.64	0.0016	No	0.25	0.000603	No
Ethylbenzene	400	0.0021	No	1100	0.000807	No
Formaldehyde	9200	0.11	No	0.15	0.0414	No
Hexane	110 [4]	0.030	No	210 [4]	0.0117	No
Propylene	NA	0.090	NE	NA	0.0349	NE
Propylene oxide	1.9	0.0056	No	0.52	0.00215	No
Toluene	520	0.0083	No	400	0.00321	No
Xylenes	270	0.0030	No	110	0.00118	No
Polycyclic Aromatic Hydrocarbons						
Benzo(a)anthracene	0.62	0.0000026	No	0.0092	0.00000102	No
Benzo(a)pyrene	0.062	0.00000073	No	0.00092	0.000000284	No
Benzo(b)fluoranthene	0.62	0.0000013	No	0.0092	0.00000051	No
Benzo(k)fluoranthene	0.38 [3]	0.0000013	No	0.017 [3]	0.000000497	No
Chrysene	3.8 [3]	0.0000029	No	0.17 [3]	0.00000114	No
Dibenz(a,h)anthracene	0.062	0.0000027	No	0.00092	0.00000106	No
Indeno(1,2,3-cd)pyrene	0.62	0.0000027	No	0.0092	0.00000106	No
Naphthalene	1.7 [3]	0.00019	No	0.056 [3]	0.0000749	No

Notes:
COPCs = Chemicals of Potential Concern
NA = Screening value not available.
NE = Not Evaluated
1 = USEPA Region 9 Preliminary Remediation Goals (PRGs) 2004. Residential values were chosen as final soil and air benchmarks.
2 = Drawn from Table 1.
3 = Cal-Modified Residential PRG used (USEPA 2004).
4 = PRG value for n-Hexane used for Hexane.

Table 8
Comparison of Soil and Air Screening Benchmarks Protective of Wildlife to Predicted Concentrations for the Colusa Generating Station

COPCs	Soil			Air		
	Soil Screening Benchmarks Protective of Wildlife[1,2] (mg/kg)	Total Predicted Concentration in Soil[3] (mg/kg · yr)	COPC Soil Concentration Exceeds Wildlife Benchmark?	Air Screening Benchmarks Protective of Wildlife[1] ($\mu g/m^3$)	Maximum Annual Average Concentration in Air ($\mu g/m^3$)	COPC Air Concentration Exceeds Wildlife Benchmark?
Toxic Air Pollutants						
Volatile Organic Compounds						
1,3-Butadiene	NA	0.000015	NE	NA	0.00000572	NE
Acetaldehyde	NA	0.016	NE	NA	0.00618	NE
Acrolein	5.27 [4]	0.0022	No	578 [4]	0.000852	No
Ammonia	NA	0.88	NE	NA	0.342	NE
Benzene	0.05 [5]	0.0016	No	9,760 [4]	0.000603	No
Ethylbenzene	0.05 [5]	0.0021	No	304,000 [4]	0.000807	No
Formaldehyde	3900 [6]	0.11	No	NA	0.0414	No
Hexane	NA	0.030	NE	NA	0.0117	NE
Propylene	NA	0.090	NE	NA	0.0349	NE
Propylene oxide	NA	0.0056	NE	NA	0.00215	NE
Toluene	0.05 [5]	0.0083	No	1,040,000 [4]	0.00321	No
Xylenes	0.05 [5]	0.0030	No	135,000 [4]	0.00118	No
Polycyclic Aromatic Hydrocarbons						
Benzo(a)anthracene	5.21 [4]	0.0000026	No	NA	0.00000102	NE
Benzo(a)pyrene	0.1 [5]	0.00000073	No	NA	0.000000284	NE
Benzo(b)fluoranthene	59.8 [4]	0.0000013	No	NA	0.00000051	NE
Benzo(k)fluoranthene	148 [4]	0.0000013	No	NA	0.000000497	NE
Chrysene	4.73 [4]	0.0000029	No	NA	0.00000114	NE
Dibenz(a,h)anthracene	18.4 [4]	0.0000027	No	NA	0.00000106	NE
Indeno(1,2,3-cd)pyrene	109 [4]	0.0000027	No	NA	0.00000106	NE
Naphthalene	0.0994 [4]	0.00019	No	NA	0.0000749	NE

Notes:
COPCs = Chemicals of Potential Concern
NA = Screening value not available.
NE = Not Evaluated
1 = For more information on these studies and additional studies see Table 7.
2 = Lowest soil screening level from literature and database research was selected as the final benchmark.
3 = Drawn from Table 1.
4 = USEPA Region 5 Soil Ecological Screening Level (August 2003).
5 = USEPA Region 4 Soil Screening Benchmarks (November 2001).
6 = Oregon DEQ Level II Screening Level Values for mammals (ODEQ 2001). No values for birds available.

