ROSEMONT MINE OUTDOOR LIGHTING &
PIMA COUNTY OUTDOOR LIGHTING CODE
TECHNICAL MEMO

ROSEMONT PROJECT
M3-PN08036

Prepared for

ROSEMONT COPPER COMPANY

January 2011
Revised From
Technical Memo Dated
December 2009

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Memorandum

To: Bev Everson
Cc: Tom Furgason
From: Kathy Arnold
Doc #: 038/11 – 15.3.2
Subject: Air Modeling Reports and Dark Skies Reports
Date: April 14, 2011

Rosemont is pleased to transmit the following reports regarding air modeling for the Rosemont Project electronically:

- **VISCREEN: Visibility Impacts Analysis at Saguaro East NP**, prepared by Applied Environmental Consultants, April 4, 2011
- **Amendment to: Emission Inventory Information Years 1, 5, 10, 15 and 20, Volume I: Calculation Methodology and Appendices A-G**, prepared by Applied Environmental Consultants, April 4, 2011
- **Amendment to: Emission Inventory Information Years 1, 5, 10, 15 and 20, Volume II: Calculation Methodology and Appendices H**, prepared by Applied Environmental Consultants, April 4, 2011
- **Revised CALPUFF Modeling Report to Assess Impacts in Class I Areas (including model files)**, prepared by Applied Environmental Consultants, April 4, 2011

The reports on air were transmitted electronically on April 4. These are the hardcopy and electronic copy of each report. The dark skies reports were submitted in February directly to the Forest Service from our consultants, these are hardcopy transmittals of each report. I am transmitting three copies to the Forest Service and two copies to SWCA of each of the above referenced documents.
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ATTACHMENTS

000-EL-201 Rev. 3 - Site General, Electrical, Area & Road Lighting, Designation
000-EL-202 Rev. 3 - Site General, Electrical, Pima Co. Outdoor Ltg. Code, Lighting Compliance Plan
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1 Background

The 2006 Pima County Outdoor Lighting Code is the Code in effect regulating the amount of light permitted outdoors within the City of Tucson and Pima County. The Code describes several Lighting Areas that are centered on the various astronomical telescope facilities located within Pima County. The Rosemont Mine is within an area of Pima County that is the most restrictive Lighting Area of the Code, namely, Area ‘E1a.’ The maximum amount of light within the Area ‘E1a’ is 18,000 lumens per acre from all outdoor lighting sources. In addition, all outdoor lighting must be full cut off or shielded for Low Pressure Sodium (LPS), High Pressure Sodium (HPS), and any other sources. Non-LPS full cutoff is limited to 3,000 lumens per acre, but also contributes to the 18,000 lumens per acre limit.

The mine is exempt from complying with the Pima County Outdoor Lighting Code, however, Rosemont Copper plans to operate within the intent of the Pima County Outdoor Lighting Code as long as mine safety and operations are not compromised. To these ends, the mine outdoor lighting design was given special attention, and the results are discussed below.

This Revision of the Technical Memo updates the Memo to the impacts of the latest design decisions made by Rosemont Copper.

2 2006 Pima County Outdoor Lighting Code

The 2006 Pima County Outdoor Lighting Code (“the Code”), in Section 202, ‘Definitions,’ “Outdoor Light Output – Total,” sets the criteria of using “… mean lumen output as defined by the lamp manufacturer, shall be the lumen value used” for calculating total lumens for lamps that “… vary in light output as they age (such as fluorescent and high intensity discharge lamps)… “.

The Code does not specifically state the criteria of what portion of a land development is used as the basis of determining the lumens per acre value. In paragraph 401.1, Table 401.1 (“the Table”), Notes to Table 401.1 #1 does state “1. Use any one of the three options, 1, 2, 3 for the entire property” (Bold is mine – F. E.). With this notation to the Table, the “ … entire property … “ is construed to be the total property of the Rosemont Mine Site, or, the full 4,415 acres.

