# PROGRAMMATIC ENVIRONMENTAL ASSESSMENT
# FOR
# CONSTRUCTION AND OPERATION OF SOLAR PHOTOVOLTAIC RENEWABLE ENERGY PROJECTS
# ON
# ARMY INSTALLATIONS

**PREPARED BY U.S. ARMY ENVIRONMENTAL COMMAND**
**JBSA FORT SAM HOUSTON, TEXAS**

AND

**PACIFIC NORTHWEST NATIONAL LABORATORY**
**RICHLAND, WASHINGTON**

***NOVEMBER 2016***

This Page Intentionally Left Blank

# PROGRAMMATIC ENVIRONMENTAL ASSESSMENT
# FOR
# CONSTRUCTION AND OPERATION OF SOLAR PHOTOVOLTAIC RENEWABLE ENERGY PROJECTS
# ON
# ARMY INSTALLATIONS

NOVEMBER 2016

**Reviewed and Approved by the U.S. Army Environmental Command**

Timothy M. Greenhaw
Colonel, U.S. Army
Commanding

This Page Intentionally Left Blank

# TABLE OF CONTENTS

## Figures



## Tables

This Page Intentionally Left Blank

# ACRONYMS

| | |
|---|---|
| § | Section |
| | |
| AC | Alternating Current |
| ACHP | Advisory Council on Historic Preservation |
| ACOM | Army Command |
| ACP | access control point |
| ACUB | Army Compatible Use Buffer |
| AD | Army Depot |
| AEC | United States Army Environmental Command |
| AFB | Air Force Base |
| AIRFA | American Indian Religious Freedom Act |
| APA | American Planning Association |
| APLIC | Avian Power Line Interaction Committee |
| AR | Army Regulation |
| ARPA | Archaeological Resources Protection Act |
| ASA IE&E | Assistant Secretary of the Army for Installations, Energy and Environment |
| AZ | Arizona |
| | |
| BA | Biological Assessment |
| BCC | Birds of Conservation Concern |
| BGEPA | Bald and Golden Eagle Protection Act |
| BLM | Bureau of Land Management |
| BMP | best management practice |
| | |
| C&D | construction and demolition |
| CAA | Clean Air Act |
| CC | Compliance Cleanup |
| CEQ | Council on Environmental Quality |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| C.F.R. | Code of Federal Regulations |
| $CH_4$ | methane |
| CO | carbon monoxide |
| CO | Colorado |
| $CO_2$ | carbon dioxide |
| CRS | Congressional Research Service |
| CWA | Clean Water Act |
| CX | Categorical Exclusion |
| CZMA | Coastal Zone Management Act |
| | |
| DA | Department of the Army |
| DASA (E&S) | Deputy Assistant Secretary of the Army for Energy and Sustainability |
| dBA | A-weighted decibels |
| DC | Direct Current |
| D.C. | District of Columbia |
| DLA | Defenses Logistics Agency |
| DLAD | Defense Logistics Agency Directive |
| DOE | United States Department of Energy |
| DoD | Department of Defense |

| | |
|---|---|
| DoDI | Department of Defense Instruction |
| DPTMS | Directorate of Plans, Training, Mobilization and Security |
| DRU | Direct Reporting Unit |
| | |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EISA | Energy Independence and Security Act |
| EITF | Energy Initiatives Task Force |
| EO | Executive Order |
| EPA | United States Environmental Protection Agency |
| EPAct | Energy Policy Act of 2005 |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| $ES^2$ | Energy Security & Sustainability |
| ESA | Endangered Species Act |
| ESCP | Erosion and Sedimentation Control Plan |
| ESS | energy storage system |
| EUL | Enhanced Use Lease |
| | |
| FAA | Federal Aviation Administration |
| FEMA | Federal Emergency Management Agency |
| FNSI | Finding of No Significant Impact |
| FONPA | Finding of No Practicable Alternative |
| $ft^2$ | square feet |
| | |
| GA | Georgia |
| GHG | greenhouse gas |
| GIS | Geographic Information System |
| GW | gigawatt |
| | |
| H&S | health and safety |
| HAP | hazardous air pollutant |
| HQDA | Headquarters, Department of the Army |
| | |
| ICRMP | Integrated Cultural Resources Management Plan |
| IEC | Iowa Energy Center |
| IEEE | Institute of Electrical and Electronics Engineers |
| INRMP | Integrated Natural Resources Management Plan |
| IPMP | Integrated Pest Management Plan |
| IRP | Installation Restoration Program |
| | |
| kW | kilowatt |
| kV | kilovolt |
| | |
| LBNL | Lawrence Berkeley National Laboratory |
| LBP | lead-based paint |
| LOS | level of service |
| | |
| $m^2$ | square meters |
| MACT | maximum achievable control technology |
| MBTA | Migratory Bird Treaty Act |
| MDC | Minnesota Department of Commerce |

| | |
|---|---|
| MEC | munitions and explosives of concern |
| MMPA | Marine Mammal Protection Act |
| MMRP | Military Munitions Response Program |
| MOA | Memorandum of Agreement |
| MOU | Memorandum of Understanding |
| MRSPP | Munitions Response Site Prioritization Protocol |
| MSU | Montana State University |
| MW | megawatt |
| MWh | megawatt hour |
| | |
| $N_2O$ | nitrous oxide |
| NAAQS | National Ambient Air Quality Standards |
| NABCEP | North American Board of Certified Energy Practitioners |
| NAGPRA | Native American Graves Protection and Repatriation Act |
| NAS | Naval Air Station |
| NC | North Carolina |
| NEMA | National Electrical Manufacturers Association |
| NEPA | National Environmental Policy Act |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NHPA | National Historic Preservation Act |
| NM | New Mexico |
| NMFS | National Marine Fisheries Service |
| $NO_2$ | nitrogen dioxide |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | National Park Service |
| NRCS | Natural Resources Conservation Service |
| NREL | National Renewable Energy Laboratory |
| NRHP | National Register of Historic Places |
| NTIA | National Telecommunications and Information Administration |
| NVBC | Naval Base Ventura County |
| NWI | National Wetlands Inventory |
| NY | New York |
| | |
| $O_3$ | ozone |
| OE/AAA | Obstruction Evaluation/Airport Airspace Analysis |
| OEERE | Office of Energy Efficiency & Renewable Energy |
| OEI | Office of Energy Initiatives |
| OSHA | Occupational Safety and Health Administration |
| | |
| Pb | lead |
| PEA | Programmatic Environmental Assessment |
| P.L. | Public Law |
| $PM_{2.5}$ | particulate matter equal to or less than 2.5 microns in diameter |
| $PM_{10}$ | particulate matter equal to or less than 10 microns in diameter |
| POL | petroleum, oil, and lubricants |
| PPA | Power Purchase Agreement |
| PRFTA | Parks Reserve Forces Training Area |
| PV | photovoltaic |
| | |
| RCMP | Range Complex Master Plan |

| | |
|---|---|
| RCRA | Resource Conservation and Recovery Act |
| REC | Record of Environmental Consideration |
| ROI | region of influence |
| RONA | Record of Non-Applicability |
| RPMP | Real Property Master Plan |
| SEIA | Solar Energy Industries Association |
| SDWA | Safe Drinking Water Act |
| SDZ | surface danger zone |
| SIP | State Implementation Plan |
| SHPO | State Historic Preservation Officer |
| SNL | Sandia National Laboratories |
| $SO_2$ | sulfur dioxide |
| SOH | Safety and Occupational Health |
| SOP | standard operating procedure |
| SSA | sole source aquifer |
| SWPPP | Storm Water Pollution Prevention Plan |
| T&E | threatened and endangered |
| TMDL | Total Maximum Daily Load |
| TSCA | Toxic Substances Control Act |
| TSF | The Solar Foundation |
| TX | Texas |
| UFC | Unified Facilities Criteria |
| U.S. | United States |
| USACE | United States Army Corps of Engineers |
| U.S.C. | United States Code |
| USDA | United States Department of Agriculture |
| USFS | United States Forest Service |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| UXO | unexploded ordnance |

# PROGRAMMATIC ENVIRONMENTAL ASSESSMENT FOR CONSTRUCTION AND OPERATION OF SOLAR PHOTOVOLTAIC RENEWABLE ENERGY PROJECTS ON ARMY INSTALLATIONS

# 1.0 INTRODUCTION

This Programmatic Environmental Assessment (PEA) has been prepared under the National Environmental Policy Act of 1969 (NEPA) (42 U.S. Code [U.S.C.] Section [§] 4321 *et seq.*), the Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [C.F.R.] Parts 1500-1508), and the Army's NEPA regulation (32 C.F.R. Part 651), Environmental Analysis of Army Actions. In general, the CEQ regulations require that prior to implementing any major action, the federal agency must evaluate the proposal's potential environmental effect as well as notify and involve the public in the agency decision-making process.

The Proposed Action being evaluated is the construction, operation, and maintenance of solar photovoltaic (PV) renewable energy projects on Army installations, to include U.S. Army Reserve facilities, Army National Guard sites, and joint bases managed by the Department of the Army (DA) (with all henceforth referred to only as "Army installations" or "installations"). The projects would generally range from approximately 10 megawatts (MW) to 100 MW of power generation capability; however, this analysis may apply to projects outside of this MW range (e.g., less than 10 MW). The size of each project would depend on the conditions at the installation. The projects could be funded and constructed by the Army, funded through a third party Power Purchase Agreement (PPA) utilizing a lease of Army or Joint Base land to an independent power producer or the local regulated utility company (e.g., via an "Enhanced Use Lease" or EUL), or funded via some other relationship with a private or public entity. The PEA looks at three action alternatives and a no action alternative. The PEA has a checklist to help installations determine whether additional site specific NEPA documentation is required. The goal of this programmatic approach is to streamline the NEPA process for the construction, operation, and maintenance of solar PV renewable energy projects by providing installations with sufficient detail about environmental impacts on resources to enable them to tier off of this PEA, as appropriate.

## 1.1 BACKGROUND

### 1.1.1 BASIS OF PROGRAMMATIC ANALYSIS

NEPA establishes procedural requirements for all federal government agencies for proposed agency action. The CEQ and the Army's NEPA regulation provide the Army regulatory requirements for implementing NEPA. NEPA directs federal agencies to evaluate and incorporate an understanding of the environmental impacts of its proposed actions into its decision-making processes, and to disclose the effects of its proposed actions to the public and officials who must make decisions concerning the proposal.

In accordance with 32 C.F.R. Section (§) 651.14(c)(1), “Army agencies are encouraged to analyze actions at a programmatic level for those programs that are similar in nature or broad in scope.” CEQ regulations encourage the use of programmatic documents, when appropriate, accompanied by "tiered" supplemental documents that focus on the site-specific issues, eliminating unnecessary duplication (40 C.F.R. §§ 1502.20 and 1508.28). A programmatic level of analysis avoids unnecessary duplicative site-specific analyses and would eliminate repetitive discussions of the same issues; in this case, the similar environmental impacts of solar PV for most resource areas at most sites. Supporting this concept, CEQ issued its final *Effective Use of Programmatic NEPA Reviews* guidance on December 18, 2014 (CEQ, 2014).

### 1.1.2 ARMY AND RENEWABLE ENERGY

The Office of Energy Initiatives (OEI) has primary responsibility over large-scale renewable projects to help achieve the Army’s renewable energy goals. OEI, initially known as the Energy Initiatives Task Force (EITF), was established in September 2011 by the Secretary of the Army. The OEI serves as the central management office for partnering with U.S. Army installations to implement cost-effective, large-scale renewable energy projects, 10 MW or greater, leveraging private sector financing. Smaller projects are generally managed by installations. OEI is leading the Army in deploying renewable generation assets on Army land.

Over the past number of years, the Army has developed considerable experience analyzing environmental impacts of various renewable energy technologies. Although solar PV is considered one of the most environmentally friendly and efficacious of the proven renewable energy technologies available, the construction, operation, and maintenance of solar PV facilities does have some environmental impacts. As many Army installations expect to continue to pursue additional proposed solar PV projects, the Army has determined a programmatic analysis would facilitate the streamlining of site-specific analyses by enabling tiering off of a programmatic-level analysis. Though this technology was analyzed in the *Programmatic Environmental Assessment Army Net Zero Installations* (Net Zero PEA) dated July 2012 (DA, 2012a), the level of analysis was focused on whether Army installations should apply this technology. Site-specific analyses could be streamlined by providing a programmatic analysis more detailed than the Net Zero PEA. This would be beneficial to both the Army and taxpayers.

**Figure 1.** 2012 Ceremony at Fort Bliss, Texas

The FNSI for the Net Zero PEA selected the following alternative: "Strategically implement Net Zero after evaluation of mission needs, consumption, and existing resource constraints while still achieving existing environmental mandates" (DA, 2012a). Net Zero included large-scale renewable energy projects which could include solar PV systems (including flat plat arrays and concentrating solar power), wind turbines, geothermal systems, waste-to-energy, biomass systems, landfill gas recovery, and hydroelectric power. Small-scale renewable energy efforts, which could have little effect on land resources, may include installation of solar PV and/or solar hot water panels on existing buildings or installation of ground source heat pumps. The Net Zero PEA looked at the impacts of solar PV systems on numerous resource areas.

This Solar PV PEA uses information and analysis from the Army Net Zero PEA and adds more information and analysis about potential solar PV projects on installations, to include providing updated information, if applicable. Additionally, this programmatic analysis leverages the knowledge learned from numerous past NEPA analyses conducted for similar projects, and lessons learned from the implementation of those projects. Army installations referenced are Anniston Army Depot, Alabama; Fort Benning, Georgia; Fort Bliss, Texas/New Mexico; Fort Bragg, North Carolina; Fort Buchanan, Puerto Rico; Fort Carson, Colorado; Fort Gordon, Georgia; Fort Hood, Texas; Fort Huachuca, Arizona; Fort Stewart, Georgia; Parks Reserve Forces Training Area, California; Sierra Army Depot, California; and West Point, New York. Analyses conducted by other military services and industry were also used as references. See Section 7 (References) for a complete listing. The Army recognizes, however, that many more solar PV projects have been analyzed and executed across the Army and elsewhere; the referenced analyses are not a complete list of analyses completed. The information obtained from the referenced NEPA analyses and the associated and signed Findings of No Significant Impact (FNSIs) or, in the case of environmental impact statements, Records of Decision, informs and supports this programmatic analysis. Figures 1, 2, 8, 9, and 10 all provide visual examples of solar PV modules being used by the Army.

**Figure 2.** Solar PV module

In 2005, the Energy Policy Act of 2005 (EPAct; 42 U.S.C. § 13201 *et seq.*) mandated federal facilities use at least 5 percent renewable energy by 2010 and 7.5 percent in 2013 and thereafter. As of February 2016, the Army has met 1.8 percent of this goal and anticipates substantial progress in the next reporting cycle from the 40.4 MW of generation capacity added in fiscal year 2015 and additional projects expected to come on line in fiscal year 2016 (DA, 2016b). On March 19, 2015, the White House released a new Executive Order (EO) – EO 13693, *Planning for Federal Sustainability in the Next Decade* – which includes requirements for federal agencies to increase the amount of electric energy and thermal energy in buildings derived from renewable electric energy; the EO establishes specific and increasing percentages by fiscal year. The 2007 National Defense Authorization Act codified the Department of Defense's (DoD's) voluntary goal that 25 percent of all energy consumed by 2025 would be from renewable energy. As of February 2016, 12 percent of the Army's total electrical consumption is from renewable energy (DA, 2016b). The 7.5 percent goal for the Army under EPAct applies only to renewable energy generated on Army land whereas the 25 percent goal under the 2007 National Defense Authorization Act includes purchase of electricity from off-site renewable generation assets.

## 1.1.3 Army Consideration of Renewable Energy Technologies

### 1.1.3.1 Intent of this Programmatic Analysis

The purpose of this PEA is to programmatically analyze anticipated impacts of solar PV installation, operation, and maintenance; use of this analysis assumes that Army installations are considering various renewable energy technologies as installations study options for meeting their renewable energy goals and energy needs. This PEA assumes installations will analyze alternative technologies along with solar PV, or have determined that these alternative technologies are not feasible to meet that particular installation's need. Installations must carefully consider all reasonable alternatives, including other renewable energy technologies, to meet their particular needs. The Army recognizes the many benefits of solar PV, including the fact that it is a proven, time-tested, and energy and cost-efficient technology with relatively few potential adverse environmental impacts in most proposed locations. For all of these reasons, solar PV is frequently chosen as the best technology to meet a given site-specific need. As with all programmatic analyses, this PEA is intended to reduce the cost of duplicative, site-specific analyses for most issues commonly associated with solar PV. It is not intended to replace thoughtful consideration of other renewable technologies, other alternatives to meet a particular installation's needs, or to express any agency preference for one renewable technology over another, in any situation.

### 1.1.3.2 Tiered Site-specific Analyses

This PEA does not eliminate NEPA requirements for specific solar PV projects planned for execution on Army installations. Each Army installation would have to consider site-specific conditions, such as where the projects would be constructed and operated and/or the size of the solar PV project(s). Site specific considerations would require an appropriate level of supplemental NEPA analysis and documentation. In some cases, it may be determined that a Record of Environmental Consideration (REC) would be appropriate, citing this PEA, other installation NEPA documents, and/or one or more Army Categorical Exclusions (CXs). In other cases, the Army anticipates further analysis would be required to meet site-specific NEPA requirements; and, if so, tiering off the site-specific environmental analysis from this PEA is expected to enable development of a site-specific analysis focused on those resource areas at the proposed site(s) where site-specific considerations require additional analysis of potential impacts. To that end, this PEA includes a checklist in Appendix A to assist installations in identifying site-specific NEPA requirements.

## 1.2 PURPOSE AND NEED FOR THE PROPOSED ACTION

### 1.2.1 PURPOSE OF THE PROPOSED ACTION

The purpose for constructing, operating, and maintaining solar PV renewable energy projects on Army installations is to provide energy security and to meet renewable energy goals. The Proposed Action secures access to the solar energy resource. The Proposed Action will also help the Army to develop and maintain the capability to respond to unforeseen electricity disruptions and recover quickly while continuing critical activities.

On June 1, 2015, the Army announced its new *Energy Security & Sustainability ($ES^2$) Strategy*. This 2015 strategy furthers efforts started in 2009 and builds on the efforts of August 2012, when the Assistant Secretary of the Army for Installations, Energy and Environment (ASA IE&E) established an energy goal responsibility attainment policy for all active Army installations, to include joint bases managed by DA (DA, 2012d). Those 2012 goals related to energy use reduction and renewable energy development at each Army installation. Renewable electric energy is defined as energy produced by solar, wind, biomass, landfill gas, marine (including tidal, wave, current, and thermal), geothermal, geothermal heat pumps, micro turbines, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project (EO 13693). This 2015 strategy positions the Army to enhance its current and future capabilities, readiness, and performance by building upon its ability to employ resources efficiently and to support all aspects of operations through efficient system design.

The 2015 $ES^2$ Strategy outlines five goals, which will be achieved through steady progress across the Army enterprise – materiel, readiness, human capital, services and infrastructure – with targeted measures and metrics as guides. These goals are: Inform Decisions, Optimize Use, Assure Access, Build Resiliency and Drive Innovation. Solar technology is interwoven in all the goals with specific mention including increasing energy efficiency through use of more renewable/alternative energy sources; and, to improve resource availability, securing Army access to multiple energy sources, in the quantities and quality required to ensure that unimpeded use can occur for the time duration needed (DA, 2015b).

DA goals related to energy intensity reduction also support the Army's Net Zero goals, which include reducing reliance on energy infrastructure susceptible to disruptions and logistical mechanisms that add risk to installation missions. Strategic implementation of the Net Zero program, which includes small- and large-scale renewable energy generation, was analyzed for environmental impacts in the Army's Net Zero PEA (DA, 2012a). The Net Zero Installation program directed Army installations to make every fiscally prudent effort to reduce their installation's overall consumption of energy and water and reduce solid waste disposal in landfills to an effective rate of zero. A wide range of alternatives for implementing Net Zero were considered in the Army's 2012 Net Zero PEA, and, of those, the energy initiatives considered included: reduction through behavior change, followed by maximizing energy efficiency and conservation; repurposing of waste energy; recycling of waste energy; and, energy recovery through renewable energy generation. The latter includes proposed actions addressed in this PEA.

In 10 U.S.C. § 2911, *Energy performance goals and master plan for the Department of Defense*, specifically at 10 U.S.C. § 2911(c), Congress requires that the DoD consider opportunities to reduce the current rate of consumption of energy, reduce the future demand and requirements for the use of energy, and to implement conservation measures to improve the efficient use of energy. At 10 U.S.C. § 2911(e)(A), Congress required DoD to set a goal to produce or procure not less than 25 percent of the total quantity of facility energy it consumes within its facilities during fiscal year 2025 and each fiscal year thereafter from renewable energy sources. The agency had to begin working toward that goal immediately; it cannot simply switch to renewable energy resources in 2025. The Proposed Action will also contribute to the Army's goal of generating one gigawatt (GW) of renewable electrical energy on Army land by 2025. It will also contribute to compliance with the EPAct of 2005 requiring the Army's consumption of not less than 7.5 percent of the total quantity of electrical energy it consumes within its facilities during fiscal year 2013 and each fiscal year thereafter from renewable energy sources. These projects could also improve installation energy security by generating electricity on site. The microgrid component of solar PV projects could also improve energy security as they allow for greater management and control of the electrical energy generation and consumption. These solar PV projects may reduce total utility costs to the Army and would reduce generation of greenhouse gas (GHG). A summary of renewable energy goals, some of which can be met, in part, through solar PV technology, is contained in Appendix D of DA's $ES^2$ Strategy (DA, 2015b).

### 1.2.2 Need for the Proposed Action

The need for the Army to meet renewable energy goals is driven by political, economic, and environmental problems around the world. Trends of global significance – such as increased urbanization, rising populations, young adult unemployment, and a growing middle class that drive resource competition – will also shape the Army's future operating environment (DA, 2015b). Additionally, the effects of climate change, rapid technology proliferation, and shifts in centers of economic activity represent major forces of change. Global resource constraints will also undermine the integrity of the Army's supply chain. Army leaders will face these challenges with a shrinking force and a constrained budget. Such diverse conditions compel the Army to foster a more resource-informed culture that supports decisions and behaviors across all levels, locations, and domains. In response to this evolving environment, the Army's installations are becoming increasingly integral to operational effectiveness. The Army can no longer assume unimpeded access to the energy, water, land, and other resources required to train, sustain, and deploy a globally responsive Army. The Army's $ES^2$ Strategy is built upon the principle of resiliency and will enhance the Army's adaptability to rapidly deploy, fight, and win whenever and wherever our national interests are threatened.

The Army must ensure that mission essential and supporting assets are available and secure by pursuing options to diversify and expand resource supplies, to increase redundancy and multiple distribution pathways, and to manage vulnerability and risk. The Army must improve productivity by reducing resource demand, investing in increased efficiency or enhanced recovery, and switching to renewable resources. Improved resource use can increase security and reduce expenses. The Army is evolving from a historic framework that viewed resource considerations as constraints on operational effectiveness to a perspective that considers the critical role of energy, water, and land resources as mission enablers. Such an integrated perspective requires balanced decisions to achieve the greatest military benefit while being a sound steward for these resources alongside neighboring civilian communities.

Resilience is a key component of the Army's energy and sustainability strategy. Resilient capabilities build upon self-reliance, teamwork, and flexibility to support a broad ability to anticipate and withstand shifting conditions, to recover rapidly, and to adapt to unforeseen disruptions as well as long-term change. The Army operates in an increasingly complex world that requires it to anticipate, prepare for, withstand, and adapt to a range of inevitable natural or man-made disruptions and to recover rapidly across the entire Army spectrum of operations. Resilience is essential for a responsive Army force posture and an effective network of installations and capabilities at home and abroad to protect U.S. interests and those of our allies. The Army will cultivate flexibility and diversity among Army capabilities and processes with respect to energy, water, and land resources. Appropriate design margins, alternative methods, and diverse sources will be incorporated into operational processes to reduce dependence of outcomes on maintaining specific conditions.

## 1.3 DECISION-MAKING

### 1.3.1 DECISION-MAKING FOR THIS PROGRAMMATIC ANALYSIS

This PEA serves to inform the Army decision-maker and the public of the potential environmental consequences of the Proposed Action and Alternatives. For this programmatic, solar PV environmental analysis, the NEPA process results in a finding as to whether there normally would be significant environmental impacts anticipated in implementation of the Proposed Action and, if yes, a notice of intent to prepare an environmental impact statement. If the finding is that anticipated impacts are normally less than significant, the decision-maker may sign a FNSI, indicating no significant impacts are anticipated, thereby concluding the NEPA process for this PEA. The Army decision-maker is the Deputy Assistant Secretary of the Army for Energy and Sustainability [DASA (E&S)].

This PEA process, to include the analysis and public and stakeholder comments received as a result of the public review period, provides the Army decision-maker with the information necessary to evaluate the potential environmental and socioeconomic impacts normally associated with the Proposed Action. The decision-maker will take into account technical, economic, environmental, and social issues, as well as the ability of each alternative to meet the purpose and need prior to determining the outcome of this PEA process, either a FNSI or a notice of intent to prepare an environmental impact statement.

### 1.3.2 DECISION-MAKING FOR ANALYSES TIERED FROM THIS PROGRAMMATIC ANALYSIS

Each Army installation will have to consider site-specific conditions on whether to construct specific projects, where they are located, the size of the solar PV project(s), and the need for ancillary power control systems such as energy storage systems (ESSs), microgrids, and back-up power generation. This PEA and subsequent decision document will provide information and analysis that can be incorporated by reference in future NEPA reviews. Where it is determined that a site-specific project requires further analysis, tiered from this PEA, the appropriate NEPA documentation would be completed prior to implementation decisions. The Army decision-maker for any subsequent site-specific analysis would be at the level appropriate for the project; it would not be the DASA (E&S). Whether the decision-maker for a site-specific NEPA analysis is from the active Army, Army National Guard, or U.S. Army Reserves depends, in part, on which entity manages the land on which the solar PV project has been proposed to be implemented.

## 1.4 SCOPE AND CONTENT OF THIS PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

This PEA is programmatic and nationwide in scope. For years, the Army has analyzed and implemented solar PV projects at Army installations (as defined in Section 1.0) across the country, so this program is not new. Because the Army is now aware of its usefulness and widespread applicability, it is important to examine the technology in this programmatic approach and streamline the NEPA process, to the extent appropriate, for Army installations generally across the U.S. and its territories.

This PEA evaluates potential direct, indirect, and cumulative effects of construction, operation, and maintenance of solar PV projects at Army installations. Potential environmental effects resulting from the Proposed Action and alternatives, including the No Action Alternative, are identified in this PEA. The PEA considers mitigation measures to reduce adverse impacts from a programmatic perspective. Potential impacts are evaluated programmatically, independent of conditions that could vary substantially site-by-site.

On-post solar PV projects could meet the aspect of the purpose and need that involves the elimination of disruptions to the power supply and securing multiple distribution pathways if designed to improve energy security. Off-post projects would not meet this part of the purpose and need, but could help meet other renewable energy goals identified in Section 1.2 (Purpose and Need for the Proposed Action). Some aspects of this PEA's resource impact analysis could be applied to these off-post projects.

This PEA does not include the decommissioning of a solar PV system as the timeframe for any such decommissioning actions are not in the reasonably foreseeable future. Solar PV systems have an average lifetime of 33 years (NREL, 2016). Over this timeframe, it is expected that the technology for the manufacturing of system components will continue to evolve rapidly and requirements affecting such future disposal actions will undergo refinement.

Additionally, this PEA does not include manufacturing activities (e.g., for producing solar PV project equipment, construction equipment, and maintenance equipment) for material or equipment used in a solar PV system, used to construct such a system, or used to maintain such a system.

Within this PEA, roof-top mounted solar PV modules assumes the structures currently exist and do not require substantial modification to enable the additional weight-bearing load. For carport-mounted solar PV modules, this PEA assumes the parking area exists and has an impervious surface. Where roof-top mounted solar PV modules are incorporated into the design of proposed new structures and new impervious surface areas, this PEA may provide information related to the solar PV component of the full project. Where roof-top mounted solar PV modules require substantial structure re-design to enable the structure to safely support the additional load, NEPA analysis for the full re-design project may use information from this PEA related to the solar PV component of the full project.

Installation-specific proposals for solar PV projects would require an appropriate level of site-specific NEPA analysis and documentation which should reference or tier off of this PEA. Where further analysis would be required to meet site-specific NEPA requirements, tiering off the site-specific environmental analysis from this PEA is expected to enable development of a site-specific analysis focused on those components at the proposed site(s) where site-specific considerations require additional analysis of potential impacts. Towards that end, the scope of this PEA includes a checklist in Appendix A to assist Army installations in identifying site-specific NEPA requirements.

As installations consider locations for proposed solar PV projects, projects are not to be proposed for impact areas located in training or testing areas. Impact areas exist for the impact and/or detonation of ordnance, or to contain fired, dropped, or launched military munitions, and are not compatible with solar PV facilities. Additionally, impact areas may contain numerous munitions and explosives of concern (MEC), which includes unexploded ordnance (UXO); the economics associated with hypothetical cleanup costs for impact areas are likely to be detrimental to the economic viability of a solar PV facility.

Projects are not to be proposed for locations, wholly or partially, within surface danger zones (SDZs). SDZs are the ground and airspace designated for vertical and lateral containment of projectiles and material resulting from the firing, launching, or detonation of weapons or explosives within our training and testing ranges and impact areas (DA, 2012c). SDZs exist for safety reasons and are not compatible with solar PV facilities. Installation considerations include whether to construct the solar PV arrays, where to construct them, and how large an array can be accommodated. To improve the flexibility, reliability, and utilization of the renewable energy resource, other considerations are addressed within this PEA. These other considerations include the extent to which ESSs may be deployed, the integration of renewable energy resources using microgrid-based strategies and technologies, conventional back-up electricity supply, the expansion of transmission lines and/or substation(s), and the possible need for construction of access roads for maintenance of the system. Collectively, these actions could result in environmental impacts that require site-specific, follow-on NEPA analysis.

## 1.5 RELATIONSHIP OF THIS PROGRAMMATIC ENVIRONMENTAL ASSESSMENT TO TIERED NEPA DOCUMENTATION

When considering a solar PV project, installations must determine whether it would be appropriate to tier from this PEA. First, the installation would use the checklist in Appendix A of this PEA to evaluate its proposed solar PV project. If the installation can respond "no" for each of the 34 statements in the checklist, then no further NEPA analysis would appear to be required and the action likely qualifies for a REC incorporating the analysis and FNSI of this PEA. If the installation checks "yes" for one or more resources, it can reconsider both the sites and layout of the project, or other mitigation, to see if the effect on the resource can be avoided and the answer changed to "no".

If application of the checklist to the proposed project at an installation requires a "yes" or "maybe" response to any checklist item and the impact(s) cannot be reduced (for example, by moving the site or changing its scale), then additional environmental analysis may be required as part of an installation-level, site-specific NEPA process. The installation should consider applicability of previous NEPA documentation prepared for the installation, and also consider if EAs for solar PV projects at other installations have dealt with the issue(s) in question. If further investigation into a "yes" or "maybe" response concludes that no additional NEPA analysis is necessary, documentation supporting that conclusion shall be retained. If the installation concludes that additional NEPA analysis is necessary, 32 C.F.R. Part 651 requires it to be prepared before any irreversible and irretrievable commitments of resources occur for the Proposed Action. The installation's site-specific NEPA document can be limited to resource areas for which further analysis is necessary and tier from this PEA for resource areas for which no further analysis is necessary.

If the installation determines that no further NEPA analysis would be required, it should prepare a REC reflecting this determination. If relying on this PEA, as well as any other NEPA analyses, the REC should cite 32 C.F.R. § 651.12(a)(2) ("action is adequately covered within an existing EA or EIS"), name the applicable analyses (i.e., this PEA) and associated FNSI or ROD, and state where the cited NEPA document(s) may be accessed. If the installation is relying on this PEA, at least in part, the filled-out checklist from this PEA should be attached, as should any concluding documentation resulting from investigations into "yes" and "maybe" responses, supporting the determination that no additional NEPA analysis is necessary. If any CXs apply, the REC should also include those citations.

## 1.6 SCREENING CRITERIA

To be considered a viable alternative and carried forward for analysis in this PEA, the alternatives or location options must meet the below-provided screening criteria. As the goal of this programmatic approach is to streamline the NEPA process for proposed solar PV projects on Army installations (e.g., site-specific projects), the following screening criteria also apply, at a minimum, to projects whose NEPA documentation tier from this PEA.

- **Mission Compatibility:** The location must be compatible with the military missions, to include training and testing activities, occurring at the Army installation. Site development and solar PV system operations and maintenance may not adversely impact current or future military training, testing, or operations activities. Site development proposed within a range or maneuver training area may require submission of a Range Closure request as outlined in Army Regulation (AR) 350-19, *The Army Sustainable Range Program* (DA, 2005a).

- **Grid Access and Electrical Tie-in Potential:** The location must be close to transmission facilities (substations) or have technical viability and economic justification for building the infrastructure required for interconnection to the Army installation distribution system or the grid (e.g., new electrical lines, new substation). The grid infrastructure must be capable of transporting, or being upgraded to transport, electricity generated by the PV project.

- **On-Installation Energy Generation Potential for Increased Energy Security:** If the purpose of the project is to meet Army energy security goals, the location must allow the Army installation to have greater control of and access to its energy supplies while reducing the possibility of external distribution failures. Preference should be given to site locations allowing maximum use of the energy produced.

- **Project Site Factors:** If constructed on the ground, the project site must have topography, aspect, slope, and soils compatible with the proposed infrastructure. If constructed on top of buildings or other structures, the structure must be capable of handling the additional load. If the project is constructed on a landfill or a site contaminated by hazardous waste or other pollutants, the project would have to be designed and operated to comply with all regulatory requirements. The site area must not be overshadowed by buildings or trees that cannot be removed.

- **Aesthetic Compatibility:** The project site must be compatible with views, neighborhoods, and historic areas.

- **Environmental Factors:** The location must allow acceptable accommodation of cultural resources and sensitive natural resources and should have minimal environmental constraints. For example, when considering potential locations for a solar PV system, avoid, if possible, sites with threatened and endangered species, protected archaeological and historic resources, Native American sacred sites, wetlands, floodplains, or other sensitive environmental resources.

- **Safety:** The project site should involve minimized exposure to and safety risks from MECs, which include UXOs. The array field must be outside of SDZs and impact areas. The location must not conflict with military training activities or jeopardize personal safety of those constructing, operating, or maintaining the facilities. The solar PV array must not adversely affect military aviation activities. Ongoing operation and maintenance needs of the solar PV system must not adversely impact traffic safety, aviation safety, or installation security.

- **Project Financeability & Use of Proven Technologies:** The solar PV system must use proven renewable energy technologies that may be financed at reasonable rates or reasonable payback for the taxpayer money. Factors influencing financeability include, among others, the availability of solar resources (Figure 3).
- **Compliance with Federal Mandates and DoD or Army Goals:** The project must enhance compliance with government mandates and DoD and Army goals and objectives regarding renewable energy production, energy security, increased energy efficiency, water conservation, and/or GHG emissions reduction.
- **Utility Considerations:** The project must be reasonably acceptable to the current electric supplier and not unreasonably interfere with their ability to absorb intermittent impacts and variance in peak energy generation.

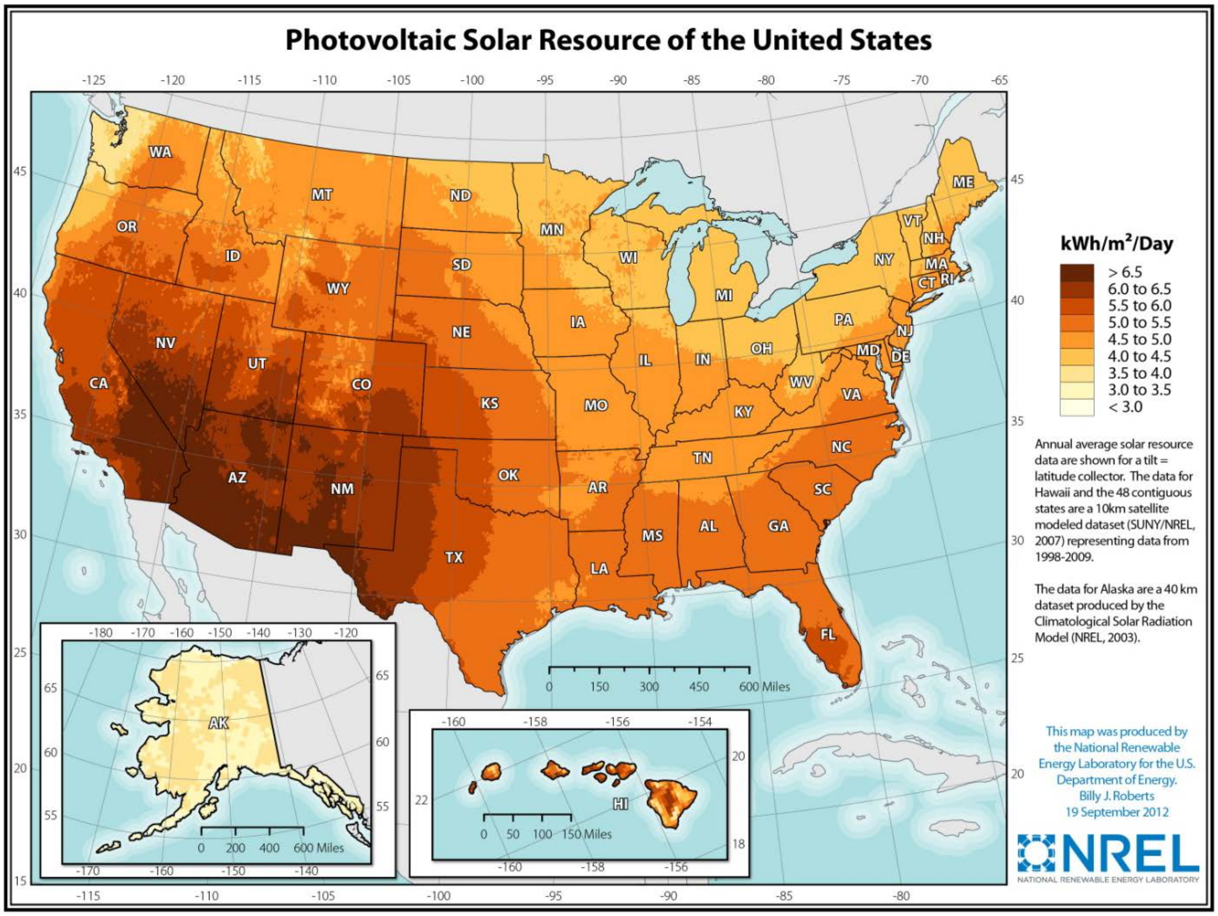
The National Renewable Energy Laboratory (NREL) provides information which may help installations determine the viability of potential solar PV projects on Army installations. Additionally, NREL has been working closely with OEI to identify potential large-scale projects. One of the tools available from NREL is the U.S. solar resource map found at Figure 3. The amount of kilowatt-hours per square meter available each day helps determine the economic viability of potential projects. The amount of solar radiation reaching a site is influenced by a number of factors including the changing position of the sun, both during the day and throughout the year; atmospheric conditions, with clouds being a predominant factor; and local geographical features causing shading and/or affecting atmospheric conditions, such as mountains, oceans, and lakes. Both man-made and naturally occurring events can limit the amount of solar radiation reaching the earth's surface. Of course, other factors, apart from the amount of available sunlight, affect financial viability.

## 1.7 REGULATORY FRAMEWORK

Army installations are guided by relevant statutes (and their implementing regulations) and EOs that establish standards and provide guidance on environmental compliance, to include natural and cultural resources management and planning.

Many of these authorities are addressed in various sections throughout this PEA when relevant to particular environmental resources and conditions. The full text of many of these laws, regulations, and EOs is available in various on-line locations, to include https://www.gpo.gov/fdsys/ and https://www.whitehouse.gov/briefing-room/presidential-actions/executive-orders.

**Figure 3.** Photovoltaic Solar Resource of the United States (NREL, 2009)




## 1.8 PUBLIC INVOLVEMENT

The Army invites public, agency, and Tribal participation in the NEPA process. Consideration of the views and information of all interested persons promotes open communication and enables better decision-making. All agencies, organizations, and members of the public having a potential interest in the Proposed Action are urged to participate in the decision-making process.

This PEA and Draft FNSI is available for a 30-day public review and comment period starting on the day the associated Notice of Availability is published in the *Federal Register*. An electronic copy of this document is available for download from the U.S. Army Environmental Command (AEC) website at http://www.aec.army.mil/Services/Support/NEPA/Documents.aspx. Please submit comments to U.S. Army Environmental Command, ATTN:  Solar PV PEA Public Comments, 2450 Connell Road (Building 2264), JBSA - Fort Sam Houston, TX  78234-7664 or via email to: usarmy.jbsa.aec.nepa@mail.mil. Inquires may also be made via phone by calling 210-466-1590 or toll-free 855-846-3940. Comments submitted within the 30-day public review period will be made part of the Administrative Record and will be considered before a final decision is made.

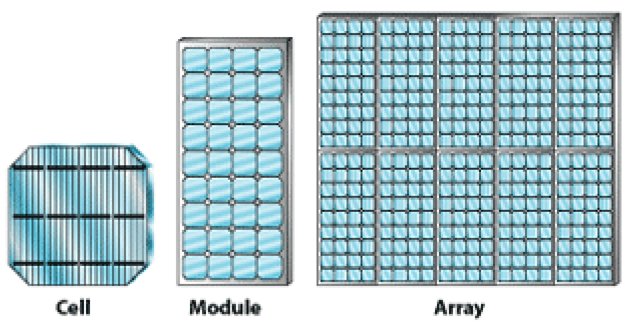
# 2.0 PROPOSED ACTION

The Proposed Action is to construct, operate, and maintain solar PV arrays on Army installations (as defined in Section 1.0). The Proposed Action includes, for those solar PV projects where the existing infrastructure is insufficient, constructing (or upgrading) and maintaining the associated infrastructure required for the transmission and management of the generated electricity to the electric grid. Associated infrastructure includes but is not limited to electricity transformers, transmission and distribution lines, and sub or switching stations; as well as ancillary power control systems such as ESSs, micro-grid components, and back-up power generators. Infrastructure expansion or upgrade required to connect the arrays to the electrical grid may, in some cases, necessitate use of off-post land. The Proposed Action may include real estate actions involving an independent power producer or local regulated utility company, with examples including a third party PPA, an EUL, and utility easements.