Table 9
Summary of Crop Studies Reviewed to Identify Air and Soil Screening Benchmarks for Plants

COPCs	Exposure Duration	Study Plant Species	Study Concentration: µg/m³ for Criteria Air Pollutants and mg/kg for Toxic Air Pollutants	Endpoint/Response	Reference	Comments
Criteria Air Pollutants						
NO_2	1 hour	Tomato	15,040 (8 ppm)	Visible foliar injury	Heck and Tangey 1979, as cited in USEPA 1983	Extent of foliar injury greatest when NO2 levels high, even for short duration.
	10 and 22 days	Tomato	210 to 1,170 (0.11 to 0.62 ppm)	Reduction in leaf size	Taylor and Eaton 1966, as cited in USEPA 1983	
	128 days	Tomato	470 (0.25 ppm)	Reduction in leaf growth, petioles, and stems; substantial decrease in fresh weight yield (22%), average fruit weight (12%), number of fruit (11%)	Spierings 1971, as cited in USEPA 1983	
	1 hour and 3 hour	Radish Swiss Chard Peas	230 to 1,880 (0.125 to 1ppm)	No visible foliar injury	Bennett et al. 1975, as cited in USEPA 1983	
	12 hours	Radish	4,000	Reduced yield (13%)	Zahn 1975, as cited in USEPA 1983	
	1 hour	Sugar Beet	1,880,000 (1000 ppm)	Reduction in fresh weight mass of roots (growth inhibition)	Czech and Nothdruft 1952, as cited in USEPA 1983	
	30 days	Eggplant	1,130 (0.6 ppm)	Reduced growth	Fujiwara 1973, as cited in USEPA 1983	
	14 days	Bush Bean	1,880 (1 ppm)	Reduced growth	Taylor et al. 1975, as cited in USEPA 1983	Author suggests threshold dose for injury of 752 ug/m³ (0.4 ppm) over prolonged period of time.
	27 days	Bush Bean	2,000	Reduced yield (27%); visible foliar injury	Zahn 1975, as cited in USEPA 1983	
	10 and 19 days	Pinto Bean	620 (0.33 ppm)	Reduced fresh and dry weights of unifoliar leaves	Taylor and Eaton 1966, as cited in USEPA 1983	
	26 days	Endive	2,000	Reduced yield (37%)	Zahn 1975, as cited in USEPA 1983	
	15 hours	Carrot	4,000	Reduced yield (30%); visible foliar injury	Zahn 1975, as cited in USEPA 1983	
NO_x	41 days	Tomato	1146 (0.6 ppm)	No effect on growth	Ishikawa 1976, as cited in USEPA 1993	
	213 hours over 7 weeks	Strawberry (Woodland)	1910 (1.0 ppm)	No significant effect on yield	Zahn 1975, as cited in USEPA 1993	
	1 hour	Oats	57,300 (30 ppm)	No effect on growth; 3 month old plants	Czech and Nothdurft 1952, as cited in USEPA 1993	
	334 hours over 40 days	Wheat	1910 (1.0 ppm)	No significant effect on yield, mass per grain (10% increase), stalk growth (12%)	Zahn 1975, as cited in USEPA 1993	
	1 hour	Wheat	57,300 (30 ppm)	No significant effect on yield	Czech and Nothdurft 1952, as cited in USEPA 1993	
	1 hour	Sugar Beet	19,100 (10 ppm)	No effect	Czech and Nothdurft 1952, as cited in USEPA 1993	Specific test endpoint not provided.
	1 hour	Sugar Beet	57,300 (30 ppm)	No effect	Czech and Nothdurft 1952, as cited in USEPA 1993	Specific test endpoint not provided.
	1 hour	Potato	19,100 (10 ppm)	No effect	Czech and Nothdurft 1952, as cited in USEPA 1993	Specific test endpoint not provided.
	1 hour	Potato	57,300 (30 ppm)	No effect	Czech and Nothdurft 1952, as cited in USEPA 1993	Specific test endpoint not provided.
NO	19 days	Tomato	750 (0.4 ppm)	Reduced leaf area, leaf weight, and stem weight	Capron and Mansfiled 1977, as cited in USEPA 1983	
SO_2	1 hour	Radish	1,950 (0.75 ppm)	First signs of visible foliar injury	Bennett et al. 1975, as cited in USEPA 1983	
	8 to 24 hours/day over 20 days	Radish	1,000	No foliar injury observed (Visible foliar injury occurred at 1,500.)	Faller et al. 1970, as cited in National Research Council 1978	
	1, 2, 4, 8 hour	Radish	1990 (0.76 ppm), 1410 (0.54 ppm), 760 (0.29 ppm), 370 (0.14 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	

Table 9
Summary of Crop Studies Reviewed to Identify Air and Soil Screening Benchmarks for Plants

