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ANL/EVS-15/4

Visibility and Visual Characteristics of the Ivanpah Solar Electric Generating System Power Tower Facility

Environmental Science Division

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March 2015

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NOTATION

The following is a list of the acronyms, abbreviations, and units of measure used in this report.

ACRONYMS AND ABBREVIATIONS

APE	area of potential effect
Argonne	Argonne National Laboratory
BLM	Bureau of Land Management
CEC	California Energy Commission
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement
HAB	heliostat assembly building
I-15	Interstate 15
ISEGS	Ivanpah Solar Electric Generating System
KOP	key observation point
NPCA	National Parks Conservation Association
NPS	National Park Service
NZILA	New Zealand Institute of Landscape Architects
PEIS	Programmatic Environmental Impact Statement
PV	photovoltaic
SOP	study observation point
VIA	visual impact assessment

UNITS OF MEASURE

ft	foot (feet)
ha	hectare(s)
km	kilometer(s)
m	meter(s)
mi	mile(s)

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VISIBILITY AND VISUAL CHARACTERISTICS OF THE IVANPAH SOLAR ELECTRIC GENERATING SYSTEM POWER TOWER FACILITY

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ABSTRACT

This report presents the results of a study conducted to document the visibility and visual characteristics of the Ivanpah Solar Electric Generating System (ISEGS), a utility-scale solar power tower facility located on land administered by the U.S. Department of the Interior Bureau of Land Management in southern California. Study activities consisted of field observations of the ISEGS facility and comparison of the observations made in the field with the visual contrast assessments and visual simulations in the ISEGS Final Environmental Impact Statement (Final EIS) and supporting documents created prior to ISEGS construction. Field observations of ISEGS were made from 19 locations within 35 mi (56 km) of the facility in the course of one week in September 2014. The study results established that reflected sunlight from the receivers was the primary source of visual contrast from the operating ISEGS facility. The ISEGS facility was found to be a major source of visual contrast for all observations up to 20 mi (32 km), and was easily visible at 35 mi. Glare from individual heliostats was frequently visible, and often brighter than the reflected light from the receivers. Heliostat glare caused discomfort for one or more viewers at distances up to 20 mi. The ISEGS power blocks were brightly lit at night, and were conspicuous at the observation distance of approximately 6 mi (10 km). The facility is substantially brighter and is seen more clearly in the field than in photographs of the facility or in the prepared simulations, which were based on photographs. The simulations of the ISEGS facility in the Final EIS, which were evaluated as part of this study, sometimes lacked spatial accuracy and realism. The evaluated simulations generally under-represented the actual visual contrast from the project, and some of the contrast ratings in the Final EIS predicted substantially lower levels of visual contrast than were actually observed for the operating facility.

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EXECUTIVE SUMMARY

This report summarizes the results of a study conducted by Argonne National Laboratory's (Argonne's) Environmental Science Division for the U.S. Department of the Interior Bureau of Land Management (BLM). The study documented the visibility and visual characteristics of a utility-scale solar power tower facility located on BLM-administered land in southern California. The Ivanpah Solar Electric Generating System (ISEGS) is currently the largest solar power tower facility in the world, and the first operational solar power tower facility on BLM-administered lands. The study documented the visual characteristics of the ISEGS facility on the basis of ground-based field observations, assessed the occurrence of glare caused by the facility in these observations, and assessed the effects of distance on the visibility of the facility. The study also compared visual simulations of the proposed ISEGS, prepared for the ISEGS Final Environmental Impact Statement (Final EIS), to photographs of the operating ISEGS facility and to its appearance as observed in the field by the naked eye.

This study was undertaken primarily to further establish baseline descriptions of the visual contrasts from utility-scale power towers, which previous studies have identified as having the largest potential for causing visual impacts among the three primary utility-scale solar technologies (photovoltaic, parabolic trough, and power tower). There are other operating power towers in various countries; however, the Ivanpah facility is much larger in size and power output than other currently operating facilities. It is representative of the "new generation" of very large power tower facilities that are proposed or under construction in the United States and elsewhere.

Study activities consisted of field observations of the ISEGS facility and comparison of the observations made in the field with the contrast assessments and simulations in the ISEGS Final EIS and supporting documents created for ISEGS prior to its construction. Field observations of the ISEGS facility were made from 19 locations within 35 mi (56 km) of the facility in the course of one week in September 2014. The study observation points (SOPs) included points selected to facilitate observing the facility from different distances and directions, but also included points used as key observation points (KOPs) in the Final EIS. The facility was observed primarily during the day, at different times of day, from a variety of angles and elevations, and primarily under sunny conditions. A total of 19 daytime observations were made. One observation was made at night to assess the visibility of the ISEGS facility lighting. The daytime field observations included photography, descriptive narratives of sources of visual contrast from the facilities, and visibility determination using a formal process developed by Argonne for previous studies of energy facility visibility. For observations from the EIS KOPs, a BLM Visual Contrast Rating form was completed, and it was used as a basis for comparing contrast assessments prepared for the EIS with contrasts from the operating ISEGS facility as observed in this study.

Significant findings from the field observations and contrast assessment comparisons include the following:

- Reflected sunlight from the receivers was the primary source of visual contrast from the operating ISEGS facility under sunny conditions, regardless of viewing distance or viewing geometry.

- Reflected sunlight from the receivers was sometimes difficult but not impossible to look at, even at short distances from the facility.

- Reflected sunlight from the receivers caused discomfort for one or both observers at distances up to 4 mi (6 km).

- In unobstructed views, the ISEGS facility was found to be a major source of visual contrast for all observations up to 20 mi (there were no observations between 20 mi [32 km] and 35 mi [56 km]).

- The ISEGS facility, including the heliostat field, was easily visible at 35 mi (56 km).

- Glare from individual heliostats was frequently visible, and often brighter than the reflected light from the receivers, even at 35 mi (56 km).

- Glare from individual heliostats caused discomfort for one or more viewers at distances up to 20 mi (32 km).

- Glare from individual heliostats was typically visible for only a few seconds, but occasionally lasted for a few minutes, and rarely for much longer periods.

- Excessively bright glare was not observed from elevated SOPs.

- "Dust halos," relatively faint patches of light reflected from atmospheric dust, were frequently visible around the operating receiver towers, and were sometimes visible at distances greater than 10 mi (16 km).

- One or more receiver towers were not operating during significant portions of the time the facility was observed.

- The ISEGS power blocks were brightly lit at night, and were conspicuous light sources at the observation distance of approximately 6 mi (10 km).

- The ISEGS facility is substantially brighter and is seen more clearly in the field than in photographs of the facility or in simulations based on photographs.

- The simulations of the ISEGS facility in the Final EIS and supporting documents in some instances exhibit low spatial accuracy and realism.

- The simulations of the ISEGS facility in the Final EIS and supporting documents in some instances substantially under-represent the actual visual contrast from the project.

- Some of the contrast ratings in the ISEGS Final EIS predicted substantially lower levels of visual contrast than were actually observed for the operating facility.

- The study findings have important implications for conducting visual impact assessments for proposed solar power tower facilities; however, additional research should be conducted with other operating solar power tower facilities, as the ISEGS facility may not be representative of future power tower facilities.

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1 INTRODUCTION

This introductory section presents the need for and purpose of the study, its scope, the intended use and users of the study results, and the report organization.

1.1 NEED AND PURPOSE FOR STUDY

Utility-scale solar energy facilities create visual contrasts with the surrounding landscape, primarily because they introduce large-scale, complex, and visually distinctive man-made structures into the existing landscape. In some cases, the surfaces of solar facility components may be highly reflective, adding substantially to their visibility. While some persons may find solar facilities interesting to look at, others may feel that the visual contrasts caused by the facilities detract from the visual qualities of the landscape view, particularly if viewers value the landscape for its natural-appearing character. Negative perceptions of the visual qualities of solar facilities can translate into opposition to individual proposed solar projects or to utility-scale solar energy generally, which could potentially result in costly delays or even cancellation of projects.

Visual impacts from utility-scale solar facilities have been recognized as a stakeholder concern and as a potential obstacle to solar facility and associated electric transmission siting. Stakeholder concerns regarding visual impacts from solar facilities have been discussed in a number of environmental assessments prepared for proposed solar facilities on Bureau of Land Management (BLM)-administered lands, and also in the BLM's and the U.S. Department of Energy's (DOE's) Solar Energy Development Programmatic Environmental Impact Statement (Solar PEIS) (BLM and DOE 2010; BLM and DOE 2012; BLM 2010; CEC 2010; DOE 2012; CEC 2013). BLM, DOE, and the National Park Service (NPS) have funded several studies to investigate the scenic impacts of utility-scale solar energy facilities in the southwestern states (Sullivan 2011; Sullivan et al. 2012a; Sullivan and Abplanalp 2013), while a separate series of studies funded primarily by DOE has investigated the occurrence of glare from solar energy facilities, primarily in the context of health and safety concerns rather than scenic impacts (Barrett 2013; Ho et al. 2009, 2011; Ho and Khalsa 2010; Ho 2011, 2012; Ho and Sims 2013; Ho et al. 2014).

Visual impacts have increasingly become an important concern not just for individuals but for organizations including Native American tribes, local governments, environmental groups, and the NPS. Concerns over potential negative visual impacts of solar facilities are routinely expressed by stakeholders during the environmental impact assessment processes that are typically required for these types of facilities (Basin and Range Watch 2010; DOE 2012; NPCA 2012; Colorado River Indian Tribes 2013; Kessler 2013; NPS 2013). As more utility-scale facilities are built, local governments, such as the San Bernardino and Sonoma County governments in California, have passed ordinances restricting commercial solar facilities specifically to protect scenic resources, among other values (San Bernardino County Sentinel 2013; Sonoma County 2013).

Despite the increasing concern expressed regarding the visual impacts of solar energy facilities, the visual characteristics of solar facilities are not well documented or understood, in part because there are relatively few utility-scale solar facilities in operation worldwide. This is especially true for solar power towers; they have only recently been developed at very large scale, and the designs vary widely, so that results for one facility cannot be assumed to apply to other facilities. The recent work conducted by Argonne National Laboratory (Argonne) for BLM and NPS has begun to document the visibility, visual characteristics, and visual contrasts associated with power tower facilities, but the projects studied were either not operational or were relatively small-scale in terms of power output (20 MW or less) (Sullivan 2011; Sullivan et al. 2012a; Sullivan and Abplanalp 2013).

Late in 2013, the Ivanpah Solar Electric Generating System (ISEGS) began normal operation. ISEGS is a 3,500-acre (1,416-ha), 392-MW solar power tower facility in the Ivanpah Valley southwest of Las Vegas, Nevada, and is the first large solar power tower facility to come online, thus providing an important opportunity to identify potential sources of visual impacts associated with large-scale power tower facilities.

Recently, Ho et al. (2014) conducted both aerial and ground-based surveys of glare at ISEGS to identify the cause and to quantify the irradiance and potential ocular impacts of glare generated by the ISEGS facility. Results for the ground-based surveys indicated that glare from the receivers had a low potential for afterimages at all monitoring locations outside the project site boundaries, and that while glare from individual heliostats also had a low potential for afterimages, it was close to the threshold for afterimages. The authors referred to the heliostats causing this type of glare as “rogue heliostats” and noted that they could cause ocular impacts to stationary viewers, but would not likely pose a problem for observers in moving vehicles because of the brief duration of views. Ho et al.’s investigation was limited to glare, and did not examine the many other potential sources of visual impacts from the ISEGS facility.

Argonne’s previous studies included several visits to the ISEGS facility at various stages in its construction. The observations made during these visits revealed that even prior to operation, because of its large size and complex and obviously man-made forms, lines, and textures, the ISEGS facility was easily visible at long distances, and contrasted strongly with the generally natural-appearing surrounding landscape in the Ivanpah Valley (Sullivan 2011; Sullivan et al. 2012a; Sullivan and Abplanalp 2013). A visit to the nearly completed facility in January 2013 showed that the unlit receiver towers were faintly visible from an elevated viewpoint more than 35 mi (56 km) from the facility (Sullivan and Abplanalp 2013), and other observations showed that individual heliostats were capable of creating annoyance glare at distances exceeding 10 mi (16 km). While these visits revealed important information about potential visual impacts of construction and the non-operational appearance of the facility, these studies necessarily left unanswered many important questions about the visibility and visual contrasts created by the facility when in operation. The current BLM-sponsored study builds on this previous work to better characterize the visual properties of operating solar power tower facilities as seen in landscape views.

The primary purposes of this study were as follows:

1. Observe and obtain photographs of the ISEGS facility in operation. ISEGS is far larger in size than any other power tower facility in the world, but is representative (at least in terms of size) of projects under construction or planned in the United States. ISEGS is currently (as of January 2015) the first and only large power tower facility in operation in the world, and relatively little is known about the visual characteristics and visual contrasts associated with large-scale operating power towers.

2. Observe the facility from the farthest distance possible, in order to assess the visibility of the facility at long distances, which is important for determining the area of potential effects in visual impact assessments (VIAs).

3. Observe the facility from high-elevation viewpoints to determine if glare from the heliostat array is increased when the facility is viewed from relatively high viewing angles.

4. Document observed glare occurrences, either from the receivers or from heliostats.

5. Compare the simulations developed for the ISEGS Final EIS (BLM 2010) to the actual appearance of the facility as observed in the field and as shown in photographs, in order to assess whether the simulations accurately and realistically depicted the appearance of the operating facility.

6. Assess the adequacy of the VIA and evaluate the need to refine the methodology in order to more accurately disclose the potential impacts.

1.2 SCOPE

The field observations of the ISEGS facility were made in the course of four days and one night between September 22 and September 25, 2014. All but one observation was conducted during daylight hours. The study was limited to observation and description of visual contrasts (changes in the visual environment, i.e., changes to what is seen) rather than impacts (changes in scenic values and human reaction to visual contrasts).