## 2.1 DESCRIPTION OF SOLAR PHOTOVOLTAIC (PV) PROJECTS

The solar PV technology converts sunlight directly into electric current through the use of semiconductors. Semiconductors are usually composed of crystalline silicon wafers, either single crystal or polycrystalline, and thin film amorphous silicon. When semiconducting materials are exposed to light, they absorb some of the sun's energy in the form of photons and emit electrons in the form of electricity. The electricity produced is Direct Current (DC). The basic PV cell produces approximately one to two watts on average. To produce more power, PV cells are wired in a series to form modules (Figure 4) with output typically ranging from 10 to 300 watts.

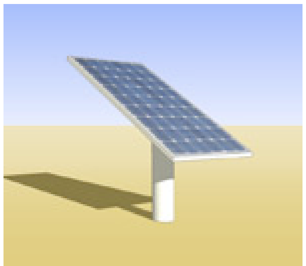
**Figure 4.** PV Arrays are Composed of Modules that are Composed of Cells (OEERE, 2013)




Several PV modules are constructed in a rack to form a PV array, with the racks being mounted to the ground, rooftops, poles, or carports. Arrays can be mounted at a fixed angle facing the sun or they can be mounted on a tracking system that follows the sun's path to optimize and increase power production (Figures 5, 6, and 7). For ground mounted systems, multiple options for mounting are available such as poured concrete footers, driven poles, and ballasted ground mounting. Roof-top system mounting options depend on whether the roof is flat or pitched. Terrain and geological conditions (for ground mounted systems) or roof angle (e.g., on buildings, garages, or carports), selection of fixed or tracker arrays, and cost all influence the type of mounting system most appropriate for individual projects.

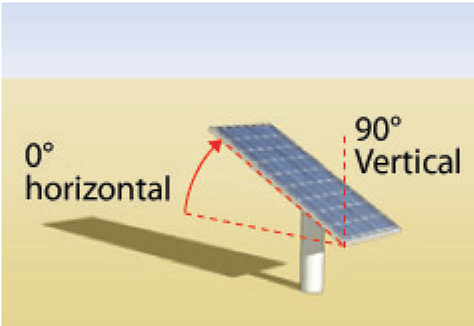
An array that produces one AC-converted MW of power can, in turn, power 164 homes (SEIA, 2016). Through extrapolation, a 10 MW facility could power over 1,600 homes and a 100 MW facility, 16,000 homes, although this assumes an average household energy demand and does not take into account variable power consumption and available sunshine driven by geographical location. Other variables related to mission, population, and installation size factor into how much an array that produces one AC-converted MW of power can power an Army installation, as depicted by examples at White Sands Missile Range in New Mexico, Dugway Proving Ground in Utah, and Fort Detrick in Maryland. White Sands Missile Range has a 4.1 MW array which provides approximately 10 percent of their installation's annual electricity needs (SEIA, 2013), Dugway Proving Ground has a 2 MW array that supplies around 10 percent of their electrical power (DA, 2016e), and Fort Detrick has a 15 MW array that supplies around 12 percent of their electrical power (DA, 2016f).

**Figure 5.** Fixed Array (IEC, 2016)



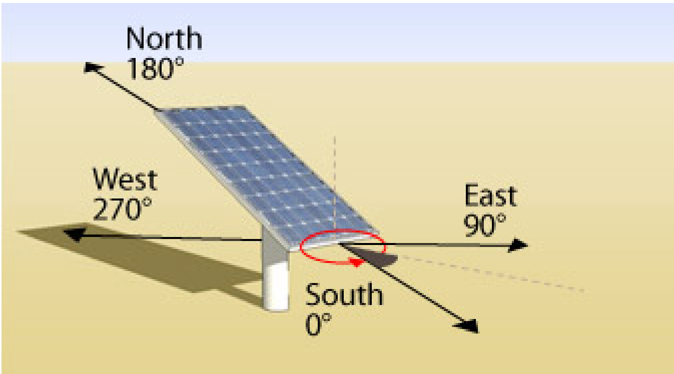
The power-producing components of a PV facility consist of the solar array field (the PV modules); the power conditioning system, which contains inverters to convert the DC electricity to Alternating Current (AC) for compatibility with the electrical grid; and one or more transformers to boost voltage for feeding the power into the electrical grid. The power conditioning system also contains devices that can sense grid destabilization and automatically disconnect the PV facility from the grid, if needed.

**Figure 6.** Tilt Tracking Array (IEC, 2016)




The projects being evaluated and analyzed would generally range from approximately 10 MW to 100 MW per site; however, this analysis may apply to projects outside of this MW range (e.g., less than 10 MW). On average, seven acres (2.8 hectares) of land are currently required to produce one MW of power. As this technology has evolved, the acreage requirement for one MW generating capacity has decreased; therefore, it is possible that future solar PV technologies may require even less acreage per MW. Based on current technology, extrapolation indicates approximately 70 acres (28 hectares) of land would be required for a 10 MW site and 700 acres (283 hectares) of land for a 100 MW site. PV systems on rooftops would generally expect to have capacity measured in watts or kilowatts (kW), not MW, and be of a much smaller size and scope.

**Figure 7.** Azimuth Tracking Array (IEC, 2016)




New solar PV projects would require the construction, operation, and maintenance of a transmission line to transmit the energy created from the solar array to the electrical grid. On average, a 100 MW array would require transmission lines with a line voltage of 115 kilovolt (kV). Transmission lines may be buried or be above ground and are located within a transmission corridor typically consisting of a 50-foot (15.24-meter) right-of-way. If the solar PV project is constructed close to a proposed end-use, or the electricity is intended to be consumed within close proximity, it is probable that the DC electricity produced from solar PV would be inverted and transformed to distribution line voltage rather than larger transmission line voltage, thus limiting conversion and line losses. Burying a transmission line would require trenching activities during construction. The depth of all underground lines would be dependent upon the voltage and would be in accordance with applicable codes, with the National Electric Safety Code (IEEE, 2016) as adopted for many states. Above-ground transmission lines supporting a 100 MW array would include wood and/or steel, direct-embedded, braced-post structures approximately 70 feet (21 meters) in height. On average, spans between posts would be 300 to 340 feet (91.44 to 103.63 meters).

When existing substations are insufficient to meet the proposed solar PV project needs, the PV projects would require the construction, operation, and maintenance of one substation or, for larger MW projects more distant from the existing energy grid, multiple substations. A solar PV project substation would consist of supporting structures for high voltage electrical structures, breakers, transformers, lightning protection, and control equipment according to regulatory requirements and specifications of the energy provider. A substation would typically be on less than two acres (0.8 hectares) of land that would be fenced.

Solar PV technology generally requires flat or gently rolling terrain with unobstructed views of the sun; ground-disturbing activities typically include vegetation removal, grubbing, and grading necessary to establish a somewhat smooth surface for the placement of the solar PV arrays. The exception would be if the PV modules were constructed on rooftops of buildings or carports on existing impervious surfaces. Then much less, if any, ground-disturbing would be required. For mounting systems involving poured concrete footers or driven poles, for example, ground excavation and/or penetration activities would also occur. For rooftop systems requiring the addition of carports over existing parking lots, site preparation would include saw-cutting through parking lot asphalt and concrete, with excavation to install footings for each vertical member of the carport structure. When using a ballasted ground mounting, no ground penetration is required as ballasted mounting systems use weight to hold down the racking and modules. Most sites would require the construction of security fencing, equipment shelters(s), distribution lines to the substation(s), transformer station, and an access road for maintenance activities and, when necessary, emergency vehicles. Similar ground-disturbing activities would be likely for these related infrastructure components. The extent of access road requirements would be affected by the size of the array field and topographic conditions; but, in general, all-weather gravel access roads may be expected around the site perimeter and between some of the rows of solar panels. For buried transmission lines, a temporary trench would be dug,

**Figure 8.** Solar Photovoltaic Array at Fort Carson, Colorado

followed by replacement of the topsoil and vegetation. For a 115 kV line, the temporary trench required to lay the buried cable would be, on average, five feet wide by four feet deep (1.5 meters wide by 1.2 meters deep). Construction of the new utility corridor(s) and any associated utilities easement with the local utility company for this action would be along existing road disturbance limits and within existing utilities easements, to the greatest extent possible, to minimize ground disturbance.

The above-described construction requirements for a solar PV system would generally be divided into two phases, which include a site preparation phase of relatively short duration followed by a longer assembly, testing, and start-up phase. A 10 MW project would require approximately five to 10 months for both phases of construction, with variables including weather and site conditions, and larger projects would require proportionally longer construction time. To support construction activities, trucks and vehicles would be required to transport construction equipment, solar PV components, and installation equipment to the site, construction and demolition (C&D) waste and construction/installation equipment from the site; and, construction workers and appropriate inspectors to and from the site.

Routine maintenance, equipment monitoring, and as-needed repairs by the system operator would follow to ensure proper operation of the solar PV system, including vegetation control, snow removal, solar module washing, and periodic module/other equipment replacement. The frequency of some of these actions will be influenced by atmospheric conditions affecting individual sites (e.g., rainfall, snowfall, dust, air pollution, etc.). Modules are typically cleaned when efficiency and energy production are diminished. The system operator would ensure that a vegetation and/or gravel cover is maintained under and around the solar array systems as much as possible to reduce any run-off or soil erosion related to module washing. Module washing would be scheduled to ensure that water does not build up and cause excessive run-off. Monitoring of the solar PV systems, array site, and associated transmission corridors would also involve checking for soil erosion due to system maintenance or natural processes, and soil erosion or sediment reaching streams would be investigated and remedied as appropriate.

## 2.2 Ancillary Power Control Systems

Ancillary power storage and control systems may be developed and deployed as part of the Proposed Action to improve the availability, reliability, and flexibility of solar PV produced electricity. The use of ESSs such as chemical batteries, fuel cells, or compressed-air storage may be a part of the solar PV facility, allowing any energy produced beyond the immediate requirements of the system to be stored for later distribution and use. A microgrid may also be used to manage stored energy, and tie in solar power with other distributed energy generation sources. Finally, to address reliability standards and redundancy needs for the bulk electrical system, the use of back-up power generation is included as part of the Proposed Action, where appropriate.

### 2.2.1 Energy Storage Systems (ESSs)

Electrical energy is typically an on-demand resource that must be transmitted or consumed at the time of generation. In the case of solar PV, without some form of energy storage, the electricity from a solar array may only be produced and used during times when incident solar radiation is sufficient to produce electricity. ESSs augment the daylight-only limitation by converting solar derived from electrical energy into another form that retains its energy content for long periods of time. The most common form of energy storage is chemical batteries where electrical energy is converted into chemical energy (energy held in the bonds of the chemicals in the battery), and then back again as the electrical system needs it. Though the oldest and most common form of chemical battery is the lead-acid battery (such as car batteries), ESSs in microgrids typically use other chemistries such as lithium-ion, sodium-sulfur, and vanadium-flow. These chemistries are more suited to the large energy exchanges used in microgrids, and have higher energy densities than lead-acid batteries.

Due to higher energy densities, chemical ESSs do not typically have large real-estate requirements. A battery set with dimensions similar to a semi-truck trailer would typically be rated at several MW, and four to twelve hours of available capacity; this compared to the tens of acres (four-plus hectares) required for an equivalent solar PV array. ESSs of this size typically come in several modules that are mounted on concrete pads and interconnected. A large portion of the total ESS is the energy storage proper, but supporting equipment such as cooling systems, battery management systems, and power converters are also present. Connections between modules, both for energy transfer and communication, must be made, as well as the connection to a transformer which translates the output of the power converter to the appropriate system voltage.

Fuel cells are another commercially available electrochemical ESS. Similar to batteries, fuel cells operate by chemical conversion of fuel (typically hydrogen) in the presence of oxygen to produce electricity. There are a variety of fuel cell configurations available commercially. When considered for stationary power applications, the technology selection is typically governed by site specific needs for physical size, electrical capacity, fuel storage limitations, and whether or not there is a need or desire to integrate waste heat into supporting processes such as in combined heat/power applications. Due to the variety of configurations, fuel cells can be sized to accommodate the specific needs of the application, including grid-connected distributed generation and base-load power, but also as back-up or emergency power systems, uninterrupted power supply, or portable power supply when grid independence is required.

In stationary power applications, fuel cells have a range of potential capacity ranging from less than a kW to well over a MW in industrial deployments, where multiple fuel cells are combined in a fuel cell stack. With hydrogen as the primary fuel (or hydrogen derived from an alternative fuel source such as methane, methanol, or biogas), the production of power from a fuel cell is considered to be essentially void of harmful emissions that are common to hydrocarbon based combustion units. Unlike batteries, which have a limit on discharge (power production capability), as long as fuel (hydrogen) continues to be supplied to the fuel cell, power production may continue to operate.

A typical commercial or industrial fuel cell application, scalable up to several MWs, can be sited on modest footprints. For example, modularly designed 1-2 MW fuel cell system would require a site area of 4,000-4,500 $ft^2$ (372-418 $m^2$), or a total of approximately 0.1 acres (0.04 hectares) (Doosan, 2014; Hydrogenics, 2013), with additional space requirements expected for supporting systems such as cooling, fuel storage, and switching/transmission as required.

Though less readily scalable, an additional form of technically feasible energy storage uses an electrically-powered pump/compressor to pressurize a storage volume with air. To convert the potential energy of the compressed air into electricity, the compressed air is fed into a combustion turbine along with a fossil fuel (often natural gas), combusted, and expanded in the power turbine using the mechanical energy produced to drive an electrical generator. When turbines such as these are used without a compressed air reservoir, approximately one-third of the gross energy output is used to drive an attached air-compressor to generate the compressed air as an integral part of the turbine operation. By using a compressor powered by excess solar PV electricity and pre-compressing the air into a storage vessel, the energy required by the combustion turbine when it is operating is reduced, effectively storing the solar energy until consumed by the turbine.

Currently, domestically deployed compressed-air energy storage (CAES) facilities utilize solution-mined subsurface salt caverns for storage, or above-ground pressurized vessels. In all configurations, the CAES facility would be sized to meet the expected output of the power plant and accompanying capacity factor. The subsurface caverns are large enough to support the volume of air and storage pressures required to make these types of systems technically and economically viable. Because of this requirement, the numbers of potential CAES facilities are significantly limited in comparison to chemical energy storage technologies such as batteries, which have no geologic requirements and which have smaller spatial requirements. Additionally, conventional CAES facilities have traditionally been used to supplement combustion-turbine generation based power generation. If no such generation exists at a candidate CAES site, including natural gas infrastructure, an additional evaluation of the viability of installing these generators must also be made.

### 2.2.2 MICRO-GRID SYSTEMS

As a complement to the installation of the solar PV project and/or accompanying ESS, a microgrid could also be installed and operated to allow for greater management and control of the electrical energy generation and consumption. Microgrids function by converting the physical electrical distribution system, which typically has only crude methods of control such as manually switching breakers, to a centralized, intelligent control system with automated and dynamic control of facility loads. Such a microgrid would typically entail a small or moderate control center, used to monitor the energy resource of the microgrid (public utility, solar PV, energy storage, diesel generation, etc.) and the current and/or projected load of the managed facility. To regulate the load of the system, controllable switches would be used to connect and disconnect various loads throughout the facility to ensure the generation resources are not overloaded. This is particularly helpful during “islanded” scenarios where conventional utility-provided energy is unavailable and the only energy assets available are those internal to the microgrid. Without a microgrid in place, it would be much more difficult to ensure the highest priority loads at the facility were being served, and an uninterrupted transition after the loss of utility-provided electricity would likely be impossible.

The installation of a microgrid largely consists of the installation of controllable switches for load and generation management. The number of switches is determined by the desired level of load-control granularity and the existing architecture of the facility's electrical distribution system. Typically the most granular level of control allows individual buildings within a facility to be controlled. As the cost of the microgrid equipment is directly related to the size and number of switches, trade-offs between granularity of load control and economics would have to be made.

In addition to the microgrid switches, a control center for the microgrid would be established. The control center facility would consist of software for monitoring and controlling the load switches and generation assets. Interface hardware between controlling computers and the controllable switches would likely be required. Personnel with specialized training would likely be necessary for ESS and microgrid operation, particularly for larger systems that include numerous and integrated assets. Routine maintenance and monitoring of ESSs and microgrid systems would also be required.

### 2.2.3 Back-Up Generation

The traditional energy source of last resort is a generator driven by a reciprocating internal combustion engine. These generators are used throughout the world in a wide variety of applications from temporary on-site generation for public events or remote bases, to stationary back-up generation for mission-critical buildings such as medical, civil authority, and military facilities. Most commonly powered by diesel fuel or natural gas, this generation technology is well-established with known use-cases, limitations and ratings, and maintenance procedures. Additionally, alternative fuels such as jet fuel, bio-diesel, or blends therein can be used as substitutes with little or no modification to the engine or its operation, further increasing their versatility if such fuel sources are readily available.

Back-up power generators do not typically provide, nor are they intended to provide, uninterrupted service. Even in the best case, there is a several-second discontinuity in electrical service if the electricity supply from the service-provider utility is lost while the diesel engines start up and reach steady-state. If uninterrupted service is required, other energy sources must be used in tandem with the back-up generation, typically a battery-based ESS.

Electrically connecting one or more back-up power supplies into a solar project, ESS, and/or microgrid system allows for additional energy security when utility-supplied electricity is unavailable, as well as potentially reduces costs associated with reliability standards that a site would be expected to meet. A site-specific power-flow analysis coupled with an understanding of site electrical requirements during unplanned outages or imposed constraints can lead to appropriate selection of the number and size of back-up generators required.

# 3.0 ALTERNATIVES CONSIDERED

The Army's NEPA regulation requires reasonable alternatives to be evaluated. The descriptions for Alternatives 1, 2, and 3 provided below are all alternatives for implementing the Proposed Action described in Section 2.0. The action alternatives (Alternatives 1 – 3) have been determined to meet the purpose of and need for the Proposed Action, as described in Section 1.2 of this PEA. The action alternatives also passed, programmatically, the screening criteria detailed in Section 1.5. Implementation of the Proposed Action may result in the selection of one, all three, or any combination of the Proposed Action alternatives.

Though this PEA is programmatic in nature, the action alternatives are designed to apply to site-specific projects. As noted previously, the goal of this programmatic approach is to streamline the NEPA process for the construction, operation, and maintenance of site-specific solar PV projects at Army installations. This programmatic level of analysis avoids unnecessary, duplicative site-specific analyses and would eliminate repetitive discussions of the same issues; in this case, the similar environmental impacts of solar PV for most resource areas at most sites. Assuming this PEA results in a FNSI and the decision-maker selects all three action alternatives for implementation, installations may tier from this PEA for any of the three action alternatives. The action alternatives are not competing alternatives but, instead, are possible methods to implement the Proposed Action. To assist installations tiering from this PEA as they apply the NEPA process to proposed site-specific projects, this PEA includes a checklist at Appendix A to help installations determine whether additional site-specific NEPA documentation is required for the applicable action alternatives.

## 3.1 NO ACTION ALTERNATIVE

The No Action Alternative has two aspects. The first is that it represents a baseline under which solar projects would not be constructed. This is a notional baseline, however, since the Army already decided to proceed with solar projects at some installations. In another sense, selection of the No Action Alternative would mean that the programmatic, checklist approach to solar PV projects presented in the PEA would not be adopted by the Army.

The No Action Alternative serves as a baseline against which to assess the environmental impacts of the Proposed Action. In accordance with CEQ regulations, the No Action Alternative is included to compare its impacts with the action alternatives (40 C.F.R. § 1502.14(d)). The No Action baseline in this analysis means that the Army will compare the environmental impacts of not constructing new solar PV projects on Army installations with the impacts of new solar PV construction. This baseline applies to installations that do not have solar PV projects, as well as to installations that have a solar PV project already and are now considering another one. Selection of the No Action Alternative would normally mean that the Army would not proceed with the Proposed Action. In this case, the Army has been analyzing and constructing solar PV technology for several years. On a nationwide scale, the Army's 2012 Net Zero PEA programmatically analyzed renewable energy technologies in a general manner, including solar PV, within the greater context of the Army's Net Zero energy generation/use goal (DA, 2012a).

Several Army installations have already constructed and are operating solar PV projects, after having conducted appropriate site-specific NEPA analyses. A No Action "baseline" at such installations includes existing or already-planned solar PV projects. The No Action Alternative is not a realistic or desirable alternative in this instance. To cease development of solar PV projects at Army installations nationwide would not meet the need for the Proposed Action.

Selection of the No Action Alternative would also mean that the Army would not use the checklist approach presented in this PEA. Installations would not be able to apply the checklist and thereby streamline their analyses for solar PV projects. Installations would continue to prepare unnecessarily duplicative analyses with repetitive discussions.

## 3.2 ALTERNATIVE 1: IMPLEMENTATION OF PROPOSED ACTION ON A GREENFIELD SITE

Alternative 1 includes using a greenfield site on an Army installation to construct, operate, and maintain a solar PV array and/or ancillary power systems. A greenfield site is land that has not been previously developed (e.g., structures), though the land may have been previously disturbed. A greenfield site includes natural vegetation, agriculture applications, or landscaped parks. As the site is on an Army installation, the potential for MECs to be discovered during site investigation or construction exists, but the site is not anticipated to contain MECs nor would it be currently managed under the Army Cleanup Program. This alternative is generally expected to range from seven acres (2.8 hectares) for a one MW facility to 700 acres (283 hectares) for a 100 MW facility, with the actual land size requirement for a given project related to the targeted wattage of the proposed facility.

For simplicity, the title for Alternative 1 will typically be shorted to "Greenfield Site" in the remainder of this PEA.

## 3.3 ALTERNATIVE 2: IMPLEMENTATION OF PROPOSED ACTION ON A PREVIOUSLY DEVELOPED SITE

This Alternative considers use of Army installation land for construction, operation, and maintenance of a solar PV project and/or ancillary power systems on a previously developed site. A previously developed site is land that has been used for commercial, industrial, or residential purposes, and has been allowed to return to nature through disuse, decay, or the removal of developed additions. The extent to which a previously developed site would have returned to nature would be dependent upon the type of development that had previously occurred and the time elapsed since the land was used for its previous purpose. A previously developed site may contain hazardous or solid waste, MECs, or other pollutants and may be managed under the Army Cleanup Program, also known as the Army's Environmental Restoration Program. The U.S. Environmental Protection Agency (EPA) may define some of these sites as Brownfields – a property whose expansion, redevelopment or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (42 U.S.C. § 9601(39)).

Proposed solar PV projects on sites managed under the Army Cleanup Program would be required to be managed in accordance with cleanup requirements for that site. The mission of the Army Cleanup Program is to return Army lands to usable condition and protect human health and the environment by performing appropriate, cost-effective cleanup of contamination resulting from past practices. The specific regulatory requirements for individual sites under the Army Cleanup Program depend on a number of factors, factors which also determine which element of the Army Cleanup Program has management responsibilities – the Installation Restoration Program (IRP), Military Munitions Response Program (MMRP), or Compliance Cleanup (CC). Most contaminated sites on Army lands have been cleaned up to regulatory required levels and are being managed as required. Construction of a PV project on an IRP, MMRP, or CC site would have to be compatible with long-term management requirements and protection of the environment from any residual contamination.

Additionally, for previously developed sites which are current or formerly contaminated lands, landfills, and mine sites, development of renewable energy systems on these lands are, conceptually, supported by the EPA, as specified under EPA's RE-Powering America's Land Initiative (EPA, 2015a).

For example, on Fort Bragg, the installation considered constructing a PV project on a closed landfill (Fort Bragg, 2012). The PEA concluded that construction of a PV farm would include minimal surface soil disturbance (less than one foot [30.48 centimeters] deep) on the landfill cap. The surface soil that covers the cap on the landfill is a minimum of 24 inches (60.96 centimeters) thick. Construction of a PV farm would pose less impact than landfill cap repairs or maintenance activities, which require 24 inches (60.96 centimeters) or more of soil to be removed to reach the cap material.

For simplicity, the title for Alternative 2 will typically be shorted to "Previously Developed Site" in the remainder of this PEA.

## 3.4 Alternative 3: Implementation of Proposed Action on or over Structures or Impervious Surfaces (e.g., on a building, garage, or carport)

This Alternative involves the construction, operation, and maintenance of a solar PV project on existing buildings or on carports over existing impervious parking areas. This alternative may also include construction, operation, and maintenance of ancillary power control systems. Construction of PV projects on roofs typically affects a smaller footprint than those mounted on the ground as the array is limited to the confines of the building footprint or parking lot area. One MW of electricity requires approximately 100,000 square feet ($ft^2$) (30,480 square meters [$m^2$]) of array area (NREL, 2008). Therefore, for a 10 MW project, approximately one million $ft^2$ (92.9 thousand $m^2$) would be required and for a 100 MW project, approximately 10 million $ft^2$ (929 thousand $m^2$) would be required. Additional considerations for this alternative include the structural integrity of the structure (e.g., existing building) and the slope of the roof. Available rooftop areas for mounting PV arrays may be limited by any number of factors, including required spaces about the array for installation and service, pathways and ventilation access for fire codes, wind load setbacks, and spaces for other equipment. A flush mounted solar PV array adds about three pounds per $ft^2$ (14.6 kilograms per $m^2$).

**Figure 9.** Solar Panels on the Maneuver Center of Excellence Headquarters, Fort Benning, Georgia

Similarly to Alternative 1, as the site is on an Army installation, with some locations across the Army having buildings which were or are used for MEC-containing activities or products, the potential for MECs to be discovered during site investigation or construction exists; however, the site is not anticipated to contain MECs nor would it be currently managed under the Army Cleanup Program.

For carport-mounted solar PV systems, each carport would include the installation of vertical members or poles at the site to support the overhanging solar modules. The size, location, and number of pole footings would vary depending on how much load the carport structure would be required to support (i.e., size of the solar PV system) and the area of coverage. Some carport designs configure modules to shade two adjoining rows of parking spaces while other module configurations shade only one row of parking spaces (Figure 10).

**Figure 10.** Carport-mounted Solar PV Panels at White Sands Missile Range, New Mexico

Within this PEA, this Alternative assumes the structures and impervious parking areas currently exist. Where solar PV modules are incorporated into the design of proposed new structures or parking areas, this PEA may provide information related to the solar PV component of the full project. The full project, for which solar PV is a component, would have to undergo appropriate NEPA documentation. For minor construction projects, the installation may be able to use the CX at 32 C.F.R. Part 651, Appendix B, (c)(1). Features such as electric vehicle charging within a parking area should also be able to use the same exclusion, in addition to (e)(2) and (e)(4), which cover installation of utility systems and minor modifications to facilities where there is no change to the environmental impact. Where roof-top mounted solar PV modules require substantial structure re-design to safely support the additional load, exclusion (e)(4) may apply; however, if further analysis is required, NEPA for the full re-design project may use information from this PEA related to the solar PV component of the full project.

For simplicity, the title for Alternative 3 will typically be shorted to "Roof" in the remainder of this PEA.

## 3.5 OTHER ALTERNATIVES

Installations can use combinations of Alternatives 1, 2, and 3. For example, an installation may determine that the optimal solar PV project to meet mission requirements and minimize any adverse environmental impacts would be construction of a small PV array on a greenfield, a larger PV array on a nearby previously developed site and a roof mounted PV system on several large carports. This alternative is not specifically analyzed in this PEA; however, the analysis for Alternatives 1 thru 3 in this document can be leveraged by an installation to support appropriate NEPA analysis for site-specific solar PV project alternatives covering a combination of Alternatives 1, 2, and/or 3.

## 3.6 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM THIS STUDY

An alternative considered but dismissed was to analyze other renewable technologies in this PEA beyond just solar PV. As noted in Section 1.1.3, this PEA assumes that Army installations are considering various renewable energy technologies as installations study options for meeting their renewable energy needs and goals. This PEA is intended to reduce the cost of duplicative, site-specific analyses for most issues commonly associated with solar PV. It is not intended to replace thoughtful consideration of other renewable technologies, other alternatives to meet a particular installation's needs, or to express any agency preference for one renewable technology over another, in any situation.

Another alternative considered but dismissed was to conduct site-specific analysis of all reasonably foreseeable solar PV projects on Army installations under a single NEPA analysis document. This alternative was dismissed as the majority of specific projects, whether currently envisioned or not, are independent actions. NEPA requirements for site-specific projects will be met, as appropriate; however, the analysis in this document is intended to be at a programmatic-level to avoid unnecessary duplicative site-specific analyses. Meeting the NEPA requirement for these site-specific projects in separate NEPA documentation would not result in inappropriate segmentation as the projects would be independent actions in many different geographic locations. Though this PEA leverages the information gleaned from various site-specific analyses, as indicated in Section 1.1.2, it does not eliminate requirements for site-specific analyses. This includes requirements for consideration of mitigation measures and cumulative impacts. For example, if solar PV projects are located within close enough distance to each other that they could cause a combined impact to some resources, installations are to apply a cumulative impact analysis when analyzing the environmental impacts of their proposed projects. In summary, inclusion of site-specific analysis in this PEA does not support the programmatic nature of this document.

Finally, the Army considered but dismissed an alternative that would consider array fields constructed, operated, and maintained on off-post lands. That alternative was dismissed because this PEA has been developed specifically to streamline NEPA for Army installations. Off-post solar PV projects may indeed meet many of the same Purpose and Need elements as the Proposed Action, but the Army lacks sufficient experience in such projects. In general, the laws, regulations, and policies governing off-post energy generation and environmental analysis can and generally do differ from those applicable to Army installations. Since the very basis of this programmatic analysis is the Army's considerable experience in on-post solar PV projects, this analysis is intended to cover only those solar PV projects proposed for Army installations.

# 4.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

## 4.1 INTRODUCTION

This chapter broadly discusses aspects of the environment that may be impacted by implementation of the Proposed Action. As Army renewable energy strategies become defined across its installations, site-specific NEPA documentation will be completed prior to decisions to implement specific projects at installations. Because this PEA provides an assessment of environmental, social, and economic issues at a programmatic level and not at the site-specific level, the descriptions of the affected environment presented in this chapter do not provide detailed information about conditions that exist at specific project sites. From a programmatic perspective, the descriptions and analyses presented in this chapter do provide decision-makers, regulatory agencies, and the public with considerations of where the solar PV project alternatives at a typical Army installation may likely affect environmental media areas, in a general sense. This chapter, Section 4.0, also includes information on the socioeconomic effects potentially resulting from the implementation of the PV projects at a typical Army installation.

Per Section 1.3 of this PEA (Decision-making), the analysis contained herein will help inform the Army decision-maker and the public as to whether there would normally be significant environmental impacts anticipated in implementation of the Proposed Action.

This PEA would also help installations as they consider viable site-specific solar PV project alternatives and ancillary power control systems. As noted previously, the goal of this programmatic approach is to streamline the NEPA process for the construction, operation, and maintenance of solar PV renewable energy projects by providing installations with sufficient detail about environmental impacts on resources to enable them to tier off of this PEA, as appropriate. Army installations tiering off of this PEA as specific locations are considered would also apply the screening criteria contained in Section 1.5.

Commands and/or installations tiering from this PEA would prepare appropriate site-specific NEPA documentation. Commands and/or installations should appropriately: (1) examine the compatibility of the proposed project with mission needs and land use inside and outside of the Army installation; (2) address potential effects to environmental media areas (e.g., air, water, biological and cultural resources) and nearby sensitive land uses (e.g., residential areas, threatened or endangered species habitat, Tribal resources); and (3) identify necessary and sufficient measures to ensure that a project does not interfere with the Army's mission or reduce adverse effects on environmental media.

As discussed in Section 1.4, in considering the implementation of a proposed solar PV project, Army installations would use a process in determining whether it would be appropriate to tier from this PEA.

## 4.2 APPROACH FOR ANALYZING IMPACTS AND IDENTIFYING MITIGATIONS

In order to enable analysis, the resource areas have been categorized as follows: land use, air quality and GHGs, noise, geological and soil resources, water resources, biological resources, cultural resources, socioeconomics, transportation and traffic, airspace, utilities, hazardous materials, health and safety. Listing resource areas in these categories enabled a managed and systematic analysis. Specific topics discussed under each category may be more expansive that what is indicated by the titles used for each resource area (e.g., socioeconomics includes recreational opportunities such as hunting and bird-watching); coverage of specific topics is explained within each resource area section.

A region of influence (ROI) was determined for each resource area and was based on the potential impacts to the affected resource; see each resource area section for the applicable ROI. The ROI may be limited to the specific location of a solar PV project or may include a larger area such as an entire watershed. The ROI was generally considered to include an installation and/or a solar PV project site (the approximate area required for construction, operation, and maintenance of each alternative), unless otherwise noted in the specific resource of concern section.

For each resource area, context and intensity are taken into consideration in determining a potential impact's significance, as defined in 40 C.F.R. § 1508.27. Context means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the Proposed Action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short and long-term effects are relevant. The intensity of a potential impact refers to the impact's severity. It includes consideration of beneficial and adverse impacts, the level of controversy associated with a project's impacts on human health, whether the action establishes a precedent for future actions with significant effects, the level of uncertainty about project impacts, or whether the action threatens to violate federal, state, or local law requirements imposed for the protection of the environment. Quantitative and qualitative analyses have been used, as appropriate, in determining whether, and the extent to which, a threshold would be exceeded. Based on the results of these analyses, this PEA identifies whether a particular potential impact would be adverse or beneficial, and to what extent. For adverse impacts, the severity of environmental impacts is characterized as negligible, minor, moderate / less than significant, or significant.

- **Negligible** – An environmental impact could occur but impact might not be perceptible.
- **Minor** – A perceptible adverse environmental impact that would clearly not be significant.
- **Moderate / Less than Significant** – An environmental impact could occur and is readily detectable but is clearly less than significant. Additional care in following standard

procedures, best management practices, or applying precautionary measures to minimize adverse impacts, may be called for. Moderate / less than significant adverse impacts would not exceed limits of applicable local, state, or federal regulations.

- **Significant but Mitigable** – A significant impact is anticipated, but the Army can implement management actions or other mitigation measures to reduce the adverse impacts to less than significant.
- **Significant** – An adverse environmental impact which, given the context and intensity, violates or exceeds regulatory or policy standards, would substantially alter the function or character of the resource, or otherwise meets the identified threshold.

Impacts can further be categorized as direct, indirect, or cumulative.

- **Direct** – Caused by the action, occurring at the same time and place.
- **Indirect** – Caused by the action and foreseeable, but occur at a later time or different place.
- **Cumulative** – The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Duration is also a factor when analyzing potential impacts.

- **Short-term** – Transitory effects that are of limited duration; generally caused by construction activities or operation start-up.
- **Long-term** – Impacts that occur or continue to occur over an extended period of time, whether they start during the construction phase, at operation start-up, or during the operations and maintenance phase.

Mitigation measures, to include avoidance, best management practices (BMPs), and standard operating procedures (SOPs), are environmental protection measures that would avoid, minimize, rectify, reduce, eliminate, or compensate for the adverse impact of the Proposed Action (32 CFR § 651.15(a)). Avoidance may include eliminating the action or parts thereof (e.g., designing a site layout that avoids a wetlands area). Minimizing may include limiting the degree or magnitude of the action and its implementation (e.g., reducing the site footprint). Rectifying may include repair, rehabilitation, or restoration measures. Reducing or eliminating may include preservation or maintenance operations during the life of the action. Compensation for the impact may be by replacing or providing substitute resources or environments. Mitigation measures considered, if any, are identified within the environmental consequences section for each resource area category and summarized in Section 6.0. If any analysis concludes ‘significant but mitigable’ impacts, the specific mitigations required to avoid significant impacts will be clearly identified.

## 4.3 Land Use

Land use refers to the various ways in which land might be used or developed, the kinds of activities allowed, and the type and size of structures permitted. General land use patterns characterize the types of uses within a particular area and can include agricultural, residential, commercial, industrial, scenic, natural, military training and testing areas and operational ranges, and recreational. Land ownership is a categorization of land according to type of owner. Owners of land in the U.S. may be federal, tribal, state, or local governments; or private organizations or individuals. Land ownership and real estate interest of lands adjacent to Army installations vary and is typically required to adhere to local land use plans, policies, and controls not applicable to Army lands. Land management plans include those documents prepared by agencies to establish appropriate goals for future use and development of the land under the applicable agency’s jurisdiction. As part of this process, sensitive land use areas are often identified by agencies as being worthy of more rigorous or protective management; these may include, for example, historic properties or sensitive natural areas.

For any proposed project affecting resources within a state coastal zone, the Coastal Zone Management Act (CZMA; 16 U.S.C. §§ 1451-1464) requires an evaluation of consistency with the enforceable policies of a state’s approved coastal management program. CZMA is further discussed in Section 4.7.

DoD's 2012 Unified Facilities Criteria for installation master planning requires installations to prepare, implement, and maintain Real Property Master Plans (RPMPs) that address all lands within the installation footprint (DoD, 2012). The Army’s regulation addressing RPMPs is AR 210-20, *Real Property Master Planning for Army Installations* (DA, 2005b); however, the Army is in the process of incorporating these RPMP requirements into AR 420-1, *Army Facilities Management* (DA, 2012b). Additional guidance for incorporating holistic energy, water, and waste management and other sustainability concepts into installation RPMPs was issued by the Assistant Chief of Staff for Installation Management in November 2011. The Sikes Act (16 U.S.C. § 670 *et seq.*) and AR 200-1, *Environmental Protection and Enhancement*, require Army installations to prepare, implement, and maintain an Integrated Natural Resources Management Plan (INRMP) for the management of its land and biological resources (DA, 2007). INRMPs are one of the contributory plans for RPMPs. AR 200-1 also requires Army installations to develop an Integrated Cultural Resources Management Plan (ICRMP) (DA, 2007); these are another contribution source for RPMPs. AR 350-19 requires Army installations with a training mission to prepare Range Complex Master Plans (RCMPs). The RCMP depicts the installation’s current range and training lands, general siting of future range complex project requirements, and the installation’s requirements and constraints that may impact ranges or training lands (DA, 2005a). RCMPs provide source data for installation INRMPs and RPMPs. Per Section 1.5 of this PEA (Screening Criteria), proposed solar PV project locations must be compatible with the military missions, to include training and testing, occurring at the installation. The Army plans to have no net loss of training or operational capability as a result of the Proposed Action.

Although viewsheds are not a land use, for the purposes of this PEA, viewsheds will be included in the Land Use section. Viewsheds encompass the landscape visible from a specific point. A viewshed "can also consist of the sum total of the area covered by views along a road or trail, as well as the aggregate of the views visible from a specific area" (APA, 2006). Topography, structures, vegetation, or other physical barriers typically are used to define the borders of a viewshed; however, a viewshed is sometimes limited by distance, changes in land use, or changes in visual character (APA, 2006).

### 4.3.1 EXISTING CONDITIONS

As of September 2015, Army installations included over 12.4 million acres (5.02 million hectares) of land, 57 multi-use airfields, 24 heliports, over 900 million square feet (83.6 million square meters) of building space, over 230 million square yards (192 million square meters) of paved area (excludes road),over 150,000 lane miles (241,401 lane kilometers) of paved and unpaved roads, over 2,000 miles (3,219 kilometers) of railroads, and just over 200 Army-owned and 150 privatized utility systems (electric, gas, water, and wastewater) (DA, 2015c). As of that same date, the Army's remaining environmental cleanup on Active Sites included just over 1,300 IRP and MMRP sites (DA, 2015c). Army land use categories include Family housing, troop housing, range and training, retail, parks and recreation, schools, transportation, industrial, and natural and cultural environmental sites (DA, 2012a). When compatible with the Army mission and long-term ecosystem management goals, some Army lands are outleased for agricultural purposes, in accordance with AR 405-80, *Management of Title and Granting Use of Real Property* (DA, 1997). Existing and future use of Army installations are guided by each installation's RPMP (DoD, 2012).

Off-post land use around Army installations varies from installation to installation as does the density of development, ranging from very rural landscapes to highly developed, urban landscapes. Off-post land ownership and real estate interest also varies.

Off-post lands have been placed in the Army Compatible Use Buffer (ACUB) program, adding another layer into the categories of land use. Though the Proposed Action for this PEA does not include consideration of off-post land for solar PV arrays, an understanding of off-post land placed in the ACUB program enables analysis of potential impacts to and/or consideration of mitigations for on-post projects. Most military installations were originally established in rural areas far from population centers. However, land around many military installations has and continues to undergo rapid development, leading to habitat fragmentation, conflicts with land use, and restrictions that can compromise military training, testing and readiness. The ACUB program is a tool to address this encroachment and achieve conservation objectives. Under 10 U.S.C. § 2684a, the Army can enter into agreements with and provide funds to partners with mutual conservation objectives to establish buffers around training and testing areas, within an ecosystem, or other defined area. This helps the installation, its neighbors, the community, and the region preserve habitat and limit incompatible land use. It helps prevent complaints over noise, dust, smoke, and airspace, while conserving species, habitat, and cultural resources. It provides the Army greater testing and training flexibility. Partners obtain financial support for land conservation, such as for endangered species and habitat, and private landowners realize financial incentives and tax benefits. The existence and extent of buffer areas under the ACUB program varies from installation to installation. More information about the ACUB program is provided in Section 4.8 (Biological Resources).

## 4.3.2 ENVIRONMENTAL CONSEQUENCES

The section provides a discussion of the possible environmental impacts to land use that could result from the No Action and Proposed Action alternatives. Included are discussions regarding possible conflicts between the Proposed Action and the objectives of land use plans, policies, and controls for off-post lands potentially impacted. Impacts to land use would be considered significant if the Army actions are: substantially incompatible with existing military land uses and land use designations or have major conflicts with Army land use plans, policies, or regulations; or create a considerable land use conflict with off-post land use. The ROI for this resource area is land use within the boundaries of an installation and immediate surrounding communities, to include regional viewsheds of an installation and project alternatives.

### 4.3.2.1 NO ACTION ALTERNATIVE

There would be no change to existing land use as a result of the No Action Alternative; therefore, there would be no new impacts.