Highlighted prints of the pages quoted are attached to this Technical Memo.

3 Design Approach and Results

The entire mine site is regulated by the Mine Safety and Health Act (MSHA, or “Em-Sha”). Similar to the Occupational Safety and Health Act, MSHA establishes requirements for providing mine workers with a safe and healthy working environment. Part of that attempt includes requirements for lighting within the mine property to offer a well lit and safe working area. More specific impact of the MSHA regulations are included later in this Memo.
3.1 Roadway and Parking Lots

The use of outdoor lighting is primarily for safety, especially at a mine site. On roadways and in parking lots, lighting allows earlier driving decisions by enabling the vehicle operators to understand the driving challenge facing them at the immediate moment. This lighting also allows pedestrians to better avoid hazards on the ground in their path of travel while they are close to roads. As a result, the roadway lighting on mine circulation roads was designed for an average illumination of 0.5 foot candle (fc). The lighting on the Primary Access Road from U. S. Highway 83 has been deferred from the initial design, but is included in the total lumens reported.

All roadway and designated parking lot lighting was designed using LPS fixtures and a maximum of 6:1 ratio between the average illumination and the minimum illumination on the surface of the road or parking lot. Lithonia “Visual Roadway Tool” outdoor lighting software was utilized to establish parameters of lamp wattage, mounting height of the light fixture above the road, position of the light fixture with respect to the road edge (“Set-back”) and distance between lights (“Light Span”). To achieve 0.5 fc, light fixtures were found to require a Light Span of 123 feet on the two-lane Haul Truck Roads within the Ore Processing Area. For the Light Truck Roads, spans of approximately 225 feet were calculated to be appropriate. Parking lots were designed using the same software.

3.2 Mine Process Area

The primary purpose of area lighting, especially around process buildings, is for safety. These areas tend to have pedestrian traffic intermingled with activities which are conducive to elevated hazards in the working environment. For this reason, HPS lighting was selected for use around these buildings.

3.3 Mine Pit

The mine pit area is the most hazardous of all the operational areas of the facility. As such, movement within the mine is highly regulated and visibility at the operational areas is critical. Using data developed over the years, the manufacturers of the shovels and drills recommend the use of HPS lighting to meet the needs of mine safety and operational visibility. The HPS lamps are concentrated around the large shovels and the areas they are working. There will be a total of three (3) shovels (all three could be working at the same time), three (3) drills and two (2) loaders. Each shovel will have lighting consisting of as many as 19-35 watt HPS, 4-400 watt HPS and 6-1000 watt HPS lights. The three drills will have a total of approximately 519,570 lumens of light from various sized lamps. This lighting is necessary to keep night operations as safe as possible at these large machines. Total lighting from HPS lamps in the Pit is 3,412,520 lumens.

The two loaders in the Pit can not utilize HPS or LPS lamps because of the very rugged service conditions. HPS and LPS lamps are designed to be operated in a
stationary position and relatively free of vibration. The lights mounted on the loaders use a xenon light source and contribute approximately 78,000 lumens of white light to the total light on the Mine property for both loaders together.

In addition, there are two support areas, a re-fueling site and an explosives storage facility, associated with the Pit, but outside the Pit boundary. LPS lamps are used to light these two areas, and these lumens are counted with “Ore Processing.”

Historically, this lighting has been shown to be required while operating mine shovels, drills and loaders at night and still be able to maintain a safe work area.

Two major access roads are associated with the Pit operations near the boundary of the Ultimate Pit Limit, and intersect on the South-East quadrant of the Pit. The lighting lumens for this important and potentially hazardous intersection are included in the “Ore Processing” total lumens count.

The 400 watt and 1000 watt HPS lamps do exceed the 3,000 lumens per lamp criteria, but the total lumens per acre is met, as shown later in this memo.

3.4 Primary Access Road

The Primary Access Road lighting is included in the total reported lumens.