1.3 INTENDED USE AND USERS

This study identifies the visual characteristics of a large utility-scale power tower solar energy facility and the visual contrasts associated with its operation. The study results can be used to

1. Better understand the nature of visual contrasts associated with utility-scale power tower solar facilities, and the mechanisms by which these facilities cause visual contrasts that generate visual impacts;

2. Identify an appropriate area of potential effect for VIAs;

3. Assess the accuracy of visual simulations of power tower facilities in VIAs:

4. Identify potential visual impact mitigation measures; and

5. Identify opportunities to strengthen VIA methods used to analyze and disclose visual impacts.

The methods used for this study might also be incorporated into a visual resource monitoring protocol for future solar energy projects.

The intended users of the document and the study results it contains include the following:

- Professionals conducting VIAs for solar energy facilities and specifying visual impact mitigation measures;

- Agency staff who regulate or approve VIAs and associated mitigation measures;

- Solar industry professionals who must implement mitigation measures; and

- Other stakeholders who may be affected by the visual impacts of solar facilities.

1.4 DOCUMENT ORGANIZATION

This report is organized into seven main sections:

1. Introduction

2. ISEGS Facility Description and Study Methodology—A description of the ISEGS facility and the methods used for conducting observations.

3. Results of Field Observations—Descriptions of the field observations of ISEGS and the visual contrasts and contrast sources associated with solar facilities.

4. Comparison of Field Observations with Final EIS Simulations and Contrast Ratings—Comparisons of visibility ratings and photographs of ISEGS made

in the field with the contrast assessments and simulations contained in the Final EIS.

5. Conclusions and Recommendations—Discussion of study results and recommendations for further studies.

6. References—References cited in this report.

7. Appendices—Data collection forms and methods used in the study.

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2 ISEGS FACILITY DESCRIPTION AND STUDY METHODOLOGY

2.1 ISEGS FACILITY DESCRIPTION

The ISEGS facility is a 3,500-acre (1,416-ha), 392-MW solar power tower facility currently in operation in southern California (Bright Source Energy, Inc. 2013). The ISEGS facility is located within the Ivanpah Valley southwest of Primm, Nevada. The facility is located on a gently sloping east-facing bajada at the base of Clark Mountain, west of Ivanpah Dry Lake. Primm Valley Golf Course is located approximately 0.5 mi (805 m) northeast of the facility at its closest point, and the community of Primm, Nevada, is located approximately 4.5 mi (7 km) northeast of the facility at its closest point. The facility site ranges in elevation from approximately 2,920 to 3,240 ft (890 to 988 m) above mean sea level. Figure 2.1-1 is a map of the region in which the ISEGS facility is located, showing the study observation points (SOPs) from which the ISEGS facility was observed. Figure 2.1-2 is a more detailed map of the southern Ivanpah Valley and the northern portion of Mojave National Preserve.

The facility uses 173,500 heliostats in three heliostat arrays to reflect and concentrate sunlight onto receivers atop three receiver towers. Each tower is centered within a heliostat array. The three receiver towers run in a line from southeast to northwest up the bajada at the base of Clark Mountain. The distance between the southeasternmost tower and the middle tower is 1.8 mi (2.9 km), and the distance between the middle tower and the northwesternmost tower is 1.5 mi (2.4 km). The southeasternmost tower, the middle tower, and the northwesternmost tower are labeled Tower 1, Tower 2, and Tower 3, respectively, in Figure 2.1-1, and are referred to as such in the remainder of this report. Tower 1 is located 1.6 mi (2.6 km) from Interstate 15 (I-15) at the point of closest approach, and Tower 3 is located 4.1 mi (6.6 km) from I-15. Measured along its long axis (southeast to northwest through the towers), the entire project is 4.8 mi (7.8 km) in length. The three heliostat arrays differ in size and configuration, varying in diameter from 1.7 to 2.2 mi (2.7 to 3.5 km) as measured corner to corner from southwest to northeast.

Each heliostat consists of two mirrors that are 7.2 ft (2.1 m) wide by 10.5 ft (3.2 m) high, mounted on pylons inserted directly into the ground. The pylons are arranged in concentric circles around the tower and are programmed by computers to track the sun's daily apparent motion across the sky while reflecting sunlight onto the receivers.

The receiver towers are 450 ft (137 m) tall. Because the towers exceed 200 ft (60 m) in height, lighting and lightning poles that are required by the Federal Aviation Administration extend approximately 10 ft (3 m) above the tops of the towers. The towers are square in cross section, and each side is approximately 60 ft (18.3 m) wide, measured at the top of the tower.

Each tower is accompanied by a steam turbine generator set, air-cooled condensers, and other auxiliary systems that are located at the base of the tower. These components are referred to as the "power block" in this report. The facility is dry-cooled and utilizes a natural gas backup.

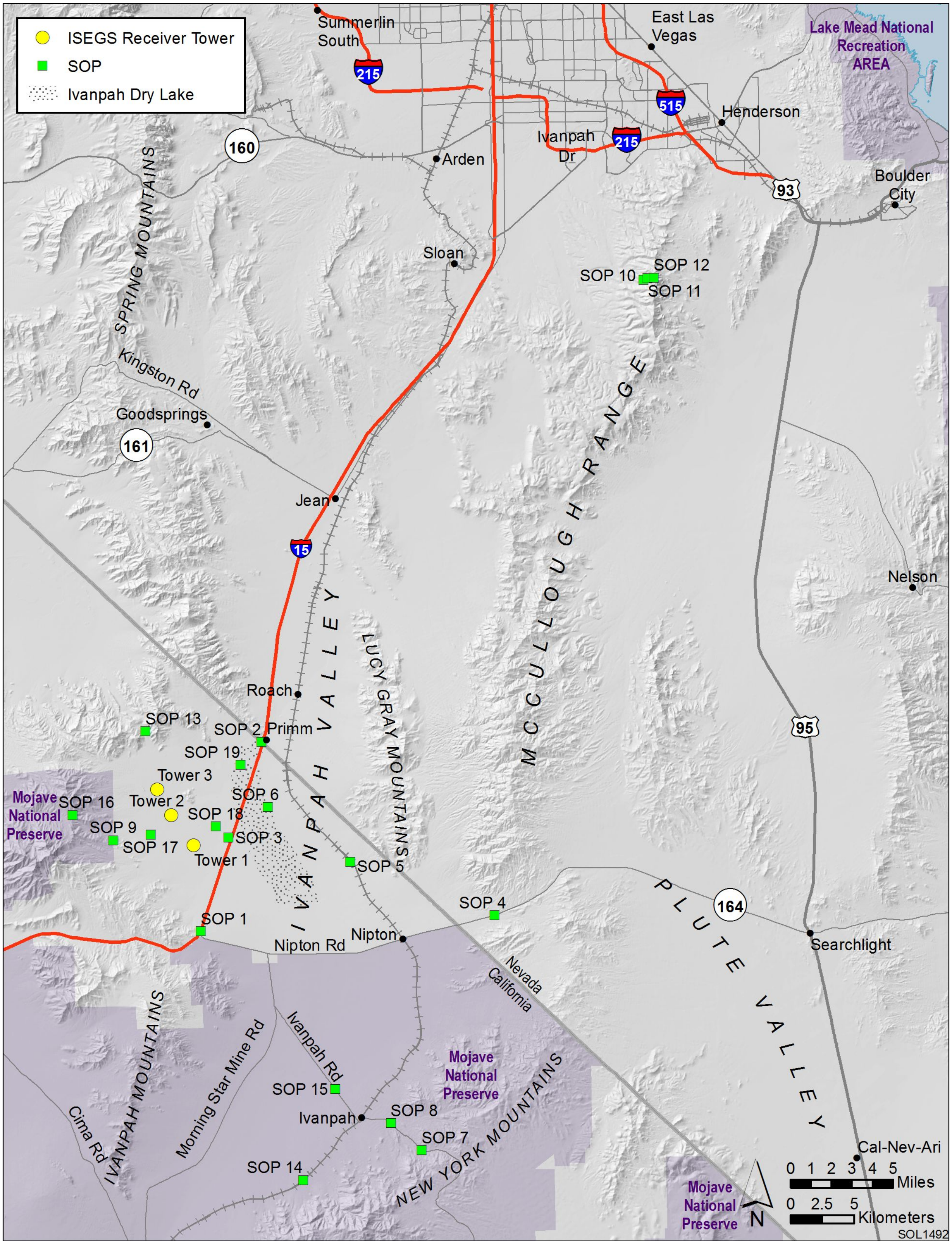

FIGURE 2.1-1 Overview of ISEGS Facility Vicinity

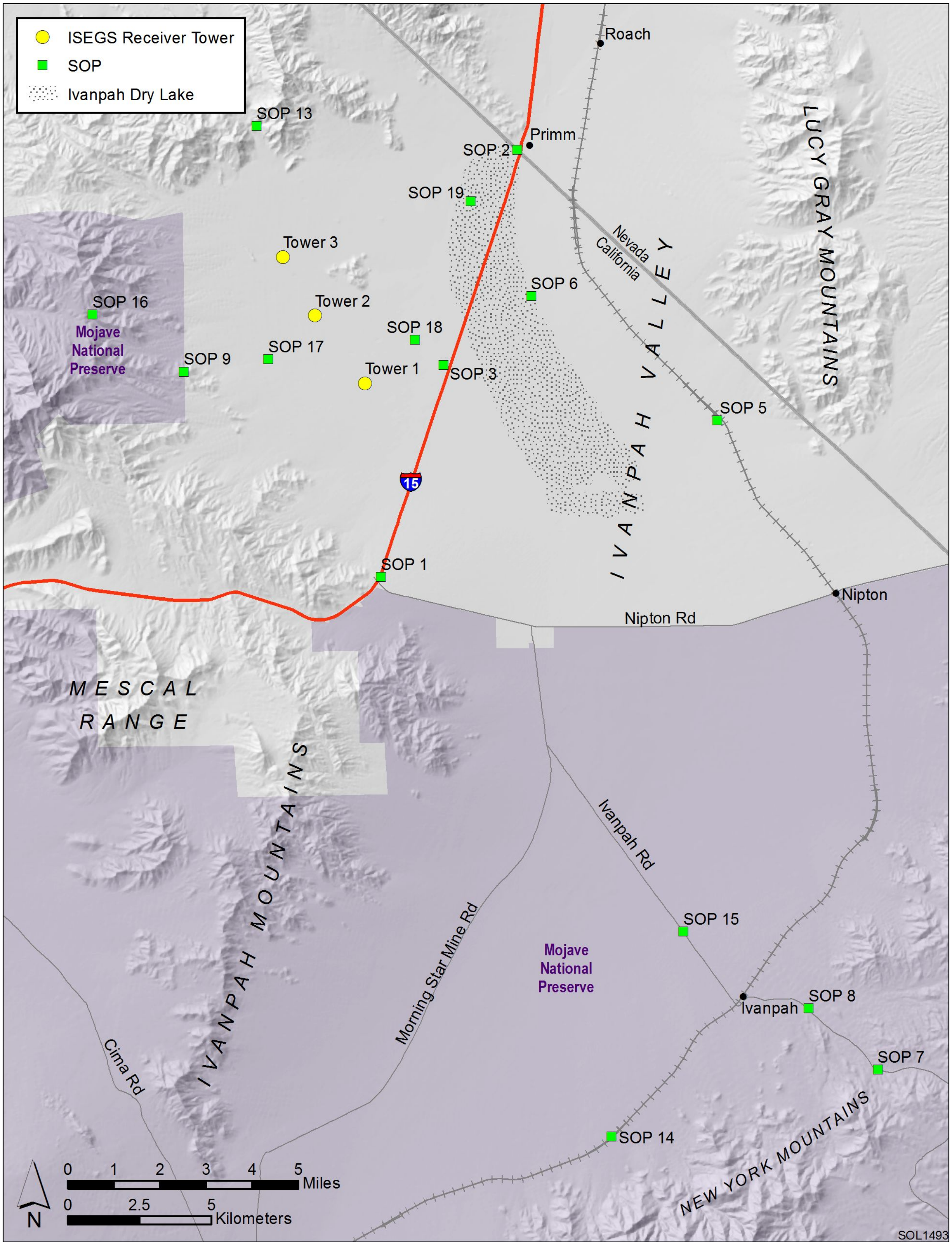

FIGURE 2.1-2 Detail of ISEGS Facility Vicinity

Other facilities at Ivanpah include an administration building, an operation and maintenance building, a substation, a transmission line, and access roads. Figure 2.1-3 is a satellite image showing the major facility components. Figure 2.1-4 is a ground-level photograph of the facility taken from SOP 5, at a distance of 9.0 mi (14.5 km), showing some of the major facility components and ISEGS's general appearance when operating.

2.2 STUDY METHODOLOGY

This section describes the procedures used to identify SOPs for the study and the procedures and forms used to collect study data. Additional information about methods and sample forms are provided in the appendices.

Note: Except as noted, all observation distances discussed in the report are measured from the SOP to Tower 2, located in the approximate center of the facility, rather than to the nearest edge of the facility or the nearest tower. Because of the large size of the facility and its spatial asymmetry, the distance to the nearest or farthest facility component in the observation or observation photographs may vary from the reported distance by up to 2.5 mi (4.0 km), depending on the orientation of the project to the viewer and the particular observed component. With respect to the towers, Tower 1 may be up to 1.5 mi (2.4 km) closer or farther than the reported distance; Tower 2 is at the reported distance; and Tower 3 may be up to 1.8 mi (2.9 km) closer or farther than the reported distance.

2.2.1 SOP Identification

Prior to conducting fieldwork, GIS viewshed analyses were conducted to identify those lands within 50 mi (80 km) of the ISEGS facility from which the facility would be visible. Within these lands, SOPs were selected for the current study. SOPs included the following:

- Points within the Mojave National Preserve where discussions with NPS staff indicated Preserve visitors might see the ISEGS facility while traveling on roads within the Preserve (SOP 7, 8, 14. 15, and 16);

- KOPs identified in the ISEGS Draft EIS (SOP 1, 2, 3, 6, 13, and 19); and

- Locations used for previous Argonne ISEGS visual impact studies (SOP 4, 5, 9, 12, and 18).