### 4.3.2.2 ALTERNATIVE 1: GREENFIELD SITE

Solar PV projects could preclude other land uses within the project footprint and could alter the character of largely rural areas. Existing land uses for a greenfield site could include scenic, natural, recreational, and agricultural areas. It may also include military training and testing areas which were largely undeveloped, assuming the proposed site passes the mission compatibility screening criteria. It could also include, for smaller solar PV systems (e.g., a 2 MW system), undeveloped parcels of land within other land use areas, such as residential, commercial, and industrial. Approximately 70 acres (28 hectares) would be required for a 10 MW site and 700 acres (283 hectares) for a 100 MW site. The PV array may be spread over several small plots across the installation. Distribution lines may require additional acreage, although this acreage would be generally linear in nature and would, to the maximum extent practicable, follow existing rights of way, using existing utility corridors. Infrastructure required for ancillary power control systems may also require additional acreage and will be dependent on the ESS and optimal location for a microgrid or back-up generator based on related distributed energy systems. A substation, typically on less than two acres (0.8 hectares), may be required if existing substations are insufficient to meet the new power load. In general, smaller installations are likely to be able to site smaller PV projects and conversely, larger installations should be able to site larger PV projects.

The solar PV array may affect the viewshed of the area. The installation of PV facilities would create a visual impact, but lacking the height of smokestacks or wind turbines, the visual impact at ground level, or within a neighboring building, would be limited. As discussed in more depth in Section 4.12.2.2, Airspace, the solar PV systems have the potential to cause glare, another type of visual impact. Near and far viewsheds may be affected by glare and result in a visual impact within neighboring buildings at elevations above ground level. Larger solar PV array fields could potentially affect a larger viewshed area than smaller array fields. As discussed in more depth in Section 4.9.2.2, some sites are important components of viewsheds associated with cultural resources. In cases where site location has the potential to impact a viewshed associated with cultural resources, careful site design in close consultation with appropriate parties could result in adverse effects ranging from none to minor. As a result of this and the fact that an operational solar PV array system does not emit pollutants into the air and does not create loud noises, conflicts with off-post land use are anticipated to be none to minor.

The solar PV project may impact soils designated as prime farmland. The impact of potentially changing agricultural outleased land to a solar PV array field is considered to be negligible. Use of farmland for national defense is exempted from the requirement that Federal programs minimize the extent to which they contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses (7 U.S.C. § 4208(b) and 7 C.F.R. § 658.3(b)).

Stakeholder coordination/consultation and/or consolidation of infrastructure during the scoping and design of the project could effectively avoid or minimize land use conflicts. Careful incorporation of solar PV projects into the installation's RPMP – and, as appropriate, RCMP – would help minimize the effect of the proposed project on land use. In summary, short-term and long-term impacts to land use are anticipated to normally range from none to minor.

#### 4.3.2.3 Alternative 2: Previously Developed Site

Consequences similar to Alternative 1 are anticipated for Alternative 2 except that, with this alternative, the site had previously been developed and/or is or was contaminated. The site would be disturbed during construction and careful design would be required to ensure compatibility with any regulatory requirements. Like Alternative 1, short-term or long-term land use impacts are anticipated to normally range from none to minor.

#### 4.3.2.4 Alternative 3: Roof

Incorporating solar arrays on or over existing structures or impervious surfaces would not change the land use, although the viewshed may be impacted as it could change the character of some rooftops. If not in a historic district, visual impacts would be expected to be minimal as the PV array modules would be mounted on existing structures or carports over existing impervious surfaces. Careful site selection and design, in coordination with appropriate stakeholders, would minimize visual impacts of roof-top arrays in historic districts. Other affected viewsheds, to include those impacting culturally-sensitive sites, would have been impacted previously by the existing construction and any additional impacts resulting from the solar PV system are anticipated to be minimal. For the 10 MW project, approximately 1,000,000

$ft^2$ (92.9 thousand $m^2$) would be required and for the 100 MW project approximately 10 million $ft^2$ (929 thousand $m^2$) of roof would be required. Land use impacts resulting from construction, operation, and maintenance of ancillary power control systems, substations, and transmission or distribution lines is anticipated to be similar to those of Alternative 2. Short-term and long-term impacts to land use are anticipated to normally range from none to minor.

## 4.4 AIR QUALITY AND GREENHOUSE GASES

Air quality is regulated by the EPA per the Clean Air Act (CAA; 42 U.S.C. § 7401 *et seq.*). The CAA established National Ambient Air Quality Standards (NAAQS) to protect public health and welfare and to regulate emissions of hazardous air pollutants. The NAAQS established ambient air quality regions. Air quality at a given location is a function of several factors, both naturally occurring and manmade, including the quantity and type of pollutants emitted locally and regionally, and the dispersion rates of pollutants in the region. Primary factors affecting pollutant dispersion are wind speed and direction, atmospheric stability, temperature, presence or absence of inversions, and topography.

NAAQS are established for criteria pollutants, including ozone ($O_3$), carbon monoxide (CO), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), particulate matter equal to or less than 10 microns in diameter ($PM_{10}$), particulate matter equal to or less than 2.5 microns ($PM_{2.5}$), and lead (Pb). NAAQS represent maximum levels of background pollution with an adequate margin of safety to protect public health and welfare. Areas are classified as attainment if they meet the NAAQS for a criteria pollutant and non-attainment if they exceed the NAAQS. Army installations can be located in both attainment and non-attainment areas.

In addition to the criteria pollutants, EPA regulates listed hazardous air pollutants (HAPs). EPA has established National Emission Standards for Hazardous Air Pollutants (NESHAPs). The EPA regulates emissions of listed HAPs using source categories that must meet maximum achievable control technology (MACT) standards to demonstrate compliance.

According to EPA‘s General Conformity Rule (40 C.F.R. Part 51, Subpart W), any proposed federal action that has the potential to cause violations in a NAAQS nonattainment or maintenance area must undergo a conformity analysis.

If net annual emissions from a proposed project remain below applicable local thresholds for Conformity, a CAA Conformity Determination is not required. If a CAA Conformity Determination is required, a Record of Non-Applicability (RONA) must be prepared. If management action or project emissions of one or more of the criteria pollutants were to exceed applicable local thresholds for Conformity, a CAA Conformity Determination would be required to determine if emissions conform to the approved State Implementation Plan (SIP).

For project sites in nonattainment or maintenance areas, a site-specific analysis would be required to determine if local thresholds for Conformity would be exceeded, requiring a Conformity Determination. Failure to conform to the SIP would exclude a proposed project site from further consideration.

Greenhouse gases (GHGs) are chemical compounds in the Earth's atmosphere that allow incoming short-wave solar radiation but absorb long-wave infrared radiation re-emitted from the Earth's surface, trapping heat in the atmosphere. Most studies indicate that the Earth's climate has warmed over the past century due to increased emissions of GHGs, and that human activities affecting emissions to the atmosphere are likely an important contributing factor. A warmer climate is expected to increase the risk of heat-related illnesses and death, worsen conditions for air quality, allow some diseases to spread more easily, and increase the frequency and strength of extreme events (such as floods, droughts, and storms) that threaten human health and safety (EPA, 2015d).

Gases exhibiting greenhouse properties come from both natural and human sources. Water vapor, carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$) are examples of GHGs that have both natural and manmade sources, while other GHGs such as chlorofluorocarbons are exclusively manmade. In the U.S., most GHG emissions are attributed to energy use. Such emissions result from combustion of fossil fuels used for electricity generation, transportation, industry, heating, and other needs. Reduction goal requirements applicable to federal agencies are set forth in EO 13693, *Planning for Federal Sustainability in the Next Decade*.

The principal GHGs that enter the atmosphere due to human activities are:

- **Carbon Dioxide ($CO_2$):** $CO_2$ enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees, and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). $CO_2$ is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.

- **Methane ($CH_4$):** Methane is emitted during the production, transport, and combustion of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

- **Nitrous Oxide ($N_2O$):** Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

- **Fluorinated Gases:** Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful GHGs that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone ($O_3$)-depleting substances. These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as High Global Warming Potential gases.

Certain national park and wilderness areas across the country are given special protection under the CAA. Today there are 156 protected areas designated as mandatory Federal "Class I" areas in the visibility protection program, some of which are in the vicinity of Army installations (EPA, 2016b). EPA's visibility protection program notes that special analyses are required when a proposed new emission source may impact Federally-designated Class I areas and areas designated as Class I by states and Tribes.

### 4.4.1 EXISTING CONDITIONS

Air quality at Army installations is representative of cities and towns across the nation. Army installations have both stationary and mobile sources of air emissions. Most Army installations hold air quality permits that require periodic air emissions monitoring, with 1,143 air permits held by Army installations as of February 2016 (DA, 2016a). These permits may be federal, state, or local, and the type of permit is a function of the equipment and the amount of criteria pollutants and HAPs emitted. Regardless of whether an Army facility has an air permit or not, other air quality regulations (e.g., dust suppression during construction activities) may still apply.

Analysis of air quality and GHG effects considers if the Proposed Action would:

- Increase the need for, or change the emissions profile, of equipment such as boilers, stationary internal combustion engines, and combustion turbine generators;
- increase ambient air pollution concentrations above any NAAQS;
- contribute to an existing violation of any NAAQS;
- interfere with or delay timely attainment of NAAQS;
- emit HAPs;
- impair visibility within any federally-mandated Class I area;
- trigger a conformity determination; and,
- increase GHG emissions.

### 4.4.2 ENVIRONMENTAL CONSEQUENCES

This section provides a discussion of the possible environmental impacts to air quality and impacts to GHGs that could result from the No Action and Proposed Action alternatives. Impacts to air quality and GHGs would be considered significant if the Proposed Action would result in a NAAQS attainment area becoming a nonattainment area or if the Proposed Action would generate substantial GHG emissions nationwide (> 75,000 tons $CO_s$ equivalents per year). The ROI for air quality analysis will be influenced by prevailing winds, weather patterns, terrain, and the nature of the pollutant being considered, to include whether an installation is in an attainment area or non-attainment area. In general, the ROI for this resource area is the airshed and the installation boundary for criteria pollutants and HAPs.

#### 4.4.2.1 NO ACTION ALTERNATIVE

Implementing the No Action Alternative would result in a negligible, adverse impact on air quality and increased potential for climate change because of the continued generation of air pollutants and GHGs from the combustion of fossil fuels. This negligible, adverse impact assumes another renewable energy technology is not used in place of solar PV and the net change in energy use does result in a decrease of fossil fuel derived energy use. Consequently, impacts to air quality as a result of the No Action Alternative are anticipated to range from none to negligible.

#### 4.4.2.2 ALTERNATIVES 1, 2, AND 3: GREENFIELD SITE, PREVIOUSLY DEVELOPED SITE, AND ROOF

The construction, operation, and maintenance of solar PV projects along with ancillary power control systems, substations, and transmission or distribution lines, could improve existing air quality conditions at an installation by directly displacing electricity produced from the combustion of fossil fuels, and accompanying emissions, with renewable solar-derived energy. As proposed, the solar PV project may include the deployment of supporting systems, such as ESS and micro-grid technologies, to improve availability.

The Proposed Action may also include the construction, operation, and maintenance of back-up power generators to meet reliability standards. As currently envisioned, the back-up power generation is not considered as ‘additional’ to existing infrastructure, but rather higher efficiency replacement generation that would be located/re-located once the proposed solar PV, energy storage, and/or microgrid systems became operational, and a power flow assessment confirmed the need for location-specific back-up power generation. Though commonly associated with fossil-fired engines using diesel or fuel oil, more recent microgrid-based systems incorporate low emissions/high efficiency natural gas or biogas based equipment. Accordingly, the overall emissions profile of any site replacing older back-up generators would be expected to be able to capitalize on newer machinery and realize air quality improvements. Regardless, solar PV projects including back-up power generation systems would be required to determine what, if any, changes would be required to existing CAA permits and whether any new permits would be required for any of the projects’ associated generator sources.

During construction of solar PV systems for all three Alternatives, temporary short-term adverse air quality impacts would be expected as a result of vehicle exhaust from the construction vehicles and equipment and from fugitive dust as a result of ground-disturbing activities and, if unpaved roads are utilized, construction vehicles traversing to and from the project site. If site construction included vegetation removal, the biomass disposal method selected – along with volume and type of biomass – may influence short-term air quality impacts (e.g., on-site burning of the biomass, composting, disposal in a landfill). The magnitude of the construction-related air emissions and fugitive dust would be influenced heavily by weather conditions and the specific construction activity occurring.

To construct a 10 MW solar PV project, approximately 90 trucks carrying materials (e.g., solar modules, inverters, racking) and vehicles to transport 40 to 80 construction workers daily would be required. During equipment delivery, there may be 5 to 7 truck deliveries per week. A 10 MW project would require approximately 5 to 10 months for construction with variables including weather and site conditions. (GroSolar, 2014). Larger projects require proportionally more material, therefore a greater number of truck deliveries and longer construction time. Construction vehicles transporting excavation and fill material would be minimized through site design as movement of large amount of dirt would be prohibitively expensive for these projects. Air quality impacts from emissions can be mitigated with emission control devices and keeping vehicles and construction equipment in good working order.

Ground-disturbing activities which may result in fugitive dust include grading (e.g., on greenfield and previously developed sites or for access roads) and excavation (e.g., for ancillary power control systems, substation, transmission line poles, inverter boxes). Fugitive dust may also result if vehicles supporting construction or maintenance have to travel on unpaved roads. Dust from construction traffic and ground-disturbing activities can be controlled using standard construction practices such as watering of exposed surfaces and covering of disturbed areas. Dust from construction and maintenance traffic can be controlled by limiting speed limits. When there are periods of high wind during excavation and grading, temporary suspension of those activities would reduce the volume of fugitive dust expected during high winds.

Construction of solar PV projects under Alternative 1 will require removal of vegetation and, for trees and taller shrubs removed, preclude regeneration of vegetation, resulting in less natural carbon sequestration. Construction of solar PV projects under Alternative 2 may also require removal of vegetation and preclude the natural regeneration of the area, resulting in less carbon sequestration. Solar PV array modules under Alternative 3 would not require the removal of vegetation, but vegetation removal may be required for infrastructure and ancillary power control systems, if either is a required component of the project. However, these and other potential construction-related impacts (e.g., operation of construction vehicles and equipment) are not anticipated to result in substantial increases of GHGs.

Construction-related impacts to air quality are expected to be relatively minor, with impacts reduced through environmental protection measures, some of which may be required by construction permits. Examples of environmental protection measures are detailed in above paragraphs and include dust control measures, emissions control devices, and vehicle maintenance. The nature and magnitude of these effects would vary by the project location and size. Consequently, impacts to Class I areas are also expected to be minor.

Operation of solar PV projects could result in long-term beneficial impacts to air quality and overall GHG emissions at an installation and within the region. By off-setting a commensurate amount of electricity using solar-produced electricity, Army installations would consume less fossil fuel-derived electricity attributable to an installation's electrical demand. For example, a 10 MW solar PV project would save approximately 4,300 kilograms (kg) of $CO_2$ per MW hour (MWh) of solar power production. A 100 MW solar PV project would save 43,000 kg of $CO_2$ per MWh of solar power production.

Though back-up generators when utilized as part of the power control system would contribute to site emissions, they are anticipated to be replacement capacity for existing back-up generators. With advancements in engine efficiency, coupling to ESSs and microgrid applications, and the potential to utilize bio-based fuels in all or part, net reductions from existing site emissions would be expected and subject to Federal regulation and standards. Consequently, long-term adverse impacts to air quality from back-up generators is anticipated to be negligible.

## 4.5 NOISE

Sound is a physical phenomenon consisting of vibrations that travel through a medium, such as air, and are sensed by the human ear. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. Noise may also impact wildlife species and their activities, especially those that rely on vocalizations for communications. Human and wildlife response to noise varies depending on the type and characteristics of the noise, distance between the noise source and the receptor, receptor sensitivity, and time of day. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human responses to environmental noise are annoyance and stress.

The Noise Control Act of 1972 (42 U.S.C. § 4901 *et seq.*), along with its subsequent amendments (e.g., Quiet Communities Act of 1978), delegates to the states the authority to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Although no EPA noise regulation exist, the EPA has promulgated noise guidelines. Similarly, most states have no quantitative noise-limit regulations. Many local governments, however, have enacted noise ordinances to manage community noise levels. The noise limits specified in such ordinances are typically applied to define noise sources and specify a maximum permissible noise level. The Army considers these in evaluating noise effects. Additionally, AR 200-1 defines recommended noise limits from Army activities for established uses of land with respect to environmental noise (DA, 2007). AR 200-1 also states for transportation and industrial noise to be assessed on a case-by-case basis using appropriate noise metrics, including U.S. Department of Transportation guidelines (DA, 2007).

### 4.5.1 EXISTING CONDITIONS

Sources and levels of noise at Army installations are representative of cities and towns across the nation, with the exception of military test and training activities (including proving grounds and detonation sites). Existing non-military sources of noise that can be heard around Army installations include road traffic, rail traffic, aircraft overflights, air cooling and heating systems, back-up generators, and natural sounds such as bird vocalizations, running water, and wind. Existing military noise environment consists primarily of three types of noise: transportation noise from aircraft and vehicles, noise from firing at small-arms ranges, and impulse noise from large-caliber weapons firing and demolition operations. On- and off-post construction activities also generate noise temporarily. Noise levels vary by source and noise generated from mission activities are often cyclic or periodic in nature.

## 4.5.2 Environmental Consequences

The significance of potential noise effects is determined by the comparison of affected receptors to the acceptable compatible land uses. Sensitive receptors include residential areas, hospitals, day care centers, and schools. Considerations used while evaluating noise effect include whether land use compatibility problems would be created (DA, 2007); and whether peak noise and random blast noise levels are exceeded 15 percent of the time and would be likely to cause significant annoyance to individuals in incompatible land use areas. The ROI encompasses solar PV project site and the area around the site which is in close enough proximity to notice noise from construction, operation, and maintenance activities.

A significant impact to noise would (1) result in the violation of applicable federal, state, or local noise ordinance; (2) create incompatible land uses for areas with sensitive noise receptors outside the installation boundary; (3) cause the reclassification of noise zones to zone 2 or 3 around sensitive receptors; or (4) be loud enough to threaten or harm human health.

### 4.5.2.1 No Action Alternative

Implementing the No Action Alternative would result in a negligible, adverse impact on noise because of the continued noise from existing generator and power plant operations. This negligible, adverse impact assumes other means were not employed to reduce noise from generator and power plant operations. Consequently, impacts to noise as a result of the No Action Alternative are anticipated to range from none to negligible.

### 4.5.2.2 Alternatives 1, 2, and 3: Greenfield Site, Previously Developed Site, and Roof

Noise would increase locally around the project site during construction for all three alternatives from the vehicles and equipment. Construction-related noise is anticipated to be short-term and would only take place during daylight hours (sunrise to sunset), when higher sound levels are more tolerable. A 10 MW project would require approximately 5 to 10 months for construction, with variables including weather and site conditions, and larger projects would require proportionally longer construction time. If construction is near or on the rooftops of sensitive areas like housing or a school, mitigation measures could be used such as scheduling heavy equipment operations during less disruptive times. An alternative site should be considered if the noise from construction equipment would likely affect sensitive wildlife populations, to include threatened and endangered species, unless the construction can be scheduled during a non-critical time (e.g., birds aren’t nesting). Sound levels that would be generated by the use of heavy equipment and vehicles (trucks, backhoes, forklifts) would be expected to lessen with distance from the source due to ground attenuation, atmospheric absorption, and, at some locations, intervening vegetation and structures. The zone of relatively high construction noise levels typically extends to distances of 400 to 800 feet (121.9 to 243.8 meters) from the site of major equipment operations (West Point, 2014). Locations more than 800 feet (243.8 meters) from construction sites seldom experience appreciable levels of construction noise.

Construction noise would dominate the soundscape for all on-site personnel. Construction personnel, and particularly equipment operators, would wear adequate personal hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

All three alternatives would generate no noise during normal operation, with the exception of the power conditioning unit which converts DC electricity to AC and regulates the AC electricity. The power conditioning unit can produce audible noise ranging from approximately 50-70 A-weighted decibels (dBA), depending on the size of the inverter/transformer (NEMA, 2000). This is consistent with the range of noise levels associated with common speech. A refrigerator, dishwasher, shower, and large business office are other examples which produce noise in the 50-70 dBA range. Noise produced by temporary use of back-up generators, when used for power control, is expected to be similar to, or less than existing back-up generator use. New back-up generators replacing existing generators would produce similar noise levels or be quieter as a result of technological advances in passive controls such as acoustic barriers and insulation, vibration dampening devises, and enclosures. Where natural gas or liquefied petroleum gas fuels are available to power the back-up generator, noise levels produced during generator operation can be lower than those generators powered by other fuels when operating at similar load. Siting and design of systems including back-up generators would include consideration of distances to sensitive receptors and use, when appropriate, of sound attenuation measures and other noise mitigation strategies.

During operations, most maintenance activities would be performed during the day, although it may be preferable to perform some maintenance activities after the sun is down to limit impacts to energy production. Maintenance activities that may potentially create noise impacting sensitive receptors should be performed during a time period where impacts could be minimized (e.g., day time, weekend) to the particular receptor that is sensitive (e.g., weekend maintenance for a child day-care that doesn’t operate on weekends; day-time maintenance for a hospital).

When solar-derived energy replaces an alternately-derived method which currently includes some noise generation, long-term minor beneficial noise impacts are anticipated; though those beneficial impacts would be in the ROI of the alternately-derived energy facility.

Noise impacts from construction activities of the proposed solar PV system and ancillary power control systems would be localized, minor, and, due to the temporary nature of construction, short-term. For projects including inverters, transformers, and PV array tracking systems, noise associated with the operation of that equipment would be minor. Because the solar PV facility will not be generating electricity at night, tracking systems would not be rotating and noise from inverters would be at less than peak levels. Noise from ESSs and microgrid systems is negligible at all times, whether in service or not. Noise from back-up generation would be consistent with existing back-up power generators, but would be specific to the PV project and/or power flow analysis. Noise from the operation of PV arrays without tracking systems and from the electric collection system would be negligible. Implementing Alternatives 1, 2, and 3 would not create substantial areas of incompatible land use for noise-sensitive receptors or violate any federal, state or local noise ordinance.

## 4.6 GEOLOGICAL AND SOIL RESOURCES

Geological resources are defined as the topography, geology, and geological hazards of a given area and soil resources are the superficial unconsolidated and usually weathered part of the earth's crust. Topography is typically described with respect to the elevation, slope, aspect, and surface features found within a given area. The geology of an area includes bedrock materials, mineral deposits, soils, paleontological resources, and unique geological features. Bedrock refers to consolidated earthen materials that may be made up of either interlocking crystals (igneous and metamorphic rocks) or fragments of other rocks compressed and cemented together over time by pressure and dissolved minerals that have hardened in place (sedimentary rocks). In most areas, bedrock is covered by soil, which consists of weathered bedrock fragments and decomposed organic matter from plants, bacteria, fungi, and other living things. The value of soil as a geologic resource lies in its potential to support plant growth, especially agriculture. Mineral resources are metallic or non-metallic earth materials that can be extracted for a useful purpose, such as iron ore that can be refined to make steel, or gravel that can be used to build roads. The economic viability of a mineral resource is dependent upon supply and demand and upon the cost to extract the mineral from the ground. Paleontological resources are the fossilized remains of plants and animals. Fossils, both vertebrate and invertebrate, have major scientific value. The principal geologic hazards influencing the stability of structures are soil stability and seismic activity.

Soil erosion potentially impacts soils, water resources, and air quality. The degree of erodibility is determined by physical factors such as drainage, permeability, texture, structure, and percent slope. The rate of erodibility is based on the amount of vegetative cover, climate, precipitation, proximity to water bodies, and land use. Disruptive activities accelerate the natural erosion process by exposing the erodible soils to precipitation and surface runoff. Highly erodible land is defined by the Sodbuster, Conservation Reserve, and Conservation Compliance parts of the Food Security Act of 1985 and the Food, Agriculture, Conservation, and Trade Act of 1990. Erodibility is one of the soil classification characteristics identified by the Natural Resources Conservation Service (NRCS).

Hydric soils are one of the three indicators of a wetland and therefore should also be taken into consideration during site selection. Hydric soils are defined by the National Technical Committee for Hydric Soils as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (NRCS, 2015). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation (NRCS, 2015). Potential impacts to wetlands are discussed in Sections 4.7 (Water Resources) and 4.8 (Biological Resources).

Aspects of geological resources, to include soils, that are relevant to the proposed solar PV projects include:

- **Topography and Soils:** The topography of a proposed project site can be determined with topographic maps published by the U.S. Geological Survey (USGS), the Bureau of Land Management (BLM), or through Geographic Information System (GIS) datasets available online. Soil information, to include soil surveys and soil classification, is available through the NRCS. The topography and soils at a project site would be characterized prior to construction to assess their suitability for construction and potential for erosion. Installation storm water management plans provide requirements for minimizing soil erosion that could impact sedimentation in streams and other water bodies. Some installations also have a fugitive dust control plan with measures to minimize fugitive dust emissions and to avoid exceeding the threshold levels dictated by state regulations; wind-borne soil is a form of fugitive dust.
- **Mineral Deposits, Paleontological Resources, and Unique Geological Features:** Site conditions would be reviewed to determine if economically viable mineral deposits, scientifically significant paleontological resources, or unique geological features are present or expected. For proposed project sites located on Army installations, the potential for the occurrence of such mineral deposits, paleontological resources, and geological features may be known from previous activities. Additional sources of information about paleontological resources in a region may be found at a state repository of fossil finds.
- **Geologic Hazards and Seismic Activity:** Geologic hazards include landslides and faulting hazards. Potential geologic hazards and seismic activity would be identified in a geotechnical study of any proposed project. The geotechnical study should provide design and construction recommendations that address potential geological hazards and seismic activity at a site.

### 4.6.1 Existing Conditions

Existing geological resources on Army installations are representative of geological resources across the U.S. Soil series at Army installations range from sandy to clay, depending on the geographic setting, with some locations including highly erodible soils. Geologic formations vary by location and include sandstones, shales, karst formations, and glacial features such as tills, moraines, and outwash plains. Similarly, geologic hazards also vary by location, ranging from areas with little to no hazards to areas subject to seismic activity due to their proximity to geologic fault lines.

### 4.6.2 Environmental Consequences

Factors considered when determining whether an alternative would have a significant effect on geological resources were evaluated and distinguished by the degree to which the effect would impair the ability of the geological resources of the Army to sustain effective training grounds and ranges, and conflict with existing federal, state, or local statutes or regulations. In general, the ROI is usually localized and restricted to the solar PV project footprint and its immediate surroundings.

A significant impact to geology and soils would occur if the Proposed Action induced wind borne or storm water related soil erosion that exceeds the amount of soil loss at which the quality of a soil can be maintained to sustain existing vegetation.

#### 4.6.2.1 No Action Alternative

There would be no change to geological resources on the installation and no soils would be disturbed as there would be no construction activity under the No Action Alternative.

#### 4.6.2.2 Alternative 1: Greenfield Site

Construction of the solar PV system on a greenfield would involve ground-disturbing activities, including vegetation removal, grubbing, and grading necessary to establish a level surface for the placement of the solar PV arrays, followed by the construction of security fencing, equipment shelter(s), an access road, and, if needed, a transmission line and sub-station. Similar disturbances may be expected in cases where the solar PV system is coupled to or with ancillary power control systems. The mounting system proposed for the array field will influence the extent of ground disturbance as some mounting systems will require excavation or ground penetration (e.g., poured concrete footers, driven poles) and others would not (e.g., ballasted ground mounting). Bedrock depth would be a factor in determining drilling needs (e.g., for pole footings to be used to mount the array). Design would also influence the extent of trenching needed between modules for power distribution of the array system to the point where the system would be connected to a power grid. Soil erosion that could result from these ground-disturbing activities would be controlled through the use of appropriate environmental protection measures, including BMPs to prevent soil erosion. Examples of erosion control BMPs include sandbags, silt fences, earthen berms, fiber rolls, sediment traps, erosion control blankets, check dams in medium-sized channels, or straw bale dikes in a smaller drain channels. Other BMPs may also be specified in an installation's storm water pollution prevention plan and fugitive dust control plan. The contractor or organization constructing the solar PV system may also have soil erosion environmental protection measures identified as requirements within the associated state-issued construction permit (e.g., the National Pollutant Discharge Elimination System [NPDES] permit). In addition, soil conservation and storm water management regulations require that appropriate BMPs be used to minimize/eliminate site-specific erosion concerns. BMPs would also assist in minimizing soil compaction issues related to construction activities. Site design, to include minimizing grading requirements in a topographically diverse site by using variable elevation heights of support posts for different blocks of arrays (Crowley, 2013), could reduce grading requirements, thereby reducing impacts to soils. For ground-disturbing activities impacting bedrock, paleontological resources may be impacted. Though the Paleontological Resources Preservation Act of 2009 (16 U.S.C. §§ 470aaa *et seq.*) does not apply to DoD lands, if the construction contractor inadvertently discovers scientifically significant paleontological resources, construction work should stop and the installation's environmental management office should be notified. Geotechnical surveys can enable improved site design for the array field, to include potential trenching needs, and will be conducted as required and in accordance with the relevant laws and regulations. As the Proposed Action does not include the construction of regularly occupied structures, there would be no potential seismic-related safety concerns. Conversion of farmland could occur on greenfield locations if the proposed site is currently under an agricultural outlease. For solar PV projects which include the construction of new transmission lines, lines would be placed along existing road disturbance limits and within existing utilities easements, to the greatest extent possible, to minimize ground disturbance.

Geological features that should be taken into consideration during site selection include low topographic relief, the absence of unique geological features, and soil characteristics with minimal construction issues. The Army maintains planning-level soil survey data for its installations and therefore will be able to take select geological, soil, and mining information into account when reviewing potential sites for specific solar PV systems. A site-specific analysis should be prepared for sites with varied topography requiring considerable grading to ensure the appropriate and sufficient application of environmental protection measures. To the extent feasible, site design should attempt to use all excavated soil from higher areas as fill for nearby lower areas so as to reduce or eliminate a need to either import or export earthen material. Solar PV array sites would be excluded from consideration if the proposed construction activities would result in substantial alteration to topography or substantially increase the potential for erosion as this type of site would substantially increase the project cost to the point of losing economic viability; in addition to increasing adverse impacts to environmental resources.

Short-term, moderate / less than significant, adverse impacts and long-term minor adverse impacts to soils would be anticipated as a result of construction activities. Negligible, long-term, adverse impacts would be anticipated as a result of increase to impervious surfaces (e.g., from equipment shelter, access road, and sub-station).

During construction and maintenance activities, potential soil contamination due to spills of hazardous materials could occur (e.g., fuel spills from vehicles and equipment). With environmental protection measures, to include BMPs and SOPs, for preventing and responding to potential contamination, impacts are anticipated to be negligible.

During operation and maintenance activities, soil erosion could occur as a result of natural processes (e.g., wind and rain) and from run-off related to module washing. To minimize potential effects, the system operator would monitor the array field and associated support infrastructure (e.g., transmission lines) to check for soil erosion. Additionally, the system operator would ensure that a vegetation and/or gravel cover is maintained under and around the solar array systems as much as possible to reduce any run-off related to module washing. Highly eroded soils and sediment from erosion reaching streams would be investigated and remedied as appropriate. Consequently, negligible long-term adverse impacts would be anticipated as a result of operations and maintenance.

In general, construction, operation, and maintenance of Alternative 1 on Army installations would not induce seismic activity, nor would it affect any of the economically-viable minerals in the applicable area.

### 4.6.2.3 Alternative 2: Previously Developed Site

Impacts to geologic and soil resources as a result of constructing a solar PV system under Alternative 2 may be less than those of Alternative 1 because previously developed sites are on already disturbed areas. As soil modification and disturbance have typically occurred on previously developed sites, the NRCS soil classification depicted on soil maps for the array site may no longer be accurate. Alternately, if the proposed site lacks established ground cover, construction activities may worsen or hasten existing soil erosion. Soil erosion mitigation measures discussed under Alternative 1 are anticipated to minimize soil erosion from construction activity on a previously developed site, with impacts ranging of none to moderate / less than significant.

If construction of a solar PV array is on a former landfill site, slope stability and landfill settlement are substantial elements that need to be considered when designing the array field. Environmental protection measures to minimize potential impacts include using settling as a siting characteristic and reviewing and updating the settlement forecast during the design process.

Impacts to geological and soil resources as a result of operation and maintenance of a solar PV system under Alternative 2 are anticipated to be similar to those of Alternative 1.

For projects on an IRP, MMRP or CC site, construction, operation, and maintenance of a solar PV array system would be required to be compatible with long-term management requirements and laws and regulations governing the site. If site design parameters calls for the removal of soil from the solar PV site during construction, removal would be restricted until the installation determines if the soil requires analytical testing.

If construction of a solar PV array is on a site that has been capped or lined, selection of a proposed mounting system when designing the array field would be required to be compatible with long-term management requirements and laws and regulations governing the site.

Implementation of Alternative 2 is anticipated to have construction-related short-term, moderate / less than significant, adverse impacts and, as related to both construction and operation and maintenance, negligible to minor, long-term impacts.

### 4.6.2.4 Alternative 3: Roof

Construction of solar PV arrays on or over existing structures or impervious surfaces would have no impact on geologic resources. For solar PV projects including construction of transmission lines or a substation, short-term impacts to soils could occur during construction, similar to those described under Alternative 1, as related to ancillary power control systems, transmission lines and substations. Impacts to geological resources, including soils, are anticipated to be negligible for Alternative 3.

Considerations for this alternative include the structural capability of the structure and the slope of the roof. Applicable building codes would be required to be met to support adding solar PV arrays to existing structures to include, in seismic-prone areas, those codes related to earthquake-resistant construction.

## 4.7 WATER RESOURCES

Water resources as defined in this assessment are sources of water available for use by humans, flora, or fauna, including surface water, groundwater, near-shore waters, wetlands, and floodplains. Surface water systems are typically defined in terms of watersheds. A watershed is a land area bounded by topography that drains water to a common destination. A watershed boundary will more or less follow the drainage divide or the highest ridgeline around the stream channels, which will meet at the bottom or lowest point of the land where water flows out of the watershed, commonly referred to as the mouth of the waterway. Surface water resources, including but not limited to, storm water, ponds, lakes, streams, rivers, and wetlands, are important for economic, ecological, recreational, and human health reasons. Year-round presence of water in surface water features varies, falling into the categories of perennial, intermittent, and ephemeral. Groundwater is classified as any source of water beneath the ground surface and may be used for potable water, agricultural irrigation, and industrial applications. Near-shore waters can be directly affected by human activity, and are important for human recreation and subsistence. Wetlands are habitats that are subject to permanent or periodic inundation or prolonged soil saturation, and include marshes, swamps, and similar areas. Areas described and mapped as wetland communities may contain small streams or shallow ponds, or pond/lake edges. Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. Floodplains are relatively flat areas adjacent to rivers, streams, watercourses, bays, or other bodies of water subject to inundations during flood events.

Aspects of water resources that are relevant to the proposed solar PV projects and ancillary power control systems include:

- **Watershed:** Any activity that affects water quality, quantity, or rate of movement at one location within a watershed has the potential to affect the characteristics of locations downstream. To assist DoD installations in understanding and managing operations from a watershed perspective, the *Department of Defense Installation Watershed Impact Assessment Protocol – a Water Resources Management Guide* was issued in June 2005 (AEC, 2005).

- **Surface Water Quality:** Surface water quality is regulated under the Clean Water Act (CWA; 33 U.S.C. § 1251 *et seq.*). Section 303(d) of the CWA requires states to identify and develop a list of impaired waterbodies where technology-based and other required controls have not provided attainment of water quality standards. Section 305(b) of the CWA requires states to assess and report the quality of their waterbodies. Total Maximum Daily Load (TMDL) for pollutants of concern are regulated for impaired water bodies at such a level to maintain the stream's designated use. The TMDL process establishes allowable pollutant loadings or parameters for a waterbody and allows water quality controls to be developed to reduce pollution and to restore and maintain water quality. The allowable load established by a TMDL suggests stream water quality would improve over time. Additional regulatory requirements may also exist for surface waters under the Safe Drinking Water Act (SDWA; 42 U.S.C. § 300f *et seq.*) for those surface waters which are sources of potable drinking water. To assist Army installations that operate, own, or partially own a drinking water treatment system, the *User's Guide for Source Water Assessment and Protection at U.S. Army Installations* was developed in 1999 (AEC, 1999).

Regulated Army installation discharges into surface waters include those from wastewater, cooling water, and storm water. CWA discharge permits are issued by the EPA or authorized state agencies under the NPDES. NPDES permits may be issued to point source discharges to "waters of the U.S." and establish the site-specific compliance requirements for the permitted facility (e.g., effluent limits and monitoring and reporting requirements). Army installations that have indirect discharges into municipal wastewater treatment plants may have similar pretreatment requirements.

Army storm water management practices are also required to comply with Section 438 of the Energy Independence and Security Act (EISA) of 2007, which directs federal agencies sponsoring development or redevelopment of over 5,000 square feet (1,524 square meters) in size to use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of water flow. This requirement is further emphasized by Army policy which states development projects of 5,000 square feet (1,524 square meters) or greater must be planned, designed, and constructed to manage any increase in storm water runoff (i.e., the difference between pre- and post-project runoff) within the limit of disturbance (DA, 2013b).

Additionally, as part of the process to obtain the 'Construction general permit' for storm water discharges during construction, the solar facility operator or construction contractor prepares a Storm Water Pollution Prevention Plan (SWPPP). SWPPPs include implementation of BMPs, performing frequent visual inspections, and conducting benchmark monitoring to determine BMP effectiveness. Monitoring results are analyzed in relationship to the identified water quality objectives and if the benchmarks are not being reached, the BMPs would be modified.

- **Groundwater and Aquifers:** Some Army installations use groundwater as a source for potable water, which is regulated under the SDWA, and/or water for other uses, such as irrigation. Aquifer recharge areas also exist on some Army installations and land uses in such areas, especially for sole or principal source aquifers (SSAs), may be restricted. A SSA is an aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer and regulations are authorized for these aquifers under Section 1424(e) of the SDWA (EPA, 2015b). Of the 77 designated SSAs in the U.S. (EPA, 2015b), some include Army installations. The previously-mentioned *User's Guide for Source Water Assessment and Protection at U.S. Army Installations* addresses groundwater aquifers and recharge areas, in addition to surface water sources (AEC, 1999).

- **Wetlands and Other Regulated "Waters of the U.S.":** Waters of the U.S. include navigable waters, tributaries of navigable water, and adjacent wetlands, ponds, and lakes; for the full definition, see 40 C.F.R. 230.3. If a formal wetland delineation has already been determined for the Army installation for the proposed project area, this can be used to determine the occurrence of jurisdictional wetlands or other regulated waters of the U.S. within the footprint of the construction area for any proposed new facilities and associated infrastructure. If no previous delineation has been performed, available Army and other federal agency data would be used to determine the potential for wetlands and other regulated waters of the U.S. within the proposed project footprint. These include aerial photographs, U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) maps, and NRCS soil classification maps (which identify the presence of hydric soils, one of the components of a wetland). Even if these sources do not provide evidence of potential wetlands, previously undeveloped sites may be inspected by a wetland biologist to determine if unmapped wetlands are present. If there are indications that wetlands may be located within the proposed project footprint, then formal wetland delineation would be conducted according to the U.S. Army Corps of Engineers (USACE) *Wetlands Delineation Manual* and any regional supplements. A wetland delineation report would then be prepared and submitted to USACE, who determines whether or not a wetland is jurisdictional and therefore subject to CWA Section 404 permitting requirements. A similar determination would be required regarding the jurisdictional status of any other water bodies in the project footprint.

- **Floodplains:** The Federal Emergency Management Agency's (FEMA) flood maps (FEMA, 2010b) can be used to determine if the proposed project area is located within a FEMA-designated 100- or 500-year floodplain. The 100-year floodplain is a Special Flood Hazard Area and this area has a one percent or greater chance of flooding each year. The 500-year floodplain has a 0.2 percent change of flooding each year and is considered a moderate flood hazard area. (FEMA, 2015a) If a project site is determined to be located within a 100-year floodplain, any federal development at that site is subject to EO 11988, *Floodplain Management*. This EO requires federal agencies to avoid, whenever possible, the long- and short-term adverse effects associated with the occupation and modification of flood plains. Federal agencies should also avoid direct and indirect support of floodplain development wherever there is a practicable alternative. On January 30, 2015, EO 11988 was amended by EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*. EO 13690 provides three approaches that federal agencies can now use to establish the flood elevation and hazard area for consideration in decision-making: climate-informed science approach, adding 2-3 feet (0.6-0.9 meters) of elevation to the 100-year floodplain, and using the 500-year floodplain. In response to EO 13690, FEMA issued floodplain management guidelines for implementing EOs 11988 and 13690, dated October 8, 2015 (FEMA, 2015b).

- **Coastal and Great Lake Waters:** Areas bordering the Atlantic, Pacific, and Arctic Oceans, Gulf of Mexico, Long Island Sound, and Great Lakes are affected by additional requirements under the CZMA, which is concerned with the degradation of coastal waters, to include degradation from nonpoint source pollution. Under the CZMA, federal agency actions within or outside the coastal zone that affect any land or water use or natural resource of the coastal zone shall be carried out in a manner that is consistent to the maximum extent practicable with the enforceable policies of a state's approved coastal management program. Currently, 34 coastal states participate; Alaska withdrew in 2011 (NOAA, 2016)

AR 200-1 provides guidance to ensure the availability, conservation, and protection of water resources, to include potable water, and enables Army compliance with the CWA, the SDWA, and applicable state and local regulations implementing these federal laws (DA, 2007).

### 4.7.1 Existing Conditions

Existing water resources on Army installations are representative of water resources across the U.S. and Army installations consist of numerous watersheds. Surface water bodies at Army installations include storm water, ponds, lakes, streams, rivers, and wetlands. A few Army installations abut near-shore marine waters and water resources regulated by the CZMA. Some installations have impaired waters, as defined by the CWA, on or adjacent to the installation. Wetlands have been formally delineated at many Army installations. Groundwater resources include confined and unconfined aquifers that may provide drinking water, and/or industrial, landscaping, and agricultural water to the installation and/or surrounding communities, depending on the groundwater body's quality and quantity. At some installations, potable water comes from surface water sources.

Some Army installations operate their own wastewater treatment plants (regulated under their site-specific permit), whereas other Army installations discharge to the surrounding community's municipal treatment plant. These 'indirect' discharges to the municipal wastewater treatment plant may also be regulated under site-specific 'pre-treatment' permits. As of February 2016, Army installations held a total of 778 CWA permits (DA, 2016a).