3.5 Leach Pads

Lighting on the Leach Pads is portable lighting and is not addressed by the Code. This lighting can be on all night, depending on ore processing schedules. The Leach Pad lighting will be specified as HPS with shields. These lumens are counted in the total lumens.

3.6 Results

Total acreage of the Rosemont Mine Site: 4,415 acres

<table>
<thead>
<tr>
<th>High Pressure Sodium Lamp Lumens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Lumens per Acre:</td>
</tr>
<tr>
<td>Total HPS lumens allowed @ 3,000 lumens/acre:</td>
</tr>
<tr>
<td>Current Total Lumens proposed:</td>
</tr>
<tr>
<td>Current Total Percent of Maximum Allowed:</td>
</tr>
<tr>
<td>Current Proposed Average Lumens per Acre:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low Pressure Sodium Lamp Lumens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Lumens per Acre:</td>
</tr>
<tr>
<td>Total LPS lumens allowed @ 18,000 lumens/acre:</td>
</tr>
<tr>
<td>Current Total Lumens proposed:</td>
</tr>
<tr>
<td>Current Total Per-Cent of Maximum Allowed:</td>
</tr>
<tr>
<td>Current Proposed Average Lumens per Acre:</td>
</tr>
</tbody>
</table>
4 Conclusions

LPS type outdoor lighting is a very attractive light (lamp) source to use in pursuit of compliance with the Pima County Outdoor Lighting Code. M3 recommends care in using LPS type outdoor lighting at the mine site for the following reasons.

A concern in using LPS lighting is that of a potential safety hazard, which could occur if personnel are injured, are bleeding, and the first responders can not see by the color of the liquid what it is. Other fluids that are color specific are hydraulic oils, which can be red, blue, or green depending on the use and off-road diesel, which is dyed red. Therefore, the color recognition of these oils is important as they have varying hazards associated with each. LPS light masks all colors. All colors appear gray under LPS lighting. To address that issue, the more potentially hazardous locations have been provided with the better color-rendering lighting of the HPS lamp.

The total lumens as presented in this Memo are based on design information available at the date of the memo. Final actual total lumens may vary from these values as the design of the mine is completed. Nevertheless, Rosemont Copper has a commitment to make every effort to remain compliant with the Pima County Outdoor Lighting Code as final design decisions are made. Further, Rosemont Copper is working with heavy equipment manufacturers and lighting manufacturers to identify light sources and shielding methods to further limit light pollution.
**Full Cutoff Light Fixture.** A luminaire where no candela occur at or above an angle of 90 degrees above the nadir. This applies to all lateral angles around the luminaire. Such candela information shall be as determined by a photometric test report from a nationally recognized independent testing laboratory and as certified by the manufacturer. Any structural part of the luminaire providing full cutoff angle shielding shall be permanently attached.

**Installed.** The attachment, or assembly fixed in place, whether or not connected to a power source, or any outdoor light fixture.

**Lumen.** Unit of luminous flux; used to measure the amount of light emitted by lamps.

**Luminaire.** The complete lighting assembly, less the support assembly. For purposes of determining total light output from a luminaires lighting assemblies which include multiple unshielded or full cutoff lamps on a single pole or standard shall be considered as a single unit. Two or more units with lamps less than three feet apart shall be considered a single luminaires.

**Multi-class Lighting.** Any outdoor lighting used for more than one purpose, such as security and decoration, such that its use fails under the definition of two or more classes as defined for Class 1, 2 and 3 lighting.

**Net Acreage.** The remaining ground area after deleting all portions for proposed and existing public streets within a development, parcel, or subdivision.