SOP locations in Ivanpah Valley are shown in Figure 2.1-2. All SOP locations are shown in Figure 2.1-1.

In most cases, the SOPs were located on roads; however, two KOPs from the ISEGS Draft EIS were located on the Ivanpah Dry Lake bed.

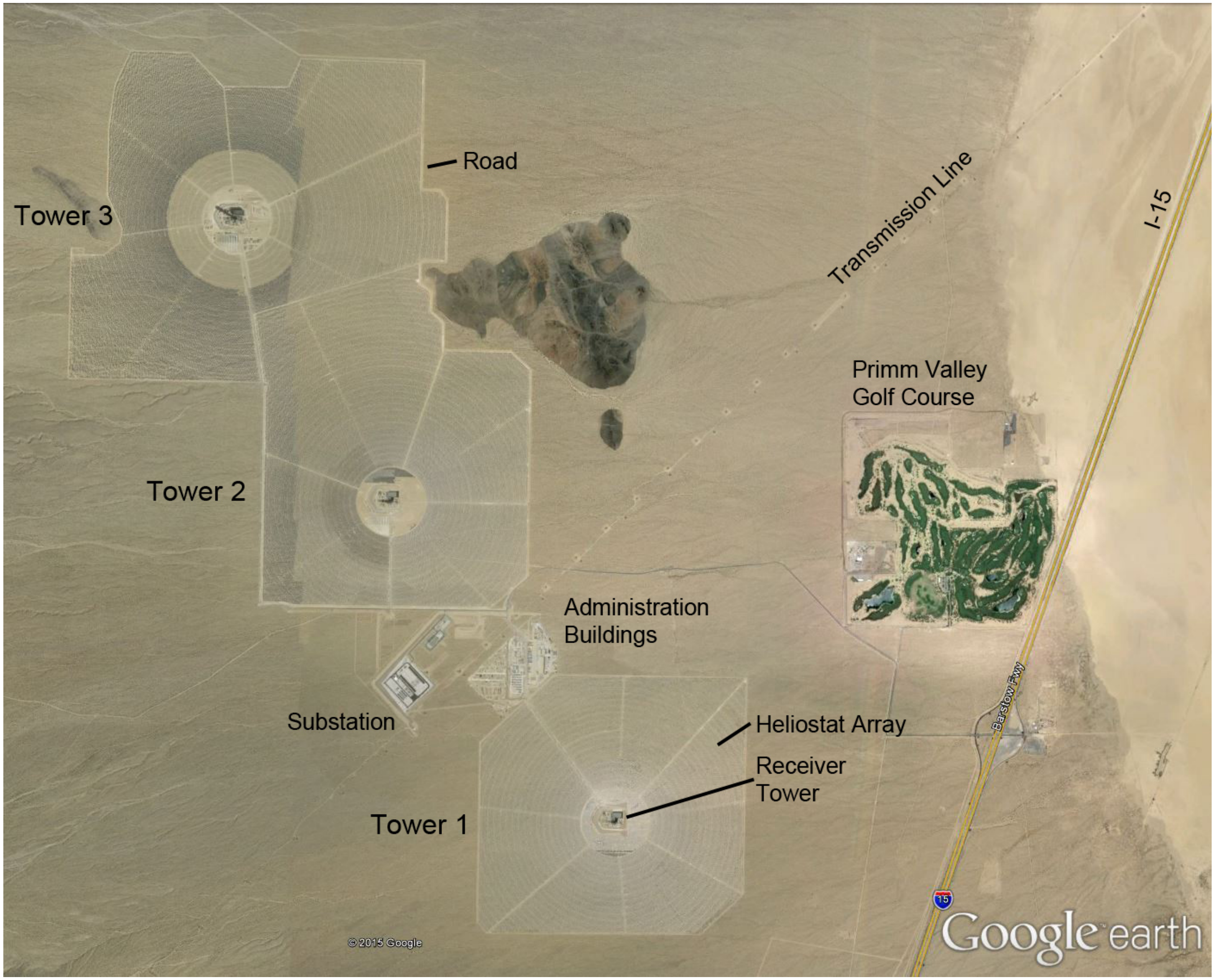

FIGURE 2.1-3 Major ISEGS Facility Components

FIGURE 2.1-4 Ground-Level View of ISEGS Facility, Showing Major Facility Components. Photo location: SOP 5. Distance to tower at center (Tower 2) is 9.0 mi ([14.5 km).

Note: In addition to SOPs identified prior to fieldwork, additional SOPs (SOP 10, 11, and 17) were selected in the field as particular visual phenomena of interest or opportunities for facility visibility presented themselves; or to make an observation of the ISEGS facility from a particular desired distance. The location of SOP 16 differed from the KOP location identified in the ISEGS Draft EIS because road conditions precluded visiting the KOP.

After identifying the SOPs, the SOP locations were exported to a GIS software package, *GIS Pro* (from Garafa Inc.), available on an Apple iPad mobile device. *GIS Pro* was used for navigation, distance determination, and data recording in the field.

All observations were made by a two-person team, both of whom are Argonne visual resource analysts trained in data collection for visual resource analysis studies using the various data collection forms employed for this study, which are discussed below. Observations were conducted every day from the afternoon of September 22, 2014, through the afternoon of September 25. Daylight observations were made as early as 8:00 am and as late as 6:00 PM, and one nighttime observation was made on September 22 at 9:00 PM. A total of 20 observations were made from 19 SOPs. Observation elevations ranged from 2,610 ft to 5,083 ft (796 m to 1,549 m) above mean sea level. Brief descriptions of the SOPs are provided in Appendix A.

2.2.2 Field Data Collection Procedures and Forms

After driving or hiking to each SOP using its pre-determined coordinates for navigation purposes, the analysts determined the actual coordinates used for the observation using the iPad's GPS positioning capability. Depending on the type of SOP and the circumstances, two to four data collection forms were used to record study data. For all daytime observations, data regarding the ISEGS facility's general visual characteristics were recorded on the *Solar Facility Visual Characteristics Study Data Collection Form*, and visibility ratings were recorded on the *Visibility Rating Form*. If a significant glare event was observed, data concerning the event were recorded on the *Solar Facility Transitory Visual Effects Data Collection Form*. For SOPs that were KOPs in the ISEGS Draft EIS, a *BLM Visual Contrast Rating Form* was completed. Examples of these forms are provided in Appendix B.

Solar Facility Visual Characteristics Study Data Collection Form

Data recorded on the *Solar Facility Visual Characteristics Study Data Collection Form* included weather conditions, general locational information, the visible components of the facility, facility backdrop color and contrast, viewing angle between the observation point and facility, lighting quality and angle, and collector orientation and color. Any visible contrasts such as glare, light patterns, plumes, or transitory effects were also recorded. A space was also provided to record additional observations not called out on the form. In addition to the *GIS Pro* software discussed above, the iPhone/iPad app *Theodolite Pro* (Hunter Research and Technology) was used to determine approximate bearings of views toward the ISEGS facility, and *SunSeeker* (OzPDA) was used to determine solar azimuth and elevation for all observations.

Solar Facility Transitory Visual Effects Data Collection Form

The *Solar Facility Transitory Visual Effects Data Collection Form* was used to record information about transitory visual effects. Transitory visual effects are of brief duration and often fluctuate in visual character, e.g., glare, rather than being of a continuous and generally less variable nature, e.g., reflected light from the receivers. Data collection items included a description of the observed phenomenon, and for glare events, the apparent glare source, type, color and location; duration of glare; and the visual discomfort level caused by the glare, if any. The back of the form included a plan-view image of the facility used to mark the location of observed transitory visual effects.

Visibility Rating Form

To record data on the *Visibility Rating Form*, each of the observers numerically rated the visibility of the ISEGS facility using a methodology developed for the Visual Impact Threshold Distance Study—an approach developed for BLM (Sullivan et al. 2012b) to assess the effects of distance and atmospheric variables on the visibility and visual contrast levels of wind facilities. In this case, the forms were adapted for use with solar facilities. The visibility assessments consist of numeric ratings on a scale of 1 to 6, scored according to the visibility of a solar facility within its landscape setting and the weather and lighting conditions at the time of the observation. Within the visibility scale, a visibility score of "1" implies a facility that is just barely visible to the unaided eye, while a score of "6" indicates a facility that dominates the view because of its size and strong color contrasts, with intermediate scores indicating intermediate contrast magnitudes. The visibility rating is a judgment of the observers, made by comparing the solar facility in view with language given on the Visibility Rating Form that describes the visual characteristics of the solar facility appropriate to each rating level. Photographs were not used for visibility ratings; the ratings were conducted through naked-eye observations of the facility in the field.

Visibility and contrast threshold distance assessments are useful for two primary purposes:

1. They are useful for determining the appropriate area of analysis for VIAs. Visibility and contrast threshold distance assessments identify the maximum distance at which a facility is likely to be seen, the approximate distances at which it is easily seen, and the distance at which it is likely to become a major focus of visual attention, and this information can be used to identify the distance from the facility for which impacts should be analyzed. For example, the minimum distance for which impacts should be analyzed in a VIA likely corresponds to the distance at which viewers are likely to see the facility at a casual glance.

2. The visibility and contrast threshold distance assessment methodology also requires that the observers record the contrast sources associated with the facility that they see, and identify the facility components or contrasts that

contribute most to the project's overall visibility. This approach is useful for identifying important contrast sources, which is key to identifying mitigation opportunities.

BLM Visual Contrast Rating Form

For those SOPs that were used as KOPs in the ISEGS draft EIS, BLM Visual Contrast rating worksheets were completed in order to facilitate comparison between contrast levels predicted at the time the EIS was prepared and those actually observed after the facility was in operation. The BLM's visual contrast rating system is a systematic process used to analyze potential visual impact of proposed projects and activities on BLM-administered lands. Using procedures established by BLM, the team rated the degree of contrast between the project and the existing landscape as *strong*, *moderate*, *weak*, or *none* for each of four design elements: form, line, color, and texture. It should be noted that the contrast rating procedures used for this study assessed the contrasts of the Ivanpah project as observed in the field, and did not systematically consider the ten environmental factors that are required by the BLM visual contrast rating procedure to be incorporated into contrast rating procedures used to assess conformance to Visual Resource Management class requirements (BLM 1986).

In addition to recording data on the various study forms, each observation included photography of the facility and its surroundings. At each daytime observation point, a series of panoramic photos were taken using an iPhone, and the panoramic photos were stitched into a single panoramic image "on the fly" using *Autostitch* (Cloudburst Research Inc.), a photography app available for the iPhone. In addition, a series of single-frame high-resolution photos were taken of the facility using a Nikon D7000 digital single lens reflex camera with an 18–300 mm zoom lens. For the single nighttime observation, the Nikon D7000 was used to take long-exposure photos; no panoramic photos were taken. These photos were the source of most of the figures in this report; the complete set is available from the lead author on request.

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3 RESULTS OF FIELD OBSERVATIONS

This section summarizes the key results of the field observations of the ISEGS facility.

3.1 VISUAL CHARACTERISTICS OF THE ISEGS FACILITY

Section 3.1 describes the general appearance and visual characteristics of the ISEGS facility both in operating and non-operating modes. Section 3.1.1 describes the general appearance of the facility as a whole. Because they are the major sources of visual contrast, the receiver towers and heliostat arrays are described separately in Sections 3.1.2 and 3.1.3, respectively. The visual characteristics of other facility components that contributed to observed visual contrasts are described in Section 3.1.4.

3.1.1 General Visual Characteristics of the ISEGS Facility

The overall appearance of the operating ISEGS facility is highly dependent on the observer's distance from the facility and the view orientation with respect to the long southeast-to-northwest axis created by the three receiver towers. In all views, absent "heliostat flares" (see Section 3.1.3 below) or non-operating towers, the brilliant reflected light of the operating receivers was by far the dominant visual element. When all towers were operating, the receivers were seen as a line of three brilliant white rectangular sources of light atop the straight vertical lines (or bands, for closer views) of the supporting towers. The visual properties of the receivers are described in more detail in Section 3.1.2. Views of the ISEGS facility roughly perpendicular and parallel to the long axis of the facility are shown in Figures 3.1-1 (SOP 2) and 3.1-2 (SOP 15), respectively.

At the base of each tower, the very broad, flat heliostat array was visible. The portion of the array closest to the observer was generally dull gray, brown, or green in color but occasionally dull white, while the portion opposite (and farthest from the observer) was silvery-white in color. The middle portion of the array was generally a dull blue or blue-gray. The visual properties of the heliostat arrays are described in more detail in Section 3.1.3.

Depending on the particular heliostat array (the arrays differ in size) and the observer orientation with respect to the array, because the array is approximately 14-25 times wider than the tower is tall, the overall visual effect of the ISEGS facility is of an object that is relatively flat and wide, with three very small but extremely bright objects atop three short vertical lines. Depending on distance and observer orientation to the array, the ISEGS facility may appear to occupy much of the field of view. At a distance of 5.7 mi (9.2 km) and an orientation nearly perpendicular to the long axis of the facility, the ISEGS facility occupies a horizontal angle of view of approximately 48°, or almost 40% of the normal field of view of 124° (NZILA Education Foundation 2010), as shown in Figure 3.1-3 (SOP 2). Viewed parallel to the long axis of the facility, the ISEGS would occupy approximately 18°, or approximately 15% of the normal horizontal field of view. At approximately 35 mi (56 km), as seen from the summit of Black Mountain and perpendicular to the long axis of the facility, the ISEGS facility occupies

FIGURE 3.1-1 View of ISEGS Perpendicular to Long Axis of the Facility. Photo location: SOP 2. Distance to Tower 2 is 5.7 mi (9.1 km). (Note partial topographic screening of Tower 2 and heliostat field.)

FIGURE 3.1-2 View of ISEGS Parallel to Long Axis of the Facility. Photo location: SOP 15. Distance to Tower 2 is 15.6 mi (25.0 km).