### 4.7.2 Environmental Consequences

Factors considered when determining whether an alternative would have a significant effect on water resources were evaluated and distinguished by the degree to which the effect would impair water quality, increase flooding, and impact water availability. In general, the ROI encompasses the watershed in which the solar PV project alternatives would potentially be located, and the aquifers beneath the installation which could potentially be impacted by the project alternatives.

A significant impact to water resources would occur if the Proposed Action resulted in a detrimental change in surface water impairment status, a detrimental change impacting potable groundwater, or an impairment to the use of groundwater aquifers. A significant impact would occur if the Proposed Action resulted in unpermitted direct impacts to jurisdictional wetlands or other regulated waters of the U.S.

#### 4.7.2.1 No Action Alternative

There would be no impacts to water resources as a result of the No Action Alternative because there would be no construction activities.

#### 4.7.2.2 Alternative 1: Greenfield Site

During construction of a solar PV system on a greenfield, there would be a possibility of sediment reaching nearby surface waters and wetlands as the ground is disturbed by excavation, grading and construction traffic. Construction on a greenfield may require removal of a substantial amount of vegetation at the proposed project site, which could result in altered drainage patterns, runoff, and sedimentation. If removal of a substantial amount of vegetation substantially alters the volume and rate of water being absorbed into the ground, site hydrology, to include recharge of aquifers, could be affected; however, EISA and Army policy require site development for all projects of 5,000 square feet (1,524 square meters) or greater to retain the pre-development site hydrology. For solar PV systems constructed in aquifer recharge zones, groundwater could potentially be impacted if degraded surface water rapidly reached aquifer zones. For solar PV systems constructed in a location anticipated to affect a coastal zone, coastal waters could potentially be impacted if degraded surface water reached coastal zones. Impacts are anticipated to be negligible to minor by designing the site to avoid water resources to the maximum extent practical, designing the site to minimize the size of disturbed areas, implementing BMPs to reduce or eliminate sedimentation and manage storm water, keeping vehicles and construction equipment in good working condition (e.g., to prevent spills or leaks), keeping the construction staging area in a clean and orderly condition, and adhering to all permit requirements (e.g., applicable CWA permits). Completion of a CZMA consistency evaluation, if required, is also anticipated to result in site design and construction parameters that would avoid or minimize impacts. Site design applies to the array field and, if needed, supporting infrastructure such as ancillary power control systems, transmission and distribution lines, and sub or switching stations. Impacts resulting from construction activity are anticipated to be short-term.

In general, construction in a floodplain is to be avoided; however, there is a process for constructing in a floodplain when no other practicable alternatives are available. Solar PV project alternatives located in whole or in part within a floodplain must undergo the process outlined in EO 11988, as amended by EO 13690, which may result in a Finding of No Practicable Alternative (FONPA). For projects located in a floodplain, EO 11988 requires identification of the impacts of the project on lives, property, and the natural and beneficial values of the floodplain. If the project results in harm to or within the floodplain, EO 11988 requires that harm be minimized and natural and beneficial values of the floodplain be restored and preserved. Methods to minimize, restore, and preserve are described in Part II, Step 5, Section 5.C. of FEMA's Guidelines for Implementing EO 11988 and EO 13690 (FEMA, 2015b). Examples include minimizing floodplain fills, grading, compaction, and impervious surfaces; and restoring natural site contours, drainage, and ecosystems. Other design components that should be addressed for proposed solar PV systems entailing a FONPA include, for example, elevating the lowest edge of all PV panels at or above the 100-year water surface elevation when at full-tilt; meeting safety requirements related to electrical components; meeting safety and structural requirements for the mounting system and ancillary structures. Consequently, impacts to floodplains as a result of the Proposed Action are anticipated to range from none to minor.

Potential water quality impacts from operations and maintenance of a solar PV system on a greenfield may result from water run-off from rainfall, snow melt, and module washing; ground disturbance from maintenance vehicles servicing the facility; and spills or leaks from maintenance vehicles and equipment. Environmental protection measures, including BMPs, would mitigate these potential impacts. The solar PV system, to include the array site, ancillary power control systems, and associated transmission corridors, would be checked by the systems operator for soil erosion resulting from system maintenance or natural processes, and soil erosion or sediment reaching streams would be investigated and remedied as appropriate. Vegetation and/or gravel cover would be maintained under and around the solar array systems as much as possible to reduce any run-off or soil erosion related to module washing and precipitation events. As Army installations are in numerous ecosystems and climates, appropriate vegetation cover, and its diversity, would vary per site and should not require watering once initially established. Preference for native plants should be considered when selecting vegetation to stabilize soils, minimize run-off, and, once established, require no watering. Generally, module washing is anticipated to occur using only water and no cleaning chemicals; however, some locations may require cleaning additives if water quality or other circumstances require additives in order to achieve panel cleaning. If these circumstances apply, operations should consider using water that has been purified to remove mineral contents that would leave a residue. Panel washing should follow recommendations from the panel manufacturer regarding alternatives to water washing, or the addition of any cleaning additives to water. Water quality should be considered in determining optimal washing to prevent residue build up, and any cleaning additives should be biodegradable and environmentally safe. Module washing should be scheduled to ensure that water does not build up and cause excessive run-off. For array sites which potentially impact shorelines, such as those along rivers, lakes, and oceans, shoreline stabilization practices may include maintenance of vegetation and/or gravel cover in the riparian area. Maintenance vehicles would avoid shorelines and, where feasible, stay on hard surface or gravel roads. Maintenance vehicles and equipment would be maintained in good working condition. By implementing these environmental protection measures, impacts are anticipated to be negligible to minor.

Solar PV projects require s water for module washing. Washing frequency is a function of local precipitation frequency, dust levels, and degree of air pollution; but, on average, modules are washed one to four times a year. Estimated water use for PV panel washing averages approximately 20 gallons (76 liters) of water per MWh (SEIA, 2010; a range of zero to 30 gallons (0 to 114 liters) per MWh is reported in SNL, 2013). Using information on the range of capacity factor values for solar PV projects (Bollinger, et al, 2016), one MW of installed generating capacity (DC) would require about 27,000 to 39,000 gallons (102,206 to 147,631 liters) per year for washing. This is comparable to the average individual's home water use in the U.S., which averages 100 gallons (379 liters) per day per person (EPA, 2008). Larger solar PV facilities would require a corresponding increase in water used for washing. For example, a 10 MW facility that generates 24,000 MWh per year would require approximately 480,000 gallons (1.8 million liters) of water per washing. For comparison, an Olympic-sized swimming pool holds around 660,000 gallons (2.5 million liters) of water. Water use for the typical Army installation is measured in millions of gallons per day (MGD), so the water needed for washing solar PV modules would be comparatively small, even for a large array. For example, a 100 MW facility would require less than 0.01 MGD (3.9 million gallons [14.8 million liters] per year), using the above estimate. Therefore, the anticipated impact on water availability is anticipated to be negligible to minor in most cases, including for those facilities where water for cleaning the modules is purchased and trucked in from off-post. For installations in areas where water resources are limited or constrained by current uses, the operator should consider the use of compressed air as a replacement for water, when feasible. For installations where water resources are limited or constrained, the anticipated impact on water availability may range up to moderate / less than significant, particularly for a large solar PV project, and may require mitigation as appropriate.

#### 4.7.2.3 Alternative 2: Previously Developed Site

In general, impacts to water resources as a result of construction of a solar PV system on a previously developed site are anticipated to be similar to those of Alternative 1, which were negligible to minor. However, if the proposed site contains contaminants on the surface or in the soils as a result of previous use and development, ground-disturbing activities described in Section 4.7.2.2 may have a higher probability of water quality impacts being moderate / less than significant instead of minor. Site investigation, when warranted, should result in the specific identification of contaminants (if any) and existing paths of migration. Depending on the site investigation results, specific measures to prevent or reduce migration of the contaminant to off-site surface water or groundwater may be required for site design and construction, operation, and maintenance activities. Potential impacts to floodplains on a previously developed site may be reduced if the site did not contain adequate storm water management controls when previously developed. Potential impacts to water resources resulting from vegetation removal on a previously developed site may be less than those on a greenfield site due to the fact that the site had previously been disturbed and may therefore have less established vegetation. In compliance with Section 438 of the EISA and Army policy, development of a solar PV system is required to retain the predevelopment site hydrology to the maximum extent practicable. As with Alternative 1, potential impacts are anticipated to be mitigated through site design and implementation of environmental protection measures, including vehicle/equipment maintenance.

If construction of a solar PV array is on a former landfill site, slope stability and landfill settlement are substantial elements that need to be considered when designing the array field. Additionally, the array field design would need to ensure landfill liners are not impacted during construction so as to continue to protect groundwater resources. BMPs to minimize potential impacts include using settling as a siting characteristic and reviewing and updating the settlement forecast during the design process.

For projects on an IRP site, construction, operation, and maintenance of a solar PV array system would be required to be compatible with long-term management requirements and laws and regulations governing the IPR site.

In summary, impacts to water resources as a result of Alternative 2 construction activities are anticipated to be negligible to moderate / less than significant.

Potential water resources impacts from operations and maintenance of a solar PV system on a previously developed site is anticipated to be similar to those of Alternative 1 – negligible to moderate / less than significant.

#### 4.7.2.4 Alternative 3: Roof

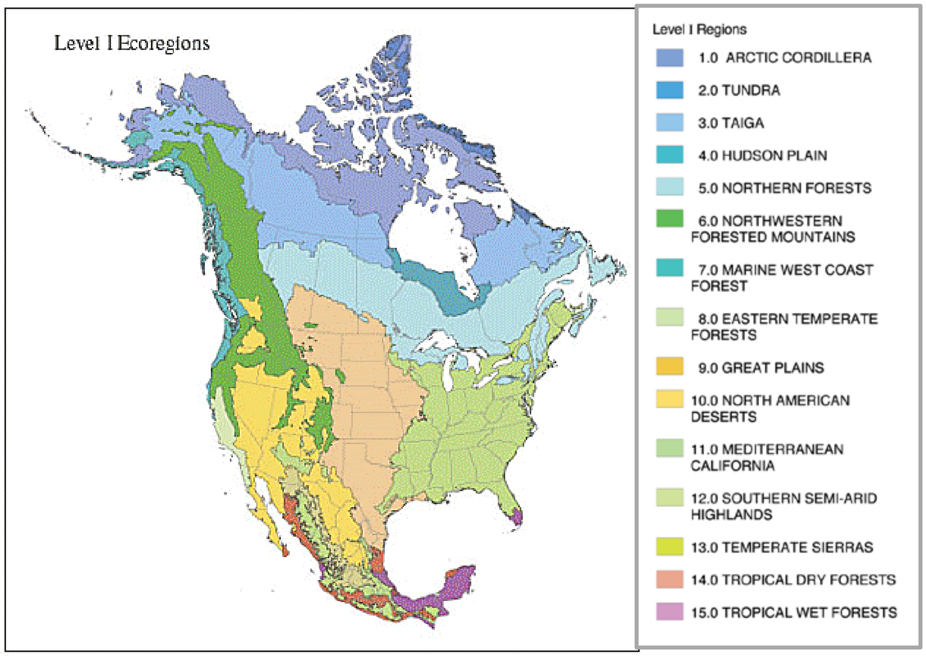
Impacts, if any, to water resources would not change by placing solar PV arrays on or over existing structures or impervious surfaces. Construction activities for placing solar PV arrays on or over existing structures or impervious surfaces would entail use of a construction staging area. Short-term impacts on water resources as a result of the use of the staging area would be similar to use of a staging area under Alternative 1, with impacts anticipated to range from none to negligible.. For solar PV projects including construction of ancillary power control systems, transmission lines or a substation, short-term impacts to water quality could occur during construction, similar to those described under Alternative 1, as a result of ground-disturbing activities and spills or leaks from construction vehicles and equipment. As with Alternative 1, impacts from ground-disturbing activities would be mitigated through site design and implementation of environmental protection measures, including vehicle/equipment maintenance, and are therefore anticipated to be negligible to minor.

As with Alternative 1, solar module washing would result in run-off. However, storm water management controls are often in place on Army installations for developed areas; therefore, impacts to water quality from solar module washing under Alternative 3 are anticipated to be negligible. Rooftop solar PV arrays are typically smaller than arrays placed on greenfields or previously developed sites; therefore, the anticipated volume of water required for Alternative 3 module washing would likely be substantially less, with negligible impacts to water availability.

## 4.8 Biological Resources

Biological resources refer to the living landscape – the plants, animals, microorganisms, and other aspects of nature – and are a component of every ecosystem. Biological resources include plants, trees, animals, fish, birds, insects, and microorganisms, with the ecosystem in which they reside consisting of a complex set of relationships between these biological resources, as well as water resources, soil resources, and people. The structure and function of an ecosystem is largely determined by energy, moisture, nutrient, and disturbance regimes, which in turn are influenced by a variety of biological and non-biological factors, including climate, geology, flora, fire, hydrology, and wind (USFWS, 2012). Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. With Army installations located in many states and territories, Figure 11 makes it obvious that the specific biological resources at installations vary. Consequently, the site-specific concerns influencing design and construction of solar PV systems would expect to vary from installation to installation.

**Figure 11.** North America Level I Ecoregions (EPA, 2015c)




Aspects of biological resources management and activities on Army installations are regulated by federal laws and regulations such as the Endangered Species Act (ESA; 16 U.S.C. § 1531 *et seq.*), Marine Mammal Protection Act (MMPA; 16 U.S.C. § 1361 *et seq.*), Migratory Bird Treaty Act (MBTA; 16 U.S.C. § 703 *et seq.*), Bald and Golden Eagle Protection Act (BGEPA; 16 U.S.C. § 668 *et seq.*), and Sikes Act (16 U.S.C. § 670 *et seq.*). State laws and regulations governing biological resources management and activities may apply to some installation solar PV projects. Applicable state laws and regulations should be considered when installations evaluate potential impacts and consider mitigation measures for proposed site-specific solar PV projects. AR 200-1 is the primary Army regulation detailing requirements affecting biological resources. AR 200-1 provides guidance to ensure the sustainability, conservation, and protection of biological resources on Army installations to enable Army compliance with applicable statutes and regulations and support the missions and operations needed to equip, sustain and train our combat forces (DA, 2007). Items to be considered when analyzing the potential impacts of the Proposed Action include those related to:

- **Sikes Act:** Under the Sikes Act, all DoD installations that hold land with significant natural resources are required to develop, maintain, and implement an INRMP. INRMPs are prepared in cooperation with the USFWS and state fish and wildlife agencies to ensure proper consideration of fish, wildlife, and habitat needs. In accordance with AR 200-1, installations must review their INRMP annually, and modify it as needed (DA, 2007). Additionally, the Sikes Act requires installation INRMPs to be reviewed every five years for operation and effect by the installation, USFWS, and the corresponding state agency.

- **ESA:** ESA was passed in 1973 to prevent the extinction of animals and plants that are drastically declining and exist only in extremely low numbers, with protection measures applied to those select species and habitats listed as endangered or threatened. No person is allowed to take a listed species without an incidental take permit. “Take” is defined broadly to include harassing and habitat modification as well as killing. Federal agencies are required to consult with the USFWS or National Marine Fisheries Service (NMFS) to ensure that the agency’s actions do not jeopardize the continued existence of listed species or destroy or adversely modify their critical habitat. Candidate species are identified when a petitioned species is warranted for listing as endangered or threatened, but precluded from immediate listing due to other USFWS or NMFS priorities. ESA is administered jointly by the USFWS and the NMFS, with USFWS having primary responsibility for terrestrial and freshwater organisms and NMFS having responsibility for mainly marine wildlife and for anadromous fish like salmon. Though there are no substantive requirements to manage for species referred to as “sensitive species” within this PEA, the Army may choose to implement sensitive species management considerations with the goal of preventing a need for listing under ESA. These sensitive species may include ESA candidate species, state-listed species, and Birds of Conservation Concern identified by the USFWS (USFWS, 2015).

- **MBTA:** MBTA makes it unlawful for any person to “pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported … any migratory bird” without a federal permit. USFWS policy interprets MBTA “take” to include nests occupied by eggs or nestlings, or are otherwise still essential to the survival of the juvenile birds (USFWS, 2003). The migratory bird species protected by the Act are listed in 50 C.F.R. § 10.13. In addition to the MBTA requirements, federal agencies also are directed under EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, to conserve migratory birds and to assess the effects of their actions on migratory bird populations. In a 2014 Memorandum of Understanding (MOU) between the DoD and USFWS, the agencies recognize that development of alternative energy sources have resulted in additional exposure of migratory birds and their resources to avian stressors. In the MOU, DoD agrees to review best practices outlined in USFWS guidance, and consult with USFWS as needed, when considering the development of these technologies on military lands.

- **BGEPA:** The BGEPA prohibits all persons from knowingly taking, possessing, or selling an eagle or eagle part, with a few limited exceptions (e.g., for Native American religious purposes). “Take”, under BGEPA, includes molest or disturb. Thus, any actions that are likely to cause injury to an eagle, decrease its productivity, or cause nest abandonment are also prohibited. Under BGEPA, both active and inactive eagle nests must be protected from disturbance, unless a USFWS permit is obtained. Otherwise, inactive nests cannot be removed and active nests must be protected using avoidance zones of appropriate size to ensure eagles are not disturbed. Using USFWS guidance, such as the *National Bald Eagle Management Guidelines* (USFWS, 2007), and consulting with the USFWS will result in identifying appropriate nest avoidance zones for nests protected under BGEPA.

- **MMPA:** All marine mammals are protected under MMPA, a law which includes the prohibition of all persons to “take” marine mammals in U.S. waters. As with the BGEPA, there are a few limited exceptions (e.g., select Alaska Native practices) under this law, which is regulated by the NMFS. Take under MMPA, includes harassment. Thus, any actions that may potentially injure or cause disruption of essential behavioral patterns, such as migration, breathing, nursing, breeding, feeding, or sheltering, are also prohibited unless an incidental harassment permit is obtained from USFWS or NMFS.

- **Noxious, Invasive and Pest Species:** Management practices for biological resources are also influenced by noxious, invasive and pest species. A noxious plant is any plant designated by a federal, state, or local government as injurious to public health, agriculture, recreation, wildlife, or property. Noxious plants are often defined as plants that are growing out of place, that are competitive, persistent, and pernicious. Invasive species are organisms that are introduced into a non-native ecosystem and which cause, or are likely to cause, harm to the economy, environment or human health. Invasive species degrade, change or displace native habitats and compete with native wildlife and are thus harmful to fish, wildlife and plant resources. Invasive species – whether insect, plant, or animal – often outcompete native species and upset the ecological balance. Invasive species may also directly impact military missions by “infesting open space needed for military operations; rendering training grounds hazardous with dense, spiny, flammable, or otherwise noxious vegetation; and reducing the extent of realistic training areas” (MSU, 2013). The U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service defines a pest species as any biotic agent (any living agent capable of reproducing itself) that is known to cause damage or harm to agriculture or the environment. Biotic causes of disease include fungi, bacteria, viruses, phytoplasmas, nematodes, and parasitic plants (Small, 2011). EO 13112, *Invasive Species*, includes federal agency responsibilities to prevent the introduction of invasive species and to control populations of such species in a cost-effective and environmentally sound manner. DA memo “Army Policy Guidance for Management and Control of Invasive Species” (DA, 2001) provides guidance on implementing this EO. Additionally, management of noxious, invasive and pest species is in accord with each installation’s Integrated Pest Management Plan (IPMP).

- **Wildland Fires:** Wildland fires may be initiated by natural events (e.g., lightning) or human activities (e.g., campfires, hot mufflers, arson, select military training activities) and may burn with intensities capable of causing loss of life, loss of property, or detrimental impacts to natural resources. The fire management programs of federal land-holding agencies includes containing and responding quickly to wildland fires and, as appropriate, using prescribed fires to reduce potential fuel loads and thus the chances of catastrophic wildland fires. The Army’s guidance on wildland fire management is specified in AR 200-1 (DA, 2007).

- **Wetlands:** Wetlands are among the most productive of all ecosystems, therefore wetland protection measures, governed under the CWA (33 U.S.C. § 1251 *et seq.*), protect the species that directly or indirectly depend on wetlands for all or part of their life cycle. See Section 4.7 (Water Resources) for additional discussions on wetlands and potential impacts.
- **Sensitive or Important Biological Areas:** Management practices for biological resources on Army installations may also be influenced by proximity to areas identified by other Federal, state or local agencies or non-governmental organizations to be of conservation/biological importance, such as parks, refuges, or landscape-level plans.

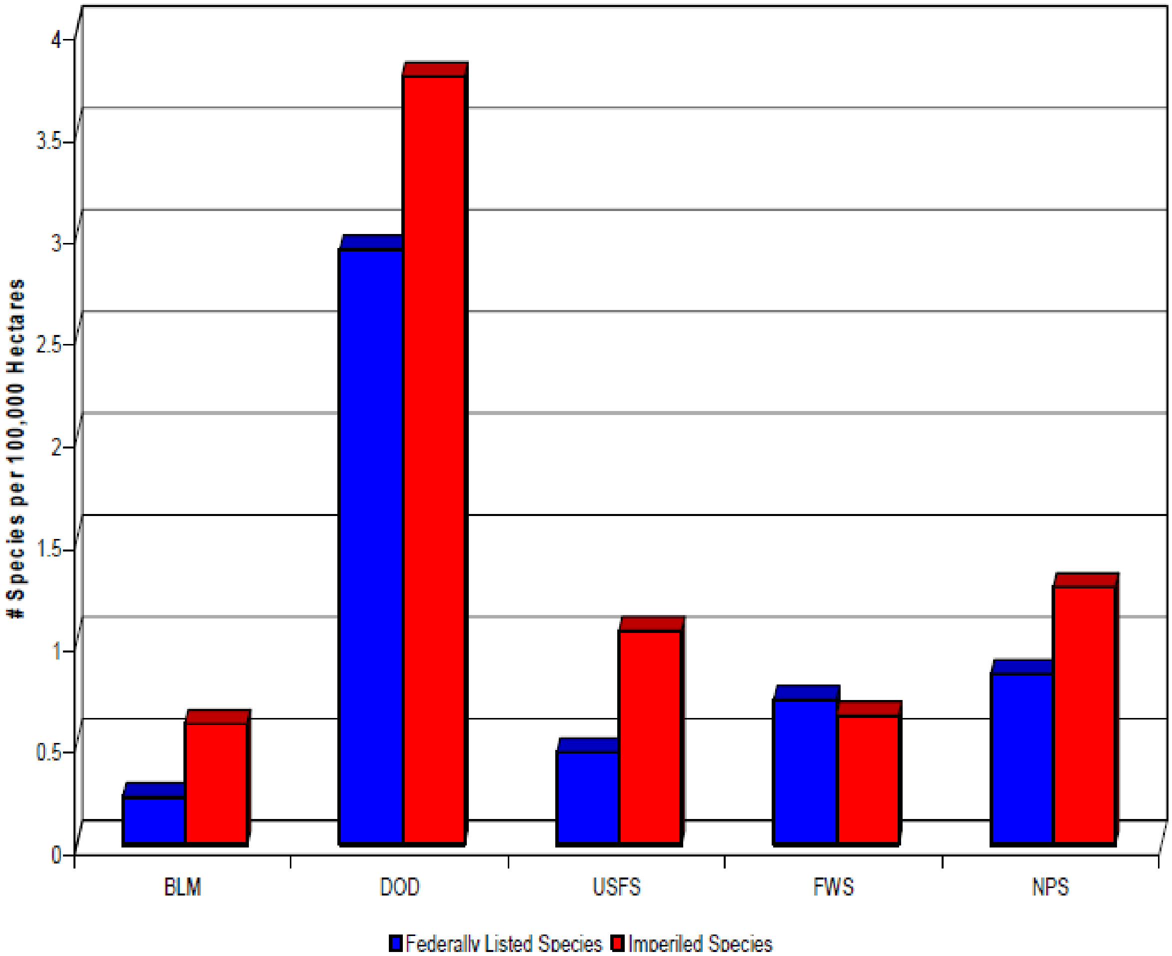
## 4.8.1 Existing Conditions

Existing biological resources on Army installations are representative of biological resources across the U.S. As with any private or public land-holding organization with numerous facilities and properties located throughout the country, Army installations occupy a number of different ecoregions; therefore, factors affecting probable responses to disturbance varies. Species of birds, mammals, reptiles, amphibians, fish, and microorganisms – and their supporting habitat – present on Army installations may vary considerably from installation to installation. Some species are protected under a conservation law such as the ESA. Some wildlife species have a year-round presence on the installation whereas others are present only temporarily (e.g., migration route or nesting). Installations have planning level surveys for many of the biological resources on their installation, with more detailed surveys completed as needed for particular species or sites.

Access limitations, due to security and safety concerns, shelter many military lands from off-post development pressures and large-scale habitat loss. As a result, some of the finest remaining examples of rare wildlife habitats are found on military installations (DoD, 2013a) and, as depicted in Figure 12, the density of protected species is much higher on military installations than other federal lands. As of February 2016, Army installations collectively had 223 federally-listed species protected by the ESA on 118 installations and 13 candidate species that, if listed, may impact the military's mission on 20 installations (DA, 2016a). Installation INRMPs guide the management of biological resources on each appropriate Army installation, to include these ESA-protected species and habitat. As a general matter, INRMPs prepared under the Sikes Act avoid the designation of critical habitat under ESA due to the INRMP providing species-specific conservation measures; however, there are a few Army installations with designated critical habitat. Each installation's INRMP takes into account, for example, that installation's specific requirements for species protection and the installation's military mission.

Management of biological resources on Army installations is also affected by off-post activities. DoD is authorized under 10 U.S.C. § 2684a to form agreements with non-federal governments or private organizations to limit encroachments and other constraints on military training, testing, and operations by establishing buffers around installations. The Army implements this authority

**Figure 12:** Density of Endangered and Imperiled Species on Federal Agency Lands (NatureServe, 2008)




BLM – Bureau of Land Management; DOD – Department of Defense; USFS – U.S. Forest Service; FWS – U.S. Fish and Wildlife Services; NPS – National Park Service

through the ACUB program. Under ACUB, the Army reaches out to partners to identify mutual objectives of land conservation and to prevent development of critical open areas. These partnerships preserve high-value habitat and limit incompatible development in the vicinity of military installations. As of February 2016, 36 Army installations had ACUB partnerships which collectively protected over 307,179 acres (124,311 hectares) of habitat (DA, 2016a). Though the Proposed Action for this PEA does not include consideration of off-post land for solar PV arrays, understanding an installation's benefits from land placed in the ACUB program enables analysis of potential affects to and or consideration of mitigations for biological resources for on-post projects.

## 4.8.2 Environmental Consequences

Multiple factors are considered when determining whether an alternative would likely have a significant effect on biological resources. These factors are evaluated by the degree to which the effect would impair the ability of the Army to sustain effective training and testing areas; result in loss of habitat or adverse effects to threatened or endangered species or species at risk; and conflict with existing federal, state, or local statutes or regulations.

In general, the ROI for biological resources encompasses the habitat or ecosystem in which the solar PV project is proposed to be located and, for migratory birds, the habitat supporting the species presence on the installation (e.g., breeding grounds, wintering areas, migratory routes, total range).

A significant impact to biological resources would occur if the Proposed Action resulted in unauthorized “take” of a protected species (e.g., under ESA, MBTA, BGEPA, MMPA); local extirpation (wiping out) of rare or sensitive species not currently listed under the ESA; a long-term loss or degradation of diversity within unique or high-quality plant communities; unacceptable loss of suitable habitat for protected species as determined by the USFWS; noncompliance with policies, regulations, and permits related to wetlands conservation and protection; and high probability of increasing the frequency and intensity of wildfires, especially in sensitive ecological areas.

#### 4.8.2.1 No Action Alternative

Implementing the No Action Alternative would result in a negligible, adverse impact on biological because of the continued impact from fossil fuel derived air pollutants and GHGs. This negligible, adverse impact assumes another renewable energy technology is not used in place of solar PV and the net change in energy use does result in a decrease of fossil fuel derived energy use. Consequently, impacts to biological resources as a result of the No Action Alternative are anticipated to range from none to negligible.

#### 4.8.2.2 Alternative 1: Greenfield Site

Development of solar PV projects on greenfields is anticipated to result in impacts to biological resources. Construction of the solar PV system on a greenfield would involve ground-disturbing activities, including vegetation removal, grubbing, and grading necessary to establish a level surface for the placement of the solar PV arrays. Ground-disturbing activities would also be entailed in the construction of security fencing, equipment shelter(s), access road(s), and, if needed, ancillary power control systems, transmission and distribution lines, and sub or switching stations. Ground-disturbing activities have the potential to affect vegetative resources by reducing the extent of plant cover, compacting soils, and causing erosion or sedimentation that degrade the ability of land to support vegetation. Ground-disturbing activities increase the potential for establishment of noxious, invasive, or pest plants. Construction vehicles and the transport of solar PV system equipment provide the potential to bring in noxious, invasive or pest pioneer species (with pioneer species defined as the first vegetative species which get established in disturbed soils). Minimizing the probability of noxious, invasive, or pest pioneer species can be assisted by ensuring construction vehicles and equipment do not introduce or spread propagules (e.g., seeds and spores) from these types of non-native species. Additionally, managed re-vegetation can support a native plant community that can reduce or compete with non-natives. Locally-present wildlife species could be impacted by loss or disturbance of habitat (including breeding areas and migratory stop-over locations), habitat fragmentation (which in turn could affect movement and migration), loss of food and prey species, introduction of new species, and changes in water availability. The potential for wildland fires during construction exists if site conditions are vegetated and dry (e.g., a combination of dry conditions and the use of heavy machinery in tall grass areas may ignite localized grass fires). An installation's designated Wildland Fire Manager determines wildland fire risk level based on data and models. When wildland fire risks are high, construction operators should take measures to minimize the potential for wildland fire. These measures include working fire extinguishers readily accessible on site, construction vehicles and equipment maintained in good working condition to prevent sparks, appropriate vehicles and equipment outfitted with a working spark arrestor (USFS, 2016), and no parking of any vehicles on dry vegetation. Additionally, construction operators should be prepared, in coordination with the appropriate fire-fighting organization, to respond rapidly to wildland fire risks that could result from dry vegetation ignited by hot components of vehicles and equipment, such as exhaust pipes. During operation and maintenance activities for the solar PV system, biological resources could be impacted from run-off related to module washing and from maintenance vehicles that come on-site to maintain the array field and associated infrastructure, to include transmission lines. Run-off could potentially cause erosion or sedimentation that degrade the ability of land to support vegetation. Maintenance and repair activities for various components of the solar PV system may require limited off-road travel of maintenance vehicles, potentially causing soil compaction and/or erosion.

Careful site selection is one factor which would minimize impacts to biological resources by avoiding sensitive or important biological areas. Geospatial data (e.g., GIS data) and installation planning level surveys should be used to identify biological resources essential to maintaining installation compliance with applicable laws, regulations, and EOs and meeting appropriate Army stewardship responsibilities. Ideally, sites selected for the array field would have no sensitive or important biological areas. The exact resources to be avoided varies from installation to installation, but may include suitable habitat for threatened or endangered species, special habitat management units, sensitive species areas, wetland areas, special natural areas, rare plant sites, and important breeding, roosting or foraging areas. Examples of items that should be identified to help inform the site selection process are biological surveys, set-back requirements, buffer distances, nesting grounds of migratory birds, nest locations of bald and golden eagles, any additional ESA-related mitigation requirements (e.g., translocation; or acquisition and protection of compensatory habitat), and state-listed species. Biological surveys typically address protected species. Set-back requirements may exist for sensitive habitats, to include habitats of protected species regulated by USFWS and NMFS, with set-backs specified in an installation's INRMP or in an applicable Biological Opinion issued under ESA. Buffer distances are typically established through consultation with the regulatory agency to avoid an 'incidental take' by disturbance or harassment of protected species, such as those protected under ESA, MMPA, and BGEPA. Under the Army's ACUB program, buffer zones can also be established in the public or private lands surrounding an installation to provide additional habitat for threatened and endangered species. Site selection factors may also take into consideration other installation activities and priorities, such as timber harvesting plans, to help minimize impacts to biological resources resulting from solar PV project development. For solar PV projects which include the construction of new transmission lines, lines would be placed along existing road disturbance limits and within existing utilities easements, to the greatest extent possible, to minimize impacts to biological resources.

Similarly, careful site design would minimize anticipated impacts to biological resources during construction, operation, and maintenance of a solar PV system. Site design factors include minimizing land disturbance, controlling soil erosion, controlling surface water runoff, minimizing a lake-like appearance of a solar array field for migratory birds, and identifying set-back requirements and buffers for sensitive biological resources. Despite the uncertainty in the population-level impacts on birds from the operation of utility-scale solar PV facilities (e.g., direct fatality as a result of collision with the facility), the level of significance is far below bird mortality caused by fossil fuels, vehicle collisions, and building collisions (Walston, et.al., 2016). Though lake-effect-related mortalities are not known to be significant (USFWS, 2014), using arrays with lower reflectivity providing discontinuous module layouts, and providing structural elements or markings to break up the reflection can result in migratory birds being less likely to approach the array field as if it were a lake. Such design modifications would reduce potential bird strike injuries or deaths. Avoiding structures that promote nesting (such as lattice-type structures), incorporating wildlife deterrents into the project design, and minimizing lighting and water that can attract insects will minimize attraction to the site by birds and bats. All light posts and permanent nighttime lighting installed to support operations would be selected to provide the lowest illumination possible while still allowing for safe operations. To prevent disturbance to potential sensitive natural resources, lighting would be set at the lowest height possible and would be shielded so that it would be directed only toward areas needing illumination.

During construction of a solar PV system, placing limitations, when appropriate, as to when select construction activities may occur would help ensure that anticipated impacts to biological resources would be moderate / less than significant. Such limitations could, for example, avoid harm to protected species during their nesting and minimize impacts to vegetation due to seasonal conditions (e.g., construction equipment in very wet or windy conditions could cause greater impacts to vegetation). For some greenfields, pre-construction surveys will be important to minimize impacts to biological resources. The timing of pre-construction surveys may depend on the resources. In general, within 30 days of site construction, the site may be surveyed by a qualified biologist to identify nests, burrows, and other wildlife shelters of concern and determine the most appropriate action to comply with species protection requirements.

Impacts from the construction of a solar PV system and ancillary power control systems to biological resources are anticipated to be moderate / less than significant through the implementation of environmental protection measures, to include avoidance, BMPs, and SOPs. BMPs and SOPs that would minimize anticipated impacts include those to control sedimentation and surface water runoff, minimize soil compaction issues; minimize air pollution; avoid accidental spills of hazardous material (e.g., fuel spills from vehicles and equipment); avoid transportation of noxious, invasive and pest species; and avoid inadvertent wildland fires sparked by construction activities. When the Proposed Action includes the construction of above-ground transmission lines, lines would be constructed in accordance with avian protection guidelines, as described in *Suggested Practices for Avian Protection On Power Lines: The State of the Art in 2006* (APLIC, 2006) to reduce bird electrocution risks, and in *Reducing Avian Collisions with Power Lines: The State of the Art in 2012* (APLIC, 2012) to reduce bird collision risks. The construction contractor will be responsible for properly maintaining construction vehicles and equipment and implementing all legally-required BMPs and SOPs (e.g., as a result of regulation, contract, legally-binding agreement, etc.) so as to help minimize or avoid impact to biological resources. Minor, short-term effects on wildlife that use the site are anticipated as they may be deterred by the construction activities, vehicles, and equipment. Minor, long-term effects on some wildlife would be anticipated due to displacement. The number of species displaced would vary, dependent in part on the degree of difference between pre-development habitat (e.g., open field, forested area) and post-development habitat (e.g., open area for the array field with habitat underneath ground-mounted solar modules that may be used for cover or protection by various small mammals or birds). Additionally, removal of vegetation and the installation of perimeter fencing are anticipated to have long-term, but moderate / less than significant impacts, on wildlife using the site. During construction activities, it is expected that some vegetation cover would be lost due to vehicles carrying supplies, movement of workers, and general activity on the site. The amount of temporarily disturbed area would depend on the size and configuration of the solar PV system designed, and would not likely cause site-wide disturbance to vegetation. When grading requires removal of top soil, top soil would be replaced after grading and subsequently re-vegetated. As Army installations are in numerous ecosystems and climates, appropriate vegetation cover, and its diversity, would vary per site and should not require watering once initially established. Preference for native plants and the wildlife species they support should be considered when selecting vegetation on solar PV project sites. Plant selection decisions at the site-specific level should take into consideration natural resources management priorities related to specific wildlife species, to include whether the site is to be used to encourage or discourage the presence of select species.

Operation and maintenance of solar PV projects on greenfields is anticipated to result in impacts to biological resources. Impacts to habitats and the wildlife they support may occur as a result of system maintenance activities or natural processes. As discussed in Sections 4.6 (Geological and Soil Resources) and 4.7 (Water Resources), the solar PV system, to include the array site, ancillary power control systems, and associated transmission corridors, would be checked by the systems operator for soil erosion resulting from system maintenance or natural processes and remedied as appropriate. This activity would simultaneously minimize long-term adverse impacts to habitat. Vegetation and/or gravel cover would be maintained under and around the solar array systems. A beneficial effect of a vegetation cover underneath ground-mounted solar modules would be to provide cover or protection for various small mammals or birds. Maintenance of a vegetative and/or gravel cover would reduce any run-off or soil erosion related to module washing and precipitation events, which could, in turn, impact habitat. Maintenance activities to control insects, other pests, noxious weeds, and invasive plants would be implemented in adherence to the installation's IPMP and INRMP and may include the use of pesticides and herbicides. With adherence to installation management plans, impacts are anticipated to be negligible. Maintenance activities related to periodic mowing has the potential to result in accidental fatalities to small wildlife, though impacts would be avoided to the extent practicable. As appropriate, seasonal restrictions to mowing may be required at selected sites to reduce potential impacts to ground nesting migratory bird species. Impacts as a result of mowing, however, are anticipated to be minor. When wildland fire risks are high, measures to minimize the potential for wildland fire during operation and maintenance would be similar to that related to construction activities, as described above, to include not parking any maintenance vehicle on dry vegetation. Through the implementation of environmental protection measures, potential impacts to biological resources from operations and maintenance activities are anticipated to be moderate / less than significant.

The Army will use a natural resource planning process and the INRMPs to consider potential sites for the construction of a solar PV system on Army installations, and the installation's Natural Resources Manager would assist in guiding construction, operation, and maintenance decisions.

Programmatically, impacts to biological resources as a result of implementing this alternative are anticipated to range from minor to moderate / less than significant. Impacts would be reduced through the implementation of environmental protection measures – to include avoidance, BMPs, and SOPs – as summarized in Section 6, Table 2. Minor impacts would be anticipated when the solar PV system site does not impact any sensitive or protected biological resources. Up to moderate / less than significant impacts may be anticipated if sensitive or protected biological resources are present on or near the site, whether annually or temporarily (e.g., migratory birds), even though mitigation measures to avoid and minimize impacts would be applied. Short-term impacts are anticipated as a result of construction activities. Long-term impacts are anticipated as a result of minor loss of habitat from increases to impervious surfaces (e.g., from equipment shelter, access road, and sub-station) and changes to habitat as a result of the array field construction.

Site-specific analysis, if needed based upon the application of the checklist at Appendix A, should assess the occurrence of resources of concern and their vulnerability. Input from state and local agencies or nongovernmental organizations (e.g., National Audubon Society) would be sought as part of the site-specific analysis. Additionally, any required informal or formal consultation under ESA, MBTA, BGEPA, and other applicable species-related laws and regulations would be required to be completed prior to implementing the Proposed Action.

#### 4.8.2.3 Alternative 2: Previously Developed Site

Impacts to biological resources as a result of construction of a solar PV system on a previously developed site are anticipated to be similar to those of Alternative 1, though previous use and development of the site increases the probability that the site may contain contaminants that, if disturbed, may impact biological resources. This is not to state, however, that a previously developed site is contaminated; only that the history of the site should be investigated to inform decision-makers and design parameters. Additionally, potential impacts to biological resources resulting from vegetation removal on a previously developed site are anticipated to be less than those on a greenfield site due to the fact that the site had previously been disturbed and may therefore have less established habitat or may have a relatively high percentage of non-native vegetation. As with Alternative 1, potential impacts are anticipated to be mitigated through site selection, site design, timing of construction activities, and implementation of BMPs and SOPs; therefore, impacts to biological resources as a result of Alternative 2 construction activities are anticipated to be negligible to moderate / less than significant.

If construction of a solar PV array and ancillary power control systems is on a former landfill site, the array field design would need to ensure the integrity of landfill liners is maintained during construction to continue to protect groundwater resources, as well as any Federally-protected species that depend on the affected aquifer.

For projects on an IRP site, construction, operation, and maintenance of a solar PV array system must be compatible with long-term management requirements and laws and regulations governing the site.

Programmatically, potential biological resources impacts from operations and maintenance of a solar PV system on a previously developed site are anticipated to be negligible to moderate / less than significant. As with Alternative 1, installations would use the checklist attached in Appendix A of this PEA to determine whether the use of CXs and reliance on existing NEPA documents as described in this PEA are appropriate, or whether additional NEPA analysis is needed. Additionally, any required informal or formal consultation under ESA, MBTA, BGEPA, and other applicable species-related laws and regulations would be required to be completed prior to implementing the Proposed Action.

#### 4.8.2.4 Alternative 3: Roof

Construction of solar PV arrays on or over existing structures or impervious surfaces would not require any vegetation or land clearing, and would not result in direct impacts to terrestrial or aquatic wildlife or habitat. Roof structures are normally not designed for or intended to be used by birds for nesting. If migratory bird species are nesting, construction activity would not commence until the birds have fledged. Similar to a greenfield site, appropriate wildlife deterrents should be incorporated into the rooftop solar PV system design. For example, the system should be designed to avoid structures that promote nesting (such as lattice-type structures) to minimize attraction to the roof by birds. For sites directly adjacent to the habitat of protected species, indirect impacts could be similar to the impacts identified in Alternative 1 regarding areas adjacent to the project site. Implementation of appropriate BMPs could be implemented during construction to keep impacts to negligible or minor.

Impacts to biological resources are not anticipated from operations and maintenance of roof-mounted solar PV arrays; however, if migratory birds attempt to nest in the array structure, negligible impacts may occur as a result of further measures to discourage nesting.