COPCs	Exposure Duration	Study Plant Species	Study Concentration: µg/m³ for Criteria Air Pollutants and mg/kg for Toxic Air Pollutants	Endpoint/Response	Reference	Comments
SO_2 (Continued)	4.2 hours/day over 18 days (July - August)	Soybean	240 (0.09 ppm) 940 (0.36 ppm)	Significant yield reductions Visible leaf injury	Sprugel et al 1980, as cited in USEPA 1983	Field fumigation experiment using the Zonal Air Pollution System (ZAPS) that simulates ambient conditions near a point source. (Note: Within ZAPS experiments reporting a mean SO_2 conc. of 790 ug/m³, the actual conc. ranged from 0 to 3,140 ug/m³).
	4.33 hours	Soybean	3670 (1.4 ppm) 4450 (1.7 ppm) 5240 (2.0 ppm)	No significant loss in yield 11% loss in yield 15% loss in yield	Miller et al. 1979, as cited in USEPA 1983	
	4.7 hours/exposure 24 exposures	Soybean	310 (0.12 ppm) 790 (0.3 ppm) 2,070 (0.79 ppm)	12.3% loss in yield 20.5% loss in yield 45.3% loss in yield	Miller et al. 1980, as cited in USEPA 1983	
	4 days	Bushbean	200	No foliar injury observed	Krause 1975, as cited in National Research Council 1978	
	1, 2, 4, 8 hour	Bean	1210 (0.46 ppm), 1180 (0.45 ppm), 1130 (0.43 ppm), 550 (0.21 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1 day	Cucumber	786	Visible foliar injury	Brennan et al. 1964, as cited in National Research Council 1978	
	4 hours	Tomato Cucumber	1,050 - tomato 1,467 - cucumber	No foliar injury observed (Visible foliar injury occurred at 1,310 for tomato and 2,020 for cucumber.)	Brennan et al. 1968, as cited in National Research Council 1978	
	1, 2, 4, 8 hour	Carrot, cucumber	2830 (1.08 ppm), 2070 (0.79 ppm), 1310 (0.50 ppm), 660 (0.25 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1, 2, 4, 8 hour	Beet, turnip	3430 (1.31 ppm), 2020 (0.77 ppm), 1180 (0.45 ppm), 600 (0.23 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1, 2, 4, 8 hour	Spinach	3510 (1.34 ppm), 2380 (0.91 ppm), 1310 (0.50 ppm), 890 (0.34 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1, 2, 4, 8 hour	Lettuce, tomato, potato	1680 (0.64 ppm), 1470 (0.56 ppm), 1130 (0.43 ppm), 1000 (0.38 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1, 2, 4, 8 hour	Celery	2280 (0.87 ppm), 1940 (0.74 ppm), 1440 (0.55 ppm), 760 (0.29 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1, 2, 4, 8 hour	Swiss Chard	2310 (0.88 ppm), 1680 (0.64 ppm), 1100 (0.42 ppm), 710 (0.27 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1 day	Swiss Chard Pepper	786	No foliar injury observed	Brennan et al. 1964, as cited in National Research Council 1978	
	1, 2, 4, 8 hour	Oats, peas, rhubarb	1650 (0.63 ppm), 1550 (0.59 ppm), 890 (0.34 ppm), 450 (0.17 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	1, 2, 4, 8 hour	Raspberry	1830 (0.74 ppm), 1650 (0.63 ppm), 1390 (0.53 ppm), 1020 (0.39 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	3 hours / 8 exposures	Wheat	100 (0.04 ppm)	No yield effect	Sij et al 1974, as cited in USEPA 1982	
	3 hours / 7 exposures	Wheat	1180 (0.45 ppm)	No yield effect	Sij et al 1974, as cited in USEPA 1982	

Table 9
Summary of Crop Studies Reviewed to Identify Air and Soil Screening Benchmarks for Plants