FIGURE 3.1-3 The ISEGS Facility Occupies Approximately 40% of the Normal Horizontal Field of View at a Distance to Tower 2 of 5.7 mi (9.2 km). Photo location: SOP 2.

approximately 8°, or just under 6% of the field of view, and the horizontal extent of the facility is easily visible at that distance, as shown in Figure 3.1-4 (SOP 12), despite topographic screening of portions of the heliostat arrays.

Overall, the appearance of the ISEGS facility during several days of observations was more consistent and more static than that of utility-scale photovoltaic (PV) and parabolic trough facilities observed in previous studies, which found that the appearance of those facilities could change dramatically in the course of a day as the sun altitude and azimuth changed, or as the observer changed position. Unlike the parabolic trough and PV facilities observed in previous field studies (Sullivan 2011; Sullivan et al. 2012a; Sullivan and Abplanalp 2013), time of day was not observed to have a substantial effect on the overall appearance of the ISEGS facility, and aside from the orientation of observers to the long axis of the facility, the view bearing was also not observed to affect the appearance of the facility substantially. The heliostats are arrayed in concentric circles around the towers, the towers look very similar from all four sides, and the cylindrical receivers are brightly illuminated on all sides; as a result, aside from minor differences in apparent shadow length and direction, the towers and arrays appear generally the same when the facility is in operation, regardless of the time of day or the view bearing. The power block is placed on one side of the tower and is rectangular in shape; thus, its apparent position, shape, and shadowing do vary somewhat depending on sun angle and view bearing. However, because of the relatively small size and dark color (shadow gray) of the power blocks, the differences become readily apparent only at relatively short viewing distances.

Similarly to parabolic trough and PV facilities, as observed in other studies, varying the observer position with respect to the vertical angle of the view to the facility was observed to have a substantial effect on the appearance of the ISEGS facility. Because the heliostat arrays are relatively low in height and cover large areas, views from elevated viewpoints often include the top surfaces of the structures in the facility, causing the facility to occupy more of the field of view and making the full areal extent and the angular geometry of the facility more apparent, as shown in Figure 3.1-5 (SOP 16). In views from lower-elevation viewpoints, the solar collector arrays appear as thinner bands, they occupy less of the field of view, and the striking symmetry of the heliostat array is less apparent; these differences serve to reduce visual contrast, as shown in Figure 3.1-6 (SOP 3). Because the ISEGS facility is located on an incline on the lower slopes of a bajada, relatively few views are truly level with the heliostat array, and thus the tops of the heliostat array are almost always visible to a degree. Given that most high-elevation viewpoints are several miles from the facility, the observed differences in contrast between high- and low-angle views are not as great as they otherwise might be.

While time of day and view bearing have only a small effect on the facility's overall appearance, and observer position has only a modest effect, two phenomena that strongly affect the facility's appearance are towers going offline (see Section 3.1.2) and heliostat flares (see Section 3.1.3). Towers going offline resulted in a relatively sudden and noticeable loss of the brilliant light of the receiver(s), but this type of event was observed infrequently, although it was of relatively long duration. Heliostat flares involved the sudden appearance of extremely bright spots of reflected light from individual heliostats in the heliostat array. This phenomenon was observed much more frequently than towers going offline, though it typically was of much

FIGURE 3.1-4 The ISEGS Facility Occupies Approximately 8% of the Normal Horizontal Field of View at a Distance to Tower 2 of 35 mi (56 km). Photo location: SOP 12. (Note heliostat flare in front of and to the left of Tower 3.)

FIGURE 3.1-5 View of ISEGS Facility from an Elevated Viewpoint at a Distance to Tower 2 of 4.8 mi (7.7 km). Photo location: SOP 16.

FIGURE 3.1-6 View of ISEGS Facility from a Non-Elevated Viewpoint at a Distance to Tower 2 of 3.0 mi (4.8 km). Photo location: SOP 3.

shorter duration. Heliostat flares were judged to have an overall greater effect on the facility's appearance than towers going offline.

Other frequently observed visual phenomena included relatively faint reflected light from atmospheric dust, referred to by Ho et al. (2014) as "dust halos" (see Section 3.1.2), flashing strobe lights on the receiver towers (see Section 3.1.2), and other facility components, such as roads, buildings, and transmission lines and substations (see Section 3.1.4). At night, flashing red lights were visible on the receiver towers, and a variety of lighting illuminated the power blocks (see Section 3.1.5).

3.1.2 Receivers

As noted above, when the towers were operating, except for heliostat flares, the brilliant reflected sunlight from the receivers was the dominant visual element of the facility, and the primary (but not sole) reason that the ISEGS facility was easily visible at all distances in the study observations. The reflected light from the receivers appeared to be pure white and bright enough to cause discomfort when viewed from short distances, with one observer recording discomfort in one case at a distance of 4 mi (6 km). The receiver appeared as a cuboid or rectangular prism longer in height than in width and depth, and either a deep black with white horizontal bands at top and bottom when the tower was not operating, or a brilliant white when the tower was operating. The receiver sits atop a visually complex latticework support structure.

Visually, the receiver surfaces appeared to be flat, deep black surfaces when the towers were not illuminated; however, when the receivers were partially illuminated, close visual inspection from short distances sometimes revealed fine white vertical lines at the corners and at regularly spaced intervals across the receiver surface, as shown in Figure 3.1-7. When the tower was fully illuminated, the light was so bright that surface details were impossible to discern, even from very short viewing distances, as shown in Figure 3.1-8. Under normal operating conditions, the receiver light was steady, i.e., it did not noticeably fluctuate; however, as described below, it was sometimes extinguished quickly when the towers powered down, and sometimes fluctuated noticeably when a tower was coming online, at which point only a portion of the receiver surface was illuminated.

The Solar PEIS (BLM and DOE 2010) predicted that at long distances, power tower receivers would appear as bright star-like points of light. However, in the ISEGS study observations, the receiver light did not appear as a point even at the longest observation distance of 35 mi (56 km); in other words, the receivers' vertically elongated shapes were apparent regardless of observation distance. The tower structures were faintly visible at 35 mi (56 km) as well.

At distances of approximately 9 mi (14 km) or less, faint streamers of light (dust halos), generally forming a conical or fan shape, were sometimes observed originating from the receivers and shining outwards and downwards. The streamers are caused by the reflection of light from dust particles suspended in the atmosphere around the receiver towers

FIGURE 3.1-7 Partially Illuminated Receiver with Visible Surface Details

FIGURE 3.1-8 Fully Illuminated Receiver with No Surface Details Visible (Note small plume above receiver and dust halo.)

(Ho et al., 2014). Close-up views of this phenomenon are shown in Figs. 3.1-8 and 3.1-9, while a longer-distance view is shown in Figure 3.1-10. While the light reflected from dust is much fainter than the receiver light, it is sometimes easily seen against dark backdrops, and its distinctive shape as well as the appearance of the light emanating from the receivers is an unusual visual effect that attracts attention. Ho et al. (2014) observed dust halos appearing as pairs of more or less elliptical clouds adjacent to the towers; however, in the observations made in this study, when visible, the dust halos were always in the conical or fan shape shown in Figs. 3.1-8–3.1-10.

During several days of observations, one or two towers occasionally went offline for extended periods under sunny conditions, and on September 25, all towers were offline for several hours despite sunny skies. When a tower was observed to go offline, the brilliant light of the receiver faded very rapidly (over several seconds) to be replaced by the deep black surface of the unilluminated receiver, bounded on the top and bottom by a horizontal band of white that contrasted strongly with the black receiver surface. The sudden loss of the receiver light was quite noticeable. After going offline, the tower(s) were observed to sometimes come back online, at least partially, over an extended period of time, with a spot or spots of bright light visible on the receiver surface, as shown in Figure 3.1-7 and Figure 3.1-11 (SOP 16), rather than the entire receiver surface being illuminated. The size and shape of the spot was observed to change noticeably in the course of seconds or minutes.

Flashing white strobe lights affixed to the towers were visible in many views at shorter distances (approximately 6 mi [10 km] or less), and were particularly noticeable when the towers were not operating. When the towers were illuminated, the strobe lights were often visible, but much less noticeable because of the visual dominance of the constant brilliant receiver light.

Small plumes of steam or water vapor were observed at the top of the receivers during a number of observations. The plumes were not judged to be a significant source of visual contrast, and were not observed beyond 9 mi (14 km). Because the ISEGS facility uses dry cooling technology, larger plumes associated with wet cooling technology do not occur, though it is possible that the observed plumes might have been larger under different atmospheric conditions.

3.1.3 Heliostat Arrays

After the receivers, the heliostat arrays and bright reflections from individual heliostats (referred to as “heliostat flares” and discussed in detail in Section 3.2) were rated by the observers as being the largest sources of visual contrast from the ISEGS facility. As noted above, the portion of the array closest to the observer (the lowest portion of the array as seen from elevated viewpoints), where heliostats face away from the observer, was observed to be generally dull gray, brown, or green in color but occasionally dull white, while the portion opposite the observer (the upper portion as seen from the viewpoint), where heliostats face the observer, was silvery-white in color, and the middle portion, generally the largest in area visually, where heliostats face directions more or less perpendicular to the line of sight, was generally a dull blue or blue-gray. Usually, when the entire array was visible, approximately the top ¼ or less was silvery white, while the remainder (the lower portion) was blue, gray, or a

FIGURE 3.1-9 Close-Up View of Dust Halos around Receiver Towers

FIGURE 3.1-10 Dust Halos around Receiver Towers. Photo location: SOP 13. Distance to Tower 2 is 4.3 mi (6.9 km).

FIGURE 3.1-11 Partially Illuminated Receiver. Photo location: SOP 16. Distance to Tower 2 is 4.8 mi (7.7 km).

relatively dull white. The silvery white color was prominent in all views, and was easily visible even at the longest-distance observation in the study—35 mi (56 km).

Close inspection showed that the silvery white color appeared to be caused by sunlight reflected more or less directly toward the observer (even though the heliostats reflect light primarily toward the receivers), while the darker colors in the middle of the array appeared to result primarily from the heliostats reflecting the blue color of the sky. The dull gray, green, and brown colors, observed in the area of the heliostats nearest the observer, was caused by looking directly through the tilted surfaces of low-angle heliostats, at the ground surface under and between the heliostats. The varied color of the ground surface included browns of bare soil and the dull browns, greens, and grays of the low vegetation found under the heliostats. This sometimes made the closest portion of the heliostat array difficult to see, especially in longer-distance views, and illustrates the beneficial effect of applying the best management practice of not completely clearing vegetation under the heliostats. At shorter distances, the pattern of the heliostats created a visible texture that combined with slight color differences to make the closest portion of the heliostat array stand out from the background. This is shown in Figure 3.1-12 (SOP 9).

In early morning or late afternoon, when viewed from the direction opposite the sun, when the heliostats closest to the observer were tilted more towards perpendicular with the ground surface, the white backs of the heliostats themselves faced the observer, causing that portion of the heliostat field to appear as a mottled range of white shades. This observation, shown in Figure 3.1-13 (SOP 13), suggests that contrasts might have been substantially reduced by color treating the backs of the heliostats and supporting structures.

At moderate and long viewing distances, the heliostat arrays appeared as a continuous colored surface, sometimes with a slightly mottled surface due to contrast between bright reflections and shadowed areas. At distances of a few miles or less, individual heliostats may become visible, depending on sun angles and observer position and view bearing. At distances very close to the facility, details of heliostats and other facility components are easily visible. A close-up view of a portion of an ISEGS heliostat array is shown in Figure 3.1-14.

3.1.4 Other Facility Components

Other ISEGS facility components and activities observed included the power block (i.e., the steam turbine generator building, cooling system, and related structures), roads, various buildings, transmission lines and a substation, fences, and the movement of vehicles and workers in the course of the day. These facility components were not visible at all in the longest-distance view (35 mi [56 km]); however, the power blocks were faintly visible at 20 mi (32 km), roads at 17 mi (27 km), and vehicles and activity at 9 mi (14 km). These other facility components were generally not prominent at distances exceeding 9 mi (14 km), but were sometimes prominent at shorter viewing distances.

FIGURE 3.1-12 Visible Texture in Heliostats Closest to Observer. Photo location: SOP 9. Distance to Tower 2 is 3.1 mi (4.9 km).

FIGURE 3.1-13 White Backs of Heliostats Visible on Heliostats Facing Away from the Observer. Photo location: SOP 13. Distance to Tower 2 is 4.3 mi (6.9 km). (Note prominent dust halos.)

FIGURE 3.1-14 Close-Up View of ISEGS Heliostat Array

The heliostat assembly building (HAB) is a very large rectangular Quonset hut-like tent structure (approximately 125 ft. x 400 ft.) that was used as the assembly point for heliostats during facility construction. The desert tan fabric covering of the HAB contrasted with its surroundings at times, and did not match the colors of surrounding structures, which are painted shadow gray in accordance with BLM recommendations. While a minor element of contrast overall, the desert tan color sometimes added noticeably to contrast, particularly when the towers were not operating, while at other times it blended more successfully with the background.

3.1.5 Nighttime Facility Lighting

While not a major focus of the study, one nighttime observation was made to assess the extent and visibility of lighting at the ISEGS facility. The observation was made at approximately 9 PM local time from a distance of 5.7 mi (9.1 km), at SOP 2. Because of proximity to I-15, Primm, and Las Vegas, the night sky was not exceptionally dark, but portions of the Milky Way were faintly visible.