For solar PV projects which include construction of transmission lines, substations, and/or ancillary power control systems, impacts to biological resources could occur during construction, operation, and maintenance, similar to those described under Alternative 1.

Impacts to biological resources are anticipated to be negligible to minor for Alternative 3.

As with Alternatives 1 and 2, any required informal or formal consultation under ESA, MBTA, BGEPA, and other applicable species-related laws and regulations would be required to be completed prior to implementing the Proposed Action.

## 4.9 CULTURAL RESOURCES

Cultural resources is a broad term addressing all aspects of human activities, including material remains of the past and the beliefs, traditions, rituals, and cultures of the present. Although cemeteries are not necessarily cultural resources as defined by the National Historic Preservation Act (NHPA; 54 U.S.C. § 300101 *et seq.*), for the purposes of this PEA, cemeteries will be included in the Cultural Resources section. As mandated by law, all federal installations and personnel must participate in the preservation and stewardship needs of archaeological and cultural resources and must consider potential impacts to these resources prior to any installation undertaking.

Cultural resources can be present within landscapes as districts, sites, buildings, structures, or objects. Cultural resources include historic properties as defined by NHPA; cultural items as defined by the Native American Graves Protection and Repatriation Act (NAGPRA; 25 U.S.C. § 3001 *et seq.*); archeological resources as defined by the Archaeological Resources Protection Act (ARPA; 16 U.S.C. §§ 470aa-470mm); sacred sites as defined in EO 13007, *Indian Sacred Sites*, to which access is provided under the American Indian Religious Freedom Act (AIRFA; 42 U.S.C. § 1996); and collections as defined in 36 C.F.R. Part 79, *Curation of Federally Owned and Administrated Archaeological Collections*. Cultural resources can include locations with enduring significance to the beliefs, customs, and/or practices of living communities. The term "historic property" is defined in the NHPA as: "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register [of Historic Places (NRHP)]". This includes artifacts, records, and remains which are related to historic districts, sites, buildings, structures or objects. Buildings and structures over 50 years of age require an Army evaluation of the property to determine eligibility for NRHP listing prior to implementing any action that may affect such resources. Occasionally, properties less than 50 years old may be of such exceptional significance that they are eligible for listing on the NRHP. Culturally-sensitive sites that pertain to the distinct values, beliefs, and ways of living for one or more Tribes, if not considered eligible for nomination to the NRHP, may still be protected by other cultural resources protection laws and EOs, such as AIRFA and EO 13007. Historic properties can include both prehistoric and historic objects, sites, buildings, structures, and districts, as well as traditional cultural properties. A traditional cultural property is eligible for inclusion in the NRHP based on its association with cultural practices or beliefs of a living community (NPS, 1998). Traditional cultural properties are rooted in that community's history and are important in maintaining the continuing cultural identity of the community (NPS, 1998). Installation ICRMPs and early coordination with the installation's cultural resources manager would guide the identification of the cultural resources ROI for site-specific projects. The

Proposed Action's ROI affected environment for cultural resources includes all historic properties within a NHPA-defined area of potential effect.

Per NHPA regulations promulgated by the Advisory Council on Historic Preservation (ACHP), the Army is required to take into account the effects of its undertakings on historic properties. The process requires the Army to consult with the State Historic Preservation Officer (SHPO) and/or applicable federally-recognized Native American Tribe(s), Alaska Native Tribe(s), and Native Hawaiian Organization(s) [collectively referred to as "Tribes" herein]. This consultation process includes seeking and considering the views of the public. To facilitate the identification of historic properties, consulting parties are identified through coordination with the SHPO and Tribes, and are those individuals or agencies that have a vested interest in historic resources within the area of potential effect. Consulting parties typically consist of the SHPO, Tribes, Historic Landmarks Foundation, local historic preservation commissions, county historians and local historical societies, local government, and any other historical group. The Army, in consultation with the SHPO and Tribes, is required to make an assessment of direct and indirect effects on the historic properties and to resolve any adverse effects that may occur from an Army undertaking. NHPA Section 106 consultation requirements are detailed in 36 C.F.R. Part 800. Early coordination with the installation's cultural resources manager would also guide the appropriate cultural resources consultation process.

The Army is authorized to use the Army Alternate Procedures, a streamlined procedure Army installations can elect to follow to satisfy NHPA consultation requirements. The Army Alternate Procedures approaches the installation's management of historic properties programmatically, instead of on a project-by-project review basis. It allows installations whose Historic Properties Component plans have been certified by ACHP to operate under SOPs that were developed in consultation with their stakeholders. A few Army installations have received their ACHP certifications and use the Army Alternate Procedures.

AR 200-1 requires Army installations to maintain an ICRMP that serves as a guide for compliance with the NHPA and other applicable federal laws and regulations, including identification and preservation of cultural resources and historic properties (DA, 2007).

Cemeteries are not necessarily cultural resources, as defined by NHPA; however, for the purposes of this PEA, cemeteries are included in this Cultural Resources section.

### 4.9.1 Existing Conditions

Existing cultural resources on Army installations are representative of cultural resources across the U.S. Installation location and size heavily influences the extent and scope of the historic properties, cultural items (as defined by Section 2 of NAGPRA), archaeological resources, sacred sites, culturally-sensitive sites, and cemeteries present on an installation. Location is also a factor affecting the identification of stakeholders, such as Tribes, who may be interested in potential effects of a proposed solar array project on installation lands. As of February 2016, Army installations collectively had the following known cultural resources:

- 58,887 buildings or structures over 50 years old and subject to NHPA (DA, 2016a); approximately 12,000 of those buildings/structures are officially designated as historic properties (AEC, 2016a);
- 21 National Historic Landmarks (AEC, 2016a);
- 82,605 recorded archeological sites on Army lands (DA, 2016a);
- 81 Native American Sacred Sites on 16 installations (DA, 2015a).

Installation-specific ICRMPs are the framework for managing and protecting these cultural resources. Consultation requirements for an undertaking are directed by the appropriate cultural resources regulation or by an agreement (e.g., an Army Alternative Procedure, Memorandum of Agreement [MOA], or Programmatic Agreement) between the Army and appropriate consulting parties.

### 4.9.2 Environmental Consequences

In general, the ROI for cultural resources encompasses the proposed solar PV project site and adjoining areas, as well as viewsheds protected under a cultural resources law or regulation which are potentially affected by the alternatives. All historic properties within an area of potential effect as defined by NHPA constitute the affected environment and ROI for cultural resources for the purposes of NEPA.

Effects to cultural resources can be direct, indirect, or cumulative. For historic properties listed or eligible for listing on the NRHP, analysis of potential impacts must also consider whether there may be adverse effects to the integrity of the historic property or those characteristics that make a property NRHP-eligible. Direct effects under NHPA include physical modification to all types of historic properties, in addition to visual effects to the physical setting of historic districts, buildings, structures, cultural properties, and objects where physical setting is an important aspect of their integrity. Indirect effects under NHPA are those that change the accessibility, use, or economic viability of the historic property. Physical effects include the partial or complete demolition or destruction of the historic property. Visual effects to historic properties occur when the setting of the property is affected by the Proposed Action to the extent that the property's ability to convey its historical importance is impaired. Effects to accessibility can occur when access to historic properties is either enhanced or restricted. Enhanced access can lead to a greater degree of direct effect to the historic property by creating more opportunities for destruction (e.g., looting of archaeological sites or vandalism of historic buildings and structures). Similar definitions of direct and indirect effects can be applied to cultural resources not considered to be historic properties as defined by NHPA.

Restricting access to cultural resources can indirectly affect the communities to which they are important for their cultural identity (e.g., limiting access by Tribal communities to traditional cultural properties, limiting access by local communities to churches or other historic buildings important to their identity). Restrictions on access can indirectly affect the use and economic viability of cultural resources that can lead to their destruction or demolition.

Under NHPA, the primary criterion for determining the significance of the potential effects from the proposed action starts with whether or not there are adverse effects on eligible historic properties. If a historic property would not be affected by a proposed action, it is determined to have no effect. Effects to historic properties that do not affect those aspects of integrity that cause a historic property to be listed in, or considered eligible for listing in, the NRHP are said to have no adverse effects. Adverse effects occur when a proposed action has a negative effect on those qualities (characteristics) that make a property eligible for listing on the NRHP. They include physical destruction or damage to all or part of the property; removal from its historic location; change in the contributing features of setting that contribute to its historic significance; and introduction of visual, atmospheric, or noise elements that diminish integrity. If the proposed action causes a change in the setting of a historic property, adverse visual effects could potentially occur to historic properties where setting has been specifically identified as an important aspect of the property's integrity. The physical environmental setting of a historic property is an important aspect in determining the significance of the property and can be important for a National Register Historic District or a National Historic Landmark. Physical environmental features that contribute to the setting can include topographic features, vegetation, simple manmade features (paths or fences) and relationships between buildings and other features or open space (NPS, 2015).

A significant impact to cultural resources would occur if the Proposed Action resulted in NHPA-defined adverse effects to a historic property listed or eligible for listing in the NRHP, unless mitigated through a MOA with the SHPO, and possibly with the ACHP, to resolve adverse effects. A significant impact to cultural resources would occur if the Proposed Action created conditions that would stop the traditional use of sacred or ceremonial sites or resources, without discussions on a government-to-government level with the affected Tribe(s). A significant impact to cultural resources would occur if the Proposed Action resulted in a violation of compliance with NAGPRA.

Informal or formal consultation with the SHPO, ACHP, Tribes, and other interested parties would be pursued by Army installations, as appropriate and per requirements, during site-specific NEPA analysis and site specific NHPA Section 106 reviews for solar PV projects.

#### 4.9.2.1 No Action Alternative

There would be no impacts to cultural resources on an installation as a result of the No Action Alternative because there would be no construction activities.

#### 4.9.2.2 Alternative 1: Greenfield Site

Construction, operation, and maintenance of a solar PV project and ancillary power control systems has the potential to affect cultural resources depending on the proposed project location and the cultural resources located at the project location. Proposed site selection options will take cultural resources data into consideration, to include Army GIS data, when considering siting specific installation projects. Construction, operation, and maintenance of solar PV arrays on greenfields containing cultural resources may adversely impact the resources. Similarly, a solar PV system constructed near historic properties, historic districts, National Historic Landmarks, or sacred sites may also impact the viewshed of the affected cultural resources. Avoidance of cultural resources is the preferred action for construction of a solar PV system. In cases where site location has the potential to impact cultural resources or affect the traditional use of sacred or ceremonial sites or resources, careful site design in close consultation with the SHPO and/or Tribe(s) may minimize adverse effects. If an installation's proposed solar PV project has the potential to result in an adverse effect to a historic property or other cultural resource, the NHPA requires a MOA with the SHPO, and possibly with the ACHP. The MOA would document agreed-upon measures to resolve adverse effects to minimize the impact to a level below significant. For projects including the construction of a transmission line, burial of the transmission line may be a mitigation measure to avoid substantial viewshed impacts; however, archaeological resources that may be buried should be considered prior to the construction of the transmission line.

For projects constructed near a cemetery, site design should ensure that substantive direct impacts to the cemetery are avoided and the cemetery should be designated off-limits to project construction and maintenance workers. For cemeteries immediately adjacent to the proposed solar PV project, an appropriate buffer around the cemetery should be established prior to project construction. Additionally, to avoid impact, pre-construction access to the cemetery for visitation and maintenance should be maintained during the construction period and after the solar PV system is operational.

Construction activities have the potential to introduce temporary visual and audible impacts to cultural resources located within or in proximity to the proposed solar PV project site. A 10 MW project would require approximately 5 to 10 months for construction, with variables including weather and site conditions, and larger projects would require proportionally longer construction time. It's anticipated these impacts would be minor in severity due to their temporary nature.

Construction of the solar PV system on a greenfield would also involve ground-disturbing activities which could result in long-term adverse impacts to cultural resources, such as archaeological resources, if present. These impacts, however, are generally mitigated through a MOA with the SHPO, and possibly with the ACHP, to resolve adverse effects. In addition to conducting applicable consultations, careful site selection (including conducting pre-disturbance cultural resource field surveys), design, and construction practices that minimizes land disturbance and controls surface water runoff will help avoid significant impacts to surface and subsurface cultural resources. Proposed projects requiring ground disturbance in areas that have not yet been surveyed for cultural resources would require surveys prior to construction. The NHPA Section 106 process would be completed prior to construction activities.

As with any construction project, there remains a potential for post-review or inadvertent discoveries. Installations may require the presence of an archaeologist to monitor for sensitive cultural resources during ground-disturbing activities that may occur in known culturally sensitive locations. During construction, if any human remains or cultural resources are found, construction work would stop, the cultural resource manager will be notified, and the applicable legal and regulatory requirements governing such a finding would be followed.

Programmatically, impacts to cultural resources as a result of implementing this alternative are anticipated to range from negligible to moderate / less than significant. Negligible impacts would be anticipated when the solar PV system site does not contain significant cultural resources and is not a culturally-sensitive location. Impacts up to moderate / less than significant may occur if cultural resources are present on or near the site, even though mitigation measures to avoid and minimize impacts would be applied. Cultural resources are non-renewable resources and, as such, negative impacts to the resource can rarely be eliminated through mitigation, which is why careful siting and avoidance are the preferred measures.

As discussed in Section 1.4, in considering the implementation of a proposed solar PV project on a greenfield, installations would use the checklist attached in Appendix A of this PEA to determine whether the use of CXs and reliance on existing NEPA documents as described in this PEA are appropriate, or whether additional NEPA analysis is needed. If the installation concludes that additional NEPA analysis for cultural resources is necessary, it is required to be prepared before any irreversible and irretrievable commitments of resources occurs as a result of the Proposed Action. If successful impact minimization efforts are unlikely to bring the severity of adverse impacts to moderate / less than significant levels and the Army continues to be interested in pursuing the potential project resulting in such a determination, the level of additional NEPA analysis required may be an environmental impact statement. Regardless of the need for additional NEPA analysis, potential affects to cultural resources must be addressed through the NHPA Section 106 consultation process prior to implementing the Proposed Action.

#### 4.9.2.3 Alternative 2: Previously Developed Site

Alternative 2 is similar to Alternative 1 although construction of solar PV projects and ancillary power control systems on previously developed sites could generally have fewer effects to cultural resources as construction would be on previously disturbed land. Previously disturbed land increases the chances that cultural resources might already have been impacted, thereby losing integrity. However, cumulative impacts to sites retaining any significance would still require consultation under the NHPA Section 106 process. Known location of cultural resources would be taken into consideration during the review of alternative solar PV sites at installations, with avoidance being the preferred method. Programmatically, impacts to cultural resources as a result of implementing this alternative are anticipated to range from negligible to moderate / less than significant. Adverse impacts to NRHP-listed or eligible historic properties may occur after concluding the NHPA Section 106 consultation process and memorializing mitigation in an MOA with SHPO, and possibly with the ACHP.

As with solar PV and ancillary power control system projects proposed on a greenfield, installations would need to use the checklist contained in Appendix A and discussed in Section 1.4 of this PEA to determine if further NEPA analysis of potential cultural resources impacts may be required for their specific Proposed Action for this Alternative. Similarly, NHPA Section 106 consultation requirements for the undertaking would also be required to be completed prior to implementing the Proposed Action.

### 4.9.2.4 Alternative 3: Roof

Construction activities on or over existing structures or impervious surfaces have the potential to introduce temporary visual and audible impacts to one or more historic properties and culturally-sensitive sites, if the construction is on or in the viewshed of a historic property or in the viewshed of a culturally-sensitive site. For solar PV rooftop projects including construction of transmission lines or a substation, similar short-term impacts to cultural resources could occur during construction. Transmission lines that are buried have the potential to impact archaeological sites.

Construction, operation, and maintenance of roof-top solar PV arrays on or in the viewshed of historic buildings, on or in the viewshed of buildings or structures within a National Historic Landmark, or in the viewshed of a culturally-sensitive site has the potential for both direct and indirect, long-term adverse impacts. Similar impacts may also result if the solar PV array project includes construction of ancillary power control systems, transmission and distribution lines, and sub or switching stations. If the proposed project includes new ancillary power control systems, transmission and distribution lines, and sub or switching stations in areas not previously disturbed, impacts to archaeological resources may be similar to those described in the Greenfield Site and Previously Developed Site alternatives.

Careful site selection, site design, and implementation of BMPs could minimize impacts to moderate / less than significant. For example, buildings selected may be limited to those which will not affect historic properties. In another example, if historic properties are selected, rooftop arrays may be limited to those with high, flat roofs with parapets that would likely not introduce physical or visual elements that would significantly affect those qualities that make them contributing resources. Site design features may include selection of material and equipment that successfully blends with the fabric of the building or structure, or can be painted or disguised in such a way as to minimize the impact. Site design may also minimize impacts through the careful placement of the modules in less visible areas.

Programmatically, impacts to cultural resources as a result of implementing this alternative are anticipated to range from negligible to moderate / less than significant. Negligible impacts would be anticipated when the solar PV system site does not involve any cultural resources on or eligible for NRHP listing and is not in the viewshed of a culturally-sensitive site. Moderate / less than significant impacts may occur if the project involves NRHP-listed or -eligible cultural resources and/or affects the viewshed of a culturally-sensitive site. Adverse impacts to NRHP-listed or eligible historic properties may occur after concluding the NHPA Section 106 consultation process and memorializing mitigation in an MOA with SHPO, and possibly with the ACHP.

As with solar PV projects proposed on a greenfield or previously developed site, installations would need to use the checklist contained in Appendix A and discussed in Section 1.4 of this PEA to determine if further NEPA analysis of potential cultural resources impacts may be required for their specific Proposed Action.

Any cultural resources consultation requirements for the undertaking would also be required to be completed prior to implementing the Proposed Action.

## 4.10 SOCIOECONOMICS

Socioeconomics is defined as the basic attributes and resources associated with the human environment, particularly population and economic activity. Economic activity is typically affected by sales, income, employment, and population. Effects on these fundamental socioeconomic components can influence other issues such as housing availability and the provision of public services. The principal factors affecting socioeconomics at Army installations are construction project expenditures; population changes as a direct result of Army growth or reduction actions; salaries (Soldier, Civilian, and contractor); and procurement of goods and services locally and regionally by Soldiers, Civilians, and their Family members.

As the Army manages its natural resources, some of those resources may be placed under the Army's forestry, agricultural, or grazing programs. These programs, tied to socioeconomic indicators, are only permitted if compatible with the installation's INRMP (16 U.S.C. § 670a). Through the forestry program, revenues supporting installation natural resources management activities are generated by the sale of forest products, such as saw-timber, firewood, pulp wood, and pine straw. The agricultural and grazing out-lease program, executed in accordance with 10 U.S.C. § 2667, supports natural resources management and minimizes Army costs to maintain the land, roads, and fences associated with the program (e.g., a hay lease may be a viable alternative for contract mowing).

For the purposes of this PEA, recreational activities will be included in the Socioeconomic section. On Army installations, in addition to the normal recreational activities that take place in outdoor, urban environments (e.g., on ball fields, in playgrounds), hunting and fishing activities are often available in accordance with 16 U.S.C. § 670a(b). Hunting and fishing programs provide recreational opportunities for Soldiers, Family members, Civilians, and the general public in controlled environments, while supporting the installation's natural resource conservation and rehabilitation goals. Opportunities made available are done so within the constraints of the military mission, safety, and fish and wildlife resources needs.

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, requires federal agencies to assess the potential for disproportionate occurrence of effects of federal projects on minority and low-income populations. For the purposes of this analysis, those groups are defined as follows:

- **Minority Population:** Persons of Hispanic origin of any race, Blacks, American Indians, Eskimos, Aleuts, Asians, or Pacific Islanders.
- **Low-Income Population:** Persons living below the poverty level, according to income data collected in U.S. Census 2010.
- **Youth Population:** Children under the age of 18 years.

In addition, EO 13045, *Protection of Children From Environmental Health Risks and Safety Risks*, requires federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children. Such risks to health and safety are attributable to products or substances that a child would be likely to come in contact with or ingest.

Socioeconomic effects for any proposed site should be evaluated in terms of their locality, duration, intensity, and whether they would be beneficial or adverse. Construction effects would likely be local, short-term, negligible, and beneficial.

### 4.10.1 Existing Conditions

As of September 2015 (DA, 2015c), the Army had 156 installations across the U.S. and in other countries (not including forward operating bases used in contingency operations). The installations included over 175,000 permanent party barracks spaces and over 86,000 Family housing units (i.e., 11,113 Army-owned units, 4,530 leased units, and 86,531 privatized units). The installations supported a population of 491,365 active Army, 198,552 Army Reserve, and 350,023 Army National Guard military personnel; 246,702 Civilian employees; and 945,956 retired military personnel. More than 55 Army installations have forestry programs; 40, hunting and fishing programs; and 35, agricultural/grazing programs (AEC, 2016b). In fiscal year 2012, the forestry program generated $16 million in proceeds, of which $12.1 million was returned to installations to support program execution; hunting and fishing programs generated $1.8 million; and the agriculture and grazing outlease program revenues were approximately $3.5 million (AEC, 2016b). When located in more rural areas or near smaller communities, the Army installation may be the largest employer and contributor to the surrounding economy. In larger urban areas, the percent of contribution from the installation may be less but still substantial. In addition to direct socioeconomic impacts, Army installations can influence the type and availability of off-post housing, employment and educational opportunities, community services and related infrastructure, industrial operations, and commercial activities.

In the U.S., the solar industry has grown, adding workers at a rate nearly 12 times faster than the overall economy in 2015 and increasing 123 percent from 2010 to 2015 (TSF, 2016). In 2015, the U.S. solar industry employed almost 209,000 solar workers in all 50 states and installed over 7,430 MW of solar energy (TSF, 2016).

### 4.10.2 Environmental Consequences

Multiple factors are considered in determining the extent to whether the Proposed Action would affect the socioeconomic structure. These factors include the extent or degree to which its implementation would change the local housing market or vacancy rates, particularly when compared to the availability of affordable housing. These factors also include the extent or degree to which the Proposed Action would increase student enrollment beyond the capacity of the local schools; change any social, economic, physical, environmental, or health conditions so as to disproportionately affect low-income or minority populations; or disproportionately endanger children.

Impacts to socioeconomics would be considered significant if the proposed alternatives caused a substantial change to the sales volume, income, employment or population on the installation and in the communities and counties in the immediate area; substantial disproportionate adverse economic, social, or health impacts on minority or low-income populations; substantial disproportionate health or safety risks to children; long-term substantial loss or displacement of recreational opportunities and resources relative to the baseline; or a substantial increase in demand for public services (e.g., fire protection, police enforcement, education, etc.). The ROI for this resource area is within the boundaries of the installation and the immediate surrounding communities and counties.

#### 4.10.2.1 No Action Alternative

There would be no change to socioeconomics or environmental justice. Implementing the No Action Alternative would result in a negligible, short-term adverse impact on economics because no construction activity would be realized. Consequently, impacts to socioeconomics as a result of the No Action Alternative are anticipated to be negligible, short-term, and none, long-term.

#### 4.10.2.2 Alternatives 1, 2, and 3: Greenfield Site, Previously Developed Site, and Roof

Short-term, beneficial impacts on the economy would occur as a result of construction. A 10 MW project would require approximately 40 to 80 construction workers for 5 to 10 months. A larger project would require similar amounts of workers but would take longer to complete. Compared to the 10,000-plus full time permanent workers on most major Army installations, this short-term impact is minor.

On-site labor is required to support operation, routine maintenance, and various levels of non-routine maintenance. The operator of two collocated solar PV facilities in California reported that the combined 579 MW facility required 15 full-time, on-site workers, and up to 25 additional intermittent and/or part-time jobs on an annual basis (SunPower 2016). Despite the limited amount of publically-available, empirical cost data, Lawrence Berkeley National Laboratory (LBNL) prepared a study which included operations and maintenance cost data for utility-scale solar facilities, of which PV is one type (LBNL, 2016). LBNL observed that these costs vary by the size of the solar facility and that the average operations and maintenance costs for PV facilities were approximately $15 per kW per year or $7 per MWh (LBNL, 2016). These costs include only those incurred to directly operate and maintain the facility and do not include property taxes, insurance, land royalties, performance bonds, various administrative and overhead costs, or other fees. Scaling this employee and cost data by the capacity of the facility, it's estimated that one full-time, on-site operations and maintenance worker would be required for every 40 MW of installed solar PV capacity, with up to two workers required on a part-time and/or intermittent basis. Based on these estimates, anywhere from two to eight full-time, on-site workers would be required to operate a 100 MW PV facility; and, less than full-time support generally would be required for systems under 40 MW. Consequently, the long-term impact on the economy as a result of workforce growth is anticipated to be none to negligible and no substantial increase in demand for public services would be required.

While dramatic impacts to utility rates and local or regional plans for utility or power generating infrastructure upgrades are unlikely as a result of the Proposed Action, it is possible that a large solar PV project on Army land that is connected to the off-post power grid could indirectly impact the local or regional economy. For example, a large project could affect utility rates, influence a local power provider's decision(s) to seek other renewable or nonrenewable power sources, or otherwise impact other energy-related decisions by governmental or private parties regarding power generation. These impacts are speculative and difficult to anticipate or analyze programmatically; nevertheless, no significant economic impacts are anticipated as a result of the Proposed Action, large or small.

Solar PV projects and ancillary power control systems that are adjacent to or in the viewshed of off-post residential areas may reduce residential or other land use property values; however, a review of the literature found no research specifically aimed at quantifying impacts to property values based solely on proximity to utility-scale PV facilities (MDC, 2015). Consequently, the impact to the value of one particular off-post property based solely on its proximity to a PV facility on Army land is difficult to determine. Widespread negative impacts to off-post property values are not anticipated.

Siting of a proposed solar PV system would consider impacts to outdoor recreation (e.g., hiking paths and the hunting and fishing program), the forestry program, and the agricultural/grazing outlease program. Impacts to outdoor recreation activities may be affected under Alternatives 1 and 2 (the Greenfield Site and Previously Developed Site alternatives, respectively). They may also be affected under Alternative 3 as a result of short-term construction staging requirements or where infrastructure is a required component of the project. Impacts to conservation reimbursable activities (forestry and agricultural/grazing outleases) may be affected under Alternative 1, and, where the existing infrastructure is insufficient, under Alternatives 2 and 3. Removal of land from one of these programs for a solar PV project will entail trade-offs as the desired outcomes of and benefits from the current use would be an incompatible feature with those of the proposed use. Revenues lost as a result of removing land from a conservation reimbursable or fee collection program would be proportionately small, with short- and long-term negative impacts anticipated to range from none to negligible. Lessees, who have no long-term expectations for outleases due to the specification contained in 10 U.S.C. § 2667, would not be able to use the land for agriculture or grazing for the life-cycle of the solar PV project. Lost recreational opportunities would be a factor of the location and size of the solar PV system relative to the baseline of available opportunities. Recreational impacts should also consider the impacts of fencing on paths taken by current recreational users. Impacts may be minimized through site selection to avoid or reduce the area of the proposed project or the size of the system. Impacts to recreational activities as a result of Alternatives 1 and 2 are anticipated to range from none to moderate / less than significant, both short- and long-term. Impacts to recreational activities as a result of Alternative 3 are anticipated to range from none to negligible, both short- and long-term.

Siting of a proposed solar PV system would need to consider whether the site of the proposed project is disproportionally impacting low income or minority populations. If only one or two of all the residential areas bordering the installation are primarily occupied by low income and/or minority populations, and the site of the proposed project is adjacent or in close proximity to that low income / minority population area, identifying an alternate location or reducing the size of the proposed project would reduce adverse effects. In general, disproportionate adverse impacts to low income or minority populations as a result of construction, operation, and maintenance are anticipated to range from none to minor.

The impacts of this alternative are not projected to have disproportionate adverse impacts on children, because no aspect of the Proposed Action would be anticipated to increase the risks described in EO 13045. For Alternatives 1 and 2, if the project site is located within reasonable walking or bicycling distance of children (e.g., near Family housing areas, off-post residences, child development centers) with no existing security measures restricting access to the proposed site, a security fence and gate with 'no trespassing' signs would be erected to preclude children from having access to the site. For infrastructure and ancillary power control systems associated with all alternatives, adherence to standards (including fencing) will minimize safety risks, including risks to children, associated with electrical shocks. For all alternatives located within reasonable walking or bicycling distance of children, with no existing security measures restricting access to the proposed site, a security fence, with 'no trespassing' signs, would be erected for the same reason around construction staging areas to deter children from playing in these areas. Additionally, construction vehicles, equipment, and materials would be stored in fenced areas and secured when not in use. If the proposed project includes construction of ancillary power control systems, and a sub or switching station, a permanent security fence, with 'no trespassing' signs, would be erected around these assets.

## 4.11 TRANSPORTATION AND TRAFFIC

Transportation is the movement of people and goods from one location to another. It is accomplished by a variety of modes, such as road, rail, air, water, and in some cases pipeline, and there are different systems within those modes. Examples of principal transportation systems include vehicular systems (e.g., highways and streets); aviation system (e.g., commercial air carriers), waterway and maritime systems, and rail systems (e.g., railroads). Traffic is related to the congestion of the applicable system being able to handle traffic flow during peak volumes. Vehicular traffic is rated on level of service (LOS), a qualitative measure graded on a letter scale from A to F, with A being the highest LOS and F being the lowest. At LOS F, traffic flow is forced, the traffic volume has exceeded the capacity of the roadway to handle it, and there are no passing opportunities.

### 4.11.1 EXISTING CONDITIONS

Army installations are like small cities, with adjoining rural areas, and have highways and streets throughout. Roadways and traffic are concentrated in areas where there are buildings, such as in cantonment areas. Many Army installations have expansive training areas with limited roadways and traffic only in support of training exercises or, at some installations, testing exercises. Some Army installations support rail transportation and a number of installations have multi-use airfields and heliports. As of September 2015, Army installations collectively had

152,988 lane miles (246,210 lane kilometers) of paved and unpaved roads; 2,171 miles (3,494 kilometers) of railroads; 28,514 linear feet (8,691 linear meters) of bridges; 57 multi-use airfields; and 24 heliports (DA, 2015c). Transportation planning is part of the real property master planning efforts on installations.

At most installations, the Main Gate is the most heavily used vehicular access gate, with peak flows associated with the start and end of the average employee's work day. The number of additional access control points (ACPs) vary at installations and may include ACPs to support temporary construction traffic.

At most installations, roads serving the cantonment area are paved whereas roads serving the training and testing areas are mostly unpaved. The condition of unpaved roads vary, with erodibility factors primarily influenced by soil type and weather.

Military vehicles use a combination of public roads, installation roads, and military vehicle trails. Vehicle convoys using public roads typically are limited in size and have requirements governing the spacing between each vehicle in the convoy. Convoy procedures reduce noise levels and prevent the convoy vehicles from dominating local traffic flow for long periods of time.

Airfields and helipads on Army installations support training of military aircraft and their crew. Army aviation systems also support air transportation of Soldiers and equipment.

## 4.11.2 Environmental Consequences

Impacts to transportation and traffic would be considered significant if the Army actions cause a reduction by more than two LOSs at roads and intersections within the ROI. The ROI for this resource area is within the boundaries of the installation and on nearby, off-post public transportation networks (e.g., roadways).

### 4.11.2.1 No Action Alternative

There would be no change to transportation and traffic as a result of the No Action Alternative.

### 4.11.2.2 Alternative 1: Greenfield Site

There would be an increase in vehicle traffic associated with construction of the solar PV project, but no perceptible increase in vehicle traffic associated with the operation and maintenance of the solar PV system.

For a 10 MW project, approximately 90 trucks carrying material (e.g., solar modules, inverters, racking) and vehicles to transport 40 to 80 construction workers daily would be required. During equipment delivery, there may be 5 to 7 truck deliveries per week. Heavy equipment (e.g., forklifts, cranes) would generally remain on site during time periods requiring their use, rather than entering and exiting the installation on a daily basis. A 10 MW project would require approximately 5-10 months for construction, with variables including weather and site conditions. (GroSolar, 2014). Mitigation measures to minimize traffic impacts during construction could include limiting what ACP(s) would be permitted to be used by the construction vehicles and scheduling deliveries to avoid poorly rated roads (e.g., LOS E or F) and intersections during peak usage times.

To the extent possible, solar projects are anticipated to be sited adjacent to existing roads. Depending on the location of the project, the construction of unimproved roads to access the site for construction and maintenance activities may be required. If new roads are necessary, BMPs would be implemented to ensure that the road does not adversely affect surface runoff. Additionally, BMPs would be implemented to ensure that appropriate features such as rolling dips or flat land drains would be implemented as necessary to remove storm water from unimproved roads in a way that minimized erosion and preserves the driving surface. Intersections of new improved or unimproved roads with existing roads would be appropriately signed to enable safe passage at the intersection.

Site locations proposed near or adjoining airfields have the potential for the Proposed Action to impact air traffic and military aircraft operations; potential impacts are discussed Section 4.12.2.2. Additionally, as discussed in Section 4.12.2.2, the design and construction of any above-ground power distribution lines needed to connect the solar PV array and/or ancillary power control systems to an installation electrical distribution system or the grid may impact low level training routes used by military aircraft within the installation boundaries. Coordination with installation aviation organizations and/or the Test Center Commander would be required to minimize or eliminate potential impacts to low-level aviation training and testing.

Operations and maintenance activities associated with the solar PV system would require only minimal vehicle and equipment support. Solar PV systems operate passively without the need for on-site personnel. Periodic system inspections, PV panel cleaning, and as-needed equipment repairs is anticipated to result in less than one vehicle trip per week and would not be anticipated to result in impacts to traffic and circulation either on the installation or on the surrounding roadways.

The anticipated impact to vehicular transportation and traffic is anticipated to be short-term and minor for construction of the solar PV project and ancillary power control systems, and negligible for solar PV system operations and maintenance. Impacts to other transportation systems, to include rail and air, are not anticipated to result from the implementation of the Proposed Action.

#### 4.11.2.3 ALTERNATIVE 2: PREVIOUSLY DEVELOPED SITE

Alternative 2 potential impacts are anticipated to be similar to those of Alternative 1, although construction of solar PV projects on some previously developed sites may generally have fewer effects to transportation and traffic if the proposed site had and retains remnants of a relatively extensive transportation network within the site.

#### 4.11.2.4 ALTERNATIVE 3: ROOF

Alternative 3 potential impacts are anticipated to be similar to Alternative 1; though construction-related impacts to traffic may be moderate / less than significant if the proposed site selection includes buildings located such that adjoining roads need to be temporarily closed and traffic diverted during construction.

## 4.12 AIRSPACE

The Federal Aviation Administration (FAA) manages all airspace within the U.S. and its territories. The FAA recognizes the military's need to conduct certain flight operations and training within airspace that is separated from that used by commercial and general aviation. The FAA has established various airspace designations to protect aircraft while operating near and between airports and while operating in airspace identified for defense-related purposes. Due to the unique nature and frequency of military operations, the airspace over Army installations is generally a form of restricted use or a special use airspace. The Army manages airspace in accordance with DoD Directive 5030.19, *DoD Responsibilities on Federal Aviation* (DoD, 2013b). The Army implements these requirements through AR 95-2, *Air Traffic Control, Airspace, Airfields, Flight Activities, and Navigational Aids* (DA, 2016c). Use of military airspace on Army installations is typically scheduled through the installation's Directorate of Plans, Training, Mobilization and Security (DPTMS).

Expanding the production and transmission of renewable energy and ensuring a modern and resilient commercial electrical grid can impact military readiness and operations, including the Army's research, development, test, and evaluation activities. In 2011, Congress endorsed and empowered the DoD Siting Clearinghouse to coordinate a comprehensive mission compatibility evaluation process to ensure the robust development of renewable energy sources and the increased resiliency of the commercial electrical grid may move forward in the U.S., while minimizing or mitigation any adverse impacts on military operations and readiness (P.L. 111-383, § 358). The DoD Siting Clearinghouse coordinates and oversees the military's review of project applications submitted for permitting through the FAA's Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) process (49 U.S.C. § 44718). One example of an airspace consideration evaluated is whether solar power towers and electrical transmission towers sited in or under designated low-altitude military training routes and special use airspace present a serious collision hazard to military aircraft. Another airspace consideration example is whether the momentary "glint" or longer duration "glare" reflecting off solar systems presents a hazard to aircraft and air traffic control tower operations.

Equipment using the airspace over Army installations may include helicopters, planes, and unmanned aerial vehicles. Training activities which may require special use airspace designation by the FAA include firing of certain artillery and mortars; unmanned aerial system operations; military specific aircraft maneuvers; some types of laser training activities; and, some types of research, development, test and evaluation efforts.

## 4.12.1 Existing Conditions

As of September 2015, Army installations included over 13.5 million acres (5.46 million hectares) of land, all with airspace above. This airspace supports military training and testing operations, to include operations at 57 multi-use airfields and 24 heliports. (DA, 2015c).

PV solar modules use silicon to convert sunlight to electricity and silicon is naturally reflective. As a result, all solar modules are designed with a layer of anti-reflective material that allows the sunlight to pass through to the silicon but minimizes reflection. Recent generations of modules have included an anti-reflective material on the outer surfaces of the glass and have the protective glass surface roughened to further limit glint (a momentary flash of light) and glare (a more continuous source of excessive brightness relative to the ambient lighting) [referred to henceforth as just glare]. The area of the aluminum frame is very thin and therefore reflection from the aluminum is not a concern (FAA, 2011).

## 4.12.2 Environmental Consequences

Impacts to airspace would be considered significant if the Army actions lead to a violation of FAA regulations that undermines the safety of military, civil, or commercial aviation; result in substantial infringement of current military, private, and commercial flight activity and flight corridors; or substantially impacts military aviation missions. The ROI for this resource area is the airspace above the installation and surrounding aviation assets.

### 4.12.2.1 No Action Alternative

There would be no change to airspace use at an installation under the No Action Alternative.

### 4.12.2.2 Alternatives 1, 2, and 3: Greenfield Site, Previously Developed Site, and Roof

The Proposed Action will not result in a request for FAA to change any airspace designations.

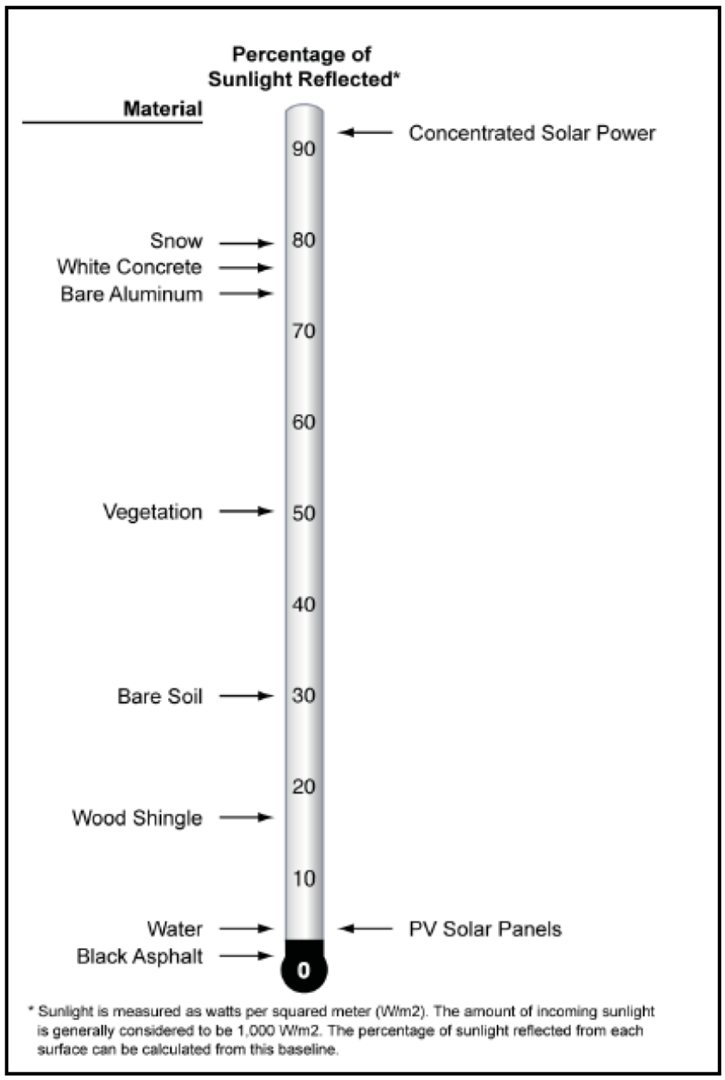
Solar PV array systems not flush-mounted to the ground are typically no taller than a single-story structure. Rooftop arrays add minimal additional height to existing buildings and structures as height affects mounting options and, when the rooftop incorporates multiple rows of rack-mounted modules, increased height correlates to a greater separation distance needed between rows so as to avoid shading during winter solstice prime daylight hours. ESS infrastructure, microgrid infrastructure, and a substation, if included as components of the solar PV system, would all typically be no more than one story in height.

Above-ground power distribution lines needed to connect the solar PV array and ancillary power control systems to an installations electrical distribution system or the grid may impact low level training routes used by military aircraft within the installation boundaries. Distribution lines may be more than one story in height, would be generally linear in nature, and would, to the maximum extent practicable, follow existing rights-of-way, using existing utility corridors. Even if such lines were of sufficient height, additional lighting of poles may be required in some locations, to include for associated ancillary power control systems. Site design of permanent nighttime lighting to support operations should be set at the lowest height possible and shielded so that it would be directed only toward areas needing illumination. Coordination with installation aviation organizations and/or the Test Center Commander would be required during design to minimize or eliminate potential impacts to low-level aviation training and testing.

At these heights, it is unlikely that the proposed project would result in a request for the FAA to change any airspace designations unless the location of new transmission lines or needed infrastructure conflicted with ongoing air space operations. Under such circumstances, it is expected that the locations of these elements of the Proposed Action could be modified or designs altered to avoid any such conflicts. Therefore, height factors of the Proposed Action would have no impacts to airspace.

Anti-reflective crystalline solar PV modules possess reflectivity properties from 2 to 7 percent, meaning 92 to 98 percent of the light from the sun’s rays are absorbed into the solar module and not reflected out. These reflectivity levels are below those of water, wood shingles, bare soil, and vegetation (FAA, 2011) (Figure 13). Nevertheless, solar PV systems have the potential to cause glare from various solar energy components.