**Opaque.** Opaque means that the material shall not transmit visible light.

**Outdoor light fixture.** An outdoor illuminating device, outdoor lighting or reflective surface, lamp or similar device, permanently installed or portable, used for illumination or advertisement. Such devices shall include, but not be limited to:
1. Street lighting.
2. Parking lot lighting.
4. Landscaping lighting.
5. Recreational lighting.
6. Billboards and other signs (advertising or otherwise).
7. Product display area lighting.
8. Building overhangs and open canopy lighting.
10. Searchlight, spotlight, flood lights, and laser lights.

**Outdoor Light Output - Total.** The total amount of light, measured in lumens, from all outdoor light fixture lamps. Total outdoor light output is calculated as follows:
1. For lamp types that vary in light output as they age (such as fluorescent and high intensity discharge lamps), the mean lumen output, as defined by the lamp manufacturer, shall be the lumen value used.
2. The total light output for each outdoor light fixture shall be based on the largest lamp that the outdoor light fixture is rated to accommodate. For the purpose of compliance with this section, the largest lamp rated for fluorescent and high intensity discharge fixtures shall be based on the installed ballast rating.

**Outdoor Recreation Facility.** An area designed for active recreation, whether publicly or privately owned, including, but not limited to baseball, soccer, football, golf, tennis, swimming pools, and race tracks of any sort.

**Person.** Any individual, tenant, lessee, owner, or any commercial entity including but not limited to firm, business, partnership, joint venture or corporation.

**Public right-of-way.** A road, street, alley or highway permanently dedicated to the public for public use.

**Temporary Lighting.** Lighting which does not conform to the provisions of this ordinance and which will not be used for more than one thirty (30) day period within a calendar year, with one thirty (30) day extension.

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2006 Pima County Outdoor Lighting Code

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Note: Highlight added for emphasis
Chapter 4
Illumination Levels and Shielding Requirements

Section 401
Total Outdoor Light Output and Shielding Requirements

401.1 General. Table 401.1 gives requirements of the total light output permitted per acre for the different lighting areas and the fixture shielding requirements for class of lighting, lamp type, and lighting area. These requirements shall be met for all lighting installations subject to this code.

401.2 Total outdoor light output. Total outdoor light output shall not exceed the lumen limits given in Table 401.1. In the table, “total” means the sum of shielded and unshielded light.

401.2.1 Determining compliance. For determining compliance with this chapter the total lumens is the sum of the following:
1. One hundred percent of the lumens from outdoor light fixtures installed on grade, on poles, and installed on the top or sides of buildings of other structures.
2. Fifty percent of the lumens from underwater light fixtures unless the fixture is aimed at an angle of less than 45 degrees above the horizontal; in which case the calculated lumens is calculated at 10 percent of the rated lumens.

401.3 Shielding requirements. All light fixtures that are required to be shielded shall be installed in such a manner that the shielding is effective as described in the Definitions Chapter for Full Cutoff Light Fixture.

401.3.1 Light trespass. In the shielding requirements of this chapter, all light fixtures on the residential side of commercial property adjacent to residential property shall be full cutoff and shall be a maximum of 10 feet above grade at the property line and no higher than a line rising 20 degrees above the 10 feet until 100 feet from the property line, measured perpendicular to the lot line.

401.3.2 House Side Shields. All outdoor lighting fixtures closer to the lot line than the mounting height of the fixture, measured perpendicular to the lot line, adjacent to residential areas, shall have internal house-side shields.

401.3.3 Fixtures within 25 feet of residential lot lines. In addition, all residential and commercial luminaires shall be full cutoff within 25 feet of adjacent residential property lines, measured perpendicular to the lot line.

401.4 Multi-class lighting. Multi-class lighting must conform to the shielding and timing restrictions, if any, that apply to the most restrictive included class.