COPCs	Exposure Duration	Study Plant Species	Study Concentration: µg/m³ for Criteria Air Pollutants and mg/kg for Toxic Air Pollutants	Endpoint/Response	Reference	Comments
SO_2 (Continued)	3 hours / 7 exposures	Wheat (Spring)	660 to 3140 (0.25 to 1.20 ppm)	No yield effect	Wilhour, et al 1978, as cited in USEPA 1982	
	72 hours/week during growing season	Wheat (Durum)	80 to 260 (0.03 to 0.10 ppm)	No yield effect	Wilhour, et al 1978, as cited in USEPA 1982	
	72 hours/week during growing season	Wheat (Durum)	390 (0.15 ppm)	Yield loss (42%)	Wilhour, et al 1978, as cited in USEPA 1982	Results reported in USEPA 1982 Table 8-3 as statistically non-significant.
	1, 2, 4, 8 hour	Buckwheat	1470 (0.56 ppm), 1020 (0.39 ppm), 680 (0.26 ppm), 390 (0.15 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	3 hours / 7 exposures	Barley	660 to 3140 (0.25 to 1.20)	No yield effect	Wilhour, et al 1978, as cited in USEPA 1982	
	72 hours/week during growing season	Barley	80 to 260 (0.03 to 0.10 ppm)	No yield effect	Wilhour, et al 1978, as cited in USEPA 1982	
	72 hours/week during growing season	Barley	390 (0.15 ppm)	Yield loss (44%)	Wilhour, et al 1978, as cited in USEPA 1982	Results reported in USEPA 1982 Table 8-3 as statistically nonsignificant.
	1, 2, 4, 8 hour	Barley	1650 (0.63 ppm), 1150 (0.44 ppm), 630 (0.24 ppm), 310 (0.12 ppm)	Foliar injury	Dreisinger and McGovern 1970, reprinted from HAS Sulfur Oxides Document 1978	
	3 hours / 7 exposures	Alfalfa	660 to 3140 (0.25 to 1.20 ppm)	No yield effect	Wilhour, et al 1978, as cited in USEPA 1982	
O_3	1 hour	Soybean	1,468 (0.75 ppm)	Reduced root and top growth and reduced nodule weight and number	Tingey et al. 1973, as cited in USEPA 1986	Root growth consistently reduced more than top growth.
	4 to 6 hours/day chronic exposure	Soybean Corn	98 to 290 (0.05 to 0.15 ppm)	Reduced yield (not specified)	Heagle et al. 1974, as cited in USEPA 1983	Author identifies the threshold for measurable effects between 98 and 196 ug/m³ (0.05 to 0.1 ppm) for sensitive plant cultivars.
	3 hours/day for 3 days/week until harvest	Corn	392 (0.2 ppm)	Reduction in kern weight (13%), top weight (20%), and root weight (24%)	Oshima et al. 1973, as cited in USEPA 1986	
	0.5 hours 1 hour 4 hours	Agricultural Crops	400 to 800 (0.2 to 0.41 ppm) 200 to 500 (0.1 to 0.251 ppm) 75 to 180 (0.04 to 0.09 ppm)	No visible foliar injury; concentrations represent limiting values for effects (see comments)	Jacobson 1997, as cited in USEPA 1983 and USEPA 1986	Limiting values are the doses of a pollutant that are unlikely to cause measurable damage to vegetation (e.g. foliar injury).
	1.5 hours for 3 exposures	Radish	785 (0.4 ppm)	Inhibition of root growth from single exposure greatest for 2-week old plant; third exposure caused greatest reduction in root growth	Tingey et al. 1973, as cited in USEPA 1986	
	4 days	Tomato	686 (0.35 ppm)	Reduced yield (not specified); fewer fruit set See comment	Oshima et al. 1975, as cited in USEPA 1986	Author notes that significant injury occurred at both 392 and 686 ug/m³ (0.2 and 0.35 ppm) O_3.
	2.5 hours/day for 3 days/week over 14 weeks	Tomato	392 (0.2 ppm)	Slight reduction in yield (1%), 32% reduction in top weight/growth, and 11% reduction in root weight	Oshima et al. 1975, as cited in USEPA 1986	
	3 hours/day over 38 days	Beet	392 (0.2 ppm)	Reduction in top growth/weight (50%)	Ogata et al. 1973, as cited in USEPA 1986	
	8 hours/day over 28 days	Pinto Bean	255 (0.13 ppm)	Reduction in top growth/weight (79%), root weight (73%), and plant height (70%)	Manning et al. 1971, as cited in USEPA 1986	
	2 hours/day over 63 days	Pinto Bean	290 (0.15 ppm)	Reduction in plant weight (33%) and bean pod fresh weight (46%)	Hoffman et al. 1973, as cited in USEPA 1986	

Table 9
Summary of Crop Studies Reviewed to Identify Air and Soil Screening Benchmarks for Plants