**Figure 13.** Reflectivity Scale (FAA, 2010)




Impacts of glare on eyesight can include discomfort, disability, veiling effects, after-image and retinal burn (Ho, 2013) and an example of glare is provided in Figure 14. The size and orientation of reflective surfaces relative to the observer, in addition to atmospheric humidity levels and particulates in the air, impact the intensity and size. Because of the risk glare potentially has on aircraft safety, codes and regulations seek to prevent unwanted glare from impacting airports and aviation operations (OEERE, 2015). In 2010, the FAA issued the *Technical Guidance for Evaluating Selected Solar Technologies on Airports* (FAA, 2010) and, as of 2013, issued interim policy

**Figure 14.** Solar Glare Example (Sandia, 2015)

replacing some sections of that guidance while they work to improve the guidance based on new information and field experience (FAA, 2015). In a study conducted to support analysis of a large solar array system at Nellis Air Force Base in Nevada, the results "indicated that under the worst case scenario, there would be a slight potential for an after image or flash glare resulting from reflected direct sunlight. This after image or flash glare is similar to the potential for flash glare due to water and less than that due to weathered, white concrete and snow" (Nellis AFB, 2011). Mitigation of glare include selecting materials which reduce reflectivity, ensuring proper design and siting of solar PV projects to minimize or eliminate impacts to aviation traffic and training activities, and having pilots use glare shields and sunglasses. Glare shields and sunglasses typically reduce radiation by approximately 80 percent (Nellis AFB, 2011).

For any potential solar PV project on an Army installation, the potential hazard of solar glare is to be evaluated. When the proposed project requires approval by the FAA (e.g., potential impacts to airports and safe flight operations), the FAA review process includes coordination with and review by the DoD Siting Clearinghouse. The Sandia National Laboratories, for example, offers a Solar Glare Hazard Analysis Tool, Empirical Glare Analysis Tool, and Analytical Glare Estimation Tool available on-line from https://share.sandia.gov/phlux. For all large-scale renewable energy projects, the Army has established a review process through the OEI which includes glare hazard determinations. This process, together with application of siting and design criteria, would assist in the identification of any potential impacts to flight operations, ensuring compatibility with air/ground operations, training, testing, and operational mission requirements. As a result, there would be no significant effect on airspace.

Site-specific studies and coordination with the installation air operations, air traffic, and airspace managers, range managers, and users would occur for each solar PV project site. FAA coordination would also occur for potential projects that could affect federal airspace from the glare off of modules.

Construction, operation, and maintenance of solar PV systems is anticipated to have no to negligible impact to airspace resources.

## 4.13 ELECTROMAGNETIC SPECTRUM

The electromagnetic spectrum is the entire range of electromagnetic radiation, characterized by frequency and wave length. The electromagnetic spectrum extends from radio waves, which have the longest wavelengths and lowest frequencies, to gamma rays, which have the shortest wavelength and highest frequencies. This spectrum supports our communication systems.

Communication systems interference includes negative impacts on radar, satellite, navigation aids, and infrared instruments. Radar or satellite interference occurs when objects are placed too close to a radar antenna or satellite communication device and reflect or block the transmissions of signals between the signal generation point and receiver. Impacts to radar or satellite can occur as a result of structures, such as an overhead transmission line. Impacts on infrared communications can occur because solar modules could retain heat beyond dusk and the heat they release can be picked up by infrared communications in aircraft, causing an unexpected signal. The DoD Siting Clearinghouse review, discussed in Section 4.12, also considers electromagnetic interference impacts on aircraft safety operations and critical test activities. This review is required for renewable energy projects which require an FAA permit through the FAA's OE/AAA process (49 U.S.C. § 44718).

Spectrum-related activities associated with the military are subject to the policies and procedures of several federal agencies. At the highest level, the spectrum management authority for all federal agencies is the National Telecommunications and Information Administration, part of the Department of Commerce. The policies and procedures for spectrum use by federal agencies are contained in the *Manual of Regulations and Procedures for Federal Radio Frequency Management*, commonly referred to as the *National Telecommunications and Information Administration Manual* (NTIA, 2014). In addition to the manual, DoD has well-established and detailed policies and procedures for the use of the electromagnetic spectrum by DoD agencies. Finally, DA has its own policies and procedures guiding the spectrum-dependent activities of Army entities. Regulations and procedures relevant to Army spectrum management issues are addressed in AR 5-12, *Army Use of the Electromagnetic Spectrum* (DA, 2016d).

## 4.13.1 Existing Conditions

Military mission operations include communications, navigations, and targetry using radar, satellite, and infrared instruments. Some installations have a greater extent of missions, compared to the average installation, involving radio frequency and spectrum use. In addition to using the electromagnetic spectrum to accomplish training activities, some installations have missions involving testing of communications and electronic equipment and utilize the Military Electromagnetic Range, which is a frequency coordination zone protected by federal mandate.

Safe operations of private and commercial aviation also depends on many similar communication components. Some Army installations are adjacent to or near non-military airfields.

## 4.13.2 Environmental Consequences

Impacts to radio frequency and spectrum use would be considered significant if the Army actions were to cause mission failure, to include those related to training and testing requirements. The ROI for this resource area is the installation and adjoining communities.

#### 4.13.2.1 No Action Alternative

No impacts on radio frequency and spectrum use would occur because no construction activities would occur under the No Action Alternative.

#### 4.13.2.2 Alternatives 1, 2, and 3: Greenfield Site, Previously Developed Site, and Roof

Under the Proposed Action, the solar PV array will collect solar radiation that includes visible wavelengths from the electromagnetic spectrum. Solar radiation will strike the PV semiconductor material with enough energy to knock electrons from their weak bonds and create an electric current.

All electrical generation systems, including ancillary power control systems, produce electric and magnetic fields, and could potentially cause electromagnetic interference. Typically small-scale systems, such as solar-powered street signs and lights, generate a negligible amount of electromagnetic interference. Solar arrays and battery-based ESSs, have a greater potential to generate significant electromagnetic and radar interference that could adversely affect mission-critical testing and training operations. Additionally, the metallic components of solar PV arrays have the potential to cause reflection of radar transmission. To reduce the potential for impacts to ongoing and future missions, project siting factors would need to consider the location of signal generation points (e.g., radar transmission facilities) and receivers. For example, the solar fields at Oakland International Airport and Meadows Field Airport, both in California, were required to meet set-backs from transmitters of 500 and 250 feet respectively (FAA, 2011). Due to their low profiles, however, most PV modules typically represent little risk of interfering with radar transmissions (FAA, 2010). In addition, solar modules do not emit electromagnetic waves over distances that could interfere with radar signal transmissions (FAA, 2010). However, to appropriately avoid or minimize potential impacts, stakeholder coordination is critical during the scoping and design of the proposed solar PV system. For proposed sites in proximity to off-post airfields, coordination may be required with the FAA to ensure aviation communications and safety are maintained.

Communications between physical assets is typically a significant part of microgrid-based systems operations (as part of the ancillary power control system). Such communications can be carried out through a variety of methods, almost all of which involve incidental (wired) to intentional (wireless) electromagnetic radiation. Communication between a centralized control center and ancillary power control system assets is necessary to ensure safe and reliable operation, particularly during the onset of emergency events, or the islanding of the microgrid system itself.

Construction activities are not anticipated to provide any short-term, adverse impacts to the electromagnetic spectrum. Operations and maintenance of the proposed solar PV project is not anticipated to be a significant source of electromagnetic interference nor are any major impacts to electromagnetic spectrum use anticipated.

If the proposed project includes the construction of above-ground transmission lines, the proposed location of the lines would need to consider the location of signal generation points and receivers so as to ensure no impact on mission would occur. Potential long-term impacts to operations that are not mission-critical may, however, range from none to moderate / less than significant.

## 4.14 UTILITIES

Utilities furnish an everyday necessity to the public at large and include provisions of electricity, natural gas, water, telecommunication service, wastewater management services, solid waste management service (non-hazardous), and other essentials. Utility plan operators and maintenance personnel are required to meet applicable federal, state, local or host nation certification requirements for the state or host nation in which they are located. Depending on the service provided, the facilities will also have specific statutory and regulatory requirements for design and operation.

### 4.14.1 EXISTING CONDITIONS

Army policy is to provide safe, reliable, efficient, and life cycle cost effective utility services that promote the health and welfare of the Soldier, Civilians, Family members, contractors, and retirees; and that provide the capability for garrisons to accomplish assigned missions (DA, 2012). Utilities are typically managed to meet other related Army goals. Examples include cost and environmental impact reductions. All military construction, renovation and demolition projects have a goal of diverting a minimum 50 percent of construction and demolition (C&D) waste (determined by weight) from landfills (DA, 2012b). Section 1.1.2 provides goals related to renewable energy.

The primary regulation guiding utilities management on Army installations is AR 420-1 (DA, 2012b), with environmentally-related components also addressed in AR 200-1 (DA, 2007). Various installation management plans addressing utilities guide installation development, operations, and maintenance of applicable infrastructure systems. An example discussed in AR 200-1 is storm water management plans (DA, 2007). Examples discussed in AR 420-1 include installation utilities management plans, water resource management plans, and integrated solid waste management plans (DA, 2012b). Utilities-related management plans may also be required by the government for contractor operations. For example, construction contractors are required to include submission of a contractor's C&D Waste Management Plan, preferably prior to the start of site clearance (DA, 2012b).

Some installations have their own facilities for generating electricity, providing drinking water, treating and discharging waste water, managing solid waste, and providing natural gas. These facilities also have associated distribution and/or collection systems. Most installations rely on utility providers in the nearby community. As of September 2015, there are 203 Army-owned and 151 privatized utility systems on Army installations supporting electric, natural gas, water, and wastewater services (DA, 2015c).

As noted in Section 1.2.1, DA is striving to achieve Net Zero with many of its utilities. Installation potable water consumption and potable water consumption intensity (gallons of water used per gross square foot of facility space) continue to be reduced, having dropped 24.3 and 26.6 percent respectively from FY 2007 to 2013 (DA, 2014a). Actions are also underway to reduce non-potable water use. In FY 2013, installations reused or recycled 43 percent of non-hazardous solid waste and 75 percent of construction and demolition debris instead of landfilling (DA, 2014a). Additionally, the Army is generating less waste, in part through informed decisions in the procurement process, which resulted in 2.23 million tons (2.02 million metric tons) less waste generated in FY 2013 than in FY 2012 (DA, 2014a).

## 4.14.2 Environmental Consequences

Impacts to utilities would be considered significant if the Army actions were to cause long-term or frequent impairment of utility service to critical services (e.g., hospitals), military mission operations, and local communities, homes, or businesses. The ROI for this resource area is the installation and immediate surrounding communities.

### 4.14.2.1 No Action Alternative

Implementing the No Action Alternative would result in a negligible, adverse impact on electricity utilities because of the continued use of power plants based on fossil fuel combustion. This negligible, adverse impact assumes another renewable energy technology is not used in place of solar PV and the net change in energy use does result in a decrease of fossil fuel derived energy use. Consequently, impacts to electricity utilities as a result of the No Action Alternative are anticipated to range from none to negligible. There would be no change to other existing utilities under the No Action Alternative.

### 4.14.2.2 Alternatives 1, 2, and 3: Greenfield Site, Previously Developed Site, and Roof

Construction of a solar PV project and ancillary power control systems would replace some of the gas and electrical energy used on the installation with electricity produced by solar, thereby reducing the installation's reliance on fossil fuels. The Proposed Action may also improve energy security for the installation. On average, a 10 MW solar PV array would generate approximately 24,000 MWh per year,[1] although this value is impacted by the location of the array (how far north and amount of sun). With a MW of solar-generated energy powering 164 homes, the current national average (SEIA, 2016), an estimated 1,600-plus homes could be powered by a 10 MW solar PV facility and 16,000 by a 100 MW facility. The percent reduction in use of gas and fossil fuel derived electrical energy would be a function of the size of the PV project and the energy use of the installation.

Most Army solar PV projects are designed for the electricity from the PV array to be added to the electrical grid either owned by the Army installation or the nearby utility provider. The project

[1] Calculated with EIA 2014/2015 average solar PV capacity factor of 27% (SEIA, 2016).

would have to be designed to be compatible with the existing grid system. Further, the ancillary power control systems are intended to have the ability to execute seamless connection and disconnection with the local electrical grid, and will require special equipment designed for such applications so that they may coordinate and communicate such operations with the local electrical utility. If connecting to the local utility provider grid, then the installation would negotiate the arrangement. Some Army installations would use a grant or land lease with the local utility company. For example, at Fort Benning, the Army set up a 35-year utilities easement with the local power company. That company will design, build, own, operate, and maintain the 30 MW PV array on that installation and the electricity generated from this PV facility will be fed into the utility company grid (FB, 2014). For projects connecting inside the installation's distribution grid, solar PV and ancillary power control systems also contribute to added energy security, providing beneficial impacts. The Proposed Action would also provide a beneficial impact as it would help enable the Army to meet renewable energy goals.

Some potable or near-potable water is required for maintenance of the solar PV project to wash the modules. A 10 MW PV array has about 35,000 modules. Washing frequency is a function of local precipitation frequency, dust levels, and degree of air pollution, but on average the modules are washed one to four times a year with approximately 20 gallons (76 liters) of water per MWh (SEIA, 2010; a range of zero to 30 gallons (0 to 114 liters) per MWh is reported in SNL, 2013). Therefore, a 10 MW facility that generates 24,000 MWh per year would require approximately 480,000 gallons (1.8 million liters) of water per washing. For comparison, an Olympic-sized swimming pool holds approximately 660,000 gallons (2.5 million liters) of water. Compared to the several million gallons of water used by the typical Army installation, the water needed for washing modules is minimal; therefore, the anticipated impact to water utility systems is anticipated to be negligible to minor. This minimal impact is also anticipated where water for cleaning the modules is purchased and trucked in from off-post. For potential impacts to water availability, see Section 4.7 (Water Resources).

Short-term negligible impacts to wastewater would be anticipated during the construction period in support of ensuring the 40 to 80 construction workers are provided appropriate restroom facilities while on the job site. Facilities (e.g., port-a-potties) and disposal services to a permitted wastewater treatment facility would be the responsibility of the construction company.

No significant impacts to landfills are anticipated. Contractors, who will be responsible for properly disposing of construction-related waste and C&D debris, are required to have C&D waste management plans for the solar PV system construction (DA, 2012b). The construction contractor's C&D waste management plan should support the Army's 50 percent minimum diversion of C&D waste, by weight, from landfill disposal (DA, 2012b). C&D debris under Alternative 1 is anticipated to include vegetation potentially mixed with rocks and soils, with grassland sites generating less C&D debris than woodland sites. C&D debris under Alternative 2 would also include material reflective of and enabling the proposed site's previous use. If the previously developed site has retained existing structures or foundations from prior development, construction may be preceded by demolition activity. C&D waste from a previous developed site may also include hazardous waste (e.g., asbestos) and, if so, the hazardous waste would need to be handled and disposed of appropriately; see Section 4.15.2 for discussions on hazardous and toxic material and waste. Processing of pre-existing concrete and masonry materials into recycled concrete aggregate should be used to save valuable landfill space and disposal expenses. For construction, packaging material of the solar PV system's component parts would generate solid waste under all three alternatives. A construction contractor's BMP to reduce waste could include estimating the packaging materials to be generated and noting whether the supplier can eliminate or recycle packaging. Smaller solar PV projects using less acreage (e.g., 1 MW system on 7 acres [2.8 hectares]) would generate substantially less solid waste and C&D debris than a substantially larger project (e.g., 100 MW system on 700 acres [283 hectares]). Impacts to landfills from small projects are anticipated to be negligible and, due in part to the Army's 50 percent minimum C&D diversion requirement, impact to landfills for large project is anticipated to be moderate / less than significant. Most PV systems have no moving parts and also have long service lifetimes, typically ranging from 10 to 30 years, with some minor performance degradation over time (CRS, 2012); therefore, no substantial solid waste is anticipated to be generated during operations and maintenance. Overall, negligible to minor impacts are anticipated to landfills as a result of construction, operation, and maintenance of a solar PV project for all three alternatives.

No impacts to other utility systems (natural gas, telecommunication services, and other essentials) are anticipated as a result of the Proposed Action.

## 4.15 HAZARDOUS AND TOXIC MATERIALS AND WASTE

Hazardous and toxic materials are substances that are hazardous to health and/or the environment. Materials that are physically hazardous include combustible and flammable substances, compressed gases, oxidizers, etc. Health hazards are associated with these materials that cause acute or chronic reactions, including toxic agents, carcinogens, and irritants.

Hazardous material (which include chemicals), hazardous substances, toxic chemicals, toxic pollutants, and hazardous waste are regulated by various federal laws. These laws include the CAA; Comprehensive Environmental Response, Compensation and Liability Act (CERCLA; 42 U.S.C. § 9601; also known as Superfund); Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA; 7 U.S.C. § 136 *et seq.*); Occupational Safety and Health Standards (OSHA; 29 U.S.C. § 651 *et seq.*); Resource Conservation and Recovery Act (RCRA; 42 U.S.C. § 6901 *et seq.*); Solid Waste Disposal Act (42 U.S.C. § 82) as amended by RCRA; and Toxic Substances Control Act (TSCA; 15 U.S.C. § 2601 *et seq.*); all, as amended. Army installations and their service providers who use, handle, and dispose of hazardous and toxic materials and waste may also be subject to state and local government requirements. Various agencies also include lists of the material and waste which they regulate. Additionally, EPA maintains a "List of Lists" which is a consolidated list of chemicals subject to the Emergency Planning and Community Right-to-Know Act (EPCRA; 42 U.S.C. § 116), CERCLA, and Section 112(r) of the CAA. The generation, transportation, treatment, storage, and disposal of hazardous wastes are regulated under RCRA (42 U.S.C. § 6901 *et seq.*). Businesses and agencies are required to adhere to applicable regulations to minimize the possibility of harm to humans and the environment by use of this type of material and the disposal of any associated waste.

As a result of past practices and activities, hazardous and toxic materials and waste is in the ground on some of the lands in the U.S. and overseas. The two primary laws governing cleanup activities for these lands are CERCLA and RCRA. One method for the proper disposal of hazardous and toxic materials and waste that has been removed from the environment is through landfilling with liners and caps. Liners and caps create a barrier between the contaminated media and the adjoining soils, water, and air, thereby shielding humans and the environment from the harmful effects of the contaminated site and limiting the migration of the content. In addition to promulgating regulations and guidance to enable cleanup of contaminated lands and prevent contamination from hazardous and toxic materials and waste, EPA has a RE-Powering America's Land Initiative (EPA, 2015a) which encourages development of renewable energy systems on current and formerly contaminated lands, landfills, and mine sites.

The solar PV industry and battery-based energy storage does entail the use of hazardous and toxic material. A constituent of solar modules is silicon. Lead is often used in solar PV electronic circuits for wiring, solder-coated copper strips, and some lead-based printing pastes. Small quantities of silver and aluminum are used to make the electrical contacts on the cell. As discussed in Section 2.2.1 (Ancillary Power Control Systems), larger battery systems may include use of lithium-ion, sodium-sulfur, and vanadium-flow chemistries that are well suited to the large energy exchanges of microgrids and have higher energy densities than smaller lead-acid batteries.

## 4.15.1 Existing Conditions

Hazardous and toxic material use on Army installations is representative of hazardous and toxic material use across the U.S. and across the municipal, services, commercial, and industrial sectors. Typical hazardous materials used on Army installations include cleaning and disinfecting supplies, antifreeze, gasoline, diesel fuel, oil, lubricants, degreasers and other industrial compounds, batteries, pesticides, and explosive and pyrotechnic devices. Toxic substances includes asbestos, polychlorinated biphenyls (PCBs), and lead-based paints (LBP). Many of the current uses of these materials are associated with routine maintenance of buildings, grounds, and equipment common to public and private sector operations. Some uses are associated with military training and testing activities. Residual hazardous materials generated during routine maintenance should be recovered for reuse, recycling, or proper disposal. Some hazardous material, such as pesticides and fuel, are consumed in the process of performing operations and/or training. Handling, use, and storage of these hazardous materials are subject to federal and state regulations, in addition to Army and DoD regulations. The Army regulations and pamphlets include AR 200-1 – *Environmental Protection and Enhancement* (DA, 2007), AR 385-10 – *The Army Safety Program* (DA, 2013a), AR 710-2 – *Supply Policy Below the National Level*) (DA, 2008b), AR 700-141 – *Hazardous Materials Information Resource System* (DA, 2015d), DA Pamphlet 700-16 – *The Army Ammunition Management Program* (DA, 1982), AR 700-143 / Defense Logistics Acquisition Directive

(DLAD) 4145.41 – *Packaging of Hazardous Material* (DLA, 2007). If hazardous and toxic material become hazardous waste, management practices would be in accordance with the laws and regulations governing hazardous waste (e.g., RCRA and AR 200-1).

Army installations maintain, as appropriate and needed, less than 90- or 180-day storage areas and/or satellite accumulation points, permitted by the appropriate regulatory agency, to facilitate the collection of hazardous wastes and to ensure that the wastes are properly managed in accordance with applicable federal, state, and DoD regulations. Transportation off-site is accomplished by appropriately licensed waste management and transportation companies. Transporters must have an EPA identification number and comply with manifest management requirements.

The Army also has sites on many of its installations that are managed under the Army's Environmental Restoration Program. The mission of this program is to return Army lands to usable condition and protect human health and the environment by performing appropriate, cost-effective cleanup of contamination resulting from past practices. It is part of DoD's Defense Environmental Restoration Program, which was established in 1986 to address hazardous substances, pollutants, contaminants and military munitions remaining from past activities at active military installations and formerly used defense sites. Cleanup actions have been completed on many sites and, as of September 2015, the Army had 1,309 cleanup sites on active installations and on 1,851 formerly used defense sites (DA, 2015c). Of the active Army sites that have achieved Response Complete, 596 sites still require long-term management (DA, 2016a). Army cleanup policy is detailed in AR 200-1.

## 4.15.2 ENVIRONMENTAL CONSEQUENCES

Factors considered in determining whether hazardous and toxic material and waste associated with an individual project would result in a significant effect include the extent or degree to which the implementation would:

- Expose military or Civilian personnel, Family members, or the public to areas potentially containing UXO or other hazardous substances without adequate protection;
- Cause a spill or release of a hazardous substance (as defined by 40 C.F.R. Part 302 [CERCLA], or Parts 110, 112, 116 and 117 [CWA]);
- Expose the environment or public to any hazardous condition through release or disposal (e.g., exposure to toxic substances including pesticides/ herbicides or open burn/open detonation disposal of unused ordnance);
- Adversely affect contaminated sites or the progress of IRP, MMRP or CC remediation activities;
- Cause the accidental release of friable (easily crumbled by hand pressure) asbestos or LBP during the demolition or renovation of a structure; or

- Generate either hazardous or acutely hazardous waste, resulting in increased regulatory requirements over the long-term.

Impacts from hazardous material and waste would be considered significant if the Army actions were to result in substantial additional risk to human health or safety, to include direct human exposure; substantial increase in environmental contamination; exceedance of facility or system capacity for hazardous material/waste management; or a violation of laws and regulations governing the management of hazardous material and waste, to include noncompliance with an installation's hazardous waste permit, if applicable. The ROI for this resource area is the installation and immediate surrounding communities.

#### 4.15.2.1 No Action Alternative

There would be no change to hazardous material usage nor the generation of hazardous waste under the No Action Alternative.

#### 4.15.2.2 Alternative 1: Greenfield Site

The Proposed Action includes risk of accidental spills and leaks from construction and maintenance vehicles. The construction contractor will be responsible for properly maintaining construction vehicles and equipment, along with any hazardous and toxic materials used in their operation, in compliance with applicable laws and regulations. The system operator would be responsible for similar activities, as related to maintenance vehicles and equipment. The contractor would also be responsible for the appropriate disposal of all hazardous waste generated during construction in compliance with applicable laws and regulations. The system operator would be responsible for the appropriate disposal of hazardous waste generated during maintenance activities, to include broken parts and packaging material of replacement parts. All hazardous and regulated materials or substances would be handled according to safety data sheet instructions. With environmental protection measures, including BMPs and SOPs, for preventing and responding to potential contamination, short-term impacts are anticipated to be minor and long-term impacts, negligible.

PV systems are almost entirely benign in operation, and potential environmental hazards occur primarily at the production and disposal stages which would be done off-site. PV solar modules may contain small amounts of hazardous materials that would pose no threat under normal circumstances. However, if damaged, those materials could potentially release hazardous substances into the environment. Operation of the solar modules would not generate any hazardous waste. ESSs containing chemical energy storage devices would pose additional risks as the chemicals used in these devices are frequently toxic and/or hazardous. Most battery based storage devices use high-strength acids, and the specific chemistry of the device could also include smaller amounts of other toxic and/or hazardous materials. The volume of the toxic and/or hazardous materials will depend on the size of the energy storage device. If a spill were to occur, procedures established in the Installation Spill Prevention, Control, and Countermeasure Plan or equivalent document will be implemented, and contaminated soil and other hazardous waste will be disposed of properly.

Most PV systems have long service lifetimes, typically ranging from 10 to 30 years, with some minor performance degradation over time (CRS, 2012); therefore, the disposition of any hazardous material contained in any components of solar PV systems would have no near-term impacts. The rapid evolution of the solar PV industry, along with the diverse, innovative, and complex technologies involved, make it very difficult to assess all end-of-life hazards related to solar PV projects. As solutions evolve and regulations are issued related to the management of hazardous waste from the operation and maintenance of solar PV systems, the Army will continue to comply with applicable requirements.

The Army follows strict SOPs for storing and using hazardous materials and disposing of hazardous waste. No new procedures would need to be implemented to comply with current requirements applicable to storing or using construction-related or operation- and maintenance-related hazardous or toxic materials. Likewise, no new procedures would be needed to dispose of any hazardous waste associated with the Proposed Action (e.g., used oil from construction or maintenance vehicles).

#### 4.15.2.3 Alternative 2: Previously Developed Site

Alternative 2 is similar to Alternative 1 but, on previously developed sites, there is the potential for the site to have existing contamination of hazardous or toxic materials or hazardous waste. This is not assuming a previously developed site is contaminated; only that the history of the site should be investigated to inform decision-makers and design parameters. Site selection for solar PV projects should consider whether a previously-contaminated site can be used safely for the project. These sites (e.g., old, closed landfills; IRP sites and/or RCRA corrective action sites) may be excellent sites if they are in the long-term operation, maintenance, and monitoring phase. The sites can be of significant size and not usable for most other applications.

Some remediation actions on IRP, MMRP, or CC sites affect the ability to use the surface for solar PV projects. Such restrictions must be taken into account during site selection processes. Construction of a PV project on these sites would have to be compatible with long-term management requirements and protection of the environment from any residual contamination.

For previously developed sites which are lined and/or capped, key design criteria include minimal settlement and the continued need for maintaining the integrity and functionality of any existing cap and liner. Design considerations would need to include eliminating penetration of caps and liners, continuing the functionality of evapotranspirative or water-balance covers, ensuring storm water is appropriately managed, ensuring the design is appropriate for wind conditions anticipated at the proposed site, and, in earthquake prone areas, ensuring protectiveness during an earthquake event. Project design would have to include site specific limitations and requirements (e.g., the allowable depth of excavation permissible above a cap).

If the previously developed site has retained existing structures or foundations from prior development, construction may be preceded by demolition activity. The contractor would also be responsible for the appropriate disposal of all hazardous waste generated during demolition, in compliance with applicable laws and regulations. As discussed in Section 1.14.2.2, construction and demolition would result in a temporary increase in landfills accepting C&D waste.

With careful application of site selection and design, along with practices and SOPs discussed under Alternative 1, the proposed implementation of Alternative 2 is anticipated to result in negligible to moderate / less than significant impacts to the environment, both short- and long-term, from hazardous and toxic material and waste as a result of construction of a solar PV system. Impacts as a result of operation and maintenance of the solar PV and ancillary power control systems are anticipated to be negligible. As discussed in Section 1.4, when considering the implementation of a proposed solar PV project and/or ancillary power control systems, installations would use the checklist attached in Appendix A of this PEA to determine whether the use of CXs and reliance on existing NEPA documents are appropriate, or whether additional NEPA analysis is needed.

#### 4.15.2.4 Alternative 3: Roof

The Proposed Action includes risk of accidental spills and leaks from construction and maintenance vehicles, similar to that discussed under Alternative 1, with short-term impacts anticipated to be minor and long-term impacts, negligible.

Construction of the solar PV array and ancillary power control systems on an existing building may expose construction workers to LBP and asbestos-containing material. The risk associated with this potential exposure can be minimized by confirming the presence of hazardous building materials prior to the work (e.g., through the installation's LBP and asbestos inventories and confirmation sampling prior to initiation of the work) and when present, implementing work plans, health and safety plans, and construction-related protective measures (e.g., personal protective equipment, air barriers, hazard labels). Impacts are therefore anticipated to be negligible.

## 4.16 Human Health and Safety

The statutory purpose of NEPA includes promoting the "health and welfare of man" (42 U.S.C. § 4321 *et seq.*) and analysis of the impacts to which the Proposed Action affects public health and safety is woven throughout many sections in Chapter 4, though may be more evident in some sections than others, such as the hazardous and toxic materials and waste section. This section is included to further assist the public and decision-maker in gaining an understanding of the potential impacts the Proposed Action has on human health and safety. Health and safety includes occupational hazards to workers as well as the exposure of the general public to conditions creating the risk of immediate injury or long-term health hazards.

### 4.16.1 Existing Conditions

Conditions that affect human health and safety on Army installations are representative of those across the U.S. Army installations include adult populations that work in a wide range of occupations, including managerial and administrative, education, health care, services, construction, facilities and equipment repair, and related occupations found in cities across the nation. The workplaces for these occupations are subject to Occupational Safety and Health Administration (OSHA) regulations and oversight, as well as Army health and safety-related regulations (e.g., AR 385-10 [DA, 2013a]).

More unique to the DoD, Army installations also have adult populations that work in activities that provide direct tactical training support to the U.S. military mission. One component of safety includes SDZs around ranges. A SDZ delineates that portion of the earth and the air above in which personnel and/or equipment may be endangered during ground weapons firing or demolition activities. These zones are established to minimize danger to the public, installation personnel, facilities/equipment, and property. In addition to adhering to the requirements of AR 385-10, Army installations also must meet the requirements of AR 385-63 – *Range Safety* (DA, 2012c). This AR is further supplemented with guidance on range safety standards and procedures detailed in DA Pamphlet 385-63 – *Range Safety* (DA, 2014b).

MECs are a safety concern on many Army installations. MECs include categories of military munitions that may pose unique explosives safety risks, such as UXO, as defined in 10 U.S.C. § 10(e)(5); discarded military munitions, as defined in 10 U.S.C. § 2710(e)(2); or munitions constituents, as defined in 10 U.S.C. § 2710(e)(3), present in high enough concentrations to pose an explosive hazard (32 U.S.C. §179.3). Installations have specific procedures which must be followed prior to ground-disturbing activities to help minimize safety hazards related to MECs. Depending on the location, and based on the understanding of past uses of that location, a site-specific survey for MECs may be required prior to ground-disturbing activities.

Facilities and access to facilities on Army lands are required to incorporate appropriate DoD and Army requirements for anti-terrorism and force protection requirements to protect Soldiers and Civilians, in addition to assets such as facilities.

As noted in Section 4.15 (Hazardous and Toxic Materials and Waste), the Army also has sites on many of its installations that are managed under the Army's Environmental Restoration Program. Cleanup actions on these sites, or other actions which result in site disturbance, have the potential to affect human health and safety. EPA and Army regulations and guidance exist to minimize the potential for adverse health and safety impacts at cleanup sites.

In addition to the adult population, most Active Component Army installations include Family housing areas with child populations, as well as the facilities that support that population (e.g., child development centers, schools, youth services facilities). These workspaces and facilities are subject to federal and state regulations, in addition to Army and DoD regulations such as AR 608-10 – *Child Development Services* (DA, 1997b), DoD Instruction (DoDI) 6055.1 – *DoD Safety and Occupational Health (SOH) Program* (DoD, 2014), DoDI 6055.4 – *DoD Traffic Safety Program* (DoD, 2009), and DoDI 6055.07 – *Mishap Notification, Investigation, Reporting, and Record Keeping* (DoD, 2011).

Human health and safety services can be obtained on Army installations with the level of services dependent, in part, on the population size being serviced. Some installations provide full-service hospitals, for example, whereas smaller locations may offer clinics and more complicated injuries and illnesses are serviced at an off-post facility. Police and fire safety and response services are also provided for all Army installations.

## 4.16.2 Environmental Consequences

Impacts to human health and safety would be considered significant direct human exposure to a health hazard or safety risk substantially increases for humans due to the Proposed Action. Impacts would also be considered significant if implementation of the Proposed Action resulted in laws and regulations governing human health and safety to be violated. The ROI for this resource area is the installation and immediate surrounding communities.

### 4.16.2.1 No Action Alternative

Under the No Action Alternative, no construction would take place, therefore no construction-related human health and safety impacts would occur. Implementing the No Action Alternative would result in a negligible, adverse impact on human health because of the continued health impacts to people resulting from fossil fuel derived air pollutants and GHGs. This negligible, adverse impact assumes another renewable energy technology is not used in place of solar PV and the net change in energy use does result in a decrease of fossil fuel derived energy use. Consequently, impacts to human health and safety as a result of the No Action Alternative are anticipated to range from none to negligible.

### 4.16.2.2 Alternative 1: Greenfield Site

Siting considerations of a proposed solar PV array project and ancillary power control systems must take into account current and foreseeable future range SDZs. Solar PV module installation would not be permitted within SDZs without explosives safety approvals for a waiver of safety regulations. There would be no adverse impacts to public health or safety associated with SDZs, so no related impacts to safety are expected.

For an array mounted at ground level, NEC 690.31(A) requires that the wiring be protected from ready access, such as through protection of wiring with non-conductive screening, limiting access with security fencing, or by elevating the array (NABCEP, 2013).

As the Proposed Action would be located on an active military installation, homeland security is an additional component of safety. Unified Facilities Criteria (UFC) 4-020-01, *DoD Security Engineering Facilities Planning Manual* (DoD, 2008), would guide planning, design, and construction criteria related to antiterrorism and force protection for the Proposed Action, including setbacks from nearby easements.

At a few installations, though a greenfield site was not previously developed, historic uses of the land may require a MEC survey be completed. Assuming the site is cleared for potential development, the probability of potential impacts from MECs would be anticipated to be low. If any evidence of MECs are encountered on the site during construction or operation and maintenance, all work would immediately cease and remain stopped until the appropriate military office has been notified, appropriate clearance procedures have been completed, and the safety hazard addressed by appropriately trained personnel.

Construction of solar PV and ancillary power control systems on an installation might have a minor effect on human health and safety to personnel involved in the construction activity. Project construction would have the potential risks inherent to any construction site, to include risks of falls and other injuries and risks associated with accidental spills and leaks from construction equipment. For construction activities taking place in a hot climate or during substantially cold climatic conditions, workers may be at risk of heat stroke or frostbite, respectively. Construction-related risks would be minimized through implementation of a comprehensive construction health and safety plan which addresses site-specific health and safety issues, including specific emergency response services and procedures and evacuation measures. Construction-related risk would also be minimized by limiting site access to personnel involved in the construction activity (e.g., authorized personnel).

Risks associated with systems maintenance would be minimal in part because solar PV arrays are benign systems with no moving parts. Some risks would be associated with module cleaning if workers are elevated above ground height to clean modules. Likewise, ESSs and microgrid systems typically have few moving parts but still pose a risk in the event of unintended discharge or overheating. Switching equipment failure or unintentional activation could lead to overloading on power distribution lines which could pose a fire hazard. Such risks are only slightly greater than the use of on-base distribution lines due to the inclusion of additional switching and protective electrical equipment. Electric shock hazard risks would also be associated with maintenance of transmission lines and other electrical conductivity components. Maintenance workers may potentially be exposed to pesticides and/or herbicides; risks would be minimized through proper adherence to the installation’s IPMP. All risks associated with maintenance activities would be minimized through implementation of applicable safety requirements, proper maintenance of tools and equipment used to conduct solar PV system maintenance activities, and appropriate security to prevent access by unauthorized personnel.

Should a PV array field be impacted by a wildland fire, firefighter training should include awareness of associated hazards to enable them to respond to the emergency safely and effectively. For example, during a fire, the PV frame structure can degrade. As installations already have electrical system infrastructure and ancillary power control systems unrelated to solar PV systems, firefighters would already be trained on firefighting techniques unique to these components of a solar PV system.

The Proposed Action would reduce the amount of fossil fuels used for energy consumption, thereby resulting in fewer air quality and GHG concerns. This, in turn, is anticipated to result in long-term beneficial impacts on human health and safety. Air quality has a direct impact to human health, and particulate matter in the air has been shown to affect cardiovascular and respiratory health and exacerbate existing conditions such as asthma. GHGs are gases that trap heat in the atmosphere which can therefore lead to rising global temperatures. A warmer climate is expected to increase the risk of illnesses and death from extreme heat and poor air quality, can worsen air quality, may expose more people to diseases, and increase the frequency and strength of extreme events (such as floods, droughts, and storms) that threaten human health and safety (EPA, 2016a). Using renewable energy sources that produces little or no air pollution and no GHG emissions provides for improved health and safety conditions.

Overall, adverse impacts to human health and safety as a result of the construction, operation, and maintenance of a solar PV project on a greenfield are anticipated to be minor.

#### 4.16.2.3 Alternative 2: Previously Developed Site

The potential human health and safety impacts as a result of the implementation of Alternative 2 are anticipated to be similar to Alternative 1 except that there may be higher risks as a result of the site having been previously developed.

The previously developed portions of a previously developed site may contain remnants of building foundations and other infrastructure. Evidence of prior development may also include piles of dirt, concrete, and other building material scattered through the proposed site. Associated risks would be minimized through implementation of a comprehensive construction health and safety plan which addresses site-specific health and safety issues, including specific emergency response services and procedures and evacuation measures. As with Alternative 1, construction-related risk would also be minimized by limiting access to authorized personnel.

If there had been hazardous material contamination on the previously developed site, the risk to human health and safety would be higher under Alternative 2 than Alternative 1. This risk, discussed in further detail under Section 4.15 (Hazardous and Toxic Materials and Waste), could be mitigated by proper design of the solar PV project based in part, upon knowledge of the type, scope, and extent of the contaminant. Through implementation of a comprehensive construction health and safety plan which addresses site-specific health and safety issues, and the implementation of the site's Installation Restoration Program management plan (if applicable), the risk to human health and safety is anticipated to be minor.

Installation requirements for a MEC survey on a proposed previously developed site will be completed prior to the start of ground-disturbing activities. If evidence of MECs are encountered on the site during construction or operation and maintenance, all work would immediately cease and remain stopped until the appropriate military office has been notified, appropriate clearance procedures have been completed, and the safety hazard addressed by appropriately trained personnel.

Overall, adverse impacts to human health and safety as a result of the construction, operation, and maintenance of a solar PV project on a previously developed site are anticipated to be minor.

#### 4.16.2.4 Alternative 3: Roof

This alternative is similar to Alternative 1 but the construction of PV modules, ESSs, and/or microgrid components on existing roof tops or car ports could pose greater risk to maintenance workers due to their elevated location (requiring use of ladders, chair lifts, etc.). The risks associated with arrays mounted on an elevated location could be minimized by updating the associated facility maintenance health and safety plan and by providing recurring periodic training.

Modification of any existing building or structure to construct the solar PV modules and ancillary power control systems could potentially encounter hazardous building materials, including asbestos and other hazardous fibrous insulating material and LBP. Risks associated with exposure to these materials can be minimized through TSCA-required building surveys, work plans, health and safety plans, and construction-related protective measures (e.g., personal protective equipment, air barriers, and hazard labels) (15 U.S.C. § 2601 *et seq.*).

No solar PV arrays or ancillary power control systems will be permitted to be mounted on any building or structure if structural integrity is not adequately addressed in architectural and engineering designs. Rooftop arrays must be structurally secured and any attachments and penetrations must be properly weather-sealed. Wind loads are a primary concern for PV arrays, especially in hurricane-prone regions. Design of the solar PV system for rooftops will incorporate wind loads appropriate for the site location. Sloped roofs also present a fall hazard and require appropriate fall protection systems and/or personal fall arrest systems for installers and maintenance workers. Design factors must also consider roof access for firefighters. Of paramount importance to the Army is the safety of personnel in buildings or under carports or other structures capable of being used for solar PV arrays. Structural integrity designs will also consider weight issues related to rainfall, snow accumulation, and solar module washing.

Though rooftop solar is considered safe, fires may occur in buildings with solar PV arrays, just as fires may occur in buildings without solar. On Army installations with solar PV systems, the firefighter’s knowledge base would need to include solar PV systems in order to enable firefighters to continue performing their job safely and effectively. Firefighter education would enable them to identify and mitigate potential hazards while working around solar PV modules at the site of an emergency. For examples, firefighters need to be aware that a PV array will always generate electricity when the sun is shining and that cut or damaged wires from a nighttime operation could become energized in the day time (Slaughter, 2006).

Some species of birds which nest in urban environments (e.g., carports) aggressively protect their territory and/or nest and will swoop at or attack humans. Rooftop solar PV system should be designed to avoid structures that promote nesting (such as lattice-type structures) to minimize attraction to the roof by birds, especially birds which actively defend their nest.

As with solar PV projects under Alternatives 1 and 2, Alternative 3 projects would be required to be constructed, operated, and maintained to meet anti-terrorism and force protection requirements.

By having appropriately trained personnel and following health and safety plans, to include ensuring proper maintenance of safety equipment, adverse impacts to human health and safety as a result of the construction, operation, and maintenance of a solar PV project under Alternative 3 are anticipated to be minor.

# 5.0 CUMULATIVE IMPACTS ANALYSIS

Cumulative impacts result when the effect of a given proposed action on the environment is added to separate past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes those actions. They can accrue from individually minor but collectively significant actions taking place over an extended period of time. Taken individually, environmental damage is incremental, occurring one action at a time; however, determining the significance of the collective actions requires an understanding of their effect on the larger environment.

This cumulative impact analysis is prepared at a level of detail that is reasonable and appropriate to support an informed decision by the Army and takes into consideration the programmatic nature of this environmental assessment. In considering the implementation of a specific proposed action on an installation, installations would use the checklist attached in Appendix A of this PEA to determine whether the use of CXs and reliance on existing NEPA documents as described in this PEA are appropriate, or whether additional NEPA analysis is needed. This includes determining whether additional cumulative impacts analysis is needed. As an installation considers specific proposed solar PV projects, the installation must consider whether other actions are underway, or proposed, that when combined with the potential effects of construction, operation, and maintenance of the proposed project, could have a significant cumulative effect on human health or the environment.