The observation showed that the power blocks, receiver towers, and immediate surroundings were very well lit, while the heliostat arrays and the rest of the ISEGS facility were almost completely dark, as shown in Figure 3.1-15 (SOP 2). Photographs were taken with exposure and white balance set so as to approximate the actual appearance of the facility reasonably well, as shown in Figure 3.1-15. In Figure 3.1-15, the "string of lights" to the left is the accumulated light from vehicles on I-15. The red lights are aerial hazard navigation lights on the receiver towers (note that most of Tower 2 and the surrounding area was screened by topography), and the four clusters of yellowish lights are the power blocks of Towers 1 and 3 (on the left and right sides, respectively, with the red tower lights above the center of each cluster). Toward the center of the photo, two clusters of light associated with the central cluster of buildings between Towers 1 and 2 are visible. Three red aerial hazard navigation lights on the towers flashed on and off continuously, in a cycle of approximately 1 second on and 2 seconds off. Each tower also had at least one solid red light. The rhythmic flashing of the red aerial hazard navigation lights attracted visual attention to the already bright lighting around the power blocks.

Additional isolated and somewhat fainter lights were visible in or near the facility. These may have been located at the corners of the heliostat arrays, but also may have been associated with other structures, the plant entrance, etc.

The red aerial hazard navigation lights and the yellowish lighting around the power blocks were judged to be brighter than the brightest star visible at the time (Vega). The isolated white lighting was judged to be fainter than the brightest stars visible at the time. Because the area around the ISEGS facility is almost completely dark, the ISEGS facility lighting was very prominent, and was judged to be a major focus of visual attention.

FIGURE 3.1-15 Nighttime View of ISEGS, Showing Facility Lighting. Photo location: SOP 2. Distance to Tower 2 is 5.7 mi (9.1 km).

3.2 GLARE INCIDENTS

Three types of glare incidents were observed in the course of the ISEGS study: glare from sunlight reflected from the surface of the receivers; glare from sunlight reflected off individual heliostats; and glare from vehicles. The three types of glare events had very different characteristics.

3.2.1 Receiver and Vehicular Glare

Annoyance glare from the receivers was recorded for one observation, made from a location 3.7 and 5.5 mi (6.0 and 8.9 km) to the nearest and farthest towers, respectively. The observation was made at approximately 10:10 AM local time. Both observers found the receivers to be uncomfortable to look at directly for more than a few seconds; however, extended viewing was possible. A photograph from that observation is shown in Figure 3.2-1 (SOP 6). It should be noted, however, that the receivers viewed in person were much brighter than they appear to be in the photograph. Interestingly, several other observations were made from shorter distances than this observation under generally the same lighting conditions, i.e., full sun; however, in these cases, viewing the receivers for extended periods did not cause discomfort.

Glare from vehicles within the facility was also recorded for one observation, made from a location 5.6 and 6.0 mi (9.0 and 9.7 km) to the nearest and farthest towers, respectively. The observation was made at approximately 4:50 PM local time. Discomfort was minimal, and the glare lasted only a few seconds.

3.2.2 Heliostat Glare

Glare from individual heliostats not facing the towers, but rather facing the observers, was by far the most common and most severe type of glare event observed during the course of the study. Because of their generally sudden onset and subsidence, these events are referred to as "heliostat flares" in this report.

One or more heliostat flares were reported for 15 of the 19 daytime observations made during the study. A typical heliostat flare lasted only a few seconds, and consisted of a very rapid large increase in brightness of a point in the heliostat array, which would shine steadily and then just as rapidly fade back to its previous brightness; however, several heliostat flares lasted for a few minutes, and the longest heliostat flare lasted more than 20 minutes. For longer-duration heliostat flares, the brightness would sometimes be constant for long periods, but might also wax and wane several times in the course of the event. Heliostat flares appeared to occur randomly. Typically, one occurred every few minutes; sometimes multiple heliostat flares were visible simultaneously. Heliostat flare events were independent of tower illumination, i.e., the flares were sometimes observed in heliostat arrays around towers that were not in operation.

FIGURE 3.2-1 Glare from ISEGS Receivers, as Seen from 4.7 mi (7.6 km) from Tower 2. Photo location: SOP 6.

The brightness of the heliostat flares varied. Many could be easily viewed without discomfort; others were as bright as or substantially brighter than the receivers, caused instant visual discomfort, were bright enough to cause flash blindness (afterimages), and could not be viewed for extended periods. Some of these exceptionally bright heliostat flares were observed at long distances, with heliostat flares causing instant discomfort to both observers at a distance of 20 mi (32 km) from the facility in one observation. Figures 3.2-2 (SOP 7) and 3.2-3 (SOP 16) show examples of heliostat flares.

Heliostat flares were observed at distances ranging from 1.4 to 35 mi (2.3 to 56 km), the longest distance at which the ISEGS facility was observed in the study, and likely would have been visible at substantially farther distances. Figure 3.2-4 shows heliostat flares as seen from the summit of Black Mountain, 35 mi (56 km) from the ISEGS facility (SOP 12). The foreground heliostat flare to the left of Tower 3 (at the right side of the photograph) is brighter than the receivers, and it should be noted, as for all of the photographs taken for this study, that when viewed in person, the glare and other reflections were substantially brighter than they appear in the photographs.

Close visual inspection showed that the heliostat flares were caused by individual heliostat pairs that were directed away from the towers, and were instead pointed more or less directly at the observer. Close-up views of the heliostat arrays showed that at any given time, even when the towers were operating, a number of heliostats were pointed in what appeared to be random directions, as shown in Figure 3.2-5. It is possible that the longer-duration heliostat flares are caused by non-operational heliostats such as these, and that the very brief heliostat flares are caused by momentary pointing of heliostats toward the observer as they are moved during normal operations.

A unique observation of heliostat flares was made in the late afternoon of September 24. In this short-distance observation (1.4 mi [2.2 km] to Tower 3, the nearest tower), instead of a single heliostat flare, a group of heliostats flared simultaneously, with each flare lasting for a short period of time, but with the heliostats within the group flaring asynchronously, and with different heliostats flaring up and fading randomly and/or varying in brightness rapidly; the result was a scintillating visual effect that immediately attracted and held attention. A still photograph of this event is shown in Figure 3.2-6 (SOP 17), but does not capture well either the brightness of the individual heliostat flares or the scintillations. The cause of this unique event is not known for certain. The tower for the array within which the flaring heliostats were located was not operating. On the basis of observations made at the time, it is possible that a large section of heliostats was directed away from the non-operating tower and toward the observers, and were pointed almost perpendicular to the ground surface. This may have caused them to sway in the wind, thus giving rise to the rapid scintillations observed.

The visual impact analysis for the ISEGS facility is contained in the *California Desert Conservation Area Plan Amendment/Final Environmental Impact Statement for Ivanpah Solar Electric Generating System FEIS-10-31* (BLM 2010). The Final EIS discusses glare as an important potential source of visual contrast from ISEGS, but does not mention heliostat flares as a potential source of glare. Given that heliostat flares were routinely observed in the course of the ISEGS visibility study, and that they were found to be substantially brighter than the

FIGURE 3.2-2 ISEGS Heliostat Flare, as Seen from a Distance of 20.4 mi (32.8 km). Photo location: SOP 7.

FIGURE 3.2-3 ISEGS Heliostat Flare, as Seen from a Distance of 4.8 mi (7.7 km). Photo location: SOP 16.

FIGURE 3.2-4 Heliostat Flares as Seen from the Summit of Black Mountain, 35 mi (56 km) from the ISEGS Facility. Photo location: SOP 12. (Heliostat flares are visible near Tower 3 (at right of photo): one in front and to the left, and one to the immediate right of Tower 3.)

FIGURE 3.2-5 ISEGS Heliostats Pointed in Apparently Random Directions

FIGURE 3.2-6 Scintillating Glare Spots on ISEGS Heliostat Array. Photo location: SOP 17. Distance to visible tower is 1.4 mi (2.2 km).

receivers at times, their exclusion from the Final EIS discussion is a serious omission of an important source of visual contrast from ISEGS.

3.2.3 Glare in High-Elevation Views

Prior to the ISEGS visibility study, there were concerns about heliostat glare being substantially more intense for views from elevated viewpoints around ISEGS, because of the possibility of potentially greater interception of reflected sunlight from the heliostats. Three observations of ISEGS were made from elevated positions close to the facility in the course of the present study. Substantially increased glare was not observed from these elevated viewpoints relative to the lower elevation viewpoints that made up the bulk of the viewpoints in the study; however, the vertical angles of view were not great, and the sample of high-elevation views was small and thus may not be representative of the general situation.

3.3 ISEGS FACILITY VISIBILITY RATINGS

As discussed in Section 2.2.2, most study observations included a facility visibility assessment that required each observer to quantitatively assess the visibility of the ISEGS facility on a scale of 1 to 6, where a visibility score of "1" implies a facility that is just barely visible to the unaided eye, and a score of "6" indicates a facility that dominates the view because of its size and strong color contrasts. For each observation, the visibility scores are averaged between the observers to obtain the *average visibility rating*.

For the 15 observations for which visibility assessments were conducted, 13 observations included two or three at least partially illuminated receivers in the view, while one observation included a view of just the receiver of one tower, with the rest of the facility screened by intervening topography. Of the 13 observations of two or more illuminated towers, all but one view at less than 20 mi (32 km) from the facility had average visibility rating scores of at least 5, indicating a facility that "contrasts with the surrounding landscape elements so strongly that it is a major focus of visual attention" and that draws viewer attention immediately and tends to hold viewer attention, but is not prominent enough to dominate the view. One observation at approximately 14 mi (23 km) and another observation at 20 mi (32 km) received an average visibility rating of 4.66.

The two observations beyond 20 mi (32 km), one at and one near the summit of Black Mountain at 35 mi (56 km), both had average visibility ratings of 4, indicating a facility that is "plainly visible, could not be missed by [a] casual observer, but does not strongly attract visual attention, or dominate view because of apparent size . . .". The change in visibility rating was due primarily to the decreased apparent size of the facility, which while bright, occupied approximately 8°, or just under 6% of the field of view.

The sample of views is too small to establish reliable contrast threshold distances, but the results do suggest that the ISEGS facility is a major source of visual contrasts that strongly attracts visual attention at distances in excess of 15 mi (24 km) and that it is a moderate source of visual contrast to distances of at least 35 mi (56 km).

4 COMPARISON OF FIELD OBSERVATIONS WITH FINAL EIS SIMULATIONS AND CONTRAST RATINGS

Another objective of the ISEGS study was to compare the "as-built" visual characteristics and contrasts of the operating facility with the visual characteristics and contrast levels portrayed in the visual simulations and visual impact analysis contained in the ISEGS Final EIS (BLM 2010) and supporting documents prepared prior to the construction of the ISEGS facility.

Pre-construction visual simulations for the ISEGS facility are contained in the Final EIS, but the same simulations are presented at a slightly larger scale and higher spatial resolution in data response documents submitted to the California Energy Commission (CEC) in response to requests by CEC staff (Solar Partners I et al., 2008a and 2008b), and these higher-quality simulations are included here.

For the Final EIS, 10 KOPs were identified for evaluation of visual impacts; however, in two cases (KOPs 1 and 2 and KOPs 3 and 4), the KOPs were actually the same points, from which views of the facility were split into two simulations. A total of 9 simulations were prepared for 9 KOPs; no simulations were prepared for one other KOP. The Final EIS noted various inaccuracies contained in the simulations, and stated that because of inherent technical limitations, the simulations could not accurately depict the full brightness of the illuminated receivers. Neither the Final EIS nor the data response documents provided information about the simulations beyond short descriptions of the simulation locations and general statements about field of view and what the simulations showed. Precise locations for the simulations were not provided, nor were dates and time of day for the base photographs, precise field of view, and numerous other data currently called for in BLM and other guidance documents (BLM 2013, Sullivan and Meyer 2014); these data greatly facilitate accurate evaluation of visual simulations for proposed facilities.

For the current study, photographs were taken at or close to most of the Final EIS KOPs; BLM contrast ratings were obtained for six of the Final EIS KOPs. Of these six KOPs, five had corresponding simulations in the CEC data response documents and were discussed in the Final EIS text; the simulations from the data response documents as well as the photographs and contrast ratings obtained for the ISEGS visibility study for these five KOPs are presented below. For each KOP, the simulation from the data response document is compared with the photograph taken during the ISEGS visibility study that most closely matches the scene included in the simulation, and the visual contrast discussion in the Final EIS is compared with the visual contrast ratings obtained for the ISEGS visibility study.

It should be noted that the analysts for the Final EIS had larger-scale (11 × 17 inch), higher-resolution simulations for their evaluations than those presented in the published version of the Final EIS document or the data response documents. Thus, the simulations used in the EIS impact analysis were likely slightly larger and sharper in detail than those presented here. It should also be noted that the simulations depict seven towers for the ISEGS facility rather than the three towers actually built, because the project design changed after the simulations were prepared. In the simulations, the locations shown for Towers 1 and 2 correspond to their as-built locations; however, instead of a single tower at the Tower 3 as-built location, there are five widely spaced towers, including a tower at the location of Tower 3. Thus, the analysts were using simulations that were not spatially accurate with respect to part of the facility, which potentially may have affected the accuracy of the contrast assessment (Sullivan and Meyer 2014).

4.1 EIS KOPs 3 AND 4 (ISEGS STUDY SOP 3): I-15 NEAR YATES WELL RD. EXIT

This KOP is located on I-15 just southwest of the Yates Well Rd. interchange; however, the ISEGS visibility study SOP is located at the Yates Well Rd. interchange. Thus, there is a minor difference in location between the KOP and SOP; however, the views are very similar. The SOP is located approximately 1.8 mi (2.9 km) from Tower 1, 3.0 mi (4.8 km) from Tower 2, and 4.2 mi (6.8 km) from Tower 3. Figures 4.1-1 and 4.1-2 show the simulated view of the ISEGS facility (divided into two simulations because the facility could not be captured in one image using the standard focal length used for the simulations), and Figure 4.1-3 shows a photograph taken from the approximate KOP location at approximately 5:50 PM local time on September 22.