COPCs	Exposure Duration	Study Plant Species	Study Concentration: µg/m³ for Criteria Air Pollutants and mg/kg for Toxic Air Pollutants	Endpoint/Response	Reference	Comments
NO_2 and SO_2	4 hours	Pinto bean Radish Soybean Tomato	NO_2 - 94 (0.05 ppm) SO_2 - 131 (0.05 ppm)	First signs of visible foliar injury	Tingey et al. 1971, as cited in USEPA 1983	Author found no visible foliar injury to same plants exposed to 3,760 ug/m³ (2 ppm) NO_2 or 1,310 ug/m³ (0.5 ppm) SO_2, when constituents administered alone.
	1 hour	Radish	NO_2 - 940 (0.5 ppm) SO_2 - 1,130 (0.5 ppm)	First signs of visible foliar injury	Bennett et al. 1975, as cited in USEPA 1983	
	4 hours	Pinto bean Tomato Radish Oats	NO_2 - 190 - 380 (0.10 to 0.02 ppm) SO_2 - 390 to 660 (0.15 to 0.25 ppm)	No foliar injury	Bennett et al. 1975, as cited in USEPA 1982	
NO_2, SO_2, and O_3	2 hours	Tomato	NO_2 - 560 (0.3 ppm) SO_2 - 310 (0.12 ppm) O_3 - 200 (0.1 ppm)	Extensive leaf damage (necrosis)	DeCormis and Luttringer 1976; Reinert and Gray 1977, as cited in USEPA 1983	NO_2, SO_2, and O_3 less injurious when used individually than when in combinations of NO_2 + SO_2, NO_2 + O_3, or SO_2 + O_3.
SO_2 and O_3	6 hours/day over 133 days	Soybean	O_3 - 200 (0.1 ppm) SO_2 - 260 (0.1 ppm)	Plant injury and defoliation	Heagle et al. 1974, as cited in USEPA 1983	
Toxic Air Pollutants						
Volatile Organic Compounds						
Benzene	- -	- -	0.01 mg/kg	- -	Oak Ridge National Laboratory RAIS database query January 2007. Swartjes, F.A. 1999. Risk-based Assessment of Soil and Groundwater Quality in the Netherlands: Standards and Remediation Urgency. Risk Analysis 19(6): 1235-1249	Plant screening benchmarks were not available. Dutch Target Soil Screening benchmarks used in the absence of plant-specific values.
Ethylbenzene	- -	- -	0.03 mg/kg	- -	Oak Ridge National Laboratory RAIS database query January 2007. Swartjes, F.A. 1999. Risk-based Assessment of Soil and Groundwater Quality in the Netherlands: Standards and Remediation Urgency. Risk Analysis 19(6): 1235-1249	Plant screening benchmarks were not available. Dutch Target Soil Screening benchmarks used in the absence of plant-specific values.
Formaldehyde	- -	- -	0.3 mg/kg	- -	Oak Ridge National Laboratory RAIS database query January 2007. Swartjes, F.A. 1999. Risk-based Assessment of Soil and Groundwater Quality in the Netherlands: Standards and Remediation Urgency. Risk Analysis 19(6): 1235-1249	Plant screening benchmarks were not available. Dutch Intervention Soil Screening benchmarks used in the absence of plant-specific values.
Toluene	- -	Soybean	200 mg/kg	Germination and plant weight	Oak Ridge National Laboratory RAIS database query January 2007. Efroymson, R.A. , M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN	

Table 9
Summary of Crop Studies Reviewed to Identify Air and Soil Screening Benchmarks for Plants

COPCs	Exposure Duration	Study Plant Species	Study Concentration: µg/m³ for Criteria Air Pollutants and mg/kg for Toxic Air Pollutants	Endpoint/Response	Reference	Comments
Xylenes	- -	see comment	10 mg/kg	- -	Oak Ridge National Laboratory RAIS database query January 2007. USEPA Region 5 soil Ecological Screening Values	Based on exposure to plants. Plant type not specified in reference.
Polycyclic Aromatic Hydrocarbons						
Benzo(a)anthracene	- -	Wheat	1.2 mg/kg	- -	USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.	Benzo(a)pyrene used as a surrogate.
Benzo(a)pyrene	- -	Wheat	1.2 mg/kg	- -	USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.	Primary reference: Sims and Overcash (1983)
Benzo(b)fluoranthene	- -	Wheat	1.2 mg/kg	- -	USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.	Primary reference: Sims and Overcash (1983)
Benzo(k)fluoranthene	- -	Wheat	1.2 mg/kg	- -	USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.	Benzo(a)pyrene used as a surrogate.
Chrysene	- -	Wheat	1.2 mg/kg	- -	USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.	Benzo(a)pyrene used as a surrogate.
Dibenz(a,h)anthracene	- -	Wheat	1.2 mg/kg	- -	USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.	Benzo(a)pyrene used as a surrogate.
Indeno(1,2,3-cd)pyrene	- -	Wheat	1.2 mg/kg	- -	USEPA 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.	Benzo(a)pyrene used as a surrogate.
Naphthalene	7 days	Lactuca sativa	32 mg/kg	Plant growth	USEPA ECOTOX database viewed January 2007.	

Notes:
COPCs = Chemicals of Potential Concern
- - = Study information not available in referenced document or database.