The cumulative impacts on a resource become significant when the total impacts from separate past, present, and reasonable foreseeable future actions are greater than the identified significance criterion for that resource. In analyzing cumulative impacts, the Army has determined the proposed development, operation, and maintenance of solar PV systems on Greenfields Sites, Previously Developed Sites, and Roofs are not anticipated to have significant, adverse, cumulative impacts. Positive, cumulative impacts, however, are possible as the Army uses solar PV to generate more of its electricity and reduces reliance on fossil fuels. This conclusion is supported in the following sub-sections.

## 5.1 SIGNIFICANT ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

There are no significant adverse environmental effects that normally cannot be avoided as a result of the construction, operation, and maintenance of proposed solar PV system or ancillary power control system alternatives, as analyzed within this PEA. Though the Army is currently in an era of downsizing, any future resurgence in growth on Army installations would still not be anticipated to have a cumulative significant effect on environmental resources as a result of solar PV systems being constructed, operated, and maintained. Through master planning activities and requirements to make decisions which are informed by the awareness of potential environmental impacts, the Army anticipates cumulative effects to normally be moderate / less than significant.

## 5.2 CONFLICTS WITH FEDERAL, STATE, OR LOCAL LAND USE PLANS, POLICIES AND CONTROLS

Solar PV projects and ancillary power control systems could preclude other land uses within the project footprint on the installation and, for a Greenfield Site alternative, could alter the character of largely rural areas. Depending on the proposed site location and area topography, the proposed project could impact the viewshed of neighboring communities; however, the site selection process should ensure no conflicts with federal, regional, state, or local land use plans, policies or controls. Implementation of the alternatives would comply with existing federal and other applicable statutes and regulations, while maintaining the Army's mission. Cumulative adverse impacts to land use plans, policies, and controls as a result of the Proposed Action are anticipated to be negligible.

## 5.3 ENERGY REQUIREMENTS

Energy required to successfully implement specific solar PV projects and ancillary power control systems would include fuel and electricity to power vehicles and equipment during construction and periodic maintenance activities. Fuel and electricity would also be used by other existing and reasonably foreseeable future facilities and operations in and around Army installations. Resources to meet energy requirements is currently available and in adequate supply, though the specific sources of fuel and electricity varies, dependent in part on market conditions and technology. BMPs and SOPs are used as standard practice by government agencies, private industry, and organizations to ensure operations use energy safely and minimize potential for spills, regardless of whether the primary driver is due to safety concerns, environmental stewardship ethics, economic factors, or regulatory requirements. Cumulative adverse impacts as a result of the Proposed Action to energy requirements are anticipated to be negligible.

## 5.4 DEPLETION OF ECONOMICALLY-VIABLE NATURAL OR DEPLETABLE RESOURCES

Construction of specific proposed solar PV projects and ancillary power control systems would include the consumption or conversion of resources that would not subsequently be able to be retrieved. This includes, for example, the use of fuel, oil, and lubricants consumed by construction and maintenance vehicles and equipment; a small amount of concrete, metals (i.e., steel), and wood used for pilings or poles; and the consumption of food products by construction and maintenance workers. Additionally, land would be used for the development of specific solar PV array projects and ancillary power control systems under Alternatives 1 and 2; though, as Alternative 2 is on a previously developed site, that land has already been disturbed. The use of land for solar PV projects and ancillary power control systems would remove the potential for agriculture, grazing, or timber harvesting on that land, though it would be possible to restore that use back. As the alternatives are for land on Army installations, some of these uses, if viable, may not be current due to conflicts with the military mission. Globally, as populations increase, more resources are used and land developed to meet the needs and desires of the populous. Cumulatively, there is a moderate / less than significant adverse impact to natural and depletable resources, with less being available over time; though the cumulative adverse impact resulting from the Proposed Action is negligible.

# 6.0 SUMMARY OF THE POTENTIAL EFFECTS OF THE EVALUATED ALTERNATIVES

No significant impacts are anticipated as a result of the No Action Alternative or any of the three action alternatives proposed in this PEA. For each resource area analyzed, Table 1 provides a summary of anticipated impacts using the categorization noted in Section 4.2 (Approach for Analyzing Impacts). Impacts are largely anticipated to be minimized through avoidance and through the implementation of BMPs and SOPs, as summarized in Table 2, starting on page 97. Avoidance may be a result of the selection of proposed site locations, how the project site is designed, and when construction activities are scheduled. BMPs and SOPs would include, for example, implementing erosion and storm water control measures during construction, maintaining construction vehicles and equipment, ensuring adequate and ecosystem-appropriate vegetation and/or gravel cover at the post-construction site, and ensuring safety equipment is appropriately used by construction and maintenance workers. No new mitigations measures are anticipated to be required.

As noted in Section 1.1.2, the analysis conducted in this PEA was informed, in part, by numerous NEPA analyses completed for similar projects within the Army and elsewhere. Consequently, Table 3 provides a comparison of the conclusions reached in this PEA against the conclusions reached in the referenced analyses. Table 3 starts on page 106. For analyses covering more than solar PV projects, the conclusions depicted in Table 3 are those applicable to the solar PV components of those analyses and do not incorporate impacts of other types of actions and alternatives. Additionally, as the various analyses were executed by different NEPA practitioners for various project proponents, the categorization of resource areas analyzed and the summary description of conclusions required, in some cases, interpretation in order to incorporate into Table 3's summary. The Table 3 resource categorization labels and levels of impacts are those used within this PEA.

As discussed in Section 1.4, in considering the implementation of a specific proposed solar PV project, installations would use the checklist attached in Appendix A of this PEA to determine whether the use of CXs and reliance on existing NEPA documents as described in this PEA are appropriate, or whether additional NEPA analysis is needed. Installations would use the checklist to evaluate their specific Proposed Action. If the installation concludes that additional NEPA analysis is necessary, it is required to be prepared before any irreversible and irretrievable commitments of resources occurs as a result of the Proposed Action.

**Table 1. Summary of the Potential Effects on the Evaluated Alternatives**

| Resource Area | No Action Alternative | Alternative 1: Greenfield Site | Alternative 2: Previously Developed Site | Alternative 3: Roof |
|---|---|---|---|---|
| No Significant Impacts identified for any resource areas. | | | | |
| **Land Use** | • No impacts | • No to minor adverse impacts, both short- and long-term | • No to minor adverse impacts, both short- and long-term | • No to minor adverse impacts, both short- and long-term |
| **Air Quality and GHG** | • No to negligible adverse impacts, both short- and long-term | • Short-term minor adverse impacts;<br>• Long-term beneficial impacts to negligible adverse impacts | • Short-term minor adverse impacts;<br>• Long-term beneficial impacts to negligible adverse impacts | • Short-term minor adverse impacts;<br>• Long-term beneficial impacts to negligible adverse impacts |
| **Noise** | • No to negligible adverse impacts, both short- and long-term | • Short-term, minor adverse impacts;<br>• Long-term beneficial impacts to minor adverse impacts | • Short-term, minor adverse impacts;<br>• Long-term beneficial impacts to minor adverse impacts | • Short-term, minor adverse impacts;<br>• Long-term beneficial impacts to minor adverse impacts |
| **Geological and Soil Resources** | • No impacts | • Short-term moderate / less than significant adverse impacts;<br>• Long-term minor, adverse impacts | • Short-term moderate / less than significant adverse impacts;<br>• Long-term negligible to minor adverse impacts | • Short-term moderate / less than significant adverse impacts;<br>• Long-term negligible adverse impacts |
| **Water Resources** | • No impacts | • Short-term negligible to minor adverse impacts<br>• Long-term negligible to moderate / less than significant impacts | • Negligible to moderate / less than significant adverse impacts, both short- and long-term | • No to minor short-term adverse impacts;<br>• Long-term negligible adverse impacts |

**Table 1. Summary of the Potential Effects on the Evaluated Alternatives** (con't)

| Resource Area | No Action Alternative | Alternative 1: Greenfield Site | Alternative 2: Previously Developed Site | Alternative 3: Roof |
|---|---|---|---|---|
| No Significant Impacts identified for any resource areas. | | | | |
| **Biological Resources** | • No to negligible adverse impacts, both short- and long-term | • Minor to moderate / less than significant adverse impacts, both short- and long-term | • Negligible to moderate / less than significant adverse impacts, both short- and long-term | • Negligible to minor adverse impacts, both short- and long-term |
| **Cultural Resources** | • No impacts | • Negligible to moderate / less than significant adverse impacts, both short- and long-term | • Negligible to moderate / less than significant adverse impacts, both short- and long-term | • Negligible to moderate / less than significant adverse impacts, both short- and long-term |
| **Socio-economics** | • Short-term negligible adverse impacts<br>• No long-term impacts | • Short-term beneficial to moderate / less than significant adverse impacts<br>• No to moderate / less than significant adverse long-term impacts | • Short-term beneficial to moderate / less than significant adverse impacts<br>• No to moderate / less than significant adverse long-term impacts | • Short-term beneficial to minor adverse impacts<br>• No to minor adverse long-term impacts |
| **Transp. and Traffic** | • No impacts | • Short-term minor adverse impacts;<br>• Long-term negligible, adverse impacts | • Short-term negligible to minor adverse impacts;<br>• Long-term negligible, adverse impacts | • Short-term minor to moderate / less than significant adverse impacts;<br>• Long-term negligible, adverse impacts |
| **Airspace** | • No impacts | • No to negligible adverse impacts, both short- and long-term | • No to negligible adverse impacts, both short- and long-term | • No to negligible adverse impacts, both short- and long-term |
| **Electro-magnetic Spectrum** | • No impacts | • No short-term adverse impacts;<br>• No to moderate / less than significant long-term adverse impacts | • No short-term adverse impacts;<br>• No to moderate / less than significant long-term adverse impacts | • No short-term adverse impacts;<br>• No to moderate / less than significant long-term adverse impacts |

**Table 1. Summary of the Potential Effects on the Evaluated Alternatives** (con't)

| Resource Area | No Action Alternative | Alternative 1: Greenfield Site | Alternative 2: Previously Developed Site | Alternative 3: Roof |
|---|---|---|---|---|
| No Significant Impacts identified for any resource areas. | | | | |
| **Utilities** | • No to negligible adverse impacts, both short- and long-term | • Short-term negligible to minor adverse impacts;<br>• Long-term beneficial impacts to minor adverse impacts | • Short-term negligible to minor adverse impacts;<br>• Long-term beneficial impacts to minor adverse impacts | • Short-term negligible to minor adverse impacts;<br>• Long-term beneficial impacts to minor adverse impacts |
| **Hazardous and Toxic Materials and Waste** | • No effect | • Short-term minor adverse impacts;<br>• Long-term negligible adverse impacts | • Short-term negligible to moderate / less than significant adverse impacts;<br>• Long-term negligible adverse impacts | • Short-term minor adverse impacts;<br>• Long-term negligible adverse impacts |
| **Human Health and Safety** | • No to negligible adverse impacts, both short- and long-term | • Minor adverse impacts, both short- and long-term | • Minor adverse impacts, both short- and long-term | • Minor adverse impacts, both short- and long-term |
| **Cumulative** | • Moderate / less than significant | • Moderate / less than significant | • Moderate / less than significant | • Moderate / less than significant |

**Table 2. Summary of Environmental Protection Measures to be Adopted**

| Resource Area | Environmental Protection Measures |
|---|---|
| **Land Use** | • Stakeholder coordination/consultation and/or consolidation of infrastructure during the scoping and design.<br>• Incorporation of solar PV projects and ancillary power control systems into the installation's RPMP.<br>• Site designed for compatibility with regulatory requirements (Alternative 2). |
| **Air Quality and GHG** | • Site design to minimize movement of large amounts of dirt (e.g., excavation and fill) (Alternatives 1 and 2).<br>• Dust control measures on the project site and unpaved roads used during construction.<br>• Temporary suspension of excavation and grading activities during periods of high winds.<br>• Emission control devises and vehicle maintenance of construction and maintenance vehicles and equipment.<br>• Emission control equipment if required on stationary back-up power supply.<br>• Adherence to requirements for CAA permit associated with back-up power generation systems, if any. |
| **Noise** | • For projects including back-up generators, site design to appropriately minimize operational noise impacts to sensitive receptors.<br>• Scheduling of construction activities to minimize impacts to noise-sensitive receptors.<br>• Personal hearing protection by appropriate construction personnel.<br>• If maintenance activities would create noise impacting sensitive receptors, maintenance performed at a time to minimize impacts. |
| **Geological and Soil Resources** | • Site design to minimize grading requirements and avoid unique geological features and soils for which there are substantial construction issues (Alternatives 1 and 2). |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Geological and Soil Resources** (con't) | • Site design, on a former landfill site, to consider slope stability and landfill settlement (Alternative 2).<br>• Site design, construction, operation, and maintenance on an IRP site compatible with long-term management requirements and laws and regulations governing the IRP site (Alternative 2).<br>• Site design meets building codes to include, in seismic-prone areas, those codes related to earthquake-resistant construction (Alternative 3).<br>• Site design of transmission lines, when part of project, to maximize placement along existing road disturbance limits and within existing utility easements.<br>• Appropriate geotechnical surveys completed, as required.<br>• Construction permits obtained, as required, and permit requirements adhered to.<br>• Erosion and storm water management control measures on the project site during construction.<br>• Fugitive dust control plan for construction developed and implemented, as required.<br>• Minimize unnecessary soil compaction during construction.<br>• Minimize import or export of earthen material to/from the site.<br>• No soil removal from an IRP site until the installation determines if the soil requires analytical testing (Alternative 2).<br>• Spill prevention and response measures in place for construction and maintenance activities.<br>• During construction, if any scientifically significant paleontological resources are found, should stop work and notify installation's environmental office.<br>• Monitor, by system operator, soil erosion, and investigate and remedy as appropriate.<br>• Maintain vegetation and/or gravel cover under and around the operating solar array system as much as possible. |
| **Water Resources** | • Site design to maximize avoidance of water features and minimize the size of disturbed areas. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Water Resources** (con't) | • If construction in a floodplain anticipated to be unavoidable, undergo process outlined in EO 11988, as amended by EO 13690, which may result in a FONPA.<br>• Site investigation, when warranted, should identify specific contaminants (if any) and existing paths of migration (Alternative 2).<br>• Site design, construction, operation, and maintenance prevents or reduces migration of contaminant (if any are warranted based on the type of contaminant) to off-site surface water or groundwater (Alternative 2).<br>• Site design, on a former landfill site, to consider slope stability and landfill settlement (Alternative 2).<br>• Site design, construction, operation, and maintenance on an IRP site compatible with long-term management requirements and laws and regulations governing the IRP site (Alternative 2).<br>• Site design of transmission lines, when part of project, to maximize placement along existing road disturbance limits and within existing utility easements.<br>• Construction permits obtained, as required, and permit requirements adhered to.<br>• Erosion and storm water management control measures on the project site during construction.<br>• Integrity and functionality of landfill liners are maintained during construction (Alternative 2).<br>• Proper maintenance of vehicles and equipment used for construction and maintenance to avoid spills, leaks, etc.<br>• Post-development vegetation and/or gravel cover appropriate for the ecosystem; vegetation covers shouldn't require watering once established.<br>• Monitor soil erosion (by system operator) and investigate and remedy as appropriate.<br>• Maintain vegetation and/or gravel cover under and around the operating solar array system as much as possible and, for systems (to include transmission lines) potentially impacting shorelines, along the riparian area. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Water Resources** (con't) | • Module cleaning water generally not anticipated to include cleaning chemicals; however, if needed, should be biodegradable and environmentally safe.<br>• For installations in areas where water resources are limited or constrained by current uses, compressed air considered as a replacement for water in order to clean modules.<br>• Module washing scheduling such that washing does not cause excessive run-off.<br>• For solar PV array fields or ESSs adjacent to shorelines, maintenance vehicles avoid the shoreline and, where feasible, stay on hard surface or gravel roads (Alternatives 1 and 2). |
| **Biological Resources** | • Stakeholder coordination/consultation conducted during the scoping and design.<br>• Appropriate biological resources surveys identified and completed in time to inform site design and/or construction activities.<br>• Site selection to avoid biological resources essential to maintaining installation compliance.<br>• Site selection to minimize impacts to biological resources essential to maintaining installation stewardship responsibilities.<br>• Site design incorporates set-back requirements to sensitive habitats and protected species.<br>• Site design to minimize the size of disturbed areas.<br>• Site design, construction, operation, and maintenance on an IRP site compatible with long-term management requirements and laws and regulations governing the IRP site (Alternative 2).<br>• Site design of transmission lines, when part of project, to maximize placement along existing road disturbance limits and within existing utility easements.<br>• Site design should provide means to diminish or break up a lake-like effect of modules so as to reduce the potential of bird strikes.<br>• Site design to minimize potential nesting sites.<br>• Site design to minimize attracting insects to lighting. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Biological Resources** (con't) | • Site design of permanent nighttime lighting to support operations will prioritize use of the lowest illumination possible while still allowing for safe operations.<br>• Site design of permanent nighttime lighting to support operations set at the lowest height possible and shielded so that it would be directed only toward areas needing illumination.<br>• Scheduling of construction activities to minimize impacts to protected species, migratory birds, and sensitive habitats.<br>• Erosion and storm water management control measures on the project site during construction.<br>• Minimize unnecessary soil compaction during construction.<br>• Dust control measures on the project site and unpaved roads used during construction.<br>• Spill prevention and response measures in place for construction and maintenance activities.<br>• Measures taken for construction and maintenance activities to minimize the potential for wildland fire when wildland fire risks are high.<br>• Appropriate monitoring and/or cleaning of equipment and vehicles to avoid transportation of noxious, invasive and pest species and minimize spread of non-native noxious, invasive, or pest pioneer species.<br>• Landfill liners not impacted during construction (Alternative 2).<br>• Construct overhead transmission lines in accordance with avian protection guidelines.<br>• Replace and re-vegetate top soil removed for grading.<br>• Post-development vegetation and/or gravel cover appropriate for the ecosystem; preference in plant selection should be for native plants and take into consideration the wildlife species they support and natural resources management objectives to attract or detract select wildlife species; vegetation covers shouldn't require watering once established.<br>• Monitor, by system operator, soil erosion, and investigate and remedy as appropriate.<br>• Maintain vegetation and/or gravel cover under and around the operating solar array system as much as possible. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Biological Resources** (con't) | • Avoid accidental fatalities to small wildlife when mowing, to the extent practicable.<br>• Apply seasonal restrictions to mowing, if appropriate.<br>• Construct, operate, and maintain solar PV project in adherence to the installation's INRMP and IPMP. |
| **Cultural Resources** | • Stakeholder coordination/consultation conducted during the scoping and design.<br>• If proposed site hasn't been surveyed for cultural resources, complete survey.<br>• Site design to minimize the size of disturbed areas.<br>• Site design incorporates cultural resource sensitivities in order to reduce impacts.<br>• Site design to minimize the effect of potential impacts to historic properties.<br>• Site design to avoid substantive direct impacts to cemeteries.<br>• Site design incorporates appropriate set-back requirements, if any, for affected cultural resources.<br>• Site design of transmission lines, when part of project, to maximize placement along existing road disturbance limits and within existing utility easements.<br>• For sites adjacent to a cemetery, off-limits criteria should be established for solar PV system construction and maintenance workers.<br>• Pre-construction access for visitation and maintenance to cemeteries impacted by solar PV construction would be maintained.<br>• Complete appropriate pre-disturbance surveys for cultural resources as part of the NHPA Section 106 process.<br>• Execute appropriate requirements described in a MOA, if applicable, as a result of the NHPA Section 106 process.<br>• Storm water management control measures on the project site during construction. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Cultural Resources** (con't) | • During construction, if any human remains or possible cultural resources are found, then stop work, notify the cultural resource manager, and adhere to applicable legal and regulatory requirements.<br>• Construct, operate, and maintain solar PV project in adherence to the installation's ICRMP. |
| **Socioeconomics** | • Site selection process confirms no disproportional adverse impacts would occur to low income or minority populations.<br>• Site design appropriately considers trade-offs, if applicable, of solar PV project versus conservation reimbursable programs (e.g., forestry and agricultural/grazing outleases).<br>• Site design to avoid substantial loss or displacement of recreational opportunities and resources relative to the baseline.<br>• For the protection of children, store construction vehicles, equipment, and materials in fenced areas and secure when not in use.<br>• If the project site is located within reasonable walking or bicycling distance of children, with no existing security measures restricting access to the proposed site, erect a security fence and gate, with 'no trespassing' signs.<br>• If the proposed project includes construction of a substation, or ESS, erect a permanent security fence, with 'no trespassing' signs, around the assets. |
| **Transportation and Traffic** | • Potential limitations of what ACPs construction vehicles may be permitted to use.<br>• Potential scheduling limitations to avoid use of poorly rated roads and intersections by construction vehicles during peak usage times.<br>• Erosion and storm water management control measures.<br>• If and as needed, temporary short-term road closures to ensure safety (Alternative 3).<br>• Coordination with the FAA and installation aviation organizations for sites proposed near or adjoining an airfield. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Transportation and Traffic** (con't) | • Coordination with installation low-level aviation trainers and/or the Test Center Commander when above-ground power distribution lines are part of the proposed project. |
| **Airspace** | • Completion of a solar glint/glare hazard evaluation.<br>• Site design features to select material to minimize potential solar glare.<br>• Site design of permanent nighttime lighting to support operations set at the lowest height possible and shielded so that it would be directed only toward areas needing illumination.<br>• Coordination conducted with installation aviation organizations and/or the Test Center Commander. |
| **Electromagnetic Spectrum** | • Stakeholder coordination conducted during the scoping and design.<br>• Site selection and site design to avoid or minimize electromagnetic interference between signal generation points and receivers. |
| **Utilities** | • Project design to be compatible with existing grid system.<br>• Temporary restroom facilities provided for construction workers include disposal services to a permitted wastewater treatment facility (contractor responsibility).<br>• Construction contractor's C&D waste management plan should support the Army's 50 percent minimum diversion of C&D waste, by weight, from landfill disposal.<br>• If material was on the selected site, should process pre-existing concrete and masonry materials into recycled concrete aggregate (Alternative 2). |
| **Hazardous and Toxic Materials and Waste** | • Spill prevention and response measures in place for construction and maintenance activities, to include plans, if appropriate, for other hazardous material encounters (e.g., asbestos, under Alternative 3).<br>• Proper maintenance of vehicles and equipment used for construction and maintenance to avoid spills, leaks, etc. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Hazardous and Toxic Materials and Waste** (con't) | • Proper disposal of all hazardous waste generated during construction and maintenance, in compliance with applicable laws and regulations.<br>• For lined and/or capped sites, site design to consider slope stability and settlement and the continued need for maintaining the functionality of any existing cap and liner (Alternative 2).<br>• Site design, construction, operation, and maintenance (e.g., on an IRP site) compatible with long-term management requirements and laws and regulations governing the site (Alternative 2).<br>• Hazardous building material inventories, if appropriate (Alternative 3).<br>• Use of protective gear and equipment by construction and maintenance workers to minimize potential impacts from hazardous material. |
| **Human Health and Safety** | • Site design appropriately considers the type, scope, and extent of the contaminant, if any (Alternatives 2 and 3).<br>• Site design considers safety of maintenance personnel and roof access for firefighters.<br>• Site design to minimize potential nesting sites, especially by birds which actively defend their nest (Alternative 3).<br>• No project permitted within SDZs without explosives safety approvals for a waiver of safety regulations.<br>• For a solar PV array, ESS, or back-up generator mounted at ground level, wiring is protected from ready access.<br>• As appropriate, MEC survey completed.<br>• If any evidence of MECs are encountered on the site during construction or operation and maintenance, cease work immediately and remain stopped until the appropriate military office has been notified and appropriate clearance procedures have been completed.<br>• Limit access to the construction site to authorized personnel.<br>• Construction vehicles, equipment, and materials stored in fenced areas and secured when not in use. |

**Table 2. Summary of Environmental Protection Measures to be Adopted** (con't)

| Resource Area | Environmental Protection Measures |
|---|---|
| **Human Health and Safety** (con't) | • Develop and implement comprehensive construction health and safety plan which addresses site specific health and safety issues, including specific emergency response services and procedures and evacuation measures (contractor responsibility).<br>• Maintain and use safety tools and equipment for appropriate construction and maintenance activities.<br>• Use of pesticides and herbicides is in adherence to the installation's IPMP.<br>• Use of protective gear and equipment by construction and maintenance workers to minimize potential health hazards and accidents and potential impacts from hazardous material.<br>• Firefighters should be trained to identify and mitigate potential hazards associated with solar PV modules at the site of an emergency. |

## Table 3. Matrix of Environmental Effects from Solar PV Projects

B = Beneficial (and less than significant) NE = No Effect N = Negligible M = Minor Effect LS = Moderate / Less than Significant Effect SM = Significant but Mitagable S = Significant - = Not Evaluated

| Location / Coverage (Reference Citation) | Generating Capacity and Land Area (acres *[hectares]*) | Land Use | Air Quality & GHG | Noise | Geological & Soil Resources | Water Resources | Biological Resources | Cultural Resources | Socioeconomics | Transportation & Traffic | Airspace | Electromagnetic Spectrum | Utilities | Haz. & Toxic Materials & Waste | Human Health & Safety | Cumulative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Army-wide: this PEA | <1 kW - 100 MW / site<br>------------<br>rooftops to 700 ac *[283 ha]* / site | NE-M | B-M | B-M | N-LS | N-LS | N-LS | N-LS | B-LS | N-LS | NE-N | NE-LS | B-M | N-LS | M | LS |
| Army-wide: Army Net Zero PEA (DA, 2012a) | not specified | M-SM | M | M | N | M | M | M | N | - | N | - | NE | M | M | M |
| Anniston Army Depot (Anniston AD, 2015) | 10 MW<br>------------<br>92 ac *[37 ha]* | NE | M | NE-N | NE-M | NE | NE-M | NE | B-NE | NE-N | NE | - | B-N | N | - | NE-M |
| U.S. Army Garrison Fort Benning (Fort Benning, 2014) | 30 MW<br>------------<br>250 ac *[101 ha]* | M | LS-SM | N | LS | M | M | N-LS | B-N | N | N | - | B-N | N-M | - | LS |
| U.S. Army Garrison Fort Bliss (Fort Bliss, 2012) | up to 30.6 MW total<br>------------<br>32 - 234 ac *[13 - 95 ha]* / site (up to 420 ac *[170 ha]* total) | M | B-M | M | LS | NE-N | M | NE | B-NE | NE-N | N | N-M | B | M | N | LS |
| U.S. Army Garrison Fort Bliss (Fort Bliss, 2014) | > 1 MW<br>------------<br>10 ac *[4 ha]* | M-LS | B-LS | N | N-LS | B-LS | M-LS | M-SM | B-N | NE-LS | NE-LS | - | B | N | - | LS |
| U.S. Army Garrison Fort Bragg (Fort Bragg, 2012) | 1 MW<br>------------<br>5 ac *[2 ha]* | LS | N | N | NE | N | LS | NE | NE | NE | - | - | NE | NE | N | LS |

## Table 3. Matrix of Environmental Effects from Solar PV Projects (con't)

| Location / Coverage (Reference Citation) | Generating Capacity and Land Area (acres *[hectares]*) | Land Use | Air Quality & GHG | Noise | Geological & Soil Resources | Water Resources | Biological Resources | Cultural Resources | Socioeconomics | Transportation & Traffic | Airspace | Electromagnetic Spectrum | Utilities | Haz. & Toxic Materials & Waste | Human Health & Safety | Cumulative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B = Beneficial (and less than significant) NE = No Effect N = Negligible M = Minor Effect LS = Moderate / Less than Significant Effect SM = Significant but Mitagable S = Significant - = Not Evaluated | | | | | | | | | | | | | | | | |
| U.S. Army Garrison Fort Bragg (Fort Bragg, 2015) | 10 MW ------------ 80 ac *[32 ha]* | N | N | N | NE | N | N | NE | NE | NE | - | - | NE | NE | N | M |
| U.S. Army Garrison Fort Buchanan (Fort Buchanan, 2010) | 218 - 558 kW / site (1,260 kW total) ------------ rooftop | NE | B-N | NE-M | NE | NE-N | NE | NE | B-NE | NE-N | - | - | NE-N | N | - | N |
| U.S. Army Garrison Fort Carson (Fort Carson, 2012) | watts - kW-size and1.8 - 219 MW / site------------rooftops and3 - 361 ac *[1.2 - 146 ha]* / site(up to 1,303 ac *[527 ha]* total) | LS | B-LS | N-LS | LS | LS | LS-SM | LS-SM | B-N | N-LS | N-LS | - | LS | LS | - | LS |
| U.S. Army Garrison Fort Gordon (Fort Gordon, 2014) | 30 MW ------------ 250 ac *[101 ha]* | M-LS | B-M | NE-M | M | M | NE-M | NE | BE-M | NE | NE | NE-M | NE-B | M | - | NE |
| U.S. Army Garrison Fort Hood (Fort Hood, 2014) | 40 MW ------------ 266 ac *[108 ha]* | M | M | NE-N | M | M | M | M | NE | NE-N | M | - | B | M | - | M |
| U.S. Army Garrison Fort Huachuca (Fort Huachuca, 2010) | <1 kW - MW-size / site ------------ rooftops to 400 ac *[162 ha]* / site | NE-LS | B-M | NE-M | NE-LS | NE-LS | B-LS | NE-LS | B-NE | NE-M | LS | N | B-N | N-M | N | B-M |

**Table 3. Matrix of Environmental Effects from Solar PV Projects** (con't)

| Location / Coverage (Reference Citation) | Generating Capacity and Land Area (acres *[hectares]*) | Land Use | Air Quality & GHG | Noise | Geological & Soil Resources | Water Resources | Biological Resources | Cultural Resources | Socioeconomics | Transportation & Traffic | Airspace | Electromagnetic Spectrum | Utilities | Haz. & Toxic Materials & Waste | Human Health & Safety | Cumulative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B = Beneficial (and less than significant) NE = No Effect N = Negligible M = Minor Effect LS = Moderate / Less than Significant Effect SM = Significant but Mitagable S = Significant - = Not Evaluated | | | | | | | | | | | | | | | | |
| U.S. Army Garrison Fort Huachuca (Fort Huachuca, 2014) | 25 MW ------------ 155 ac *[63 ha]* | N-M | B-M | NE-M | LS | LS | LS | LS | B-NE | N | N | N | B-N | N-M | B-N | B-M |
| U.S. Army Garrison - Fort Stewart (Fort Stewart, 2014) | 2 - 30 MW / site (up to 55 MW total) ------------ 19 - 200 ac *[19 - 81 ha]* / site (up to 350 ac *[142 ha]* total) | NE | NE | NE | NE-M | NE-M | NE-M | NE | NE | NE | - | - | B-LS | NE | NE-M | B-M |
| Parks Reserve Forces Training Area (PRFTA, 2013) | 2 MW ------------ 10 ac *[4 ha]* | N | B-NE | NE-N | NE-N | N | N | NE | NE-N | NE | - | - | B-NE | NE | NE | M |
| Sierra Army Depot (Sierra AD, 2014) | 2.5 MW ------------ 13 - 30 ac *[5 - 12 ha]* | N | BM | N | N-M | N | N-M | N | B-N | N | N | - | N | N-M | - | N-M |
| U.S. Army Garrison West Point (West Point, 2014) | 5,000 watts - 3 MW / site (up to 8.15 MW total) ------------ rooftops to 6 ac *[2.4 ha]* | N-M | B-M | N-M | N-M | N-M | N-M | NE-LS | B-N | N-M | - | - | B-M | N-M | - | B-LS |

**Table 3. Matrix of Environmental Effects from Solar PV Projects** (con't)

| Location / Coverage (Reference Citation) | Generating Capacity and Land Area (acres *[hectares]*) | Land Use | Air Quality & GHG | Noise | Geological & Soil Resources | Water Resources | Biological Resources | Cultural Resources | Socioeconomics | Transportation & Traffic | Airspace | Electromagnetic Spectrum | Utilities | Haz. & Toxic Materials & Waste | Human Health & Safety | Cumulative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B = Beneficial (and less than significant) NE = No Effect N = Negligible M = Minor Effect LS = Moderate / Less than Significant Effect SM = Significant but Mitagable S = Significant - = Not Evaluated | | | | | | | | | | | | | | | | |
| multiple California Naval installations (Navy, 2016) | 180 kW - 0.61 MW / site------------rooftops to18.5 ac / site(total up to 40.26) | NE-N | B-M | NE-M | N-M | NE-LS | NE-LS | NE-M | B-M | NE-M | - | N | B-N | N-M | N | LS |
| Naval Air Station Lemoore (Lemoore, 2015) | 20 - 390 MW (up to 390 MW total) ------------ 140 - 2,730 ac / site *[57-1,105 ha / site]* (up to 2,730 ac *[ 1,105 ha]* total) | N | B-M | N | LS | NE-N | NE-LS | LS | B-LS | NE-M | N | N | B-N | N | N | LS |
| Naval Base Ventura County, Port Hueneme (Port Hueneme, 2015) | up to 10 MW total ------------ 0.75 - 28 ac *[0.3 - 11 ha]* / site (up to 45 ac *[18 ha]* total) | N | B-M | NE-N | N | NE-LS | LS | NE | B-NE | NE-M | - | - | B-M | N-LS | N-M | LS |
| Marine Corps Base Camp Pendleton (Camp Pendleton, 2015) | 1 - 20 MW / site (up to 39 MW total) ------------ 6 - 139 ac *[2.4 - 56 ha]* / site (up to 272 ac *[110 ha]* total) | LS | B-M | NE-N | NE-M | N-LS | N-LS | LS | NE | NE-N | - | - | B-M | N-LS | NE-N | LS |

## **Table 3. Matrix of Environmental Effects from Solar PV Projects** (con't)

| Location / Coverage (Reference Citation) | Generating Capacity and Land Area (acres *[hectares]*) | Land Use | Air Quality & GHG | Noise | Geological & Soil Resources | Water Resources | Biological Resources | Cultural Resources | Socioeconomics | Transportation & Traffic | Airspace | Electromagnetic Spectrum | Utilities | Haz. & Toxic Materials & Waste | Human Health & Safety | Cumulative |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B = Beneficial (and less than significant) NE = No Effect N = Negligible M = Minor Effect LS = Moderate / Less than Significant Effect SM = Significant but Mitagable S = Significant - = Not Evaluated | | | | | | | | | | | | | | | | |
| Nellis Air Force Base (Nellis AFB, 2011) | 18 MW ------------ 160 ac *[65 ha]* | NE | B-M | NE-N | NE-M | NE-M | M | NE | B-NE | NE-M | N | - | B-NE | N-M | N | B-LS |
| Bureau of Land Management land in six southwestern states (BLM/DOE, 2012) | ≥ 20 MW / site (up to 23,791 MW total) ------------ (up to 19,285,000 ac *[7,804,363 ha]* total) | S | B-M | M | SM | LS | S | SM | B | LS | LS | LS | LS | LS | LS | S |
| Minnesota Public Utilities Commission; Aurora Distributed Solar site permit application (MDC, 2015) | 1.5 - 10 MW / site (up to 100,000 MW) ------------ 13 - 108 ac *[5 - 44 ha]* / site (up to 1,200 ac *[486 ha]* total) | LS | M | NE-M | LS | LS | LS | NE-LS | B-N | NE-M | NE-LS | N | NE-LS | N-M | N | LS |

# 7.0 REFERENCES


7 U.S.C. § 136 *et seq.* Federal Insecticide, Fungicide, and Rodenticide Act of 1996, as amended.

7 C.F.R. Part 658. Farmland Protection Policy Act.

7 U.S.C. §§ 4201-4209. Farmland Protection Policy.

10 U.S.C. § 2667. Leases: non-excess property of military departments and Defense Agencies.

10 U.S.C. § 2684. Cooperative agreements for management of cultural resources.

10 U.S.C. § 2684a. Agreements to limit encroachments and other constrains on military training, testing, and operations.

10 U.S.C. § 2911. Energy performance goals and master plan for the Department of Defense. 2009.

15 U.S.C. § 2601 *et seq.* Toxic Substances Control Act of 1976, as amended.

16 U.S.C. §§ 470aa-470mm. Archaeological Resources Protection Act of 1979, as amended.

16 U.S.C. §§ 470aaa *et seq.* Paleontological Resources Preservation Act of 2009

16 U.S.C. § 668 *et seq.* Bald and Golden Eagle Protection Act of 1940, as amended.

16 U.S.C. § 670 *et seq.* Sikes Act of 1960, as amended.

16 U.S.C. § 703 *et seq.* Migratory Bird Treaty Act of 1918, as amended.

16 U.S.C. § 1361 *et seq.* Marine Mammal Protection Act of 1972, as amended.

16 U.S.C. §§ 1451-1464, Coastal Zone Management Act of 1972, as amended.

16 U.S.C. § 1531 *et seq.* Endangered Species Act of 1973, as amended.

16 U.S.C. § 2901 *et seq.* Fish and Wildlife Conservation Act (“Nongame Act”) of 1980, as amended.

25 U.S.C. § 3001 *et seq.* Native American Graves Protection and Repatriation Act of 1990, as amended.

29 U.S.C. § 651 *et. seq.* Occupational Safety and Health Act of 1970, as amended.

32 C.F.R. Part 179. Munitions Response Site Prioritization Protocol (MRSPP).

32 C.F.R. Part 651. Environmental Analysis of Army Actions.

33 U.S.C. § 1251 et. seq. Clean Water Act of 1972, as amended (originally titled Federal Water Pollution Control Act of 1948, as amended).

36 C.F.R. Part 79. Curation of Federally-Owned and Administered Archeological Collections.

40 C.F.R. Part 51, Subpart W. Determining Conformity of General Federal Actions to State or Federal Implementation Plans.

40 C.F.R. Part 1500 *et seq.* Council in Environmental Quality, Executive Office of the President, Regulations For Implementing The Procedural Provisions Of The National Environmental Policy Act.

42 U.S.C. § 82. Solid Waste Disposal Act, as amended.

42 U.S.C. § 116. Emergency Planning and Community Right-to-Know Act of 1986, as amended.

42 U.S.C. § 300f *et seq.* Title XIV of The Public Health Service Act: Safety of Public Water Systems (Safe Drinking Water Act) of 1974, as amended

42 U.S.C. § 1996. American Indian Religious Freedom Act of 1978, as amended (Protection and preservation of traditional religions of Native Americans)

42 U.S.C. § 4321 *et seq.* National Environmental Policy Act of 1969, as amended.

42 U.S.C. § 4901 *et seq.* Noise Control Act of 1972, as amended.

42 U.S.C. § 6901 *et seq.* Resource Conservation and Recovery Act of 1976, as amended.

42 U.S.C. § 7401 *et seq.* The Clean Air Act of 1970, as amended.

42 U.S.C. § 9601. Comprehensive Environmental Response, Compensation, and Liability Act of 1980, “Superfund”, as amended.

42 U.S.C. § 11001 *et seq.* Emergency Planning and Community Right-to-Know Act of 1986, as amended.

42 U.S.C. § 13201 *et seq.* Energy Policy Act of 2005.

43 C.F.R. Part 3. Preservation of American Antiquities.

49 U.S.C. § 44718. Structures interfering with air commerce.

50 C.F.R. § 10.13. List of Migratory Birds.

54 U.S.C. § 300101 *et seq.* The National Historic Preservation Act of 1966, as amended.

AEC, 1999. *User's Guide for Source Water Assessment and Protection at U.S. Army Installations*. Prepared by the U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, MD. Prepared in collaboration with the U.S. Geological Survey, Washington, D.C. Sponsored by the U.S. Army Environmental Center, Aberdeen Proving Ground, MD. 1999.

AEC, 2005. *Department of Defense installation Watershed Impact Assessment Protocol – A Water Resources Management Guide*. Prepared by the Logistics Management Institute, McLean, VA. Sponsored by the U.S. Army Environmental Center, Aberdeen Proving Ground, MD. June 2005.

AEC, 2016a. "Historic Buildings and Landscapes," U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. June 2016. Accessed on June 14, 2016 at: http://aec.army.mil/Services/Preserve/HistoricBuildingandLandscapes.aspx.

AEC, 2016b. "Conservation Reimbursable and Fee Collection Program." U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. Accessed on September 12, 2016 at: https://www.aec.army.mil/Services/Conserve/ConservationReimbursablePrograms.aspx.

Anniston AD, 2015. *Final Environmental Assessment for the Construction and Operation of Photovoltaic Power Generation Facility at Anniston Army Depot*. Prepared for Anniston Army Depot, Bynum, AL. July 2015.

APA, 2006. American Planning Association; Steiner, Frederick R.; and Butler, Kent. *Planning and Urban Design Standards, Student Edition*. September 2006. Published by John Wiley & Sons, Inc., Hoboken, NJ.

APLIC, 2006. *Suggested Practices for Avian Protection On Power Lines: The State of the Art in 2006*. Avian Power Line Interaction Committee, Edison Electric Institute, and the California Energy Commission. Washington, D.C. and Sacramento, CA. 2006.

APLIC, 2012. *Reducing Avian Collisions with Power Lines: The State of the Art in 2012*. Avian Power Line Interaction Committee, Edison Electric Institute, and the California Energy Commission. Washington, D.C. October 2012.

Audubon, 2016. Conservation – Saving Important Bird Areas. National Audubon Society, Manhattan, NY. Accessed on June 10, 2016 at: http://www.audubon.org/conservation/saving-important-bird-areas.

BLM/DOE, 2012. *Final Programmatic Environmental Impact Statement (PEIS) for Solar Energy Development in Six Southwestern States* (FES 12-24 ● DOE/EIS-0403). Prepared for the U.S. Department of the Interior Bureau of Land Management and U.S. Department of Energy for locations in Arizona, California, Colorado, Nevada, New Mexico, and Utah. Bureau of Land Management, Washington, D.C. July 2012. Record of Decision signed October 12, 2012.

Camp Pendleton, 2015. *Final Environmental Assessment for Construction, Operation, and Decommissioning of a Solar Photovoltaic System at Marine Corps Base Camp Pendleton, California*. Prepared by U.S. Department of Navy, Naval Facilities Engineering Command Southwest, San Diego, CA. Prepared for U.S. Department of the Navy and U.S. Marine Corps. November 2015. Finding of No Significant Impact signed December 10, 2015.