Examination of Figures 4.1-1, 4.1-2, and 4.1-3 shows that the lighting for the simulations is very different from the lighting for the photograph, and therefore caution needs to be exercised when making comparisons. In the simulations, except for the receiver on Tower 1, the tower elements are indistinct, with the power block elements and the more distant towers barely visible. In the photograph, these elements are more plainly visible. In the simulations, the small rectangle of light simulating the tower receiver is squarer than the receivers on the as-built towers shown in the photograph. The tower structure visible in the simulation also seems to be less substantial than the as-built tower in the photograph, with the simulated tower seeming to be almost transparent so that it blends in with the background, while in the photograph, it has a denser and more solid appearance. The heliostat fields are brighter and more evenly colored in the simulation than in the photograph, while the receivers themselves are less bright. The dust halos in the simulations are shown much brighter and more sharply defined and also covering a much larger area than shown in the photograph, and while the appearance of the reflected dust is highly variable, on the basis of all of the observations made in the course of the study, the simulations substantially exaggerate its visibility.

The discrepancies in the actual placement and construction of facility components in the simulations are discrepancies in spatial accuracy, that is, showing the facility or its components at the wrong location, size, or positioning, or showing the facility with either missing or extra components (BLM 2013, Sullivan and Meyer 2014). It should be noted that the simulation shows the proposed facility design correctly, according to the proposed design at the time, and thus cannot be considered an error, only an inaccuracy that could not be avoided. The failure to show the receivers as bright as they would be in reality, and showing the dust halos brighter and more sharply delineated than they would be in reality, constitute errors in realism, that is, not showing the facility as it would really appear.

An error in realism is apparent in Figure 4.1-1, which shows the simulated view of Tower 1 in operation, with the receiver illuminated and a dust halo visible, but with an overcast sky.

FIGURE 4.1-1 Visual Simulation of ISEGS Facility Tower 1 as It Would Be Seen from the Final EIS KOP 4, I-15 Near Yates Well Rd. Interchange

FIGURE 4.1-2 Visual Simulation of ISEGS Facility Tower 2 and Tower 3 Cluster as It Would Be Seen from the Final EIS KOP 3, I-15 Near Yates Well Rd. Interchange

FIGURE 4.1-3 Photograph of ISEGS Facility as Seen from ISEGS Visibility Study SOP 3 (ISEGS Final EIS KOPs 3 and 4), I-15 Near Yates Well Rd. Interchange

Given that the tower cannot operate in overcast conditions, the simulation is unrealistic, i.e., it does not show the facility as it would really appear. As noted in the BLM publication *Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities* (BLM 2013),

> "[Simulations] should be realistic (i.e., they should look like the facility would actually look when built, as seen from the relevant KOP), and they should be colored and shaded realistically, with cast shadows that are depicted accurately and realistically. Any known errors in accuracy or realism should be clearly stated so that viewer expectations are appropriate."

Neither the data response document (Solar Partners I et al. 2008a) nor the Final EIS (BLM 2010) mentions this error in realism.

The Final EIS (BLM 2010) describes the visual contrasts for this view as follows:

> ". . . The project would be highly prominent from this near-middle-ground viewpoint. The tall solar collector towers would introduce strong vertical form and line contrast. This form contrast would be strongly amplified by bright illumination of the heated solar receiver at the top of each tower, as well as by light rays of reflected sunlight when ambient dust particles are present in the surrounding air. The mirror arrays would alter the character of the desert floor to a distinctly man-made texture, including the mechanical structures of mirror units closest to the viewer, and the bright, reflective mirror surfaces visible beyond the solar towers. Although the form and line contrast of the mirror arrays would be weak, the textural contrast they would introduce is considered strong due to the vast scale and visual magnitude of the affected area, which is so broad that it could not be seen in one view. Visible areas of disturbed soil between Ivanpah 1 and 2 could contrast sharply in color and brightness with any surrounding undisturbed soil surface.
>
> In addition to this strong level of contrast, the project would exhibit strong spatial and scale dominance. The vast scale of the project would be such that it could not be taken in in a single view . . ." (page 4.13-15).

This language and the assigned contrast level are generally consistent with the visual contrast analysis and the visibility assessment conducted for the ISEGS study. The visual contrast assessment found that there were strong contrasts created by changes to the color of vegetation, and also strong contrasts in form, line, and color from the visible facility structures. The contrast assessment noted the brilliant white light of the receivers, the silvery-white color of portions of the heliostat fields, and the strong vertical and horizontal lines of the receiver towers and other structures. The contrast assessment also noted the changes to texture created by the heliostat fields, as well as the complex angular geometry of the receiver tower structure and the blocky appearance of the power block elements. The visibility assessment for this view indicated an average visibility rating of 5.66 for the ISEGS facility, indicating that ISEGS was a major focus of visual attention that attracted and held views.

4.2 EIS KOP 5 (ISEGS STUDY SOP 1): I-15 NIPTON RD. INTERCHANGE

This KOP is located at the northbound entrance ramp to I-15 at Nipton Rd. The KOP is located 4.2 mi (6.8 km) from Tower 1, 5.8 mi (9.3 km) from Tower 2, and 7.3 mi (11.7 km) from Tower 3. Figure 4.2-1 shows the simulated view of the ISEGS facility, and Figure 4.2-2 shows a photograph taken from the approximate KOP location at approximately 4:00 PM local time on September 22.

Close examination of Figures 4.2-1 and 4.2-2 shows that in the simulation, the project appears to be on level ground on a flat valley floor, while the photograph shows the facility to be located on a slope, with the rightmost portion of the facility noticeably lower than the left side. In fact, the facility is located on a noticeable slope, and the simulation is inaccurate in this respect. In the simulation, the heliostat fields are portrayed as nearly level with the line of sight, but the photograph shows that because the heliostat fields are on a slope, the tops of the arrays are more visible than shown in the simulation, and they are slightly larger in visible area. In the simulation, distinct dark lines (probably intended to depict shadow under the heliostats) are shown immediately under the heliostat arrays, but in the photograph, no such lines are visible, possibly because of a different sun angle in the photograph than portrayed in the simulation, but also because the array is not actually level with the line of sight. Most importantly, the heliostat arrays and especially the receivers are distinctly brighter in the photograph than in the simulation. The overall result is that the ISEGS facility is substantially more visible in the photograph than in the simulation presented in the Final EIS and data response document. As noted elsewhere in this report, as viewed in the field by the naked eye, the receivers and the facility in general were noticeably brighter than they appeared in photographs; i.e., the discrepancy between the simulation and the naked-eye view is even larger than that between the simulation and the photograph.

In the Final EIS (BLM 2010), little is said about the contrasts caused by the facility as seen from this KOP and visible in the simulation, except that the degree of contrast is described as moderate. Contrast is described as follows:

> "Contrast of the project at this farthest viewpoint on I-15 would be moderate, rapidly increasing to strong contrast as motorists progressed northward. Visual exposure to the site is high until motorists reach the Primm Valley Golf Course, which obstructs highway views to the site.
>
> Project dominance would remain moderate (co-dominant) at this distance. Scale and prominence of the mirror fields would be large but co-dominant within the overall field of view.
>
> View blockage would be moderate from this location. The bright solar receivers would strongly attract attention, but would appear largely to the right (east) of Clark Mountain, the principal object of scenic views." (page 4.13-17).

FIGURE 4.2-1 Visual Simulation of ISEGS Facility as It Would Be Seen from the Final EIS KOP 5, I-15 Nipton Rd. Interchange

FIGURE 4.2-2 Photograph of ISEGS Facility as Seen from ISEGS Visibility Study SOP 1 (ISEGS Final EIS KOP 5), I-15 Nipton Rd. Interchange

The visual contrast assessment for the ISEGS visibility study found strong contrasts created by changes to the color and lines of vegetation where vegetation had been cleared or otherwise altered, and strong contrasts in form, line, and color from the visible facility structures, the brilliant white light of the receivers, the silvery-white color of portions of the heliostat fields, and the strong vertical and horizontal lines of the receiver towers and other structures. The visibility assessment for this view indicated an average visibility rating of 5.66 for the ISEGS facility, indicating that ISEGS was a major focus of visual attention that attracted and held views. This suggests that the moderate contrasts predicted in the Final EIS were in fact strong contrasts for the as-built facility.

4.3 EIS KOP 6 (ISEGS STUDY SOP 6): IVANPAH DRY LAKE BED, EASTERN SIDE

This KOP is located near the eastern edge of Ivanpah Dry Lake, almost due east of Tower 2. The KOP is located 4.1 mi (6.6 km) from Tower 1, 4.7 mi (7.6 km) from Tower 2, and 5.5 mi (8.9 km) from Tower 3. Figure 4.3-1 shows the simulated view of the ISEGS facility, and Figure 4.3-2 shows a photograph taken from the approximate KOP location at approximately 10:25 AM local time on September 23, which captures the same approximate field of view shown in the simulation. Figure 4.3-3 is a wider-angle view of all three towers.

Figure 4.3-1 shows that in the simulation, Tower 1 is not visible, yet it is closer and more prominent in the actual view (as shown in Figure 4.3-3) than the portrayed towers. The omission of Tower 1 from the simulation was discussed in the Final EIS (BLM 2010), and it was noted that Tower 1 would appear closer and brighter than the towers shown; however, if the impact assessment for this KOP was based primarily on this simulation, the failure to include the closest and most visible tower in the simulation may have resulted in a substantial under-rating of contrast, and the simulation itself greatly misrepresents the view of ISEGS from KOP 6.

Comparison of the simulation to the photograph in Figure 4.3-2 shows that the receivers are substantially larger in size and much brighter in the photograph than in the simulation, especially for the farthest towers. For the most distant towers, the reflected light from atmospheric dust is plainly visible in the simulation, but the receivers themselves are faint. In fact, it would not be possible to see the reflected light from atmospheric dust as portrayed here if the receivers were illuminated as dimly as shown in the simulation. As for EIS KOPs 3 and 4, the visibility of reflected light from atmospheric dust appears to be exaggerated. In the simulation, only one heliostat field is plainly visible (around Tower 2) and is shown as a very thin dark line, while in the photograph, the tops of two heliostat arrays are plainly visible, especially the silvery-white portion of the arrays immediately around the base of the left-most tower. Overall, the ISEGS facility is substantially brighter and more visible in the photo than in the simulation.

The Final EIS describes the visual contrasts for this view as follows:

> "…because of distance and the relatively oblique vertical angle of view, the mirror arrays would occupy a narrow portion of the field of view, appearing relatively flat from Ivanpah Lake viewpoints. Form, line and color contrast of the mirror fields would thus be relatively weak. The vertical 459-foot towers and

FIGURE 4.3-1 Visual Simulation of ISEGS Facility Towers 2 and 3 as They Would Be Seen from the Final EIS KOP 6, Ivanpah Dry Lake Bed, Eastern Side

FIGURE 4.3-2 Photograph of Towers 2 and 3 of the ISEGS Facility as Seen from ISEGS Visibility Study SOP 6 (ISEGS Final EIS KOP 6), Ivanpah Dry Lake Bed, Eastern Side

FIGURE 4.3-3 Photograph of Towers 1, 2, and 3 of the ISEGS Facility as Seen from ISEGS Visibility Study SOP 6 (ISEGS Final EIS KOP 6), Ivanpah Dry Lake Bed, Eastern Side

bright glow of solar receivers would have greater line and color contrast but would remain moderate and co-dominant with other features in the view. Light rays, when present as depicted in the simulation, would be prominent, but would remain generally subordinate within the overall view. Based on currently available data, project contrast would range from weak to moderate depending on prevalence of light rays and brightness of solar receivers." (page 4.13-18).

The statement that the heliostat arrays would occupy a very narrow portion of the field of view, and would appear relatively flat, is shown by the photograph not to be accurate. Because the facility is located on a slope directly facing the viewer, the tops of the heliostat arrays are visible, and add substantially to the contrast created by the facility.

The visual contrast assessment for the ISEGS visibility study found strong contrasts in form, line, and color from the visible facility structures. The visibility assessment for this view indicated an average visibility rating for the ISEGS facility of 5.83, the second highest rating for the entire study, indicating that ISEGS was a major focus of visual attention that attracted and held views. During the field observation, both observers found the receivers difficult to look at because of excessive brightness. The results of the contrast rating and visibility assessment thus suggest that the weak-to-moderate contrasts predicted in the Final EIS were in fact strong contrasts in the as-built facility.

4.4 EIS KOP 7 (ISEGS STUDY SOP 19): IVANPAH DRY LAKE BED, WESTERN SIDE, NORTHERN PORTION

This KOP is located at the western side of the far northern portion of Ivanpah Dry Lake, northeast of Tower 2. The KOP is located 4.6 mi (7.4 km) from Tower 1, 4.2 mi (6.8 km) from Tower 2, and 4.3 mi (6.9 km) from Tower 3. Figure 4.4-1 shows the simulated view of the ISEGS facility, and Figure 4.4-2 shows a photograph taken from the approximate KOP location at approximately 3:10 PM local time on September 25 that captures the same approximate field of view shown in the simulation. Figure 4.4-3 is a wider-angle view of all three towers. At the time the photographs were taken, one of the ISEGS receivers (Tower 3) was not illuminated, and the other two receivers were only partially illuminated.

Figure 4.4-1 shows that in the simulation, Tower 1 is not visible, yet it is prominent in the actual view (as shown in Figure 4.4-3). Similarly to the simulation for KOP 6, the failure to include Tower 1 in the simulation may have resulted in an under-rating of contrast, and the simulation does not correctly depict the actual view of ISEGS from KOP 7.