Table 10
Summary of Generic Soil Screening Benchmarks Protective of Wildlife

COPCs	Soil Benchmarks Protective of Wildlife [1] (mg/kg or µg/m³)				Study Animal Species	Reference
	EPA Region 4 Soil Screening Benchmarks [2]	EPA Region 5 Ecological Screening Levels [3]		ODEQ Level II SLVs [4]		
		Soil	Air			
Toxic Air Pollutants						
Volatile Organic Compounds						
Acrolein	- -	**5.27**	578	- -	meadow vole	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.
Benzene	**0.05**	0.255	9,760	3300	- -	Region 4 Soil Screening Benchmarks based on Ministry of Housing, Spatial Planning and Environment, 1994.
Ethylbenzene	**0.05**	5.16	304,000	- -	- -	Region 4 Soil Screening Benchmarks based on Ministry of Housing, Spatial Planning and Environment, 1994, and Beyer 1990.
Formaldehyde	- -	- -	- -	**3900**	- -	- -
Toluene	**0.05**	5.45	1,040,000	1440	- -	Region 4 Soil Screening Benchmarks based on Ministry of Housing, Spatial Planning and Environment, 1994, and Beyer 1990.
Xylenes	**0.05**	- -	135,000	120	- -	Region 4 Soil Screening Benchmarks based on Ministry of Housing, Spatial Planning and Environment, 1994, and Beyer 1990.
Polycyclic Aromatic Hydrocarbons						
Benzo(a)anthracene	- -	**5.21**	- -	- -	masked shrew	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.
Benzo(a)pyrene	**0.1**	1.52	- -	125	- -	Region 4 Soil Screening Benchmarks based on Beyer 1990.
Benzo(b)fluoranthene	- -	**59.8**	- -	- -	masked shrew	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.
Benzo(k)fluoranthene	- -	**148**	- -	- -	masked shrew	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.
Chrysene	- -	**4.73**	- -	- -	masked shrew	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.
Dibenz(a,h)anthracene	- -	**18.4**	- -	- -	masked shrew	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.
Indeno(1,2,3-cd)pyrene	- -	**109**	- -	- -	masked shrew	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.
Naphthalene	0.1	**0.0994**	80100	3900	masked shrew	Region 5 Soil ESLs are based entirely on receptor-specific exposure model values derived from adjusted toxicity reference values (TRVs) by applying three uncertainty factors.

Notes:
COPCs = Chemicals of Potential Concern
- - = Value or information not available in benchmark compilation guidance document.
1 = **Bold** indicates the lowest screening value, which was selected as the final wildlife benchmark for soil (only one source of air benchmarks available). Study information is in reference to selected wildlife soil benchmark only.
1 = USEPA Region 4 Soil Screening Benchmarks (November 2001).
2 = USEPA Region 5 Soil Ecological Screening Level (August 2003).
4 = Oregon DEQ Level II Screening Level Values for mammals (ODEQ 2001). No values for birds available.

2. NOISE

This noise assessment was prepared to address the concern raised regarding potential project noise affecting the residences located approximately 1.7 miles (about 9,000 feet) southeast of the proposed Colusa Generating Station site. This concern was analyzed in depth in Section 8.5 of the project's AFC. We will attempt here to summarize and clarify the discussion provided in the AFC.

Of the many distinct major and minor factors that influence how sound is generated, how it travels, and how it is perceived and affects a sensitive receptor, there are only three major parts to a meaningful analysis:

- *Source* characteristics (how much sound will be generated, is the source large or small, short or tall, etc.)
- *Path* characteristics (how great is the separation distance, are there natural or man-made barriers, is surface flat like water or rough like tilled soil, etc.)
- *Receptor* characteristics (noise-sensitive including residential, nature of existing noise sources, environment is moderately quiet or noisy, type of structures affected, etc.)

Based on the analysis in the AFC, the *source* noise was comprehensively analyzed using a powerful three-dimensional computer model (that has been tested many times for accuracy). The modeling and all assumptions were conservative.

The *path* length is about 9,000 feet, thus allowing the generated sound to spread out, attenuate, and dissipate considerably before it reaches the *receptors*. Over this considerable distance, the sound level of the plant observed at 100 feet from the generators would be perceived as only 1/16 as loud when observed outside the residence. The residence at ML-1 is assumed to be of normal construction possessing average acoustical characteristics (this is discussed further below). Some typical existing noise sources are in the general area, such as roads and a highway plus agricultural activities. All of these sources combine to produce an existing 54 dBA Day-Night Average Sound Level (L_{dn}).

To explain these terms, decibels, abbreviated dB, are the units used to measure sound like inches may be used to measure distance. The "A" means that an adjustment has been applied to the measured value to match more closely what a human hears. The L_{dn} is a single number community noise descriptor for a typical 24-hour period that includes a substantial penalty (+10 dBA) for nighttime (10:00 p.m. to 7:00 a.m.) noise. The existing level of 54 dBA is below the U.S. Environmental Protection Agency's recommended ideal community noise level for residential exterior areas, and well below the local planning agency guidelines.

No change, to very little change, both measurably and perceptually will occur to the noise environment at ML-1 when the Colusa Generating Station becomes operational. This is based on the fact that the plant noise is predicted to be 44 dBA L_{dn} at ML-1. This will increase the existing L_{dn} by less than one-half of a dBA. Even inside of a laboratory, this small change is difficult to perceive and would not be perceptible in the real-world outside environment. One may ask, why doesn't 44 dBA L_{dn} from the plant, when added to the existing 54 dBA L_{dn}, result in 98 dBA L_{dn} (a really loud noise level)? That is because the decibels are ratio units that add logarithmically. For example, 40 dBA plus 40 dBA for two sources would result in a total noise level of 43 dBA, 60 + 60 yields 63, etc. Importantly, when the source levels differ in level, the

louder sound dominates to the point where the softer sound is of no importance. Specifically, when two sounds differ by 10 dBA or more, the cumulative effect is imperceptible because the overall increase is 0.4 dBA or less. For example at ML-1 the 44 dBA L_{dn} from the plant added to the existing 54 dBA L_{dn} results in 54.4 dBA L_{dn}. This is an imperceptible change, which would be difficult to measure.