401.5 Fixtures installed under canopies and overhangs. Outdoor lighting fixtures shall not be counted in determining the total light output when they are full cut-off light fixtures installed under canopies, building overhangs, or roof eaves.
### Table 401.1
Maximum Total Outdoor Light Output Requirements
Lumen Caps: Mean Lumens per Net Acre (4)

<table>
<thead>
<tr>
<th>Lighting Area as Defined in Chapter 3</th>
<th>E3</th>
<th>E3a</th>
<th>E2</th>
<th>E1c</th>
<th>E1b(5)</th>
<th>E1a(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial and industrial <strong>“Option 1” (1)(2) (mostly LPS lighting)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (full cut-off LPS, plus full cut-off non-LPS)</td>
<td>450,000</td>
<td>350,000</td>
<td>200,000</td>
<td>125,000</td>
<td>48,000</td>
<td>18,000</td>
</tr>
<tr>
<td>Limit on non-LPS full cut-off.</td>
<td>45,000</td>
<td>35,000</td>
<td>18,000</td>
<td>6,000</td>
<td>3,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Limit on unshielded component (LPS or non-LPS)</td>
<td>12,000</td>
<td>9,000</td>
<td>6,000</td>
<td>3,000</td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td>Commercial and industrial <strong>“Option 2” (1)(2) (full cut-off for all lighting)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All lighting must be full cut-off</td>
<td>300,000</td>
<td>150,000</td>
<td>65,000</td>
<td>25,000</td>
<td>25,000</td>
<td>12,500</td>
</tr>
<tr>
<td>Limit on unshielded component</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Commercial and industrial <strong>“Option 3” (1)(2) (full cut-off for most lighting)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (full cut-off plus unshielded)</td>
<td>200,000</td>
<td>100,000</td>
<td>50,000</td>
<td>25,000</td>
<td>12,500</td>
<td>12,500</td>
</tr>
<tr>
<td>Limit on unshielded component</td>
<td>12,000</td>
<td>9,000</td>
<td>6,000</td>
<td>3,000</td>
<td>3,000</td>
<td>0</td>
</tr>
<tr>
<td>All residential zoning (3)(4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (full cut-off plus unshielded)</td>
<td>55,000</td>
<td>39,000</td>
<td>24,000</td>
<td>15,000</td>
<td>12,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Limit on unshielded component</td>
<td>12,000</td>
<td>9,000</td>
<td>6,000</td>
<td>3,000</td>
<td>3,000</td>
<td>3,000</td>
</tr>
</tbody>
</table>

**Notes to Table 401.1**

1. Use any one of the three options, 1, 2, 3 for the entire property.
2. This refers to all land-use zoning classifications for multiple family uses, commercial, and industrial sites.
3. This refers to all residential land-use zoning, including all densities and types of housing, such as single family detached and duplexes.
4. If LPS is used for residential lighting, then the total lumens in the table, for all areas, can be increased by 50 percent of full cut-off LPS lighting.
5. In addition to the lumen caps given in the table above, the maximum illumination level under any canopy in lighting Area E1a shall not exceed 30 lumens per square foot nor in Area E1b shall not exceed 55 lumens per square foot of the canopy area.
6. Flood or spot lamps shall be aimed no higher than 45 degrees to the horizontal (half-way between straight down and straight to the side) when the source is visible from any adjacent residential property.
7. Seasonal decorations using unshielded low-wattage incandescent lamps (not exceeding 7 watts each) shall be allowed from Thanksgiving to the 15th of January each year.
8. All Class 3 lighting shall be extinguished between 11:00 P.M. (or when the business closes, whichever is later) and sunrise the following day.
9. Unshielded fixtures (not full cut-off) shall not exceed 3,000 lumens each.
10. In lieu of calculating total lumens per Section 401.2, a single residential lot of any size shall be considered in compliance with the Lumen Cap if it has a maximum of 5 – 850 lumen (60 watt incandescent or 13 watt compact fluorescent) Full Cut-Off luminaires in Lighting Areas E3, E3a & E2 or a maximum of 4 – 550 lumen (40 watt incandescent or 9 watt compact fluorescent) in Areas E1c, E1b & E1a. If this option is utilized, no unshielded luminaires are allowed.