The simulation shows similar levels of receiver illumination compared to the other simulations, and comparison with the photograph shows that for Tower 2, the level of illumination shown in the simulation is roughly equivalent to the partial illumination shown in the photograph. For Tower 3 and the other towers in the simulation, the level of illumination shown is closer to the unilluminated Tower 3 shown in the photograph than to an illuminated

FIGURE 4.4-1 Visual Simulation of ISEGS Facility Towers 2–7 as They Would Be Seen from the Final EIS KOP 7 on the Ivanpah Dry Lake Bed, Western Side

FIGURE 4.4-2 Photograph of ISEGS Facility Towers 2 and 3 as Seen from ISEGS Visibility Study SOP 19 (ISEGS Final EIS KOP 7) on the Ivanpah Dry Lake Bed, Western Side

FIGURE 4.4-3 Photograph of Towers 1, 2, and 3 of the ISEGS Facility as Seen from ISEGS Visibility Study SOP 19 (ISEGS Final EIS KOP 7) on the Ivanpah Dry Lake Bed, Western Side

tower. In fact, the unilluminated Tower 3 in the photograph is more easily seen than the towers as they are depicted in the simulation. Similarly to the other simulations presented here, the dust halo brightness and sharpness is exaggerated in the simulation, while the heliostat fields are much more visible in the photograph than in the simulation.

The Final EIS (BLM 2010) describes the visual contrasts for this view as follows:

> "…the mirror fields would be viewed at a relatively oblique, low angle, reducing their overall prominence in the field of view. The solar receiving towers would be prominent due to the intense brightness of the illuminated solar receivers atop each tower. The overall level of project contrast would range from weak to moderate depending upon prevalence of light rays and brightness of solar receivers. In the presence of light rays as depicted in the simulation, or high levels of receiver illumination, contrast would be moderate." (page 4.13-19).

The visual contrast assessment for the ISEGS visibility study found strong contrasts created by changes to the background color where vegetation had been cleared or otherwise altered, and also strong contrasts in line, color, and texture from the visible facility structures, even though two of the towers were only partially illuminated and one was not illuminated at all. The visibility assessment for this view indicated an average visibility rating of 5.33 for the ISEGS facility, indicating that ISEGS was a major focus of visual attention that attracted and held views. This finding suggests that the weak-to-moderate contrasts predicted in the Final EIS were strong contrasts in the as-built facility.

4.5 EIS KOP 9 (ISEGS STUDY SOP 13): UMBERCI MINE RD.

The KOP in the Final EIS (BLM 2010) is located on a trail to the Umberci Mine, almost due north of the northwest corner of the ISEGS facility. The ISEGS visibility study SOP from which photos of the facility were taken is farther from the facility, and at a slightly higher elevation, but with a generally similar view. The SOP is located 2.9 mi (4.6 km) from Tower 3, 4.3 mi (6.7 km) from Tower 2, and 6.0 mi (9.7 km) from Tower 1. Figure 4.5-1 shows the simulated view of the ISEGS facility, and Figure 4.5-2 shows a photograph taken from the SOP location at approximately 5:50 PM local time on September 24. It should be noted that the nearest towers in the simulation are not shown at the same locations as the towers in the photograph, in part because of the previously mentioned design change, but also because of the relatively large difference between the KOP and SOP locations.

Figures 4.5-1 and 4.5-2 show that in the simulation, the receivers do not appear to be illuminated, although dust halos are visible; again, it would not be possible to see the reflected light from atmospheric dust as portrayed here if the receivers were not illuminated. The omission of illuminated towers is not noted in the Final EIS. It obviously would greatly affect the visual contrast created by the facility, and it is possible that the analysts assumed the towers would be illuminated, because the receiver light is mentioned as a strong source of visual contrast in the EIS discussion. The simulation depicts a substantially different tower design than the as-built

FIGURE 4.5-1 Visual Simulation of ISEGS Facility as It Would Be Seen from the Final ISEGS EIS KOP 9 on Umberci Mine Rd.

FIGURE 4.5-2 Photograph of ISEGS Facility as Seen from the ISEGS Visibility Study SOP 13 (Final ISEGS EIS KOP 9) on Umberci Mine Rd.

facility depicted in the photograph, and the power block elements that are plainly visible in the photograph are missing from the simulation. The heliostat fields are much brighter than those depicted in the simulation, but this might be an effect of lighting angle; as noted, information about the times and dates of the views depicted in the simulations was not presented in the EIS.

The Final EIS states that "The backs of the mirror units are assumed in the simulation to be painted in a dark color," presumably as a mitigation measure to make them blend in with the shadowed ground surface and vegetation (page 4.13-20). Observations and photographs made during the ISEGS visibility study revealed that the heliostat backs were a solid white color; i.e., the mitigation was not implemented. This fact introduces a potential source of error into the contrast assessment if the simulation served as a basis for the assessment; as noted previously, implementation of this recommended best management practice (BLM 2013) would likely have reduced visual contrast from the heliostats.

The Final EIS describes the visual contrasts for this view as follows:

> "The individual 12-foot-tall mirror units are distinguishable in this simulation. To provide a sense of scale, the towers are 459 feet tall. The backs of the mirror units are assumed in the simulation to be painted in a dark color. As discussed above and depicted in Figure 4.13-7 B, the appearance of the visible mirror surfaces would vary widely, from dark blue to bright solar diffuse glare, depending upon time and season. The visibility of mirror reflection would be greater from this and other KOPs within the Wilderness Area than from the valley floor due to the elevated viewer position.
>
> As depicted . . . form, line, color and texture contrast of the project structures would all be strong from this viewpoint. Towers would exhibit strong form and line contrast. The mirror fields would exhibit strong texture contrast with the natural ground plane. The glowing solar collectors and visible areas of mirror surface would exhibit strong color contrast against the ground plane and background mountain slopes. . .
>
> Due both to relative proximity to the project and the elevated viewing angle, the scale and spatial dominance of the project would be high (dominant). As illustrated in the simulation, the project would extend over the entire field of view and could not be taken in in a single view. The brightly lit solar receivers would compete with the mountain peaks and ridges for visual dominance." (pages 4.13-20 and 4.13-21).

This description is in general agreement with the visual contrast rating and visibility assessment conducted for the ISEGS visibility study. The visual contrast assessment for the visibility study found strong contrasts in form, line, color, and texture from the visible facility structures. The visibility assessment for this view indicated an average visibility rating for the ISEGS facility of 6, the highest rating for the entire study, indicating that ISEGS was a major focus of visual attention and that it dominated the view because of its very large apparent size.

4.6 FINAL EIS KOP 8 (ISEGS STUDY SOP 2): LOOKING SOUTH FROM PRIMM, NEVADA

The Final EIS (BLM 2010) did not include a simulation for KOP 8 (Looking South from Primm, Nevada); however, the Final EIS discussion of KOP 8 indicated weak-to-moderate expected visual contrast levels for the view. Figure 4.6-1 shows a photograph of the ISEGS facility from EIS KOP 8. The visual contrast rating and visibility assessment conducted for the ISEGS visibility study found the actual contrast levels to be strong, on the basis of (1) changes to vegetation and (2) the introduction of brightly colored structures, especially the brilliantly reflecting receivers and silvery-white heliostats.

4.7 SUMMARY OF COMPARISONS BETWEEN PROJECTED AND ACTUAL CONTRAST LEVELS

Five simulations were presented in the Final EIS (BLM 2010) for which corresponding visual contrast ratings and photographs were taken as part of the ISEGS visibility study. The simulations depicted the anticipated appearance of the ISEGS facility as it would be seen from particular KOPs, while the photographs taken during the ISEGS visibility study depicted the actual appearance of the facility in operation, though it was noted both in the Final EIS and by the observers in the ISEGS visibility study that neither the simulations nor the photographs were capable of accurately depicting the full brightness of the illuminated receivers.

Comparison of the simulations with the photographs showed that all of the simulations exhibited discrepancies in spatial accuracy and realism, and in some cases the discrepancies were substantial. The simulations did not present all of the facility components in their as-built locations because the project design was changed after the simulations were prepared. Two simulations omitted substantial portions of the facility that would have been easily visible from the KOPs. Other project elements visible in the photographs, such as receiver towers, the power block elements, and tower structure details, were sometimes absent from the simulations or differed substantially in appearance. Most importantly, the simulations generally under-represented the brightness of the illuminated receivers, exaggerated the brightness and area of reflections from dust halos, and sometimes under-represented the brightness of the heliostat arrays. In one case, the simulation showed facility components with mitigation measures that were not actually implemented. In general, the simulations showed low fidelity to the as-built ISEGS facility, and in several cases, substantially under-represented the visual contrasts of the facility.

For four of the six KOPs discussed in this report, the Final EIS projected weak to moderate visual contrasts from the project as it would be seen from the KOPs, while the ISEGS contrast ratings and visibility assessments for the operating facility indicated that the actual visual contrasts observed during the field assessments were strong. A comparison of the visual contrast ratings presented in the Final EIS and those made during the ISEGS visibility study is

FIGURE 4.6-1 Photograph of ISEGS Facility as Seen from the ISEGS Visibility Study SOP 2 (Final ISEGS EIS KOP 8) in Primm, Nevada

presented in Table 4.7-1. While the photographs taken during the contrast assessments do not show the receivers to be as bright as they were to the naked eye, they do show the receivers to be substantially brighter than shown in the simulations. For the remaining two KOPs, both the Final EIS and the ISEGS visibility study indicated strong visual contrasts. In general, the visual contrast levels predicted in the Final EIS were lower than those actually observed for the as-built facility as determined by the ISEGS visibility study.

TABLE 4.7-1 Comparison of ISEGS Final EIS (BLM 2010) Visual Contrast Ratings to ISEGS Visibility Study Contrast Ratings

Final EIS KOP	Visibility Study SOP	KOP/SOP Name	Final EIS Contrast Rating	Visibility Study Contrast Rating
3, 4	3	I-15 near Yates Well Rd. exit	Strong	Strong
5	1	I-15 Nipton Rd. interchange	Moderate	Strong
6	6	Ivanpah Dry Lake Bed, Eastern Side	Weak to moderate	Strong
7	19	Ivanpah Dry Lake Bed, Western Side	Weak to moderate	Strong
9	13	Umberci Mine Rd.	Strong	Strong
8	2	Looking South from Primm, Nevada (Whiskey Pete's)	Weak to moderate	Strong

5 CONCLUSIONS AND RECOMMENDATIONS

This study characterized the visual properties and visual contrasts associated with the operating ISEGS facility. It also compared the predicted contrast levels and visual simulations from the ISEGS Final EIS (BLM 2010) with the actual contrast levels and photographs of the as-built ISEGS facility in operation.

Significant findings of the field observations and contrast comparison include the following:

- Reflected sunlight from the receivers was the primary source of visual contrast from the operating ISEGS facility under sunny conditions, regardless of viewing distance or viewing geometry.

- Reflected sunlight from the receivers was sometimes difficult but not impossible to look at, even at short distances from the facility.

- Reflected sunlight from the receivers caused discomfort for one or both observers at distances up to 4 mi (6 km).

- In unobstructed views, the ISEGS facility was found to be a major source of visual contrast for observations up to 20 mi (there were no observations between 20 mi [32 km] and 35 mi [56 km]).

- The ISEGS facility, including the heliostat field, was easily visible at 35 mi.

- Glare from individual heliostats was frequently visible, and often brighter than the reflected light from the receivers, even at 35 mi (56 km).

- Glare from individual heliostats caused discomfort for one or more viewers at distances up to 20 mi (32 km).

- Glare from individual heliostats was typically visible for only a few seconds, but occasionally lasted for a few minutes, and rarely for much longer periods.

- Excessively bright glare was not observed from elevated SOPs.

- “Dust halos,” relatively faint patches of light reflected from atmospheric dust, were frequently visible around the operating towers, and were sometimes visible at distances greater than 10 mi (16 km).

- One or more towers were not operating during significant portions of the time the facility was observed.

- Consistent use of appropriate colors that blend well with the visual backdrop for all structures would likely reduce overall contrasts from the facility.

- Appropriate color treatment of the backs of the heliostats and the supporting structures would reduce the perceived contrast from the heliostat field.

- The ISEGS power blocks were brightly lit at night, and were conspicuous sources of light at the observation distance of approximately 6 mi (10 km).

- The ISEGS facility is substantially brighter and is seen more clearly in the field than in photographs of the facility or in the simulations, which were based on photographs.

- The simulations of the ISEGS facility in the Final EIS and supporting documents in some instances exhibit low spatial accuracy and realism.

- The simulations of the ISEGS facility in the ISEGS Final EIS substantially under-represent the actual visual contrast from the project.

- Some of the contrast ratings in the ISEGS Final EIS predicted substantially lower levels of visual contrast than were actually observed for the operating facility.

The study findings have important implications for conducting VIAs for proposed solar power tower facilities. The study results also have implications for facility siting, design, and mitigation.

The Solar Programmatic EIS and other solar power tower EISs used 25 mi (40 km) as the maximum area of potential effect (APE – the maximum distance at which visual impacts were assessed) for the VIAs. The ISEGS visibility study showed that the ISEGS facility was a moderate source of visual contrast at 35 mi (56 km), suggesting that future VIAs should have APEs of at least 35 mi (56 km), if not greater.

The ISEGS visibility study showed that heliostat flares were an important source of visual contrast from the ISEGS facility. If this type of visual contrast is typical of all power tower facilities, it should be included in the VIAs for these types of facilities, and potential mitigation methods for heliostat flares should be developed.

The study showed that glare from heliostat flares could cause discomfort to observers over long distances, suggesting that either solar facility siting or viewing platform designs (i.e., siting of scenic or recreation trails and sites and scenic viewpoints) should avoid creating situations where observers will be required to look at the facility for extended periods of time.

The study also demonstrated that the simulations prepared as part of the ISEGS VIA were not accurate and realistic depictions of the as-built facility, and they generally under-represented the degree of visual contrast caused by the ISEGS facility. While the spatial inaccuracy is partially due to the change in facility design after the VIA was conducted, it is important in the future that the visual characteristics of solar power tower facilities be as accurately and realistically depicted as possible in simulations used as the basis for assessment of visual impacts. The results of the ISEGS study suggest that more rigorous evaluation of simulations used in VIAs may be warranted.

Finally, the study showed that for several KOPs, the Final EIS predicted lower levels of visual contrast than were actually observed for the as-built facility. This suggests that further research is needed to determine if impact assessments based on simulations that are unable to accurately depict the strong levels of visual contrast created by solar power towers systematically underestimate the visual contrasts caused by the operating facilities.