We also looked at the potential effects of plant noise at ML-1 on a short-term or instantaneous basis. The predicted exterior sound level from the plant at ML-1 is 40 dBA L_{eq} (another sound descriptor—similar to L_{dn} but with no time-of-day adjustment). This exterior "quiet" sound level would not interfere with communication activity (including conversation, telephone, television), with intellectual activity (including quiet recreational pursuits such as reading or concentrating on balancing a checkbook, etc.), or likely with sleep. Normal residential construction *with windows open* typically provides an additional reduction in sound level of about 10 to 13 decibels. Thus, inside of the residence, the exterior 40 dBA L_{eq} of plant sound would be reduced to 30 dBA L_{eq} or less, a very quiet level and one that satisfies even the most conservative sleep disturbance criteria. In actuality, it is likely that the existing level of environmental noise at ML-1 will mask or "drown out" the plant sound most of the time. One of these local noise sources is the Delevan Compressor Station. Its operational characteristics and thus, noise emission, may have changed slightly over the past few years. In response to a recent meeting with Emerald Farms regarding noise concerns, URS plans to conduct additional environmental noise measurements at ML-1 in April 2007 to further support the information already presented in the AFC noise analysis.

3. ELECTROMAGNETIC FIELD

COMBINED CYCLE PLANTS AS POSSIBLE SOURCE OF EMI INTERFERENCE

Standards published in the United States that are related to power plant electromagnetic interference (EMI) issues generally address avoidance of interference problems within the plant and its control systems. Standards do not currently exist that address issues related to the EMI emission levels to areas outside of the power plant, due to the fact that no interference is realized outside of the immediate vicinity of the plant.

The amount of electromagnetic energy radiated by 60 Hz electrical power systems is negligible because the wavelength (5,000 km or 3,000 miles) is so long compared to the size of the equipment carrying or generating the energy. Therefore, the interference issues are limited to near-field inductive or capacitive effects which are appreciable only when in very close proximity (less than about 10 m or 30 feet) to the current-carrying equipment. For this reason, 60 Hz field effects are not present outside the plant boundary, except as may exist in the direct close proximity of the outgoing power lines. However, the field levels of overhead power lines are quite low, as can be seen from the following data taken from "Background Paper on Power Line Fields and Public Health," March 29, 1996 by D. Hafmeister.

> "Typical 230 kV transmission power lines produce average fields at distances of 30 and 60 meters as follows:

Line Voltage	Electric Fields (at 30/60 meters)	Magnetic Fields (at 30/60 meters)
230 kV	0.3/0.05 milligauss	7.1/1.8 milligauss

> For reference, average magnetic fields at a distance of 30 cm (12 inches) are: color television (7 milliGauss (mG)), microwave (4 mG), analog clocks (15 mG), electric razors (20 mG to 100 mG at 15 cm) and hair driers (1 mG to 300 mG at 15 cm)."

In addition to the 60 Hz electrical systems, there are other possible sources of EMI within a power plant and its outgoing power lines, including localized corona (partial discharges), transient currents caused by faults and switching operations, and plant communications systems.

Partial discharges – this is an electrical phenomenon that occurs due to local ionization around an electrical conductor. It may occur within equipment as a result of insulation deterioration, and also occurs naturally under certain conditions near exposed HV conductors (such as overhead power lines). Partial discharges generate radio frequency emissions, which can cause interference, mainly to AM transmissions within a particular frequency band. From "PG&E Delta Distribution Planning Area Capacity Increase Substation Project Environmental Assessment," August 2005:

> "Overhead transmission lines do not, as a general rule, interfere with normal radio or TV reception……Typically, corona interference to radio and television reception is not a design problem. Interference levels both in fair weather and in rain are extremely low at the right-of-way edge for 230 kV and lower transmission lines, and will usually meet or exceed reception guidelines of the Federal Communications Commission (FCC)."

Plant communications systems include digital communications with the offsite utility system, telephone lines, and hand-held radio systems. Communications to offsite locations are either

through the telephone system or via fiber-optic connections. Neither of these is considered a source of interference to facilities outside the plant. Hand-held radio system channel frequencies will also be coordinated with all local in-use frequencies, as required by the local jurisdiction to avoid any interference issues.

No interference mechanism to local GPS or laser-based systems is identified, due to the extremely high frequency (typically in the Gigahertz range) and/or line-of-site nature of those systems. It is noted that all new power plants utilize such technologies internally, such as GPS clock synchronization for the plant control system and laser levels for aligning equipment, with no observable interference effects even with very close proximity to high-energy electrical systems.