CEQ, 2010. *Guidance on Federal Greenhouse Gas Accounting and Reporting.* Council on Environmental Quality, Washington, D.C: Executive Office of the President. October 2010.

CEQ. 2014. *Effective Use of Programmatic NEPA Reviews*. Washington, D.C. Council on Environmental Quality, Washington, D.C. December 18, 2014.

Crowley, 2013. Crowley, Michael, Contributor. "Rethinking Solar Array Field Conventions." *The S.U.N.Report – SolarEnergyWorld US News*. June 18, 2013. Available at: http://www.solarenergyworld.com/2013/06/21/rethinking-solar-array-field-conventions/.

CRS, 2012. *U.S. Solar Photovoltaic Manufacturing: Industry Trends, Global Competition, Federal Support*. Congressional Research Service, Washington, D.C. June 13, 2012.

DA, 1982. *DA Pamphlet 700-16 – The Army Ammunition Management System*. Department of the Army, Washington, D.C. December 1, 1982.

DA, 1995. "General Conformity Under the Clean Air Act –- Policy and Guidance" Memorandum. Assistant Chief of Staff for Installation Management; Headquarters, Department of the Army. Washington, D.C. June 27, 1995.

DA, 1997a. *Army Regulation 405-80 – Management of Title and Granting Use of Real Property*. Department of the Army, Washington, D.C. October 10, 1997.

DA, 1997b. *Army Regulation 608-10 – Child Development Services*. Department of the Army, Washington, D.C. July 15, 1997.

DA, 2001. "Army Policy Guidance for Management and Control of Invasive Species." Department of the Army, Assistant Chief of Staff for Installation Management, Washington, D.C. June 26, 2001.

DA, 2005a. *Army Regulation 350-19 – The Army Sustainable Range Program*. Headquarters, Department of the Army, Washington, D.C. August 30, 2005.

DA, 2005b. *Army Regulation* 210-20 *Real Property Master Planning for Army Installations*. Headquarters, Department of the Army, Washington, D.C. May 16, 2005.

DA, 2007. *Army Regulation 200-1 – Environmental Protection and Enhancement*. Headquarters, Department of the Army, Washington, D.C. December 13, 2007.

DA, 2008a*. Master Planning Technical Manual*, Headquarters, Department of the Army. Washington, D.C. August 2008.

DA, 2008b. *Army Regulation 710-2 – Supply Policy Below the National Level*. Headquarters, Department of the Army. Washington, D.C. March 28, 2008.

DA, 2012a. *Programmatic Environmental Assessment Army Net Zero Installations*, Headquarters, Department of the Army. Washington, D.C. July 2012. Finding of No Significant Impact signed October 2, 2012.

DA, 2012b. *Army Regulation 420-1 – Army Facilities Management*. Headquarters, Department of the Army. Washington, D.C. Rapid Action Revision, August 24, 2012.

DA, 2012c. *Army Regulation 385-63 / MCO 3570.1C – Range Safety*. Headquarters, Department of the Army. Washington, D.C. Rapid Action Revision, January 30, 2012.

DA, 2012d. "Energy Goal Attainment Responsibility Policy for Installations" Memorandum. Assistant Secretary of the Army for Installations, Energy and Environment; Headquarters, Department of the Army. Washington, D.C. August 24, 2012. Available at: http://army-energy.hqda.pentagon.mil/policies/key_directives.asp.

DA, 2013a. *Army Regulation 385-10 – Army Safety Program*. Headquarters, Department of the Army. Washington, D.C. November 27, 2013.

DA, 2013b. "Sustainable Design and Development Policy Update" Memorandum. Assistant Secretary of the Army for Installations, Energy and Environment; Headquarters, Department of the Army. Washington, D.C. December 16, 2013. Available at: http://army-energy.hqda.pentagon.mil/policies/key_directives.asp.

DA, 2014a. *U.S. Army Sustainability Report 2014*. Headquarters, Department of the Army. Washington, D.C. September 24, 2014.

DA, 2014b. *Department of the Army Pamphlet 385-63 – Range Safety*. Headquarters, Department of the Army. Washington, D.C. Rapid Action Revision, April 16, 2014.

DA, 2015a. "FY14 Army Environmental Universe," Headquarters, Department of the Army, Assistant Chief of Staff for Installation Management. Washington, D.C. February 2015.

DA, 2015b. *Energy Security & Sustainability ($ES^2$) Strategy*. Department of the Army, Washington, D.C. May 1, 2015.

DA, 2015c. “Army Universe Chart,” Headquarters, Department of the Army. Washington, D.C. September 30, 2015.

DA, 2015d. *Army Regulation 700-141 – Hazardous Materials Information Resource System*. Headquarters, Department of the Army, Washington, D.C. September 30, 2015.

DA, 2016a. “FY16 Army Environmental Universe.” Headquarters, Department of the Army, Assistant Chief of Staff for Installation Management. Washington, D.C. February 1, 2016.

DA, 2016b. *Department of the Army FY 2015 Annual Energy Management Report*. Department of the Army, Washington, D.C. February 17, 2016.

DA, 2016c. *Army Regulation 95-2 – Air Traffic Control, Airspace, Airfields, Flight Activities, and Navigational Aids*. Headquarters, Department of the Army. Washington, D.C. April 30, 2016.

DA, 2016d. *Army Regulation 5-12 – Army Use of the Electromagnetic Spectrum*. Headquarters, Department of the Army. Washington, D.C. February 15, 2016.

DA, 2016e. “Dugway Proving Ground new solar array celebrates with ribbon-cutting ceremony.” Department of the Army, Washington, D.C. July 19, 2016. Available at: https://www.army.mil/article/171754/dugway_proving_ground_new_solar_array_celebrates_with_ribbon_cutting_ceremony.

DA, 2016f. “Massive Detrick solar array only a fraction of Army’s renewable energy capacity.” Department of the Army, Washington, D.C. June 22, 2016. Available at: https://www.army.mil/article/170027/massive_detrick_solar_array_only_fraction_of_armys_renewable_energy_capacity.

DLA, 2007. *DLAD 4145.41 / AR 700-143 / Naval Supply Corps System Command Instruction (NAVSUPINST) 4030.55C / Air Force Instruction (AFI) 24-210(I) / and Marine Corps Order (MCO) 4030.40 – Packaging of Hazardous Material*. Defense Logistics Agency, Fort Belvoir, Virginia. October 2007.

DoD, 2008. *Unified Facilities Criteria (UFC) – DoD Security Engineering Facilities Planning Manual (UFC 4-020-01)*. Department of Defense, Washington, D.C. September 11, 2008.

DoD, 2009. *Department of Defense Instruction Number 6055.4 – DoD Traffic Safety Program*. Department of Defense, Washington, D.C. April 20, 2009, as amended.

DoD, 2011. *Department of Defense Instruction Number 6055.07 – Mishap Notification, Investigation, Reporting, and Record Keeping*. Department of Defense, Washington, D.C. June 2011.

DoD, 2012. *Unified Facilities Criteria (UFC) – Installation Master Planning (UFC 2-100-01)*. Department of Defense, Washington, D.C. May 15, 2012.

DoD, 2013a. “Threatened and Endangered Species on DoD Lands.” Department of Defense, Washington, D.C. May 24, 2013. Accessed on June 2, 2015 at: http://www.dodnaturalresources.net/files/TE__s_fact_sheet_5-24-13.pdf.

DoD, 2013b. *Department of Defense Directive Number 5030.19 – DoD Responsibilities on Federal Aviation*. Department of Defense, Washington, D.C. September 13, 2013.

DoD, 2014. *Department of Defense Instruction Number 6055.01 – DoD Safety and Occupational Health (SOH) Program*. Department of Defense, Washington, D.C. October 14, 2014.

Doosan, 2014. “PureCell Model 400 Fuel Cell System” Datasheet. Doosan Fuel Cell America, Inc., South Windsor, CT. 2014. Accessed on August 8, 2016 at: http://www.doosanfuelcell.com/attach_files/link/PureCell%20Model%20400%20Datasheet.pdf.

EITF. 2012. Army Energy Initiative Task Force (EITF) Solar Module Reflectivity Information Paper: Fort Stewart, GA. 2012.

EO 11988. *Executive Order 11988 – Floodplain Management*. The White House, Washington, D.C. May 24, 1977.

EO 12898. *Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*. The White House, Washington, D.C. February 11, 1994.

EO 13007. *Executive Order 13007 – Indian Sacred Sites*. The White House, Washington, D.C. May 24, 1996.

EO 13045. *Executive Order 13045 – Protection of Children From Environmental Health Risks and Safety Risks*. The White House, Washington, D.C. April 21, 1997.

EO 13112. *Executive Order 13112 – Invasive Species*. The White House, Washington, D.C. February 3, 1999.

EO 13186. *Executive Order 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds.* The White House, Washington, D.C. January 10, 2001.

EO 13690. *Executive Order 13690 – Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*. The White House, Washington, D.C. January 30, 2015.

EO 13693. *Executive Order 13693 – Planning for Federal Sustainability in the Next Decade*. The White House, Washington, D.C. March 19, 2015.

EPA, 2015a. "RE-Powering America's Land Initiative: Renewable Energy on Potentially Contaminated Land, Landfills and Mine Sites." U.S. Environmental Protection Agency, Washington, D.C. July 2015. Available at: http://www.epa.gov/oswercpa/docs/re_powering_program_overview.pdf.

EPA, 2015b. Sole Source Aquifer Protection Program. U.S. Environmental Protection Agency, Washington, D.C. Accessed on April 14, 2015 at: http://water.epa.gov/infrastructure/drinkingwater/sourcewater/protection/solesourceaquifer.cfm.

EPA, 2015e. Ecoregion Maps and GIS Resources. U.S. Environmental Protection Agency, Western Ecology Division, Corvallis, OR. March 30, 2015. Accessed on June 1, 2015 at: https://www.epa.gov/eco-research/ecoregions-north-america.

EPA, 2016a. Climate Impacts on Human Health. U.S. Environmental Protection Agency, Washington, D.C. Accessed on June 10, 2016 at: https://www3.epa.gov/climatechange/impacts/health.html.

EPA, 2016b. "Mandatory Class I Areas" -- Map of Visibility Program Protected Areas. U.S. Environmental Protection Agency, Washington, D.C. Accessed on September 12, 2016 at: https://www.epa.gov/sites/production/files/2016-02/npsmap_basemap_classi_11x17.jpg.

FAA, 2010. *Technical Guidance for Evaluating Selected Solar Technologies on Airports*. Federal Aviation Administration, Washington, D.C. November 2010.

FAA, 2011. *Airport Cooperative Research Program (ACRP) Synthesis 28 – Investigating Safety Impacts of Energy Technologies on Airports and Aviation*. Airport Cooperative Research Program, Transportation Research Board, sponsored by the Federal Aviation Administration. Washington, D.C. 2011.

FAA, 2015. Airport Environmental Program – Interim Solar Guidance. Federal Aviation Administration, Washington, D.C. Accessed on May 20, 2015 at: http://www.faa.gov/airports/environmental/.

FEMA, 2015a. Flood Zones. Federal Emergency Management Agency, Washington, D.C. Accessed on April 16, 2015 at: https://www.fema.gov/floodplain-management/flood-zones.

FEMA, 2015b. *Guidelines for Implementing Executive Order 11988, Floodplain Management, and Executive Order, 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*. Federal Emergency Management Agency, Washington, D.C. October 8, 2015. Available at: http://energy.gov/sites/prod/files/2015/10/f27/FloodPlainsGuidlines2015.pdf.

Fort Benning, 2014. *Final Environmental Assessment for Implementation of a 30 MW PV Solar Facility at Fort Benning*, Georgia. Prepared for U.S. Army Garrison Fort Benning, GA. Prepared by U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. July 2014. Finding of No Significant Impact signed September 10, 2014.

Fort Bliss, 2012. *Final Environmental Assessment – Solar Photovoltaic Facilities on the Training Ranges, Fort Bliss, Texas and New Mexico*. Prepared by U.S. Army Corps of Engineers, Tulsa District, Tulsa, OK; U.S. Army Environmental Command, Fort Sam Houston, TX; and Fort Bliss TX. August 2012. Finding of No Significant Impact signed September 9, 2012.

Fort Bliss, 2014. *Final Environmental Impact Statement for the Implementation of Energy, Water, and Solid Waste Sustainability Initiatives at Fort Bliss, Texas and New Mexico*. Prepared for U.S. Army Garrison Fort Bliss, TX / NM. December 2013. Record of Decision signed June 20, 2014.

Fort Bragg, 2012. *Programmatic Environmental Assessment for the Construction and Operation of Photovoltaic Farms at Fort Bragg, North Carolina*. Prepared for U.S. Army Garrison Fort Bragg, NC. May 2012. Finding of No Significant Impact signed November 6, 2012.

Fort Bragg, 2015. *Supplemental Environmental Assessment and Finding of No Significant Impact for the Construction and Operation of a Photovoltaic Farm at Fort Bragg Military Reservation, North Carolina*. Prepared by U.S. Army Garrison, Fort Bragg, NC. December 2014. Finding of No Significant Impact signed February 9, 2015.

Fort Buchanan, 2010. *Environmental Assessment for Implementation of: Energy Savings Performance Contract, United States Army Garrison at Fort Buchanan, Guaynabo, Puerto Rico, and U.S. Army Reserve Centers*. Prepared for U.S. Army Garrison Fort Buchanan, Puerto Rico. October 2010. Finding of No Significant Impact signed October 28, 2010.

Fort Carson, 2012. *Fort Carson Net Zero Waste, Water, and Energy Implementation Final Environmental Assessment and Finding of No Significant Impact*. Prepared for U.S. Army Garrison Fort Carson, CO, and U.S. Army Environmental Command, Fort Sam Houston, TX. September 2012. Finding of No Significant Impact signed September 25, 2012.

Fort Gordon, 2014. *Environmental Assessment for a Solar Photovoltaic Generating Array System*. Prepared by U.S. Army Garrison Fort Gordon, GA and U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. September 2014. Finding of No Significant Impact signed November 10, 2014.

Fort Hood, 2014. *Environmental Assessment for Implementation of Solar Photovoltaic Renewable Energy Enhanced Use Lease at Fort Hood*. Prepared for U.S. Army Garrison Fort Hood, TX. Prepared by U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. October 2014. Finding of No Significant Impact signed November 21, 2014.

Fort Huachuca, 2010. *Programmatic Environmental Assessment – Renewable Energy Resources at Fort Huachuca, Arizona*. Prepared for U.S. Army Garrison Fort Huachuca, AZ. February 2010. Finding of No Significant Impact signed July 9, 2010.

Fort Huachuca, 2014. *Environmental Assessment – Construction of a Photovoltaic System on United States Army Garrison Fort Huachuca, Arizona*. Prepared for U.S. Army Garrison Fort Huachuca, AZ and U.S. Army Energy Initiatives Task Force, Arlington, VA. February 2014. Finding of No Significant Impact signed March 20, 2014.

Fort Stewart, 2014. *Final Environmental Assessment and Finding of No Significant Impact for Implementation of Solar Photovoltaic Generating Systems at Fort Stewart, Georgia*. Prepared for U.S. Army Garrison Fort Stewart, GA. July 2014. Finding of No Significant Impact signed July 21, 2014.

GroSolar, 2014. Email from Ryan Marlborough, Commercial Sales Analyst, GroSolar, White River Junction, VT. September 2014.

Ho, 2013. Ho, Clifford K. (Sandia National Laboratories). “Relieving a Glaring Problem.” *Solar Today*, p. 28. April 2013.

Hydrogenics, 2013. “Fuel Cell Megawatt Power Generation Platform” Datasheet. Hydrogenics Corporation, Mississauga, Ontario, Canada. December 2013. Available at: http://www.hydrogenics.com/docs/default-source/default-document-library/fuel-cell-megawatt-power-plant-platform.pdf?sfvrsn=0.

IEC, 2016. Solar Energy – Sun Tracking Configurations for Photovoltaic Production. Iowa Energy Center (IEC), Ames, IA. Accessed on February 17, 2016 at: http://www.iowaenergycenter.org/solar-calculator-tool/.

IEEE, 2016. 2017 *National Electrical Safety Code (NESC)*. IEEE Standards Association, Piscataway, NJ. August 2016.

LBNL, 2016. *Utility-Scale Solar 2015: An Empirical Analysis of Project Cot, Performance, and Pricing Trends in the United States*. U.S. Department of Energy, Lawrence Berkeley National Laboratory, Berkeley, California. August 2016. Available at: https://emp.lbl.gov/publications/utility-scale-solar-2015-empirical.

Lemoore, 2015. *Final Environmental Assessment for the Proposed Construction, Operation, and Decommissioning of a Solar Photovoltaic System at Naval Air Staion Lemoore, California*. Prepared for U.S. Department of the Navy, Naval Facilities Engineering Command Southwest, San Diego, CA. September 2015.

MDC, 2015. *Aurora Distributed Solar Project Environmental Assessment (In the Matter of the Site Permit Application for the 100 MW Aurora Distributed Solar Project at Multiple Facilities in Minnesota, Minnesota Public Utilities Commission Docket E6928/GS-14-515)*. Minnesota Department of Commerce (MDC), Saint Paul, MN. January 2015.

MSU, 2013. "Strategic Management of Invasive Species in the Northwest United States Workshop" 11-114 Fact Sheet. Center for Invasive Plant Management, Montana State University, Bozeman, MT. April 2, 2013. Available at: http://www.denix.osd.mil/nr/legacy/projectfactsheets/fact-sheets/11-114-fs/.

NABCEP, 2013. *NABCEP Photovoltaic (PV) Installer Resource Guide*, v.6. North American Board of Certified Energy Practitioners (NABCEP), NY. 2013.

NatureServe, 2008. "The Role of DoD Lands for Endangered Species Protection" 06-302 Fact Sheet. NatureServe, Arlington, VA. 2008. Available at: http://www.denix.osd.mil/nr/legacy/projectfactsheets/fact-sheets/06-302-fs/.

Navy, 2016. *Final Environmental Assessment for Construction and Operation of Solar Photovoltaic Systems at Multiple Installations in California*. U.S. Department of the Navy, Navy Region Southwest, San Diego County, CA. January 2016. Finding of No Significant Impact signed February 11, 2016.

Nellis AFB, 2011. *Final Environmental Assessment – Outgrant for Construction and Operation of a Solar Photovoltaic System in Area I, Nellis Air Force Base, Clark County, Nevada*. U.S. Air Force, Nellis Air Force Base, NV. March 2011. Finding of No Significant Impact signed March 13, 2011.

NEMA, 2000. *NEMA Standards Publication No. TR 1-1993 (R2000): Transformers, Regulators and Reactors*. 2000. National Electrical Manufacturers Association, Rosslyn, VA.

NOAA, 2014. *The National Coastal Zone Management Program* Fact Sheet. National Oceanic and Atmospheric Administration, Office for Coastal Management, Charleston, SC. 2014. Accessed on August 2, 2016 at: https://coast.noaa.gov/czm/media/czmfactsheet2014.pdf.

NPS, 1998. *National Register Bulletin: Guidelines for Evaluation and Documenting Traditional Cultural Properties*. Department of the Interior, National Park Service, Washington, D.C. 1998.

NPS, 2015. "How to Apply the National Register Criteria for Evaluation. How to Evaluate the Integrity of a Property." Department of the Interior, National Park Service, Washington, D.C. Accessed on November 11, 2015 at: http://www.nps.gov/nr/publications/bulletins/nrb15/nrb15_8.htm.

NRCS, 2015. "Hydric Soils Definition". U.S. Department of Agriculture, Natural Resources Conservation Service. Accessed on April 10, 2015 at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/pr/soils/?cid=nrcs141p2_037283.

NREL, 2008. *Supply Curves for Rooftop Solar PV-Generated Electricity for the United States*, Technical Report NREL/TP-6A0-44073. U.S. Department of Energy, National Renewable Energy Laboratory, Golden, Colorado. November 2008. Available at: http://www.nrel.gov/docs/fy09osti/44073.pdf.

NREL, 2009. "Photovoltaic Solar Resource of the United States" map. U.S. Department of Energy, National Renewable Energy Laboratory, Golden, Colorado . October 13, 2009. Available at: http://www.nrel.gov/gis/images/solar/national_photovoltaic_2009-01.jpg.

NREL, 2016. *Distributed Generation Renewable Energy Estimate of Costs*. U.S. Department of Energy, National Renewable Energy Laboratory, Golden, Colorado. February 2016. Accessed on June 10, 2016 at: http://www.nrel.gov/analysis/tech_lcoe_re_cost_est.html.

NTIA, 2014. *Manual of Regulations and Procedures for Federal Radio Frequency Management* (May 2014 Revision of the May 2013 Edition). U.S. Department of Commerce, National Telecommunications and Information Administration, Washington, D.C. June 24, 2014.

OEERE, 2013. Photovoltaic System Basics. Office of Energy Efficiency & Renewable Energy (OEERE). August 20, 2013. Available at: http://www.energy.gov/eere/energybasics/articles/photovoltaic-system-basics.

OEERE, 2015. Solar Energy Resource Center – Codes, Standards & Utility Policies. Office of Energy Efficiency & Renewable Energy. Accessed on May 20, 2015 at: http://energy.gov/node/807181/ask/question/question_11.

P.L. 107-118. Small Business Liability Relief and Brownfields Revitalization Act (the "Brownfields Law"). January 11, 2002.

P.L. 110-140. Energy Independence and Security Act of 2007.

P.L. 111-383, § 358. Study of Effects of New Construction of Obstructions on Military Installations and Operations.

Port Hueneme, 2015. *Final Environmental Assessment for Construction, Operation, and Maintenance of Solar Photovoltaic Systems at Naval Base Ventura County, Port Hueneme, California*. U.S. Department of Navy, Naval Facilities Engineering Command Southwest, San Diego, CA. June 2015. Finding of No Significant Impact signed August 13, 2015.

PRFTA, 2013. *Finding of No Significant Impact and Environmental Assessment for Implementation of Net Zero Energy Goals at Parks Reserve Forces Training Area*. Prepared for U.S. Army Garrison Fort Hunter-Liggett's Parks Reserve Forces Training Area, Dublin, CA. Prepared by U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. September 2013. Finding of No Significant Impact signed September 2013.

Sandia, 2015. "Solar Glare Hazard Analysis Tool Available for Download." Sandia National Laboratories, Albuquerque, NM. March 13, 2014. Available at: http://energy.sandia.gov/solar-glare-hazard-analysis-tool-available-for-download/.

SEIA, 2010. "Utility-Scale Solar Power - Responsible Water Resource Management." SEIA – Solar Energy Industries Association. March 18, 2010. Available at: http://www.seia.org/sites/default/files/wateruse11072011-120712145702-phpapp01_0.pdf.

SEIA, 2013. "Enlisting the Sun: Powering the U.S. Military with Solar Energy 2013." SEIA – Solar Energy Industries Association. May 17, 2013. Available at: http://www.seia.org/research-resources/enlisting-sun-powering-us-military-solar-energy-2013.

SEIA, 2016. "What's in a Megawatt? Calculating the Number of Homes Powered by Solar Energy." SEIA – Solar Energy Industries Association. Accessed on June 13, 2016 at: http://www.seia.org/policy/solar-technology/photovoltaic-solar-electric/whats-megawatt.

Sierra AD, 2014. *Finding of No Significant Impact and Environmental Assessment for Implementation of Net Zero Energy Goals at Sierra Army Depot.* Prepared for Sierra Army Depot, CA. Prepared by U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. December 2013. Finding of No Significant Impact signed February 4, 2014.

Slaughter, 2006. *Fundamentals of Photovoltaics for the Fire Service*. Rodney Slaughter, Training Consultant for the California Solar Energy Industries Association, Sacramento, CA and Sacramento Municipal Utility District, Sacramento, CA. September 2006. Available at: http://osfm.fire.ca.gov/training/pdf/photovoltaics/pvstudentmanual.pdf.

Small, 2011. Small, Mary. *CMG GardenNotes #331 – Plant Pathology*. Colorado Master Gardener[sm] Program, Colorado State University Extension. December 2011. Available at: http://www.ext.colostate.edu/mg/Gardennotes/331.pdf.

SNL, 2013. *Water Use and Supply Concerns for Utility-Scale Solar Projects in the Southwestern United States*, SAND2013-5238. Klise, Geoffrey T., et al. Sandia National Laboratories, Albuquerque, NM and Livermore, CA. July 2013. Available at: http://energy.sandia.gov/wp-content/gallery/uploads/SAND2013_5238.pdf.

Stein, et.al., 2008. Stein, Bruce A., et.al. "Federal Lands and Endangered Species: The Role of Military and Other Federal Lands in Sustaining Biodiversity." *BioScience* (vol. 58, no. 4, pp 339-347). April 2008.

SunPower, 2016. "The Solar Star Projects." SunPower Corporation, San Jose, California. Accessed on September 9, 2016 at: https://us.sunpower.com/utility-scale-solar-power-plants/solar-energy-projects/solar-star-projects/.

TSF, 2016. *2015 National Solar Jobs Census*. The Solar Foundation, Washington, D.C. February 2016. Available at: http://www.thesolarfoundation.org/national/.

USDI, 1992. *Classification of Wetlands and Deepwater Habitats of the United States*. U.S. Department of the Interior, Washington, D.C. 1992.

USFS, 2016. "Program Areas -- Spark Arrester Guides." U.S. Forest Service, National Technology & Development Center, San Dimas, CA. Accessed on September 8, 2016 at: http://www.fs.fed.us/t-d/programs/fire/spark_arrester_guides/index.htm.

USFWS, 2003. "Migratory Bird Permit Memorandum. Subject: Nest Destruction." U.S. Fish and Wildlife Service, Washington, D.C. April 15, 2003.

USFWS, 2007. *National Bald Eagle Management Guidelines*. U.S. Fish and Wildlife Service, Washington, D.C. May 2007. Available at: https://www.fws.gov/northeast/ecologicalservices/pdf/NationalBaldEagleManagementGuidelines.pdf.

USFWS, 2012. What is an Ecoysystem? U.S. Fish and Wildlife Service, Midwest Region, Fort Sneiling, MN. September 24, 2012. Accessed on June 1, 2015 at: http://www.fws.gov/midwest/EcosystemConservation/ecosystem.html.

USFWS, 2014. "Avian Mortality at Solar Energy Facilities in Southern California: A Preliminary Analysis." Prepared by Kagan, Rebecca A.; Viner, Tabith C.; Trail, Pepper W.; and Edgard O. Espinoza. U.S. Fish and Wildlife Service National Fish and Wildlife Forensics Laboratory. April 2014. Available at: http://alternativeenergy.procon.org/sourcefiles/avian-mortality-solar-energy-ivanpah-apr-2014.pdf.

USFWS, 2015. Birds of Conservation Concern. U.S. Fish and Wildlife Service, Washington, D.C. September 25, 2015. Accessed on October 12, 2016 at: https://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php.

Walston, et.al., 2016. "A preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States." *Renewable Energy* (vol. 92, pp 405-414). Walston Jr., Leroy J.; et.al. July 2016. Available at: http://www.sciencedirect.com/science/article/pii/S0960148116301422.

West Point, 2014. *United States Army Garrison West Point Net Zero Energy Installation Initiative Environmental Assessment and Finding of No Significant Action*. Prepared for U.S. Army Garrison West Point, NY and U.S. Army Environmental Command, Joint Base San Antonio – Fort Sam Houston, TX. February 2014. Finding of No Significant Impact signed February 21, 2014.

# 8.0 LIST OF PREPARERS

## 8.1 U.S. ARMY ENVIRONMENTAL COMMAND

Joint Base San Antonio – Fort Sam Houston, Texas

| Team Member and Contribution | Professional Discipline | Years Exp. |
|---|---|---|
| Pamela M. Klinger<br>Project Manager<br>Lead Author | Master of Planning<br>B.S., Geology | 24 |

| Reviewers and Area(s) of Specialty |
|---|
| ❖ Connie L. Barnett, Architectural Historian<br>❖ Heidi S. Brothers, NEPA Planner<br>❖ Thomas Bucci, Environmental Attorney<br>❖ Damon Cardenas, Environmental Technology Project Officer<br>❖ Lucas Cooksey, Wildlife Biologist<br>❖ John Doss, NEPA Project Officer<br>❖ Brett W. Downey, Environmental Attorney<br>❖ Mark Gettel, Environmental Engineer – Water Resources<br>❖ Paul Josephson, Environmental Engineer – Air Resources<br>❖ Vanessa Hinkle, NEPA Project Officer<br>❖ Karl Kleinbach, Archaeologist<br>❖ Cathy Kropp, Public Affairs Specialist<br>❖ Jason Lynch, Environmental Engineer – Hazardous Waste and Materiel<br>❖ William Miller, Entomologist<br>❖ Alberto Moreno, Forester<br>❖ Elisa Ortiz, Environmental Engineer – Water Resources<br>❖ Roger Paugh, NEPA Project Officer<br>❖ Nicole Sikula, Botanist<br>❖ Denean Summers, NEPA Project Officer<br>❖ Larry Zimmerman, Forester |

## 8.2 PACIFIC NORTHWEST NATIONAL LABORATORY

Richland, Washington

| Team Member and Contribution | Professional Discipline | Years Exp. |
|---|---|---|
| Jim Cabe<br>NEPA Consultant | Environmental Engineering<br>M.B.A., Engineering Management<br>B.S., Chemistry | 13 |
| Trevor Hardy<br>Grid and Energy Systems Consultant | Ph.D., Electrical Engineering<br>M.S., Electrical Engineering | 11 |
| Ann Miracle<br>NEPA Consultant | Environmental Risk Assessment<br>Ph.D., Molecular Genetics<br>M.S., Population Genetics | 15 |
| Tara O'Neil<br>NEPA Consultant | M.B.A.<br>B.A. Anthropology, emphasis on Archaeology | 23 |
| Karen Studarus<br>Grid and Energy Systems Consultant | Ph.D., Electrical Engineering<br>M.S., Electrical Engineering | 12 |

## 8.3 DEPARTMENT OF THE ARMY REVIEWERS

Army stakeholders were actively involved in the development of this PEA. Reviewers from the Army's stakeholder team came from Headquarters, Department of the Army (HQDA); Army Commands (ACOMs); and Direct Reporting Units (DRUs). Personnel from a few Army installations (not listed) also participated as reviewers.

| Organizations Represented |
|---|
| ❖ Office of Energy Initiatives under the ASA IE&E, HQDA<br>❖ Office of the Assistant Chief of Staff for Installation Management, HQDA<br>❖ G-3/5/7, HQDA<br>❖ Office of General Counsel, HQDA<br>❖ Office of the Judge Advocate General, HQDA<br>❖ U.S. Army Aeronautical Services Agency<br>❖ U.S. Army Forces Command<br>❖ U.S. Army Training and Doctrine Command<br>❖ U.S. Army Materiel Command<br>❖ U.S. Army Test and Evaluation Command<br>❖ U.S. Army Reserve Command<br>❖ U.S. Army Installation Management Command<br>❖ U.S. Army National Guard<br>❖ U.S. Army Corps of Engineers |

# Appendix A. ENVIRONMENTAL CHECKLIST FOR SOLAR PHOTOVOLTAIC PROJECT(S)

*(The following assumes this PEA results in a FNSI and the decision-maker selects all three action alternatives for implementation; however, the following does not pre-suppose the conclusion of this NEPA process.)*

To ensure compliance with the President's Council on Environmental Quality (CEQ) guidance (40 C.F.R. Parts 1500-1508) and the Army's National Environmental Policy Act (NEPA) regulation (32 C.F.R. Part 651), the below checklist supports referencing of the *Programmatic Environmental Assessment for Construction and Operation of Solar Photovoltaic Renewable Energy Projects on Army Installations* and the associated Finding of No Significant Impact (FNSI) for site-specific projects on Army installations. This programmatic environmental assessment (PEA) addresses solar photovoltaic (PV) systems, to include associated energy storage, microgrid infrastructure, and infrastructure to connect to the grid. The environmental checklist facilitates the consideration of environmental effects for proposed site-specific projects and provides a framework for identifying site-specific NEPA requirements.

"Installations" include active Army garrisons and installations, U.S. Army Reserve facilities, U.S. Army National Guard sites, and joint bases managed by the Department of the Army.

Use of the PEA assumes that installations are considering alternative renewable energy technologies and will analyze alternative technologies along with solar PV, or have determined that these alternative technologies are not feasible to meet that particular installation's need. Installations must carefully consider all reasonable alternatives, including other renewable energy technologies, to meet their particular needs.

Army installations tiering from the solar PV PEA and associated FNSI shall use this checklist to determine whether reliance on the PEA (and possibly other NEPA analyses and one or more Categorical Exclusions [CXs]) are appropriate, or whether additional NEPA analysis is needed for a specific proposed project.

If the installation can respond "no" to each of the statements in the checklist below, then no further NEPA analysis would appear to be required and the action likely qualifies for a Record of Environmental Consideration (REC).

If the installation checks "yes" for one or more resources, it can reconsider both the sites and layout of the project, or other mitigations, to see if the effect on the resource can be avoided and the answer changed to "no".

When a project qualifies for a REC, the installation REC should cite 32 C.F.R. § 651.12(a)(2) ("action is adequately covered within an existing EA or EIS") and name the solar PV PEA and FNSI. If the REC is also based on other environmental analyses and/or CXs under 32 C.F.R.

Part 651, the REC should name the other applicable analyses and associated FNSI or ROD and cite any applicable CX(s). The completed checklist should be attached to the installation's REC.

If careful application of this checklist to the proposed project at an installation requires a “yes” or “maybe” response to any checklist item, then additional environmental analysis may be required as part of an installation-level, site specific NEPA process. If, upon investigation of each “yes” and “maybe” response on the checklist, the installation determines that no further environmental analysis is required and that a REC is appropriate, documentation of the results of the investigation should be maintained with the REC and completed checklist.

If the installation concludes that additional NEPA analysis is necessary, 32 C.F.R. Part 651 requires it be prepared before any irreversible and irretrievable commitments of resources occur for the Proposed Action. The site-specific NEPA process should be streamlined by tiering off of the solar PV PEA, with the tiered document focused only on those resource areas where site-specific considerations require additional NEPA analysis of potential impacts. Within the tiered analysis (e.g., within an appendix), as it relates to resource areas for which no further analysis was needed, documentation should be included regarding the completed checklist and those “yes” and “maybe” investigations which concluded that a resource area did not need further analysis. as a result of the Proposed Action.

This checklist is to enable the identification of the documentation required to meet NEPA requirements. Requirements to comply with other federal and state environmental and/or energy laws and regulations are to be adhered to, as appropriate and applicable. These may include, for example, those requiring site-specific consultations with other federal, state, and Tribal governments and agencies (such as consultation under the Endangered Species Act or National Historic Preservation Act); completing NEPA-like requirements of the state, if any and if applicable; or complying with certain state requirements for systems proposed to be connected to an off-post power grid.

# Environmental Checklist for Solar Photovoltaic Project

*[Insert description of installation's Proposed Action to include location(s) and installation name, size of solar PV array(s), energy storage system(s) and microgrid infrastructure; details on the connection to the electrical grid; construction requirements; and proposed dates.]*

***a. Land Use***

1. Construction of the proposed project, to include associated infrastructure, if any, on the installation is in conflict with the real property master plan and/or range complex master plan. NO / MAYBE / YES

***b. Air Quality***

2. Construction activities associated with the proposed project would contribute to a change in the air quality compliance status in the region (e.g., from attainment to nonattainment). NO / MAYBE / YES

***c. Noise***

3. Noise generated during construction of the proposed project would have a significant negative impact on sensitive noise receptors (e.g., residential areas, hospitals, and schools) and/or sensitive wildlife populations, to include threatened and endangered species. NO / MAYBE / YES

***d. Geological and Soil Resources***

4. Construction of the proposed project is anticipated to include construction activities on highly erodible soils. NO / MAYBE / YES

5. Construction of the proposed project is to be done on a closed landfill, Installation Restoration Program (IRP), Military Munitions Response Program (MMRP), or Compliance Cleanup (CC) site and would cause significant soil contamination or violate regulations. NO / MAYBE / YES

***e. Water Resources***

6. Construction, operation, or maintenance of the proposed project would result in unpermitted direct impacts to waters of the U.S., regulated recharge zones, and/or groundwater aquifers. NO / MAYBE / YES

7. Construction of the proposed project is anticipated to include construction activities on jurisdictional wetlands or require additional surveys to identify and delineate jurisdictional wetlands (same as Q14 below). NO / MAYBE / YES

8. Construction of the proposed project is anticipated to affect a coastal zone regulated by the Coastal Zone Management Act (CZMA), requiring a CZMA consistency evaluation that has not yet been completed. NO / MAYBE / YES

9. Construction of the proposed project, to include associated infrastructure, if any, would require substantial modification of the installation's storm water discharge prevention plan. NO / MAYBE / YES

10. Potable water availability at the installation is dependent on groundwater that is currently stretched to or beyond its capacity, and brackish or salt water intrusion is currently a problem. NO / MAYBE / YES

11. Construction is proposed to be done on a closed landfill, IRP, MMRP, or CC site and would cause significant surface water or groundwater contamination or violate regulations. NO / MAYBE / YES

### *f. Biological Resources (including Threatened and Endangered Species)*

12. Construction, operation, or maintenance of the proposed project is likely to result in an unauthorized "take" of a protected species (e.g., under the Endangered Species Act, Migratory Bird Treaty Act, Marine Mammal Protection Act, or Bald and Golden Eagle Protection Act) and/or construction activity is anticipated to effect critical habitat, as designated by the U.S. Fish and Wildlife Service under the Endangered Species Act. (Note: All required USFWS or NMFS informal or formal consultation must be completed prior to commencing with the proposed project.) NO / MAYBE / YES

13. Construction, operation, or maintenance of the proposed project is likely to result in an unauthorized "take" of a state-protected species and the installation is required to comply with the associated legal and regulatory requirements of the state. NO / MAYBE / YES

14. Construction of the proposed project is anticipated to include construction activities on jurisdictional wetlands or require additional surveys to identify and delineate jurisdictional wetlands (same as Q7 above). NO / MAYBE / YES

15. Construction of the proposed project is located in whole or in part within a floodplain and must undergo the process outlined in Executive Order 11988, as amended by Executive Order 13690, possibly resulting in a Finding of No Practicable Alternative. NO / MAYBE / YES

16. Construction of the proposed project is anticipated to include construction activities in biological sensitive areas other than those mentioned above. NO / MAYBE / YES

17. All or part of the proposed construction area needs to be surveyed for one or more protected species, such as threatened or endangered species protected under the Endangered Species Act (a YES means that the appropriate biological resource survey does not exist for all or part of the construction area). NO / MAYBE / YES

18. Construction of the proposed project would cause a substantial decrease in the relative percentage of any one vegetation type (native to the region) within the installation, particularly if the vegetation type in the region is already highly fragmented as a result of human activity. NO / MAYBE / YES

### *g. Cultural Resources*

19. All or part of the proposed construction area needs to be surveyed for cultural resources (a YES means that a cultural resources survey does not exist for all or part of the construction area). NO / MAYBE / YES

20. Construction of the proposed project is anticipated to have adverse effects on National Historic Preservation Act (NRHP)-listed and/or -eligible historic properties and those effects are unlikely to be able to be avoided or mitigated. (Note: All required NHPA Section 106 consultation with SHPO, ACHP, Tribes, and other interested parties must be completed prior to commencing with the proposed project.) NO / MAYBE / YES

21. Construction, operation, or maintenance of the proposed project will prevent the traditional use of sacred or ceremonial sites or resources by Federally-recognized Native Americans, Alaska Natives, or Native Hawaiians. (Note: All required NHPA Section 106 consultation with SHPO, ACHP, Tribes, and other interested parties must be completed prior to commencing with the proposed project.) NO / MAYBE / YES

### *h. Socioeconomics*

22. Construction of the proposed project is anticipated to result in substantial loss or displacement of recreational opportunities and resources (e.g., hunting and fishing) relative to the baseline. NO / MAYBE / YES

23. Only one or two of all the residential areas bordering the installation are primarily occupied by low income and/or minority populations, and the site of the proposed project is adjacent or in close proximity to that low income / minority population area. NO / MAYBE / YES

### *i. Transportation and Traffic*

24. Construction of the proposed project would require large construction and delivery vehicles to traverse poorly rated roads (e.g., Level of Service E or F) and intersections during peak usage times, or would degrade existing roads to Level of Service E or F. NO / MAYBE / YES

### *j. Airspace*

25. The glint/glare report on the proposed project indicates a likely significantly negative impact on air operations at or near the installation. NO / MAYBE / YES

### *k. Utilities*

26. The proposed project is designed so that it is not compatible with the existing nearby electrical grid system or is located such that there is no use for the generated electricity. NO / MAYBE / YES

27. Construction of the proposed project would sever the provision of utilities (electricity, natural gas, water, telecommunication service, wastewater management services, solid waste management service (non-hazardous), and other essentials), to local communities, homes, and businesses for durations that would affect health, welfare, and economic viability. NO / MAYBE / YES

### *l. Hazardous and Toxic Material and Waste*

28. Construction is proposed on a closed landfill, Installation Restoration Program, Military Munitions Response Program or Compliance Cleanup site and would cause contamination or violate a Federal Facility Agreement, permit, and/or regulation. NO / MAYBE / YES

29. The installation would need to build, or significantly modify, facilities necessary to store waste petroleum, oil, and lubricant products associated with the construction, operation, and maintenance of the proposed project, in accordance with local/state/federal regulations. NO / MAYBE / YES

30. Construction of the proposed project would require substantial modification for the installation's Spill Prevention, Control and Countermeasures Plan. NO / MAYBE / YES

### *m. Human Health and Safety*

31. Construction, operation, or maintenance of the proposed solar PV project would require substantial modification of the installation's health and safety plan. NO / MAYBE / YES

32. The addition of roof-top mounted solar PV modules requires substantial structure re-design to enable the structure to safely support the additional load.
NO / MAYBE / YES

***n. General***

33. The installation (e.g., some ARNG installations) or the solar PV system operator is required to comply with state-level NEPA-like requirements and those requirements include analysis of topics not addressed in the PEA. NO / MAYBE / YES

***o. Cumulative Effects***

34. Other actions are underway, or proposed, that when combined with the potential effects of construction, operation, and maintenance of the proposed project, could have a significant cumulative effect on human health or the environment. NO / MAYBE / YES