While the ISEGS visibility study clearly advances the state of knowledge regarding the visual properties of utility-scale solar power tower facilities and assessment of their visual contrasts, it cannot be assumed that the visual characteristics of the ISEGS facility and the visual phenomena observed would be the same for other power tower facilities using different project designs and layouts. The ISEGS facility contains three towers, uses dry cooling technology, lacks storage structures, and uses a complex metal tower structure rather than visually simple concrete towers, which dominate the current proposed power tower designs. While the ISEGS facility represents the new generation of power tower facilities being built in the southwestern U.S., its visual characteristics may be unique. A larger sample of facilities is needed to make valid assumptions about the characteristics of other projects. Large-scale power tower facilities may cause very large visual impacts, but because facilities of this size have no precedent, there is more to learn about how they may impact scenic resources. As a general conclusion, further research into the visual characteristics of operating power tower facilities is needed in order to develop accurate VIAs for proposed projects and to develop siting and mitigation strategies to minimize the visual impacts of this type of solar energy facility.

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APPENDIX A: STUDY OBSERVATION POINT (SOP) DESCRIPTIONS

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APPENDIX A: STUDY OBSERVATION POINT (SOP) DESCRIPTIONS

This appendix includes brief descriptions of the SOPs used in the ISEGS visibility study. The latitude and longitude for each SOP are provided in parentheses after the SOP name.

SOP 1: Nipton Road Exit (35.47431, -115.44703)

SOP 1 is located approximately 5.83 mi SSE of ISEGS on the I-15 Nipton Road on-ramp. It depicts the view of ISEGS of motorists on I-15 as they enter the valley from the south or as they turn onto I-15 from Nipton Road. For motorists traveling north on I-15, it is the first view of the facility. This SOP was analyzed in the Final EIS (BLM 2010) as KOP 5.

SOP 2: Whiskey Pete's, Primm, Nevada (35.60777, -115.39196)

SOP 2 is located 5.65 mi NE of ISEGS in the parking lot of Whiskey Pete's in Primm, Nevada. Primm straddles I-15 and crosses the California-Nevada border. It is a high-volume visitor destination known for its local casino-resorts and as a rest stop for travelers on their way to Las Vegas, Nevada. This SOP was analyzed in the Final EIS (BLM 2010) as KOP 8.

SOP 3: I-15 at Yates Well Road (35.54052, -115.42168)

SOP 3 is located 3 mi W of ISEGS on Yates Well Road. Yates Well Road is the access road to the Primm Valley Golf Course, ISEGS, and the Mojave National Preserve. This SOP was analyzed in the Final EIS (BLM 2010) as KOP 3 and 4.

SOP 4: Nipton Road, First Visibility (35.48222, -115.19284)

SOP 4 is located 16.5 mi ESE of ISEGs on Nipton Road. This SOP represents the first glimpse of ISEGS by motorists traveling west on Nipton Road from Searchlight, Nevada.

SOP 5: Nipton Desert Road (35.52173, -115.31682)

SOP 5 is located 9.02 mi E of ISEGS, just west of Nipton Desert Road. Nipton Desert Road is used to access other unpaved dirt roads that lead to Ivanpah Dry Lake, which is a popular recreation destination (see KOP 6).

SOP 6: Ivanpah Lake East (35.56172, -115.38759)

SOP 6 is located 4.72 mi E of ISEGS on the eastern side of Ivanpah Dry Lake. Ivanpah Dry Lake is used by recreationists for international land sailing competitions, archery, kite buggying, and world-championship disc throwing (BLM 2014). This SOP represents the view of ISEGS by recreationists on the east side of I-15.

SOP 7: Ivanpah Road, First Visibility (35.31701, -115.25939)

SOP 7 is located 20.39 mi SE of ISEGS on Ivanpah Road, in the Mojave National Preserve. Ivanpah Road is used by visitors entering and exiting the Mojave National Preserve and is the main road through the New York Mountains. This SOP represents the first glimpse of ISEGS by motorists traveling NW on Ivanpah Road as they enter the Ivanpah Valley.

SOP 8: Ivanpah Road 2 (35.33659, -115.28552)

SOP 8 is located 18.44 mi SE of ISEGS on Ivanpah Road, in the Mojave National Preserve. It is approximately 2 mi NW of SOP 7 and is representative of the view of ISEGS as visitors travel down Ivanpah Road to exit the Mojave National Preserve.

SOP 9: Ivanpah Overlook (35.53972, -115.52162)

SOP 9 is located 3.11 mi W of ISEGS in the foothills of the Clark Mountains, within the Mojave National Preserve. This location was chosen in place of Benson Mine, as washed-out roads and rough terrain made it difficult to reach Benson Mine by car or foot.

SOP 10: Black Mountain, First Visibility (35.92956, -115.05316)

SOP 10 is located 34.82 mi NE of ISEGS on Black Mountain, just outside of Henderson, Nevada. Black Mountain is a popular hiking destination with hundreds of visitors each year signing the summit register. This SOP represents a hiker's first visibility of ISEGS while ascending Black Mountain.

SOP 12: Black Mountain Summit (35.93099, -115.04409)

SOP 12 is located 35.25 mi NE of ISEGS on the summit of Black Mountain. This SOP represents a hiker's view of ISEGS while looking out to the southwest from the summit of Black Mountain.

SOP 13: Umberci Mine (35.61654, -115.49224)

SOP 13 is located 4.3 mi S of ISEGS in the Clark Mountains, at Umberci Mine. Umberci Mine contains numerous open and unfenced shafts, adits, and other mining structures. This SOP is a popular visitor destination because of its location between the Stateline and Mesquite Wilderness Areas. SOP represents a view looking down into the Ivanpah Valley from the mine.

SOP 14: Brant-Cima Road 1 (35.29726, -115.36197)

SOP 14 is located 18.92 mi SE of ISEGS, on Brant-Cima Road, in the Mojave National Preserve. Brant-Cima Road runs parallel to the Union-Pacific Railroad that runs along the eastern side of Ivanpah Dry Lake. This SOP represents a motorist's first view of one of the power towers while travelling NE on Brant-Cima Road.

SOP 15: Ivanpah Road 3 (35.36131, -115.3323)

SOP 15 is located 15.56 mi SE of ISEGS, on Ivanpah Road, approximately 2 mi NW of its intersection with Brant-Cima Road. This SOP represents a view of ISEGS while traveling on Ivanpah Road.

SOP 16: Colosseum Mine Road (35.55806, -115.55644)

SOP 16 is located 4.83 mi W of ISEGS, in the Clark Mountains, just off Colosseum Mine Road. This SOP represents the view of ISEGS from a close-range distance at high elevation.

SOP 18: Primm Valley Golf Course (35.54855, -115.43262)

SOP 18 is located 2.24 mi W of ISEGS just outside of the SW corner of Primm Valley Golf Course. This SOP represents the view of ISEGS at close-range. This SOP is similar in distance to KOP 1, which was analyzed in the Final EIS (BLM 2010). KOP 1 was not revisited because Argonne did not have access to the golf course.

SOP 19: Ivanaph Dry Lake West (35.59183**,** -115.41029)

SOP 19 is located 4.19 mi NE of ISEGS, in the NW portion of Ivanpah Dry Lake. This SOP represents a view of ISEGS from the west side of Ivanpah Dry Lake. This SOP was analyzed in the Final EIS (BLM 2010) as KOP 7.

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APPENDIX B: SAMPLE DATA COLLECTION FORMS

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APPENDIX B: SAMPLE DATA COLLECTION FORMS

Solar Facility Visual Characteristics Study Data Collection Form

SITE DESCRIPTION

Observation #:	Observers:			Date:	Time:	
Facility:			Secondary Facility:			
Location:						
Weather: Clear	Mostly Clear	Partly Clear	Partly Cloudy	Mostly Cloudy	Cloudy	
	Cirrus	Rain	Fog	Snow		
Visibility:	Good	Fair	Poor			
GPS Coordinates:				Bearing:		
VAV Descriptor:	Superior	Normal	Inferior			
General Description of Viewed Facility:						
Facility Backdrop:	Sky	Sky/Ground	Ground			
Facility Backdrop Lightness:	Dark	Medium	Light			
Facility Backdrop Contrast:	High	Medium	Low			
Facility Backdrop Color:						
Lighting Quality:	Even Sun	Part Sun/Part Shade	Even Shade			
Solar Azimuth:			Elevation:			
Lighting Angle:	Frontlit	Sidelit Left	Sidelit Right	Backlit	Shade	Not Apparent
Collector Field Orientation:	Forward	Forward Oblique	Side	Rear Oblique	Rear	
Collector Array Color(s):						
Glare Visible?	Yes	No				
Light Patterns Visible?	Yes	No	Plumes Visible?	Yes	No	
Other Transitory Effects?	Yes	No				
Other Infrastructure Prominent?	Yes	No				
Other Observations:						

PHOTOGRAPHS

Photographer	
Camera	
Lens	

Photo Number	**FL**	**Bearing**	**Subject**

Solar Facility Transitory Visual Effects Data Collection Form

Obs. #:	Observers:	Date:	Time:
Facility:	Secondary Facility:		
Location:			
Glare Type: Point Beads and approx. # Line Other (specify)			
Glare Location: Array Front Sides Top Other Infrastructure (describe)			
Apparent Glare Source:			
Glare Discomfort: Minimal After extended view After brief view Instant			
Glare Duration: Persists with short movement Changes with short movement			
Collector Array Color(s):			
Light Pattern Orientation and Description:			
Plume Height (Relative to Building) and Description:			
Other Prominent Infrastructure Description:			
Other Observations:			

Solar Facility Transitory Visual Effects Data Collection Form (Cont.)

Solar Facility Visibility Study: Visibility Rating Form

Observation #:	Date:	Time:
Facility:	Location:	
Rater:	Other observers:	

VISIBILITY RATING

VISIBILITY RATING	NOTES

QUESTIONS

Would the facility be likely to attract the attention of a casual viewer? Yes No
Is the facility a major focus of visual attention? Yes No Explain.
Which facility elements contribute most to visibility? Facility Size Component Size Geometry Color Glare/Glinting Other Explain.
Does the facility repeat basic elements of form/line/color/texture found in predominant natural features?
Does the facility repeat basic elements of form/line/color/texture found in predominant man-made features?
Notes

Solar Facility Visibility Study: Visibility Rating Form (Cont.)

Note: "View in general direction of study subject" defined as field of view visible when observer is looking toward study subject without turning head more than 45 degrees in either direction.

VISIBILITY LEVEL 1: Visible only after extended, close viewing; otherwise invisible.
Describes an object/phenomenon that is near the extreme limit of visibility and which could not immediately be seen by a person who was unaware of its location in advance, and looking for it. Even under those circumstances, the object can only be seen after looking at it closely for an extended period of time.

VISIBILITY LEVEL 2: Visible when scanning in general direction of study subject; otherwise likely to be missed by casual observer.
Describes an object/phenomenon that is very small and/or faint, but which—when the observer is scanning the horizon or looking more closely at an area—can be detected without extended viewing. It could sometimes be noticed by a casual observer; however, most people would not notice it without some active looking.

VISIBILITY LEVEL 3: Visible after brief glance in general direction of study subject and unlikely to be missed by casual observer.
Describes an object/phenomenon that can be easily detected after a brief look and which would be visible to most casual observers, but lacks sufficient size or contrast to compete with major landscape elements.

VISIBILITY LEVEL 4: Plainly visible, could not be missed by casual observer, but—for views in general direction of study subject—does not strongly attract visual attention or dominate view because of apparent size.
Describes an object/phenomenon that is obvious and with sufficient size or contrast to compete with other landscape elements, but with insufficient visual contrast to strongly attract visual attention and insufficient size to occupy most of the observer's visual field.

VISIBILITY LEVEL 5: Strongly attracts visual attention for views in general direction of study subject. Attention may be drawn by strong contrast in form, line, color, or texture, by luminance, or by motion.
Describes an object/phenomenon that is not of large size, but that contrasts with the surrounding landscape elements so strongly that it is a major focus of visual attention, drawing viewer attention immediately, and tending to hold viewer attention. In addition to strong contrasts in form, line, color, and texture, bright light sources (such as lighting and reflections) and moving objects associated with the study subject may contribute substantially to drawing viewer attention. The visual prominence of the study subject interferes noticeably with views of nearby landscape elements.

VISIBILITY LEVEL 6: Dominates view because study subject fills most of visual field for views in its general direction. Strong contrasts in form, line, color, texture, luminance, or motion may contribute to view dominance.
Describes an object/phenomenon with strong visual contrasts that is of such large size that it occupies most of the visual field, and views of it cannot be avoided except by turning the head more than 45 degrees from a direct view of the object. The object/phenomenon is the major focus of visual attention, and its large apparent size is a major factor in its view dominance. In addition to size, contrasts in form, line, color, and texture, bright light sources, and moving objects associated with the study subject may contribute substantially to drawing viewer attention. The visual prominence of the study subject detracts noticeably from views of other landscape elements.

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

Date

District

Resource Area

Activity (program)

SECTION A. PROJECT INFORMATION

1. Project Name	4. Location	5. Location Sketch
2. Key Observation Point	Township ______ Range ______ Section ______	
3. VRM Class		

SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM			
LINE			
COLOR			
TEXTURE			

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM			
LINE			
COLOR			
TEXTURE			

SECTION D. CONTRAST RATING ☐ SHORT TERM ☐ LONG TERM

1.

DEGREE OF CONTRAST		FEATURES											
		LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
		Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
ELEMENTS	Form												
	Line												
	Color												
	Texture												

2. Does project design meet visual resource management objectives? ☐ Yes ☐ No (Explain on reverse side)

3. Additional mitigating measures recommended? ☐ Yes ☐ No (Explain on reverse side)

Evaluators' Names | Dates

SECTION D. (Continued)

Comments from item 2.

Additional Mitigating Measures (See item 3)

★US GOVERNMENT PRINTING OFFICE: 2002-773-001-46077

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