The following is an excerpt from the Colusa Application for Certification, including Table 5.3-2:

"These results of the EMF analysis are shown in Table 5.3-2, and indicate that the maximum magnetic fields seen after the addition of the E&L Westcoast, LLC Colusa project are located where the existing four 230 kV lines are cut and looped into the CGS switchyard. Table 5.3-2 shows magnetic and electric fields generated by the existing PG&E transmission system and the interconnection to the CGS. It shows the fields generated under existing maximum line loading and after addition of the CGS. It also shows the field strengths at a point 250 feet away from the lines.

The highest value calculated was 85.0 milligauss (mG) at the point of intersection of the PG&E transmission lines and the new lines looping into the new CGS switchyard. The corresponding maximum electric field at this location was 0.88 V/m. As one moves away from this location, both fields degrade rapidly. For example, at a distance of 250 feet from the point of maximum field strength, the magnetic field is reduced to 3.8 mG.

The results show how all of the fields degrade rapidly with distance from the lines. Since the nearest permanent residence is approximately 1.7 miles from the proposed project, magnetic and electric fields generated by the transmission lines are essentially negligible both before and after development of the CGS.

Table 5.3-2
EMF and Electric Fields

		PG&E Transmission Lines								CGS Interconnect				Maximum Value	
		Circuits Before		North After		Circuits Before		South After		Before		After			
	Units	Max	250′	Max	250′	Max	250′	Max	250′	Max	250′	Max	250′	Max	250′
Magnetic Field	MG	15.0	1.94	11.2	1.3	15.0	1.94	43.9	2.6	NA	NA	39.9	4.46	85.0	3.8
Electric Field	V/m	0.9	0.034	0.9	0.034	0.9	0.034	0.9	0.034	–	–	0.88	0.20		

Note:
250′ = at a distance of 250 feet.

Conclusion

No significant EMI mechanisms have been identified within a typical power plant facility which could potentially disrupt or otherwise interfere with communications or other EM based devices and systems outside the plant boundary. This is reflected in the lack of U.S. standards governing any such emissions, as well as the lack of any significant anecdotal references to such phenomenon. It is noted that many existing power plant facilities are in very close proximity to other facilities and businesses, with no observed EMI interference problems.

4. LAND USE

Based on the analysis presented in the AFC, the project is not expected to result in any significant unmitigated impacts. In the absence of any significant impacts on surrounding properties, the project would not be expected to negatively affect the value and marketability of any such properties, including those specifically identified. Specific areas of possible concern are addressed in detail in the AFC, and briefly summarized below.

Land Use Compatibility

As stated in Section 8.4.2.2 of the AFC, the project is consistent with existing land uses in the area, which include the PG&E Compressor Station, transmission lines and natural gas lines. Colusa County also supports locating power plants in proximity to these resources.

Visual Impacts

As indicated in the AFC, the project would not have significant visual impacts. In Section 8.11.2.3.2 of the AFC, impacts were evaluated impacts from Key Observation Points (KOPs), which included two points (identified as KOPs 1 and 2) located near Parcels 1 and 15 referenced in the comment. The less-than-significant impact determination was based on several factors, including the project's distance to these properties; a high degree of modification to the natural setting from the PG&E Compressor Station and existing transmission line corridors; and back dropping of the project by the nearby topography.

Noise

As presented in Section 8.5.2.2 of the AFC and in the response to Item 2 above, the project would increase daytime noise levels by an imperceptible amount. Interior noise levels with the "windows open" at night would also not be significantly impacted by power plant noise. The power plant noise levels would not exceed exterior criteria at the closest residences as established by Colusa County.

Air Quality

As discussed in Section 8.1 of the AFC, and elsewhere in this response, the project is not expected to result in any significant impacts to air quality that might affect the use and enjoyment of properties in the vicinity of the project. Operation of the project is not expected to have any impact on agricultural resources or operations. Furthermore, no adverse effects are likely to occur to the plant and animal communities that may be present in the vicinity of the site or humans that consume locally grown produce.

Public Health

As presented in Section 8.6 of the AFC, a complete health risk assessment (HRA) was conducted to analyze potential impacts to public health associated with the project. The conclusions of the HRA are that the health effects impacts of the proposed project are well below all significance thresholds established for purposes of analyzing such impacts.

Traffic and Transportation

As set forth in Section 8.10 of the AFC, while construction activity will perceptibly increase the level of traffic in the area at certain times of day, these increases will be temporary, and in any event are not predicted to significantly affect the level of service of any affected roadways.

Traffic impacts associated with operations of the plant (approximately 30 full-time employees) will not significantly impact surrounding roadways.

Conclusions

Based on the foregoing, and the detailed analysis of these and other areas presented in the AFC, the project is not expected to negatively affect the referenced property (Parcels 1 and 15).